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Investigating critical success factors (CSFs) for implementation of supply chain information systems and video technology in warehouse operations

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Abstract

Supply chains are increasingly recognised as a critical force in the business environment. Strong competition is forcing companies to constantly renew their products, services and business processes. It is important to ensure quick information sharing within the organisation, enabling modelling of the whole supply chain. Supply chain information systems (SCIS) can help to integrate business partners and business systems, creating efficiency and agility. The use of video technology, a tool within SCIS, is also increasingly interesting, as it enables tracking and tracing of goods along the product flows. In this light, a global network camera producer, Axis Communications, is interested in implementing video technology in the shape of a Visual Goods Tracking (VGT) Solution in their warehouses. However, it is difficult to succeed with SCIS implementations and the failure rate is high. Furthermore, little is known about how to successfully implement video technology in a warehouse, why it is interesting to investigate these topics further. The purpose with this thesis is therefore to investigate critical success factors (CSFs) when implementing SCISs in warehouse operations and how these factors can contribute to overcome barriers that prevent implementation of video technology in warehouse operations. This purpose is addressed through a literature review and two consecutive empirical studies, performed during the Spring of 2016. First, a literature review was conducted with the purpose of identifying CSFs for the implementation of SCIS. The review was followed by the first empirical study containing a qualitative part; an interview study, and a quantitative part; a survey. Six practitioners with experience from SCIS implementations were interviewed in order to gain a deeper understanding of the CSFs. By conducting a survey, where respondents graded the criticality of each identified CSF, the results from the literature review and the interview study were validated. The results generated a list of eight CSFs: Communicate effectively; Manage change; Establish sufficient resources and competences; Manage people and culture; Assure top management support; Create a clear vision and build a business case; Educate and train and Chose the right vendor and system. The second empirical study was an in-depth single case study performed at one of Axis' warehouses and studied a SCIS implementation in real-time. The single case study generated a final design, an implementation plan and a business case for a VGT-solution. The combined knowledge from the literature review and the two empirical studies provided a strong basis for conclusions regarding CSFs for video technology implementation and how to overcome existing barriers when implementing video technology in warehouses. This thesis has created an understanding of how to succeed with implementations of SCIS and video technology in warehouses. It has been achieved through strong validation, rigor and trustworthiness. Further research should move beyond identifying the CSFs and study how to apply these identified CSFs.

Keywords: critical success factors, supply chain information systems, warehousing, video technology, visual goods tracking, barriers, implementation

Sammanfattning

Leveranskedjor blir allt oftare erkända som ett kritiskt element i affärsvärlden. Stor konkurrens tvingar företag att konstant uppdatera sina produkter, tjänster och processer. Det är viktigt att säkerställa snabb informationsdelning inom organisationen, vilket möjliggör modellering av hela leveranskedjan. Användningen av leveranskedjeinformationssystem (SCIS) hjälper till att integrera affärspartners och affärssystem, vilket skapar effektivitet och smidighet. Användandet av videoteknologi, ett verktyg inom SCIS, blir också allt mer intressant då det möjliggör spårning av och sökning efter produkter. I detta ljus är Axis Communications, en global leverantör av nätverkskameror, intresserade av att implementera videoteknologi, i form av en visuell produktspårnings-lösning (VGT), på sitt lager. Kunskapen är idag begränsad i hur man på ett framgångsrikt sätt implementerar video teknologi på ett lager varför det är intressant att utforska ämnet vidare. Syftet med uppsatsen är således att utforska kritiska framgångsfaktorer (CSF) vid implementeringen av SCIS i lager och hur dessa faktorer kan bidra till att överkomma barriärer som hindrar implementeringen av video teknologi i lager. Detta syfte adresseras av en litteraturstudie och två på varandra följande empiriska studier, utförda under våren 2016. Först genomfördes en litteraturstudie med syfte att identifiera CSFer för implementering av SCIS. Detta följdes av den första empiriska studien bestående av en kvalitativ del; en intervjustudie, och en kvantitativ del; en survey. Sex deltagare med erfarenhet från SCIS implementeringar intervjuades för att skapa djupare förståelse för CSFerna. Resultatet från litteraturstudien och intervjustudien validerades sedan genom att utföra en survey där svarande fick gradera varje identifierad CSFs kriticitet. Resultaten genererade en lista av åtta CSFer: Kommunicera effektivt; Hantera förändring; Säkerställ tillräckliga resurser och kompetenser; Hantera människor och kultur; Försäkra support från högsta ledningen; Skapa en vision och bygg ett business case; Utbilda och träna samt Välj rätt leverantör och system. Den andra empiriska studien var en djupgående singel-fallstudie utförd på ett av Axis lager och studerade en SCIS implementering i realtid. Studien genererade en slutlig design, implementeringsplan och ett business case för en VGT-lösning. Den kombinerade kunskapen från litteraturstudien och de båda empiriska studierna utgjorde en stark bas för slutsatser angående CSFer för videoteknologi och hur barriärer kan överkommas vid implementering av videoteknologi i ett lager. Denna uppsats har skapat en förståelse för hur man skall lyckas med implementering av SCIS och videoteknologi i ett laget. Detta uppnåddes genom stark validering och trovärdighet. Framtida forskning borde vidare studera hur man uppnår de identifierade CSFerna och inte stanna vid endast identifiering av CSFer.

Nyckelord: kritiska framgångsfaktorer, leveranskedje-informationssystem, lager, video teknologi, visuell produktspårning, barriärer, implementering

Acknowledgements

When we started our master's thesis we knew little about how to conduct research and how to develop a trustworthy study. Today, we feel much more confident and we have learned so much along the way. It has been an inspiring journey and the perfect closure of our Master of Science in Industrial Engineering and Management.

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Fredrik Luttropp and Philip Åhlin

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1. Introduction

1.1 Background

Supply chains should ensure reliable and timely deliveries all the way from the supplier to the customer and are increasingly recognised as a critical and competitive force in the business environment (Hinkka *et al.*, 2015; Melnyk *et al.*, 2014). A leading supply chain research organisation (AMR) stated that the 25 companies with the most successful supply chains in 2008 had an average return of 17,89% compared to the industry average of 6,43% (Melnyk *et al.*, 2014). The competitive environment is quickly changing and in order to stay abreast with competition companies constantly have to renew their products, services and business processes. They need to focus on new technologies to gather and manage data in order to support their strategies, plans and decisions (Yüksel & Yüksel, 2011). The increasing complexity puts stronger emphasis on the development of location and identification technologies in order to increase control of logistics and transportation (Shamsuzzoha & Helo, 2012). The main driver is called visibility; to have a traceable and trackable supply chain. This is a challenging task as visibility often disappears when information is transferred between enterprises, over geographical areas or through information systems, often referred to as supply chain information systems (SCIS) (Musa *et al.*, 2013; Denolf *et al.*, 2015). Examples of SCIS that have appeared over the recent years are Enterprise Resource Planning (ERP), Electronic Data Interchange (EDI), Warehouse Management System (WMS) and Radio Frequency Identification (RFID). These information systems help to integrate business partners and systems, creating efficiency and agility (Shuang & Shaw, 2008; Faber *et al.*, 2013). The systems enable quick channels of information, which will allow modelling of the whole supply chain (Legutko *et al.*, 2012).

There is a need for tracking systems to link the physical reality with information systems in order to increase documentation and reliability. There is also a great need to reduce paperwork and manual handling and instead use more accurate information systems (Hinkka *et al*., 2013). Efficient tracking of goods is supposed to reduce costs, increase the speed of deliveries and making it possible to identify bottlenecks along the material flow. The decrease of cargo thefts has also been mentioned as an important reason to track products. This is specifically important for shipments carrying high value goods or important cargo (Oliviera *et al.*, 2015). Even though the evidence is clear that many companies could benefit from the use of tracking, to reduce delivery errors, it is scarcely used and mainly by high volume global industries (Shamsuzzoha & Helo, 2012). Axis Communications is a company that is in need of more efficient tracking of products. They have experienced numerous claims from customers due to delivery discrepancies, especially at their distribution centres in the United States. Axis believes that the problems occur at the customer's sites when the product is no longer in Axis' possession. They need a better way to monitor and document their internal processes in their warehouse in order to either prove for the customer that they have delivered what was promised or to understand where in the process errors have occurred. Visual Goods Tracking (VGT) Solutions belongs to the family of SCIS and is a type of video technology that enables tracking of products. Implementing a VGT-solution at Axis' distribution centres could possibly reduce costs due to customer claims and at the same time increase the service level. However, it is difficult to succeed with SCIS implementations and the failure rate is high (Denolf *et al.*, 2015).

1.2 Purpose and RQ

Considering what is emphasised in the background above, the purpose of this thesis is *to investigate critical success factors when implementing supply chain information systems in warehouse operations and how these factors can contribute to overcome barriers that prevent implementation of video technology in warehouse operations.* The research was therefore built around the two following research questions:

RQ1: How can a SCIS implementation become successful and how critical are the success factors in general?

The first research question marks the starting point of the research. The aim of the first part of the question is to identify and understand existing CSFs when implementing SCIS. The second part of the research question aims to further investigate the general relevance of the identified success factors. Through a literature review an initial list of CSFs was created. The question was then addressed by a study including two empirical methods; an interview study and a survey. The purpose of the interview study was to gain deeper understanding of the identified CSFs. The survey examined the opinion of a large population and enabled insights regarding the general criticality of the identified CSFs. The survey also enabled a reduction of CSFs from the list of identified CSFs.

RQ2: How can existing barriers be overcome when implementing video technology in warehouse operations?

This question partly builds upon the findings of the master's thesis conducted by Danielsson and Smajli (2015), that investigated how video technology can improve warehouse operations and how barriers prevent implementation. Visual Goods Tracking was identified as one solution using video technology to improve warehouse operations, which Axis, a collaborating partner, consider to be a technology they could benefit from. The second research question also builds on the first research question and is addressed by the single case study performed at Axis. The combined knowledge from the single case study and the previous study provided a strong basis for conclusions regarding CSFs for video technology and how to overcome existing barriers when implementing video technology in warehouses. A visualization of the RQs is shown in figure 1 and an overview of the connection between the RQs and related studies is presented in table 1.

Figure 1: Visualisation of the RQs

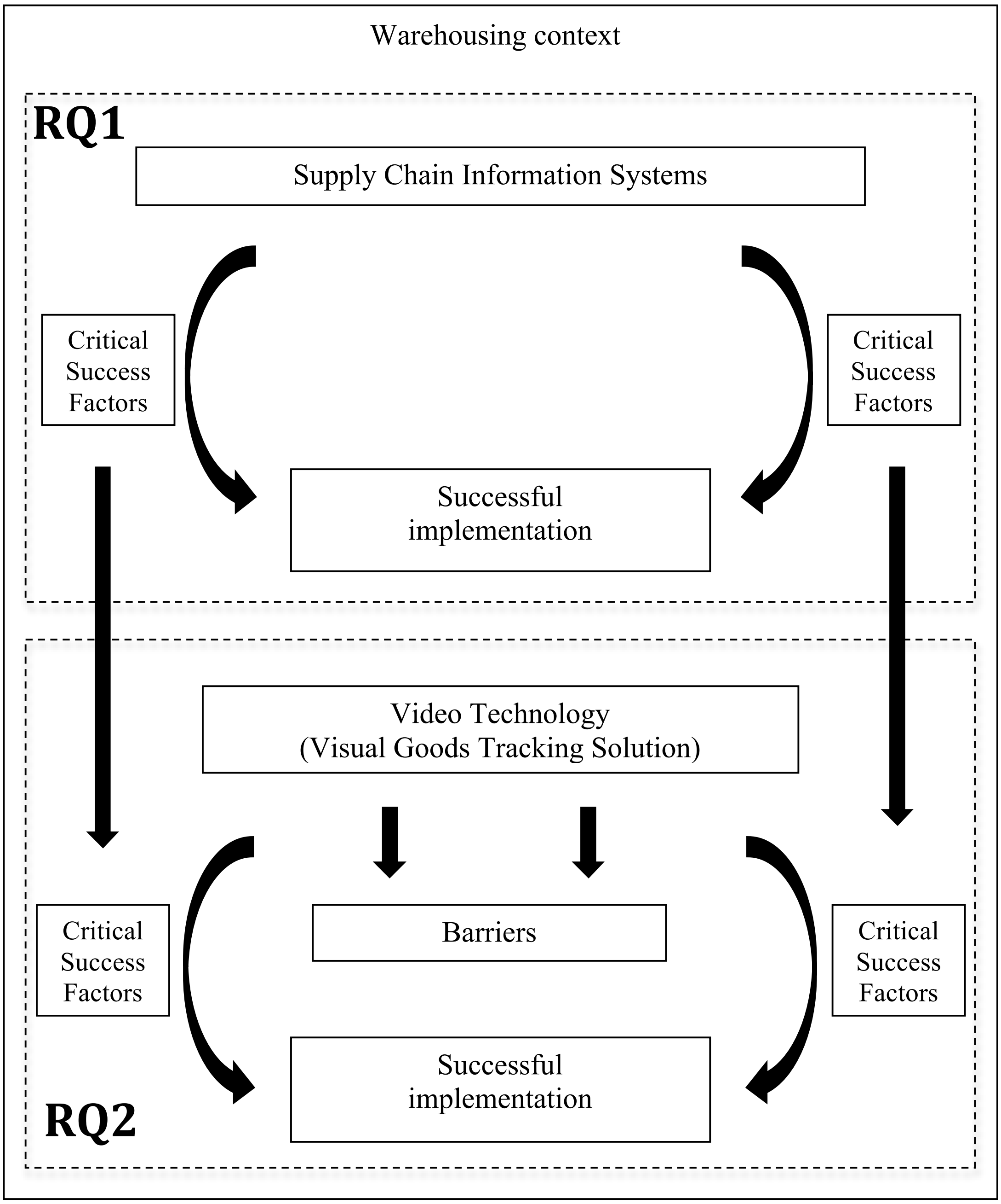


Table 1: Connecting research question with methods

RQ	Description	Literature review	Interview study	Survey	Single case study
1	How can a SCIS implementation become successful and how critical are the success factors in general?	X	X	X	
2	How can existing barrier be overcome when implementing video technology in warehouse operations?	X	X	X	X

1.3 Delimitations

In order to limit the scope of the research a number of delimitations were set. The research had to be efficient in order to reach strong conclusions within a time frame of 20 weeks. A number of pre-defined conditions were set by Axis, which also limited the scope of the thesis. The search for CSFs is limited to only consider the identification and interpretation as well as examining the relevance of the CSFs. The research will not investigate how to apply the CSFs or who should be responsible for applying them. Theory on how to apply CSFs is scarce and such an investigation would require an extensive qualitative research (Denolf *et al.*, 2015). The research on SCIS CSFs only concerns systems used in warehouses. It is limited to ERP-systems, WMS, EDI and RFID, as these are the most common systems in the warehousing context (Shuang & Shaw, 2008; Faber *et al.*, 2013). To reduce the travel time the participants in the interview study have to work within the geographical region Skåne. The single case study performed at Axis will only examine how a VGT-solution can be implemented by considering the warehousing processes from picking to shipping. The delivery discrepancies can be derived from these processes. Based on a request from Axis the solution will also only evaluate quantity and not quality. When studying the processes at Axis, the internal claim or customer service procedures will not be considered as this does not affect the design of the final solution. The provided recommendations will only consider implementation of the solution at one of Axis configuration and logistics centres, CLC1, as this is the only CLC that we have access to.

1.4 Structure of thesis

This thesis includes a literature review, followed by two consecutive studies examining CSFs for SCIS and video technology. First, the methodology behind the studies is presented, beginning with describing the research strategy. The methodology chapter then continues with describing the research design and how the studies of the thesis are contributing to answering the research questions. Finally, the quality of the research is discussed. The next chapter, frame of reference, first gives an introduction to the modern warehouse, followed by theory on supply chain information systems. Barriers are then identified for the implementation of video technology in a warehouse based on the findings of Danielsson & Smajli (2015). Finally, a literature review on SCIS CSFs is presented. The following two chapters present the two studies with purpose, findings, analysis and conclusions. Chapter six is a discussion chapter, elaborating on the results from the studies. The chapter includes a discussion on contributions to research and practice and suggestions for further research.

2. Methodology

The methodology chapter begins with presenting and motivating the overall structure and design of the research as well as other choices made regarding research strategy. This is followed by a description of the design for each of the four methods together with relevant theory for each chosen method. The chapter ends with a discussion on the research quality considering validity and reliability.

2.1 Research strategy

2.1.1 Multiple methods

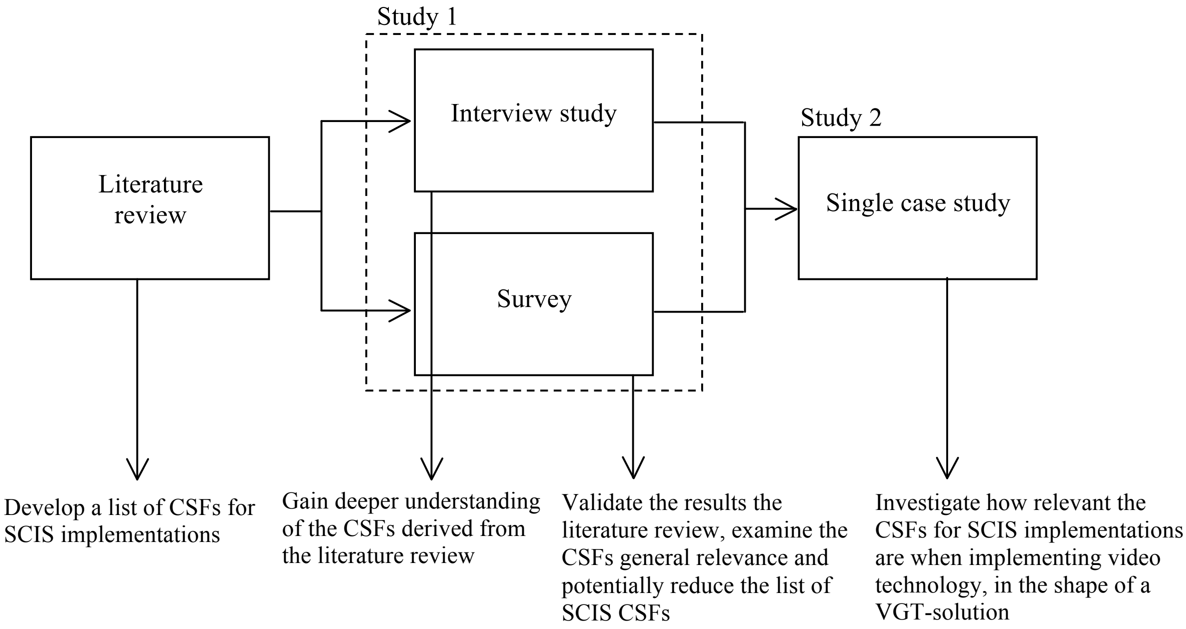
Much of the existing research on CSFs is limited to the identification of the CSFs. Only few researchers go beyond the identification to examine the relevance of the factors in general. Although many different methods has been used not much CSF research has been conducted using a combination of qualitative and quantitative methods (Remus & Wiener**,** 2010**)**. However, the interest to use a combination of the two, so called mixed- and multimethod designs, is increasing. Multiple projects are interrelated within a broad topic and together they contribute to answering the research question(s). There are several advantages in using this kind of design. The main advantage is the triangulation, where the data is validated by combining the methods. Another advantage is that the design contributes to creativity through discovering new or paradoxical aspects that inspire to further research. A third advantage is the expansion of the scope of the research. Using both qualitative and quantitative methods may result in a more complete picture of the studied topic (Esteves & Pastor, 2003).

In the literature the nomenclature of the different designs is often interchangeable. The terms “mixed method” design, “multimethod” design and “multiple method” design are all commonly used for describing similar designs (Esteves & Pastor, 2003). Tashakkori and Teddlie (2003, p. 11) define multiple methods as *“research in which more than one method or more than one worldview is used”*. Esteves and Pastor (2003) describe two designs using multiple methods. The first is called mixed methods design. This design incorporates both qualitative and quantitative methods within a project. Several methods can be supplemental to one major or a core method. Clues or new insights from the supplemental methods can be followed up in the core method. The other design is called multimethod design. The researcher then conducts several methods, each one complete in itself. The results are then triangulated (Esteves & Pastor 2003). Morse (2003) claims that the major difference between the two designs is that within a multimethod design each project is completed in itself. The result from one project can be used in the next project. Morse (2003) claims that there are simultaneous and sequential designs within multimethod designs.

Combining simultaneous and sequential multimethod design to answer RQs

To build enough understanding to answer the RQs a combination of simultaneous and sequential multimethod design was used. The research started with a literature review followed by two consecutive studies, incorporating three different empirical methods. Each study and method was completed in itself. The two studies followed each other and the second study built on the knowledge from the first one. The first study aimed to answer RQ1 and the second RQ2. Three qualitative methods were performed: a literature review; an interview study and a single case study. One quantitative study was performed: a survey. The first study incorporated a simultaneous performance of the interview study and the survey. The second study included a single case study. Together these methods lead us to conclusions that would not have been possible with the use of only one study or method. However, the complexity of the research design is of course increasing with several studies using different methods. Therefore, it is important that the design is thoroughly motivated. The reader should understand why these methods were chosen and how the methods contributed to answering the RQs. The overall structure of the research together with the purpose of each method is visualised in figure 2 below.

Figure 2: Visualisation of the two consecutive studies and the four methods



2.1.2 Case study research

To be able to answer the RQs it is important to conduct suitable research. A good start is to base the research on the type of research questions (Yin, 2009). If the research question possesses a "how" or a "why", performing a case study could be a good approach. As both of the research questions starts with "how", case study research was regarded as a suitable research strategy. Another argument for using case study research is that the research was theory-building and contributed to new theory within CSF research. Theory-building research needs primary data to build on, which makes case studies a good choice (Voss *et al.*, 2002). RQ1 was partly addressed through an interview study, not a case study. However, the two types of studies have similarities. For example, the data collection is similar, as a case study often incorporates data collection through interviews (Yin, 2009; Eisenhardt, 1989; Meredith, 1998). Several theories for case study research were therefore adopted when designing the interview study.

A case study is described as a history of a current or past phenomenon that has been drawn from multiple evidence, and is regarded as one of the most powerful research methods to develop new theory (Voss *et al.*, 2002). A case study typically combines data collection methods such as interviews, observations, and archive analysis, where the evidence is most often qualitative but can also be quantitative (Eisenhardt, 1989; Meredith, 1998). The case study allows investigators to understand meaningful and holistic characteristics of real-life events, such as organizational and managerial processes (Yin, 2009). Yin (2009) suggests that one strength of conducting a case study is that the study is based on real-time observations and phenomena studied in its natural settings. It also allows for exploratory depth.

One general divide considering case studies concern the use of single or multiple case studies, where a multiple case study covers multiple cases, which makes it possible to draw so called “cross-case” conclusions. The evidence from a multiple case study is regarded as more robust compared to a single case study. A single case study is on the other hand regarded as better if it is supposed to consider more rare or critical cases. A single case study also requires fewer resources and usually takes less time to conduct compared to a multiple case study (Yin, 2009). If choosing a single case study the generalisability becomes limited, as there is a risk of misjudging single events and exaggerating easily accessible data. Using multiple case studies where a comparison between cases can be performed can mitigate these problems. Single case studies can be divided into five different types, seen in table 2. The single case study can be “critical”, “common”, “unusual”, “revelatory” or “longitudinal” (Voss *et al.*, 2002).

Table 2: Single case study types (Yin, 2009)

Type of sinlge case study characteristics	
Critical	The case study is critical to theory and is preferable used to decide whether propositions are correct or not
Common	To provide insights on theoretical interest the case can capture the circumstances of an "every day situation"
Unusual	The case study is representing an unusual deviation from theoretical standards
Revelatory	The researcher can study a peviously inaccessible phenomenon
Longitudinal	The very same case will be studied at two more points in time

2.1.3 Survey research

A survey is a research method that is used when answering RQs starting with "who", "what", "where", or "how much" (Yin, 2009). The second part of RQ1 incorporates a "how critical", which is a type of "how much". Therefore, the use of a survey was also regarded as a suitable method for the research. Lekvall and Wahlbin (2007) describe that a survey aims to gather data to answer specific question formulations, which is usually accomplished by briefly comparing a larger amount of cases. The results are most often presented quantitatively, in charts or diagrams, which requires the same questions to be asked to all respondents. The survey also tries to build knowledge not just about the participants but also an underlying target population that the participants represent. To reach out to the whole target population would simply not be possible. Instead the researcher has to make a selection of the population who are then asked to participate in the survey. As RQ1 investigates the general criticality of the CSFs the generalizability of the results from survey research was highly desirable. How accurate conclusions the researcher is able to draw depends on selection size, selection procedure and loss of participants in the selection. To evaluate how strong the inference is between the results and the target population is very difficult. It is the researcher's task to try to minimize the risks of a weak inference, by conducting the survey in the best possible way (Lekvall & Wahlbin, 2007).

2.1.4 Purpose of the studies

Considering what was emphasised above, case study research and survey search was regarded as the most suitable research to answer the RQs. Furthermore, an extensive literature review is important as it is essential to understand prior theory within the studied topic (Randolph, 2009). Each method had a purpose of contributing to answering one or both of the RQs. The purpose of the literature review was to develop a list of CSFs. This list became the basis for further research. By conducting an interview study with six experts we gained deeper understanding of the derived CSFs. The interview study investigated the views of practitioners who are or have been involved in SCIS implementations. Simultaneously, we conducted a survey, where the results from the literature review were validated. The survey also contributed to insights regarding the CSFs general relevance and the ones that were not considered critical were removed from the list of CSFs. From the first study we were able to draw conclusions from both qualitative and quantitative data. This enabled us to discover the topic in depth as well as from a broad perspective. The last study included a single case study, investigating how relevant the CSFs for SCIS implementations are when implementing video technology, in the shape of a VGT-solution. We combined the obtained knowledge from the two studies and identified CSFs for a VGT-implementation. Before conducting the literature review, barriers preventing implementations of video technology had been identified. The CSFs that were considered relevant for the VGT-implementation and thus also for video technology were connected to the identified barriers in a final framework. The following chapter will describe the design of each performed method.

2.2 Research design

2.2.1 Literature review

An extensive literature review is important. Randolph (2009, p.1) explains that *"if the literature review is flawed, the remainder of the thesis may also be viewed as flawed, because a researcher cannot perform significant research without first understanding the literature in the field"*. The review examined CSFs for implementations of SCIS. Articles were chosen using a rigorous screening and selection process. All articles were peer-reviewed and found in LubSearch, using three keywords. As there was remarkably more research found on CSFs for ERP-implementations than for other information systems, the search criteria changed between the articles. For ERP articles only one combination of keywords was used: [enterprise resource planning, critical success factors, implementation]. The rigorous prior research on ERP provided the opportunity to only include new and relevant theory. The abstracts of articles that had a relevant title and an impact factor above 1 were read. Among the articles that were found relevant the most cited article per year, from 2012 to 2016, was chosen. See table 3, below, for the selection of ERP-articles.

Table 3: Selection of ERP-articles

Initial requirements	Peer-reviewed Available in LubSearch Impact factor > 1
Keyword used in database search	[enterprise resource planning, critical success factors, implementation]
Year	2012-2016
Selection criteria	Relevant CSF research on ERP implementations Most cited article in published year among relevant articles
Number of articles selected	5

For articles concerning other information systems we did not use the same screening process. In order to extend the article search we included articles published between the years 2000 to 2016. The combinations of keywords used were: [global information systems, success factors, implementing]; [supply chain management systems, critical success factors, implementing]; [rfid, success factors, implementation]; [rfid, success]; [rfid, critical success factors, implementing]; [edi, success factors, analysis]. The abstracts of articles that had a relevant title and an impact factor above 0.5 were read. Articles with the highest relevance, most citations and presence in a journal with a high impact factor were chosen. This resulted in an additional amount of 6 articles. Together with the articles concerning ERP-systems a total of 11 articles were included in the literature review. See table 4, below, for the selection of SCIS-articles and table 5 for an example of the articles chosen for the literature review. As suggested by Randolph (2009) a spreadsheet was used to document the extracted data, the CSFs, from the reviewed articles. The data was then analysed and factors relating to each other created CSF subcategories. In turn, these subcategories created more general categories of CSFs.

Table 4: Selection of other SCIS-articles

Initial requirements	Peer-reviewed Available in LubSearch Impact factor > 0.5
Keyword used in database search	[global information systems, success factors, implementing]; [supply chain management systems, critical success factors, implementing]; [rfid, success factors, implementation]; [rfid, success]; [rfid, critical success factors, implementing]; [edi, success factors, analysis]
Year	2000-2016
Selection criteria	Relevant CSF research on SCIS implementations
Number of articles selected	6

Table 5: Example of articles in the literature review

Author	Year	Title	Citations	Journal	Impact factor
Ram *et al.*	2013	Implementation Critical Success Factors (CSFs) for ERP: Do they contribute to implement success and post-implementation performance?	77	I. J. of Production Economics	2.379
Ram & Corkindale	2014	How critical are the critical success factors (CSFs)? Examining the role for CSFs for ERP	19	Business Process Management Journal	2.185
Yao *et al.*	2012	The Adoption and Implementation of RFID Technologies in Healthcare: A literature review	95	J. of Medical Systems	2.213

2.2.2 Study 1: Interview study and survey

Interview study

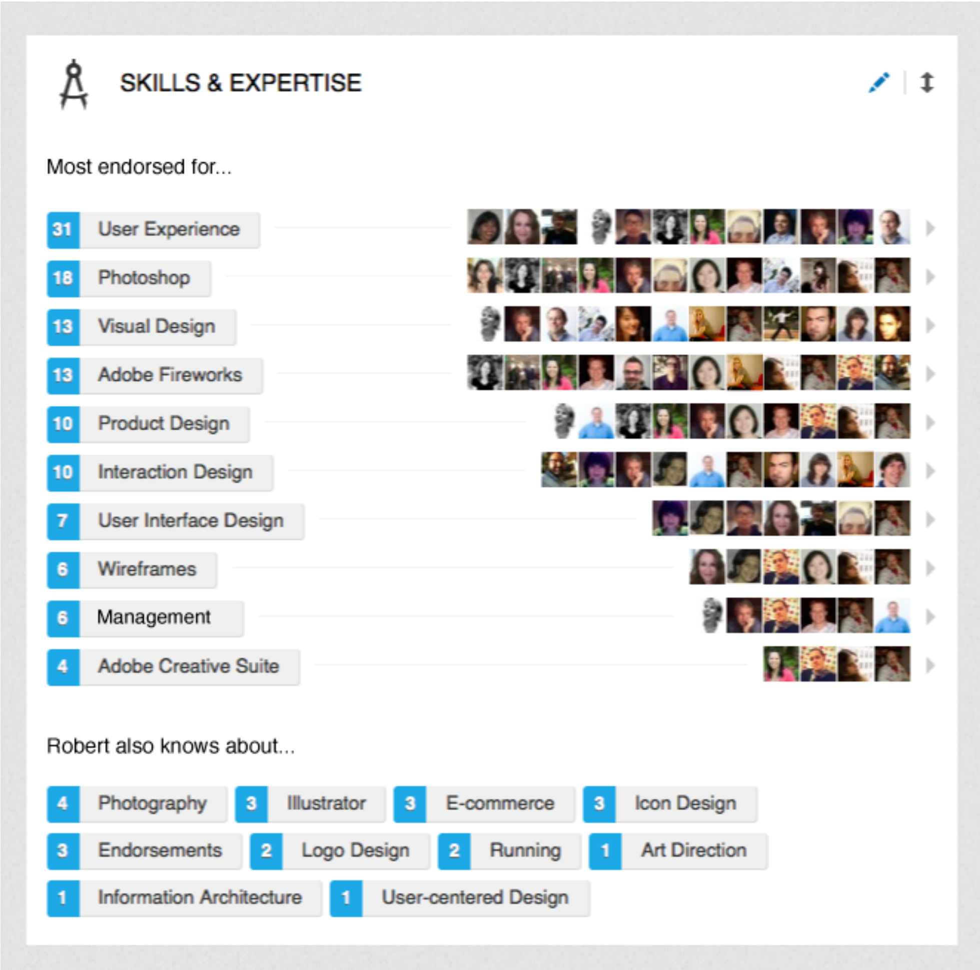
We aimed to dig deep into the worldviews of the practitioners through an interview study. As we wanted to *"gain insight and understanding of a particular situation or phenomenon"* (p. 550) the purpose was similar to an instrumental case study (Baxter & Jack, 2008). Due to the similarities to a multiple case study we used existing theory for case studies to guide the design of the interview study. An important step when conducting a case study is to define the unit of analysis (Yin, 2009). In our interview study the unit of analysis was CSFs for the implementation of SCIS. The unit of observation, were practitioners who had implemented SCIS. During a period of three weeks we met with six practitioners and investigated their views on how to successfully implement SCIS.

Selection of participants

Another important part of a case study is the selection of cases. The boundaries of the case study have to be set and the process needs to be confirmed and qualified. Sampling is normally done by identifying a population and from that selecting a random or stratified sample (Voss *et al.*, 2002). The goal of theoretical sampling is to select cases in order to either replicate or extend emerging theory. Two questions that often arise when performing a multiple case study are when to stop the iteration process between theory and data and when to stop adding cases. No more cases should be added when the theoretical saturation has been reached, i.e. when the incremental learning curve is simply too low. The amount of cases depends on the specific case study but between four to ten cases is optimal (Eisenhardt, 1989). Eisenhardt (1989) suggests that fewer than four says normally too little and more than ten can make the study too complex. It is important to evaluate if each case meets the criteria of the sample. If not, the researcher should have the courage to discard the case from the study (Voss *et al.*, 2002).

To ensure a trustworthy and high quality study we divided the selection processes into two steps: screening and selection. The first step involved identification of potential practitioners by screening profiles on the professional media site LinkedIn.com. What company or organisation they worked for or what position they currently had was not critical. Instead, we expected that a person with previous experience from SCIS implementation projects would be able to answer questions concerning CSFs for those projects. There were three basic requirements in the initial screening stage for including practitioners in the interview study, see table 6. The first requirement was experience from SCIS implementations in warehouses. The second requirement was a minimum of two relevant LinkedIn "skills & expertise" and at least 10 endorsements for one of these "skills & expertise". Relevant fields of expertise were considered to be supply chain, logistics, warehouse management, ERP, RFID, WMS and EDI. Finally, they had to be located within 100 km from Lund University. Otherwise the study would have been too time consuming. To see the LinkedIn "skills & expertise" and endorsements tool, see figure 3 below.

Figure 3: LinkedIn skills & expertise and endorsements tool (Gupta, 2016)



The second step was more qualitative and concerned selection of the participants. We found 30 practitioners that fulfilled the initial requirements and they were all contacted by e-mail. Ten replied and confirmed interest in participating and were phoned up for further evaluation. Initially the practitioners were asked if they understood the purpose of the case study and how they would be able to contribute. They were then asked about their career; both present and previous positions and experience from these positions. The practitioners had to fulfil three criteria in the second part of the selection process. First, they had to show extensive knowledge about at least one type of SCIS implementation. If they had been deeply involved in the implementation process of several projects, such as managing the projects or working full time in the project group, they were considered to have fulfilled the criteria. Secondly, they should have been working with SCIS implementations on two different positions. Finally, they had to have at least 10 years of experience from SCIS implementations. If the practitioner was regarded as qualified to participate and accepted the invitation, a date and time for an interview was agreed upon. If they did not feel comfortable or lacked experience, the practitioner was excluded from the interview study. After the second part of the selection process six practitioners were selected, see table 6. The process was iterative and more cases could have been added. However, after six cases the incremental learning curve was very low, why no more cases were added. The meeting schedule can be seen in appendix A.

Table 6: Selection of participants in the interview study

Initial requirements	Experience from SCIS implementations A minimum of two relevant LinkedIn "skills & expertise" and at least 10 endorsements for one of these "skills & expertise". Located within 100 km from Lund University
Number of practitioners found	30
Number of practitioners interested in participating in the study	10
Phone interview selection criteria	Extensive knowledge about at least one type of SCIS implementation Worked with SCIS implementations on two different positions A minimum of 10 years of experience from SCIS implementations
Number of practitioners selected	6

Trial interview to test the interview guide

The purpose of the trial interview was to test the interview guide and observe different phenomena that could possibly occur during the actual interview study. Voss *et al.* (2002) claims that it is important to have a deliberate interview guide when performing interviews. The guide should state the questions to be asked and what data that is required (Voss *et al.*, 2002). We had to decide upon a few questions that would generate as much valuable information as possible. The interview guide was evaluated regarding how much valuable information the interview as well as each question generated. It was also evaluated if there were any gaps in the guide that had to be filled with additional questions or if the questions had to be changed. After the trial interview a few questions were slightly modified. However, no major changes to the interview guide were made and no additional questions were added. The trial interview was considered successful, giving us confidence to begin the interview study. Table 7 gives an overview of the experience of the six practitioners qualified to the interview study and the practitioner, qualifyied to the trial interview.

Table 7: Overview of the selected participants

Participant	1	2	3	4	5	6	Trial interview
Present position	ERP-manager	Managing director	Project manager	ERP-manager	System developer	Supply chain planner	Warehouse manager
Experience at position	3 years	3 years	5 years	2 years	3 years	4 years	4 years
Previous position	Decision support manager	Consultant and product manager	Application consultant	ERP system engineer	ERP consultant	Supply chain coordinator	Operations planner
Experience at position	27 years	5 years	6 years	6 years	7 years	6 years	3 years
Experience from SCIS implementations	30 years	24 years	17 years	12 years	11 years	12 years	10 years
Field of expertise	ERP, EDI	WMS, RFID	WMS	ERP	ERP, EDI	ERP	WMS, ERP
LinkedIn "skill & expertise"	ERP-systems	Warehouse management	Warehouse management	ERP	Warehouse management	Warehouse management	Warehouse managment
Amount of endorsements	15	60	20	10	8	11	10
LinkedIn "skill & expertise"	EDI	Logistics	Logistics	EDI	ERP-systems	Supply chain	Logistics
Amount of endorsements	8	78	11	5	12	15	7

Data collection through focused Interviews

In the interview study *focused interviews* were used, where a single interview is held during a short period of time (Yin, 2009). We wanted the participants to remember essential details from earlier implementations and consequently remember specific CSFs for the implementation projects. For this purpose semi-structured interviews seemed to be a suitable type of interview. We used an interview guide that acted as a guideline, but with much room to explore more than just the questions in the guide. The *funnel method* was adopted, where broad questions are asked initially and as the interview continues the questions become more specific (Voss *et al.*, 2002). For further interest in the design of the interview guide, see appendix D.

Another important aspect when performing interviews is the ability to listen and, for example, absorb information without bias (Yin, 2009). We followed Eisenhardt's (1989) suggested interview technique where the interviewers take different roles when interviewing. One lead the interview and the other acted as an observer and note taker. This makes it possible to reach different perspectives and insights (Eisenhardt, 1989). To reduce the risk of bias we changed roles between the interviews.

Deductive thematic analysis to interpret the findings

The most difficult aspect when conducting a case study is the analysis, as it is the least developed field within the practice. In contrast to other areas there are very few formulas or cookbook recipes to guide the researcher in how to perform a case study analysis (Yin, 2009). The overall idea is to become familiar with each of the cases, which means that they should all be individually evaluated after the data-collection (Eisenhardt, 1989). As recommended by Eisenhardt (1989) the interviews were transcribed to enable a structured analysis of the findings (i.e. the data). The analysis method that we used was thematic analysis. In a thematic analysis “themes” and “codes” are used interchangeably. A theme (or coding category) is a specific pattern found in the extracted data (i.e the transcriptions of the interviews). To enable a structured organisation of the data the patterns are labelled with codes and a set of categories are created (Joffe & Yardley, 2004). Joffe and Yardley (2004) explain that a coding category can refer to either a manifest or a latent content of the data. Manifest content is directly observable, such as the mentioning of a specific word in a series of transcripts. Latent content is data that requires interpretation to really be understood (Joffe & Yardley, 2004). For example, a code might be "communication". If an interviewee mentions the word communication (manifest content) the related data is labelled with that code. If an interviewee emphasises the importance of team work, it might be interpreteted as connected to communication and therefore labelled with the code "communication" (latent content). The codes help the researchers to create subcategories and categories of the data. We used both types of categories in our analysis, although latent content was more used. Another distinction is the use of deductive and inductive coding. In inductive coding themes are drawn from the data itself (Boyatzis 1998). However, we used deductive coding, where themes are drawn from existing ideas. The themes of CSFs found in the literature review were applied. Joffe and Yardley (2004, p. 57) claim that *“theoretically derived themes allow the researcher to replicate, extend or refute prior discoveries”.* The analysis provided an opportunity to discover new CSFs and potentially extend the list. As suggested by Joffe and Yardley (2004) we described and interpreted the developed themes. Finally, we explored connections between the themes.

Survey

Moving beyond the identification of CSFs to determine their general criticality was an essential part of this research. Through a survey it is possible to *"gather information about the characteristics, actions, or opinions of a large group of people, referred to as a population"* (Pinsonneault & Kraemer, 1993, p. 2). Pinsonneault & Kraemer (1993) explain that a survey enables an understanding of the general opinion of a large population without investigating the opinion of each individual. Therefore, we believe that conducting a survey creates an opportunity to enable generalisability. Pinsonneault & Kraemer (1993) argue that surveys can be used for exploration, description, or explanation. In our survey practitioners involved with SCIS were asked to rate the criticality of the CSFs extracted from the literature review and the interview study. The purpose was clearly descriptive. The results from the study made it possible to obtain an understanding of the general opinion among practitioners and determine if any of the CSFs were supposed to be excluded from the list. The study also enabled triangulation, creating more validity to the research.

Participant selection

Lekvall & Wahlbin (2007) describe many different methods on how to select a population to study. These methods can either be "possibility selection"- or "non possibility selection" methods. The major difference is that for "possibility selection" methods it is possible to calculate the risk of inference errors. Some selection methods are more likely to increase the risk of inference errors than others (Lekvall & Wahlbin, 2007). The target population that we wanted to study was practitioners working in Sweden that had participated in at least one implementation of a Supply Chain Information System. We chose to apply a "seeking selection" method, which is a "non possibility selection" method where the researchers seeks up participants that is believed to be included in the target population. To minimize the risks of inference errors the selection process can follow certain rules, in order to give the whole target population the same possibility to be included in the selection (Lekvall & Wahlbin, 2007). The respondents in this survey were contacted and requested to answer the survey via LinkedIn.com and the survey was sent to the participants in a Google questionnaire. The respondents were all members in LinkedIn groups concerning

ERP, WMS, RFID or EDI. Each group consisted of approximately 600-20 000 members. The amount of selected participants in each group was chosen proportionally to the amount of members of all the chosen groups. Swedish members were then randomly selected. The total number of participants was 112 persons. The selection of the participants can be seen below in table 8. In the table it is possible to see that the selection size within each group was adapted after the size of the group in relation to the total amount of all four groups. The percentage of members selected in was 0.31% and this was equal for each group. Finally it can be seen that the response rate was never below 26% and the average response rate was 31%.

Table 8: Selection of participants in the survey

LinkedIn group	ERP project management	WMS Project management	Working group for EDI	RFID	Total
Members in group	20000	3600	640	12400	**36640**
Percentage of selection size	55%	10%	2%	34%	
Selection size	61	11	2	38	**112**
Percentage of members selected	0.31%	0.31%	0.31%	0.31%	**0.31%**
Respondents	17	6	2	10	**35**
Response rate	28%	55%	100%	26%	**31%**

Conducting the survey

A significant loss of participants is not good for the inference of the survey. Actions should be taken to reduce the loss of participants from the selection. One example is giving out rewards (Lekvall & Wahlbin, 2007). Therefore we gave the participants the option of taking part of the results of the survey. Other actions that can be taken in order to minimize inference errors are to conduct the questionnaire correctly. The questionnaire should not be too difficult for the respondent to answer, only include one question at a time and not be of leading character. The alternatives to answer the questions must be exhaustive. If the respondents are supposed to choose an answer from a scale it usually preferable to use a graphical instead of a verbal scale due to its better interval characteristics. The scale should consist of an odd number of alternatives to give a “middle opinion”. Outside the scale the respondent should also be given the possibility to answer “do not know/no opinion”. A scale of seven steps is often applied (Lekvall & Wahlbin, 2007). The survey in this study was designed to be simple to understand and to take minimal time to finish. The survey was presented with an explanation of the purpose of the survey. The major part was about answering questions regarding the criticality of the CSFs found in the literature review. The respondents could answer these questions using a graphical interval scale with seven steps, spanning from “not at all critical” to “very critical”. In order to give the possibility of receiving the result of the survey the respondents were also able to fill in their contact details. To see the protocol of the survey, see appendix E. The response rate of the survey was approximately 31%. To evaluate if the loss has possibly affected the inference it can be valuable to look at the participants that did not answer the survey in order to detect any possible differences between them and the rest of the sample (Lekvall & Wahlbin, 2007). However, we could not detect such a difference. To view the survey, see appendix C. The data analysis design for surveys with descriptive purposes is often simple. Simple descriptive statistics such as means and medians are common (Pinsonneault & Kraemer, 1993).

In our analysis of the survey we calculated means, standard deviations and the confidence intervals. Confidence intervals were calculated using the formula below:

$$\bar{x} \mp Z\alpha/_2 * \frac{\sigma}{\sqrt{n}}$$

$\bar{x}$ = Margin of error $\qquad$ $Z\alpha/_2$ = Confidence level

α = Confidence coefficient $\qquad$ σ = Standard deviation

n = Respondents

The confidence coefficient was set to 95%. In the analysis we discuss at what mean rating and lower bound a CSF should be considered critical.

2.2.3 Study 2: Single case study

The single case study was performed within the organisation of Axis and followed an iterative process. Conclusions were drawn alongside the data collection. The purpose was to investigate how a VGT-solution should be implemented in their warehouse and develop an understanding of the CSFs for the implementation. Meredith (1998, p. 451) explains that *“a single case is particularly appropriate for completely new, exploratory investigations”*. The study performed at Axis can be considered as exploratory and critical, as it extends present theory within the topic (Yin, 2009). Within Axis there is a deep knowledge of camera technology and camera solutions, which provided a unique opportunity for an investigation of implementing video technology in a warehouse. First all relevant data was collected through interviews, meetings and observations. When we had gained enough knowledge from the collected data a VGT-solution was designed. On the request from Axis an implementation plan was created and a business case was built. The content of the implementation plan and the business case can be seen in the last chapter of the single case study. The business case is also presented as a separate document in the appendix. From new knowledge on how to implement a VGT-solution it was possible to compare the importance of specific CSFs for the VGT implementation to general SCIS implementations. An analysis of the criticality of each CSF, derived from the first study, was conducted. The CSFs that were considered critical for a VGT-implementation were connected to the barriers identified by Danielsson and Smajli (2015) in a final framework.

Quantitative data collection of claim statistics

The purpose of a VGT-solution is to enable a more effective handling of customer claims. The first part of the single case study was therefore a cost investigation of the claims. This helped us analyse the root causes of today's claim costs. The claim statistics were mainly available in an online spreadsheet. There was a lack of information about the claims and it was decided to only include claims that had been properly documented in the spreadsheet. The findings from this investigation provided guidance on how the VGT-solution should be implemented.

Qualitative data collection through Interviews, meetings and observations

All qualitative data in the single case study was gathered through the use of interviews, meetings and observations. The interviewing technique used was *in-depth interview* were interviews are held over a longer period of time with follow-ups (Yin, 2009). When interviewing people at Axis, not familiar with the project, simple interview guides were used in order to add structure. A document with the questions was sent to the interviewee one or two days before the interview. Meetings were held with employees more deeply connected to the project. The meetings were less formal than interviews. No interview guides were used and the meetings were often held as follow-ups. Finally, observations were used when something had to be observed without any interference of questions. Interviews, meetings and observations were always set to a fixed date, place and time and the purpose of the activity was sent to the people it concerned a couple of days before the activity.

Qualitative data was gathered within three main areas: hardware; software and operating procedures. The first area concerned cameras, scanners and computers. Interviews and meetings were for example held with experts on camera technology. The second area concerned the examination of how the Video Management System worked and how it should be integrated. Interviews and meetings were held with external consultants who were experts on the system. Interviews were also held with ERP-experts at Axis regarding the integration of the VMS. Finally, an understanding of the operating procedures in the warehouse was needed. The processes in the warehouse were observed and operators were interviewed. The single case study followed an iterative process. Conclusions were drawn alongside the data gathering in order to narrow the focus and to make the process efficient. A testing day was held when a first idea on how to design the solution was formulated. During this day cameras were mounted and final decisions were taken regarding type, amount and angles of the cameras. To see the meeting schedule for the single case study, see appendix B.

2.3 Quality of research

It is important to validate the quality of the research and therefore four tests have been developed. These have been summarized in several textbooks over the years. The first test is called construct validity and concerns the risk that "subjective" judgements are used in order to collect data. Using multiple sources of evidence, establishing a chain of evidence and having key informants reviewing draft case study report can solve this. The second test is called create internal validity, which is about making correct inferences. If something cannot be proven from observations it can be difficult to draw strong conclusions, which, if possible, would lead to internal validity (Yin, 2009). The third test is called external validity and concerns whether a study's findings can be generalizable beyond the case study. In order to validate the findings the same results must be proven to occur for other cases (Yin, 2009). It refers to the possibility to generalize from the data of the research to a broader population and settings. There are basically three methods that can generate generalizability. The first one is to include as many independent variables as possible; the second is to include multiple populations in the study to make the theory more comprehensive. The final method is to test the theory on alternative populations where, if the theory would pass the test, the relevance would be extended (Meredith, 1998). The last test is called reliability where the objective is to prove that if someone else would perform the same study they would reach the same conclusions and findings (Yin, 2009). For a case study this is hard since the same conditions can never be completely duplicated. In this case the same case study methodology should be used even though it might result in a different prediction (Meredith, 1998).

Research validity

In order to construct validity different sources were used which also enabled a chain of evidence. The research was built up by two studies and four methods, which enabled triangulation of the results in several steps. A qualitative research was performed through a literature study and an interview study. It was then possible to see if their results were consistent or if they contradicted each other. As we created categorisations of the results from the literature review and the interview study it was important to validate the outcome with a quantitative study. This was achieved through a survey, giving the possibility of validating the results. In order to triangulate the results further an in-depth single case study was conducted making it possible for us to draw conclusions from our own experiences. Concerning the interview study every transcription was sent back to the interviewee to assure the quality of the gathered information. Concerning the single case study several key-informants reviewed the drafts of the reports continuously in order to validate the analysis and conclusions. The literature review was conducted by only including peer-reviewed articles published in well-known academic journals. Based on the rigour procedures from the case studies and the literature review trustworthiness was expected to be achieved from the research.

In order to create internal validity a form of pattern matching was used when comparing the results from the literature review with the interview study. This analysis technique was only possible for the study on CSFs for the implementation of SCIS. Internal validity was not reached for the part of the study investigating video technology. However, as this was single case study of a new phenomenon internal validity was not expected to be achieved and therefore not considered a problem. In order to create external validity the research relied to a large extent on a comprehensive literature study considering the study on CSFs when implementing SCIS. Conducting the survey also helped to make the research more externally valid as the result from the literature review was tested on a large population. External validity is also believed to have been achieved from the interview study as it included many independent variables as each participant had a unique background and experience from SCIS implementations.

Research reliability

Giving reliability to the research is important and was achieved by carefully describing how each study was conducted. Considering the literature review and study 1, other researchers should likely come to the same conclusions by following the same procedure. Reliability was also achieved by the use of a clear interview guide when conducting the interview study. The survey was also conducted using a clear methodology and each step is clearly presented. Considering the single case study each interview, meeting and observation was documented with time, date, department and purpose. If replicating the study with the help of the documentation it should be possible for another researcher to come to the same or a similar conclusion.

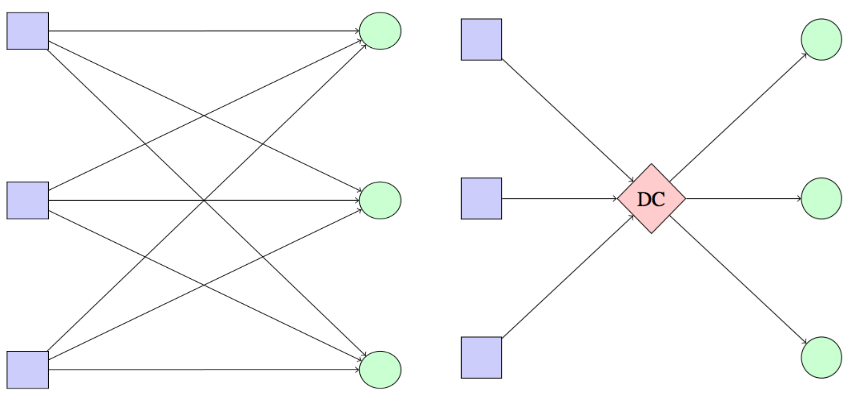
3. Frame of reference

The purpose of the theory chapter is to highlight relevant theory. The first two parts give an introduction to warehousing and supply chain information systems. The third part presents Danielsson and Smajli's (2015) identified barriers that prevent implementation of video technology in a warehouse. The last part includes a literature review on SCIS CSFs.

3.1 Warehousing

Warehouses have a central role in the supply chain of a company. Their main function is to buffer the material flow along the supply chain to handle variability caused by the consolidation of products, seasonality's or batching in transportation and production (Gu *et al.*, 2007). The warehouse consolidates deliveries from upstream units and aggregates them to downstream units, which can be seen in figure 4, below. This can be made both as an internal process within a company or as an external process between different companies (Bartholdi & Hackman, 2014).

Figure 4: The warehouse as an intermediate aggregator (Bartholdi & Hackman, 2014)

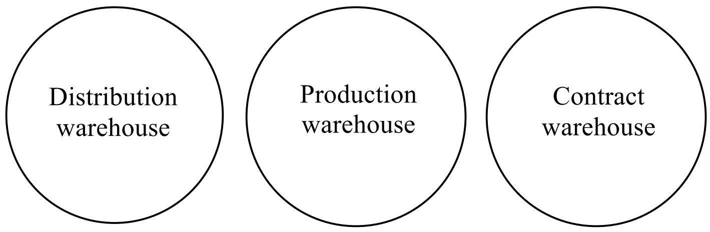


A warehouse also enables to postpone product differentiation by creating the possibility of having the configuration closer to the customer (Bartholdi & Hackman, 2014). Other value adding functions could be labelling, product customization, pricing and kitting to improve the efficiency of the warehouse and the supply chain (Gu *et al.*, 2007). The warehouse plays an intermediate role between the different members within the supply chain. Many companies are centralizing their warehouse and production facilities to manage them more efficiently. This puts greater pressure on the warehouse as its responsibility increases with greater diversity and more complex internal logistics (Faber *et al.*, 2013). These large DCs serve extensive areas, often entire continents. Centralization comes with increased productivity and shorter response time, which is crucial as the product life cycle keeps decreasing (Van den Berg & Zijm, 1999). By centralizing warehouses it is possible to satisfy a more diverse customer demand (Bartholdi & Hackman, 2014).

Types of warehouses

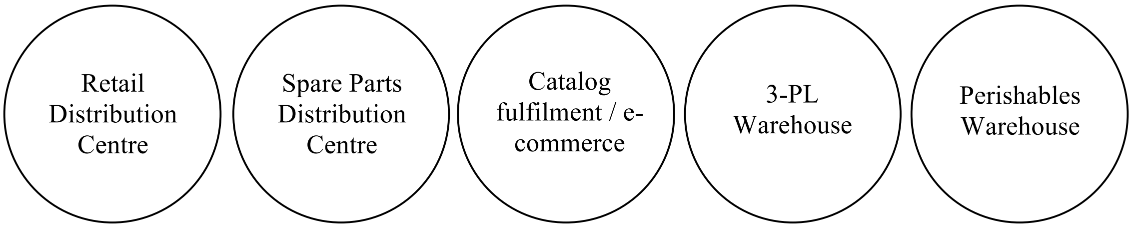
Warehouses can generally be distinguished between three different types, see figure 5. Distribution warehouses, production warehouses and contract warehouses. A distribution warehouse is where products from different suppliers are collected or assembled before being delivered to a number of customers. A production warehouse is used when storing raw materials, semi-finished products and also finished products in a production facility. A contract warehouse is used when the warehouse operation is performed on behalf of one or more customers (van den Berg & Zijm, 1999).

Figure 5: Types of warehouses (van den Berg & Zijm, 1999)



Another categorization is provided by Bartholdi and Hackman (2014), dividing warehouses into five different types, see figure 6, below. A retail distribution centre is a warehouse where the customer typically is a retail store. The customer is likely receiving shipments on regularly scheduled days and a typical order could comprise hundreds or thousands of items. A distribution centre might serve hundreds of customers similarly, thus the product flow is huge. A Service parts distribution centre hold spare parts for expensive capital equipment; examples of this could be airplanes, automobile, computer systems or medical equipment. They generally serve two different order streams, stock orders and emergency orders. A stock order is for dealers who are replenishing their shelves while emergency orders is when a repair shop or an equipment owner urgently requires some special parts. A catalog fulfilment/ e-commerce normally receives small orders from individuals by fax, phone or the internet. Even though the orders are small there can be many of them and they have to be shipped immediately after the order has arrived. A 3PL warehouse is a warehouse where a company is outsourcing its warehousing operations. The 3PL might have one facility for many customers and by that gaining economies of scale and can compensate for seasonal differences among their customers. Finally, a perishables warehouse typically handles food, vaccines or fresh flowers where refrigeration is required due to the short shelf-life (Bartholdi & Hackman, 2014).

Figure 6: Types of warehouses (Bartholdi & Hackman, 2014)



The warehouse process

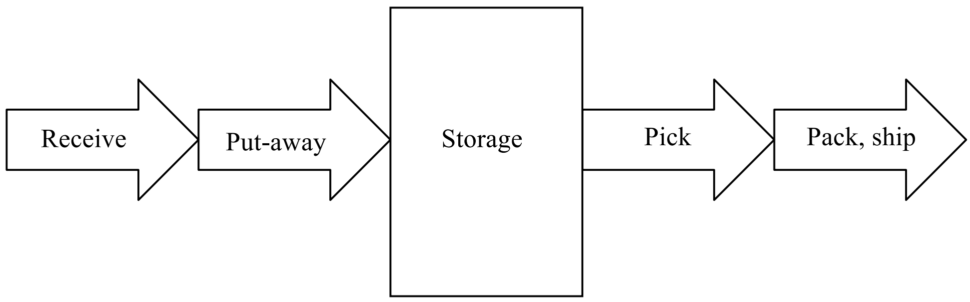
The warehouse process can be divided into some distinct phases. These phases are not always described in the same way in the literature and different notations has been identified. A collection of relevant sources can be seen in table 10, below, where the used notations are summarized into a five-step process. The first step considers the receiving process where the goods arrive to the warehouse and are transformed or checked. This is normally followed by a put-away process where the goods are placed at a storage location (Bartholdi & Hackman, 2014). There could be two inventory areas, a reserve area for bulk storage and a forward area for easy retrieval by order pickers (Rouwenhorst et al., 1999). When an order has arrived a pick-list is generated and the goods are retrieved from the storage, which could be done either automatically or manually. The goods can then be transported to a consolidation or sorting station. During the final step the goods are checked, packed and finally loaded on a truck, train or carrier (Rouwenhorst et al., 1999). Cross-docking is also used in some warehouses where the products are transferred directly to the shipping area without being placed in an inventory (de Koster *et al.,* 2006).

Table 10: The warehouse process framework

Used notation	Source	Warehouse operation	Description
Receiving	Rouwenhorst *et al*., 2000 de Koster *et al*., 2007 Gunasekaran *et al*.,1999 Van der Berg *et al*. 1999 Bartholdi & Hackman, 2014	1 - Receiving	Considers the process from when the notification of incoming goods arrives. The product is registered and inspected to assure ownership and eventual damages to the goods.
Storing Put-away Inbound Transfer Inbound Handling	Rouwenhorst *et al.*, 2000 Van der Berg *et al*. 1999 de Koster *et al*., 2007 Gunasekaran *et al.*,1999 de Koster *et al*., 2007 Gunasekaran *et al.*,1999 Gunasekaran *et al*.,1999	2 - Put-away	Considers the process of putting the product at the right storage location. A destination is chosen and the product is transported to the location. The location is scanned and reported.
Storage	Gunasekaran *et al*.,1999	3 -Storage	Considers the actual storage of the goods
Order picking Outbound Handling Outbound Transfer Accumulation/sortation	Rouwenhorst *et al.*, 2000 de Koster *et al.*, 2007 Gunasekaran *et al.*,1999 Van der Berg *et al.* 1999 Bartholdi & Hackman, 2014 Gunasekaran *et al.*,1999 Gunasekaran *et al*.,1999 de Koster *et al.*, 2007 van der Berg *et al*., 1999	4 - Order picking	Begins with checking if the goods are available for shipping followed by a pick-list that is typically generated by a Warehouse Management System (WMS). The product is scanned when retrieved from a storage location to update the inventory.
Cross-docking	de Koster *et al*., 2007	Cross - docking	The goods are immediately shipped and the warehouse acts like a aggregator
Packing Shipping Expediting	Gunasekaran *et al*.,1999 Bartholdi & Hackman, 2014 Rouwenhorst *et al.*, 2000 Rouwenhorst *et al.*, 2000 de Koster *et al*., 2007 Gunasekaran *et al.*,1999 Van der Berg *et al.* 1999 Bartholdi & Hackman, 2014 Gunasekaran *et al*.,1999	5 - Packing/ Shipping	Begins by checking if the order has been properly picked whereafter the orders are consolidated for each customer. The products are prepared, registered and scanned to announce that they are ready for shipping.

To summarize the process comparison, different notations are used although their meanings are closely linked. Based on the comparison in table 10 the warehousing process of Bartholdi & Hackman (2014), can serve as a model for what the modern warehousing process looks like, see figure 7 below.

Figure 7: The warehouse process (Bartholdi & Hackman, 2014)



Warehousing activities concern several aspects such as the physical storage and retrieval of materials. It also consists of the processing of information of the goods stored. Basically the methodology of warehousing is information oriented and it requires efficient technology to handle the data concerning the movement of the goods. Today's warehouses have to think universally built on the idea of connecting multiple sites and supply chains together to create a network-centric view (Gunasegaram *et al.*, 1999). Since the logistics cost makes up a large portion of a company's total costs, these operations play a vital role in making a company competitive. This has been seen in warehouses where big improvements have arrived in warehouse technology (Rouwenhorst *et al.*, 1999). These improvements are for example the development of Radio Frequency Identification (RFID), Warehouse Management Systems (WMS) and bar coding (Gu *et al.*, 2007).

3.2 Supply Chain Information Systems

The success of a firm is no longer limited to its performance internally, but the competition is rather between one supply chain and another supply chain (Denolf *et al.*, 2015). Information system integration is the degree of which supply chain partners integrate their information technology systems to enable electronic information sharing and transactions between them (Gonzálvez-Gallego *et al.,* 2015). To improve collaboration between supply chain partners it is necessary to adopt supply chain information systems (SCIS), to share information with accuracy, speed and relevance (Denolf *et al.*, 2015). Information systems are therefore powerful tools to develop effective supply chains (Gonzálvez-Gallego *et al.*, 2015).

SCIS can for example help organizations to develop efficient warehousing and transportation. For transportation, the use of SCIS could be helpful for mode and route planning, electronic identification, managing claims and tracing and tracking. Tracing and tracking is important when products are transported over large areas using multimodal shipment. It can also be important in order to identify the condition of shipments. In warehousing SCIS could be used for warehousing functions including kitting, packing, assembling and electronic tagging. Most of these warehouse activities can be handled by using a WMS (Spokharel, 2005). Another important SCIS is Enterprise Resource Planning (ERP) (van den Berg & Zijm, 1999). Generally information systems are supposed to support warehouse management, those systems can both be tailor-made for a particular warehouse or be a standard software package (Faber *et al.*, 2013).

3.3.1 Enterprise Resource Planning

80 percent of the Fortune 500 companies are using ERP to succeed in their operations (Saenz de Ugarte *et al.*, 2009). An ERP-system is a technology infrastructure that allows the company to share information both between internal units and to external partners, such as suppliers and customers. ERP is described as an integrator of business processes and data where the goal is to break the barriers between functional departments (Legutko *et al.*, 2012). ERP serves as a common information platform that integrates the different business applications (Olhager & Selldin, 2003), such as inventory management, production planning, human resources and finances (van den Berg & Zijm, 1999). By supporting tracking and tracing technologies ERP improves the critical information flow, which allows for quick and important information exchanges and increases flexibility (Shuang & Shaw, 2008; Legutko *et al.*, 2012). Companies that have succeeded in their implementation of such a system can also benefit from more on-time deliveries, lower operating costs and inventory levels.

ERP-systems are very common in several types of industries and many firms are extending their systems with modules, primarily to support integration with supply chain partners (Olhager & Selldin, 2003). Companies continue to invest in ERP-systems but all companies do not experience visible benefits when implementing the systems (Nwankpa 2015). Nwankpa (2015) concludes that even though the use of ERP-systems is cutting edge technology it is of highest importance that the end-users are well taught in how to use the system effectively. This does not come automatically after a successful implementation. Olhager and Selldin (2003) also points out that although ERP-systems have a very positive effect on information speed, quality and accessibility the system does not necessarily decrease costs for information technology.

3.3.2 Warehouse Management System

A Warehouse Management System (WMS) is a system that manages the inventory, the storage locations, and the workforce. This is done in order to ensure that orders are picked, packed and shipped in a quick and structured manner. The WMS orchestrates the flow of people, machines and products through the access of the information about every item, storage location in the warehouse and its physical dimensions (Bartholdi & Hackman, 2014). In order to create a competitive warehouse it is often necessary to implement a WMS and an important question is whether to use a standard or a tailor-made system. A standard WMS offers less costs, less time spent on implementation, a proven solution and better after sales. A customized WMS does not force the owner to make compromises between a desired work plan and the work plan required by the system (Faber, *et al.*, 2002).

A WMS must communicate with other information systems about transportation, finance, production control and procurement. An increasing number of these systems are integrated with an ERP-system. The WMS also need to communicate with other systems like RFID and barcodes. There is a clear difference between a WMS and an ERP-system. ERP-systems have a planning horizon of several weeks and it covers every functionality within the organization. A WMS on the other hand is short-term planning focusing on shop floor control and the systems for warehousing and cross-docking only (Faber, *et al.*, 2002).

3.3.3 RFID & Barcodes

RFID

Ever since Wal-Mart in 2003 obligated its top 100 suppliers to start using RFID the technology has quickly gained popularity (Delen *et al.*, 2007). Tracking is the most beneficial application of RFID (Lim *et al.*, 2013), which enables visibility that is crucial in order to create an effective supply chain and to minimize the bullwhip effect. Supply chain partners can choose to share data about items as they move through the supply chain (Dos Santos & Smith, 2008).

The simplest RFID technology consists of a tag attached to the identified item, a reader and a computer. There are two different types of tags, passive and active tags. Passive tags are the most commonly used and receives energy from an electromagnetic field that is send out by the reader. These tags only stay energized when being inside the range of the reader. The computer can then control the reader and capture the data. The active tags do not need a reader to become energized but instead they possess a small battery with the ability to energize the tag. The active tags have longer reading range, are more accurate and can contain more complex information. However, they have limited lifetime, are bigger in size and more expensive (Delen *et al.*, 2007).

Dos Santos and Smith (2008) point out that although many benefits can derive from RFID the acquiring organisation should consider risks that can come with it. For example, competitors may access data by strategically placing readers next to supply routes. By individual item identification competitors might be able to learn a lot about the organisation's supply chain and processing and delivery systems. Options to minimize the risks could be encrypted passwords or blocker tags, which could illegalize efforts to access the information (Dos Santos & Smith, 2008).

Barcodes

The barcode is an optical technology for transferring data into a system. The barcode is attached to an item and contains the necessary data to identify the item. The benefits from barcodes are similar to RFID and the data enable visibility and tracking of products. There are different types of codes, linear 1D codes and non-linear 2D codes where the 2D codes can include a lot more data (Musa *et al.*, 2013). Since the technology is optical (Musa *et al.*, 2013) the reader needs to be in direct line of sight with the barcode and can only read one code at the time. This makes the barcode less efficient compared to RFID, which can read several tags at the same time (Delen *et al.*, 2007). However, barcode technology is much simpler and cheaper which still makes the technology popular (Musa *et al.*, 2013).

Delen *et al.* (2007) also discuss other advantages and disadvantages with barcodes. Another significant advantage with barcodes is that the codes have no performance loss when used on or around water or metal, while RFID tags can be damaged. Barcodes can be produced either before the unit production or directly on the objects, while the RFID tags must be placed on the objects after production or at least included in the existing production process. This makes the production of barcodes more flexible. A benefit of using RFID tags is that they are much more durable regarding heat, dirt and solvents. RFID tags are though much more expensive but can also be used several times (Delen *et al.*, 2007). Despite the many advantages of RFID compared to barcodes, there is today no application where RFID has fully replaced barcodes (Musa *et al.*, 2013).

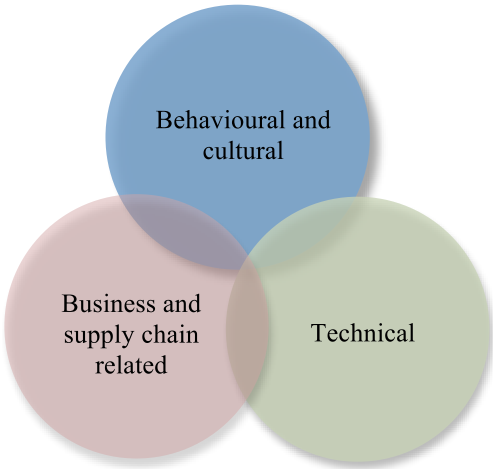
3.3.4 Electronic Data Interchange

Electronic Data Interchange (EDI) is an information technology that standardises information exchange (Anderson & Lanen, 2002). It enables electronic data exchange, often done automatically. The implementation of an inter-organizational EDI needs a considerable amount of collaboration, usually requiring costly and time-consuming processes. This also applies when needing to tie additional partners to an existing network. When EDI is successfully implemented the firm can benefit from effective handling of the information flow between the firm and its supply chain partners. EDI also enables lower transaction costs and more efficient business relationships (Narayanan *et al.*, 2009).

3.3 Barriers preventing video technology implementation

Danielsson and Smajli (2015) identify a number of barriers to the implementation of video technology in a warehouse context. These barriers are related to technology, behavioural and cultural or business and supply chain related aspects. The categories are illustrated in figure 8, below. Considering Behavioural and cultural aspects examples of barriers found were resistance to change and change in culture. Examples of Technical barriers were integration problems, loss of flexibility and system reliability. The barriers connected to the category Business and supply chain were investment costs, price/performance ratio, lack of standardisation and interruption of warehousing operations. There is a lack of knowledge on how to overcome these challenges described in the literature (Danielsson & Smajli, 2015).

Figure 8: Categories of barriers (Danielsson & Smajli, 2015)



3.4 Literature review on CSF research

The purpose of the literature review is to develop a list of CSFs for SCIS implementations.

The chapter begins with presenting a definition of CSFs and what SCIS articles that have been examined. The derived CSFs are then described. Finally, a list of general CSFs is created and presented together with the CSF subcategories for each CSF.

3.4.1 SCIS CSFs based on literature

Since the 1990s much interest have been developed for SCIS implementations, especially for ERP implementations. Two reasons that can explain the increasing interest are the high failure rate and that the systems absorb a large share of a company's budget (Denolf *et al.*, 2015). Denolf *et al.* (2015) give an example when Hewlett Packard performed an ERP implementation that became five times more expensive than expected. To succeed with the implementations it is important to be aware of the CSFs. Ngai *et al.* (2004, p. 623) define CSFs as *"the limited number of areas in which satisfactory results will ensure successful competitive performance for the individual, department, or organization. CSFs are the few key areas where 'things must go right' for the business to flourish and for the manager's goals to be attained"*. We searched for such factors for different SCIS in the literature. In order to conduct a valid literature review several information systems had to be included. Therefore, the review included articles on CSF research for implementations of Enterprise Resource Planning (ERP) systems, Radio Frequency Identification (RFID), Electronic Data Interchange (EDI), Supply Chain Management Systems (SCMS) and Information Systems (IS). After the screening process a total of 11 articles were reviewed. The articles were given a number from 1-11 in order to use a simple index when summarizing the CSFs in table 10.

Table 9: Literature review articles

#	Authors	Year	Academic Journal
1	Shaul & Tauber	2012	Industrial Management & Data Systems
2	Ram *et al.*	2013	International Journal of Production Economics
3	Ram & Corkindale	2014	Business Process Management Journal
4	Manisha *et al.*	2015	Journal of Business Perspective
5	Saade & Nijher	2016	Journal of Enterprise Information Management
6	Biehl	2007	Communications of the ACM
7	Ngai *et al*.	2004	Production Planning & Control
8	Yao *et al.*	2011	Journal of Medical Systems
9	Ting *et al.*	2013	International Journal of Engineering Business Management
10	Ngai *et al.*	2014	Journal of Engineering and Technology Management
11	Gunasekaran *et al.*	2004	Industrial Management & Data Systems

Factors found in the reviewed articles were grouped and categorized. First, subcategories were created, which in turn formed more general critical success factors. In total nine general CSF themes were identified and the "story" of each CSF is described below.

Communicate effectively

When implementing a SCIS effective communication between supply chain partners is required (Shaul & Tauber, 2012; Ram *et al.*, 2013; Ngai *et al.*, 2004). Ngai *et al.* (2004, p. 626) suggested that the *"growing trend of globalization"* creates opportunities for communication. The Internet, for example, is used by many organisations (Ngai *et al.*, 2004). It is vital to cooperate cross-functionally between units and teams (Shaul & Tauber, 2012; Ram *et al.*, 2013; Ram & Corkindale, 2014; Biehl, 2007), and communicate effectively within the organisation (Ram *et al.*, 2013; Ram & Corkindale, 2014; Manisha *et al.*, 2015; Ngai *et al.*, 2004; Yao *et al.*, 2012).

Manisha *et al.* (2015, p. 258) explained that *"as organizations move towards integration with the outside world, proper communication is imperative between the users, top management, project management team and leader".* The project group should also establish effective teamwork (Shaul & Tauber, 2012; Ram *et al.*, 2013; Ram & Corkindale, 2014; Manisha *et al.*, 2015; Saade & Nijher, 2016; Ting et al., 2013).

Measure performance

Many of the reviewed articles suggested that evaluation and monitoring of the implementation performance is required (Shaul & Tauber, 2012; Saade & Nijher, 2016; Yao *et al.*, 2012; Ting *et al.*, 2013; Ngai *et al.*, 2011). Ting *et al.* (2013) described that this is especially important in the early stages of the implementation. Monitoring the performance enables the project group to respond to potential problems with the system. The performance should be benchmarked to the targets determined in the beginning of the project. The targets should be specific and concrete (Ting *et al.*, 2013). Saade & Nijher (2016, p. 84) mentioned that it is important to *"develop frameworks to measure the results of the implementation on a timely basis and document it"*. The project group should also develop trouble shooting tools (Shaul & Tauber, 2012) and performance measurement systems (Ngai *et al.*, 2004).

Manage change

Seven of the reviewed articles emphasised the importance of good project management skills. (Ram *et al.*, 2013; Ram & Corkindale, 2014; Manisha *et al.*, 2015; Saade & Nijher, 2016; Ting *et al.*, 2013; Ngai & Gunasekaran, 2004). SCIS projects are often large and involve a lot of financial recourses. Good management skills contribute to *"streamline integration across the stakeholders"* (p. 11) and reduce cost of the project. Consequently the project is completed within budget and on schedule (Ting *et al.*, 2013). The project group should develop project plans, timelines, schedules (Ram *et al.*, 2013; Biehl, 2007; Yao *et al.*, 2012; Ngai & Gunasekaran, 2004) and an implementation strategy (Ram *et al.*, 2013). Ngai & Gunasekaran (2004) recommended that plans and schedules for the project should be clear and available to all participants. Four of the articles emphasised the need of good change management skills (Ram & Corkindale, 2014; Manisha *et al.*, 2015; Saade & Nijher, 2016; Biehl, 2007, Ting *et al.*, 2013). Manisha *et al.* (2015, p. 250) explained that *"one key task is to build user acceptance of the project and a positive employee attitude".* Most of the articles implied that user involvement should be highly prioritised (Shaul & Tauber, 2012; Ram *et al.*, 2013; Ram & Corkindale, 2014; Manisha *et al.*, 2015; Saade & Nijher, 2016; Biehl, 2007). Resistance to change is a common cause of project failure and is often due to job changes and uncertainty of the system. Therefore user involvement should take place much before the actual implementation (Manisha *et al.*, 2015). Ngai *et al.* (2011, p. 124) claimed that users should be involved in *"the design and development process to understand their expectations and attitude towards the new technology in a more throughout sense"*. Finally, four articles mentioned the importance of a dedicated project champion (Ram *et al.*, 2013; Ram & Corkindale, 2014; Manisha *et al.*, 2015; Saade & Nijher, 2016).

Establish sufficient resources and competences

Two articles claimed that sufficient financial resources are required to succeed with the implementation (Biehl, 2007; Ngai & Gunasekaran, 2004). Ngai & Gunasekaran (2004, p. 96) stated that *"lack of financial support and adequate resources will inevitably lead to failure"*. Technical experts should be available to support both hardware and software issues (Ngai *et al.*, 2004; Ting *et al.*, 2013; Ngai & Gunasekaran, 2004). Many technical problems often occur early in the process. *"Inadequate technical support will lead to faults in system design and unrealistic expectations to performance results"* (Ting *et al.*, 2013, p. 10). Furthermore, the technical infrastructure within the company has to be sufficient (Shaul & Tauber, 2012, Ram & Corkindale, 2014; Manisha *et al.*, 2015; Saade & Nijher, 2016) and reliable technology should be in place (Ngai *et al.*, 2004). Articles in the review also emphasised the importance of sufficient capabilities among employees (Ram & Corkindale, 2014; Biehl, 2007) as well as their capacity to learn (Ram & Corkindale, 2014; Saade & Nijher, 2016). Finally, the vendor and other trading partners have to be committed to the project and provide enough support (Shaul & Tauber, 2012; Manisha *et al.*, 2015; Saade & Nijher, 2016).

Manage people and culture

Several articles highlighted the culture of the organisation and the readiness for change as critical factors to consider (Shaul & Tauber, 2012; Ram *et al.*, 2013; Ram & Corkindale, 2014; Manisha *et al.*, 2015; Saade & Nijher, 2016; Ngai & Gunasekaran, 2004). Manisha *et al.* (2015) explained that a project is much more likely to succeed *"if the system is aligned with the organisational culture"* (p. 250). Ngai *et al.* (2011) claimed that the motivation within the organisation is critical. Therefore the company should explain the potential benefits to the employees (Ngai *et al.*, 2011). Articles also mentioned other important aspects to consider when managing people within the organisation. Trust among employees is an important factor (Shaul & Tauber, 2012; Ngai *et al.,* 2004), as well as high morale (Shaul & Tauber, 2012). Ram & Corkindale (2014) also explains that the employees should have a positive attitude towards the new system. Finally, the project group should consider privacy concerns when implementing the new system (Yao *et al.*, 2012).

Assure top management support

Ten of the eleven articles emphasised the importance of top management involvement and support (Shaul & Tauber, 2012; Ram *et al.*, 2013; Ram & Corkindale, 2014; Manisha *et al.*, 2015; Saade & Nijher, 2016; Biehl, 2007; Ngai *et al.*, 2004; Yao *et al.*, 2012; Ngai *et al.*, 2011; Ngai & Gunasekaran, 2004). Top management support is often recognised as one of the most important success factors. Through top management support the project will obtain *"sufficient financial support and adequate resources for building a successful system"* (Ngai *et al.*, 2004, p. 627). Furthermore, Manisha *et al.* (2015, p. 250) explained that their support is essential *"to take fast and effective decisions, to resolve conflict, to promote company-wide acceptance of the project and to build cooperation among the diverse groups within the organization"*. Finally, Saade & Nijher (2016, p. 81) claimed that unnecessary resistance can be avoided as well as *"ensuring that the vision is communicated to all the employees".* To obtain top management support two articles suggested that it is important that top management understands the benefits from the project (Ngai *et al.*, 2004; Ngai & Gunasekaran, 2004).

Create a clear vision and build a business case

The implementation should be justified through a cost/benefit analysis (Ram & Corkindale, 2014; Ngai *et al.*, 2011) and a business case should be built (Ram *et al.*, 2013).*"Cost effectiveness should be a key issue in judging the business value"* (Ngai *et al.*, 2011, p. 125). However, both hard and soft benefits should be identified. Hard benefits are often quantified cost reductions. On the contrary soft benefits are often difficult to quantify, such an increased service level (Ngai *et al.*, 2011). Furthermore, the creation of a clear business plan and vision is highlighted in several articles (Ram & Corkindale, 2014; Manisha *et al.*, 2015; Saade & Nijher, 2016; Biehl, 2007; Yao *et al.*, 2012; Ting *et al.*, 2013). As recourses are limited *"a clear vision will provide managers with guidelines for making informed decisions on the utilization of limited resources that will produce optimal benefits for the project"* (Ngai *et al.*, 2011, p. 11). Articles also mentioned similar factors such as having well-defined goals and clear objectives for the project (Ram & Corkindale, 2014; Saade & Nijher, 2016; Biehl, 2007; Yao *et al.*, 2012).

Educate and train

All reviewed articles emphasised the importance of education and training of employees (Shaul & Tauber, 2012; Ram *et al.*, 2013; Ram & Corkindale, 2014; Manisha *et al.*, 2015; Saade & Nijher, 2016; Biehl, 2007; Ngai *et al.*, 2004; Yao *et al.*, 2012; Ting *et al.*, 2013; Ngai *et al.*, 2011; Ngai & Gunasekaran, 2004). End-users should receive proper education to be able to use the new system correctly (Shaul & Tauber, 2012; Ram *et al.*, 2013; Saade & Nijher, 2016; Ngai *et al.*, 2004; Ngai *et al.*, 2011). Ngai *et al.* (2011, p. 125) claimed that *"this can help to enhance their acceptance of the new system and boost their confidence in using it"*. If training and education is not provided to the employees there will be a high resistance to change (Manisha *et al.* 2015). Ting *et al.* (2013) suggested that the system should be demonstrated and its benefits explained. Finally, the company should also consider training of other employees within the organisation, such as technical staff (Shaul & Tauber, 2012).

Choose the right vendor and system

Several articles suggested that the company should select the system package carefully (Shaul & Tauber, 2012; Ram *et al.*, 2013; Ram & Corkindale, 2014; Saade & Nijher, 2016; Ting *et al.*, 2013). The system should be selected *"by taking into consideration the environmental factors, which are identified in the requirement analysis step"* (Ting *et al.*, 2013, p. 6). Ting *et al.* (2013) also suggested that the company should consider developing its own application software that is a better fit for use. Selecting a reliable and experienced vendor is essential if the company decide to collaborate with a partner to implement the system (Yao *et al.*, 2012; Ngai *et al.*, 2011). *"It is not just a one-off support for installation. It is A long-term partnership"* (Ngai *et al.*, 2011, p. 123). Yao *et al.* (2012) claimed that the vendor should show enough knowledge, capability and experience in implementing projects as well as be familiar with the company's business. It is also important with having a smooth system integration (Shaul & Tauber, 2012; Ram *et al.*, 2013; Ram & Corkindale, 2014; Yao *et al.*, 2012). Yao *et al.* (2012) propose that the system should, if possible, be integrated with existing IT infrastructure. This will *"ensure data integrity and system compliance"* (p. 3519). Finally, five of the articles emphasised the need of having a high data accuracy which could be enabled by choosing the right system (Shaul & Tauber, 2012; Ram & Corkindale, 2014; Manisha *et al.*, 2015; Saade & Nijher, 2016; Biehl, 2007). To see the list of CSFs identified for implementations of SCIS, in the literature review, see table 10, below.

Table 10: CSFs for SCIS implementations derived from literature review

#	Critical Success Factor	CSF subcategory	Sources
1	Communicate effectively	Communicate effectively with supply chain partners	1, 2, 7
		Cooperate cross-funtionally and communicate effectively within the organisation	1, 2, 3, 4, 6, 7, 8, 9
		Establish effective teamwork within the project group	1, 2, 3, 4, 5, 9
2	Measure performance	Monitor and evaluate performance	1, 5, 8, 9, 10
		Develop trouble shooting tools and other performance measurement systems	1, 7
3	Manage change	Establish excellent project management skills	2, 3, 4, 5, 9, 11
		Formulate a clear project plan, timelines, schedules and implementation strategy	2, 6, 8, 11
		Establish excellent change management skills	3, 4, 5, 6, 9
		Involve the end-users in the implementation process	1, 2, 3, 4, 5, 6, 10, 11
		Select a project champion	2, 3, 4, 5
4	Establish sufficient resources and competences	Obtain financial support and resources	6, 11
		Assure sufficient technical support to assist with hardware and software difficulties	7, 9, 12
		Establish a reliable and sufficient technology and technical intrastructure	1, 3, 4, 5, 7
		Assure high capacity and competency among the staff and users	3, 5, 6
		Ensure sufficient commitment and support from the vendor and other trading partners	1, 4, 5
5	Manage people and culture	Establish a motivated organisation ready for change	1, 2, 3, 5, 10, 11
		Create a culture of trust, high morale, integrity and a positive attitude	1, 3, 4, 6, 7, 8
6	Assure top management support	Assure top management involvement and support	1, 2, 3, 4, 5 ,6, 7, 8, 10, 11
		Make sure top management understands project benefits	7, 11
7	Create a clear vision and build a business case	Build a business case to justify project and to create a shared belief of costs/benefits	2, 3, 10
		Create a clear business plan and vision and well defined goals and objectives	2, 3, 4, 5, 6, 8, 9, 11
8	Educate and train	Educate and train end-users and other staff to esure that the system is properly used	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11
9	Choose the right ventor and system	Assure good fit of the system in the organisation	1, 2, 3, 5, 9
		Ensure compatibility with existing systems and delivery of accurate and reliable data	1, 2, 3, 4, 6, 7, 8
		Select vendor carefully	8, 10

4. Study on SCIS CSFs

The study on SCIS CSFs includes an interview study and a survey. *The purpose of the interview study is to gain a deeper understanding of the CSFs derived from the literature review. The purpose of the survey is to validate the results from the literature review, examine the CSFs general relevance and potentially reduce the list of SCIS CSFs.*

Concerning the interview study we use a deductive thematic analysis and the findings are structured around the derived CSFs from theory. The findings from the survey are presented with key-metrics. Then follows an analysis of the findings. First, the analysis focuses on interpreting the findings from the interview study within each CSF category, as well as identifying connections between the categories. Lastly, we analyse is the results from the survey, and create a strict definition of a CSF.

4.1 Findings

Table 11: Findings from interview study and survey

#	Critical Success Factor	CSF subcategory	Sources*	Mean (Lb - Ub)	Standard deviatio	Respondents
		Interview study		**Survey**		
1	Communicate effectively	Establish effective crossfunctional communication within the organisation	1, 2, 6	6.7 (6.6-6.9)	0.51	34
		Project group enjoys good cooperation and shares a unified view of how to change	2, 5			
		Establish transparancy both internally and along the supply chain	1, 3, 6			
2	Manage change	Select a dedicated and experienced project manager who is staying within the organisation	1, 2, 4, 6	6.2 (5.9-6.5)	0.91	35
		Have a dedicated and experienced project group striving to accomplish a common target	3, 4, 5, 6			
		Involve the end-users from the beginning of the implementation project	1, 2, 3, 4, 5, 6			
		Have a clear project plan with a structured process and a clear prioritisation strategy	3, 4, 5, 6			
		Perform a sufficient analysis of current situation and system requirements before developming the system	4, 5, 6			
3	Assure top management support	Assure top management involvement and support	1, 6	6.2 (5.9-6.6)	1.05	35
		Make sure top management understands consequences of the implementation and believe in the project	2, 3			
		Top management should initiate the project	4			
4	Educate and train	Educate and train end-users to ensure that the system is used correctly	2, 3, 5, 6	6.0 (5.7-6.2)	0.71	35
		Ensure sufficient education of the organisation in order to maintain and develop the system	3, 5			
5	Establish sufficient resources and competences	Establish sufficient human, financial and technical resources and competences	2, 3, 4, 5, 6	5.9 (5.7-6.2)	0.73	35
		Choose a vendor with the right competance	2, 5			
		Have a clear understanding of the current processes and the business logic	2, 3, 6			
		Assure that the organisation has the resources to succeed with the project	4, 6			
6	Choose the right vendor and system	Choose a vendor with the right competance	2, 5	5.9 (5.5-6.2)	1.05	34
7	Manage people and culture	Manage expectations and make employees in the organisation believe in the success of the project	1, 3	5.7 (5.3-6.0)	1.06	35
		Establish a culture of trust and participation and make empoyees feel comfortable about the change	3, 4, 6			
		Create a willingness to change within the organisation	5			
8	Create a clear vision and build a business case	Build a business case	2, 4	5.5 (5.1-5.8)	1.11	34
		Create a clear business plan, vision and clearly defined targets	2, 3, 4, 6			
9	Measure performance	Frequently test and evaluate the system	1, 3, 5, 6	5.2 (4.8-5.6)	1.13	35
		Establish a proper documentation and follow up process during and after the project	5, 6			

*Meeting schedule is found in appendix A

Communicate effectively

Three of the participants explicitly emphasised the importance of communicating effectively. One participant explained that effective communication is required to create a unified view of the project among the people involved. This is not an easy task and cultural differences within the organisation can, for example, prevent good communication.

> *"Cultural differences between people working in the offices in Sweden and Germany made the communication difficult and the employees were lacking trust in each other's decisions."*

Half of the participants felt that transparency is critical for the success of a project. They explained that each function within an organisation that is affected by a change has to be involved in the change. Sharing information and enabling transparency is essential. For example, if the processes change concerning the receiving of orders, procurement becomes affected by the change and has to adapt. Sometimes functions that are not directly involved in a project may also be affected. One example of this could be customer service as customers might be affected by delivery problems. Lack of transparency can also have an affect on the attitude of the employees towards a project. Rumours can be created, spreading disinformation and concern among the employees. The project can therefore experience unnecessary resistance. It is also important to be transparent towards supply chain partners, for example about delivery delays caused by the implementation.

> *"Good communication was of high importance and everyone within the company was informed of the development of the project, for example concerning delays, updates or changes. We even informed suppliers that we went through an implementation phase and that delays were to be expected."*

A final aspect of effective communication that two participants highlighted is the importance of good teamwork within the project group.

> *"The project group is important and it is essential that the group can work together effectively, enjoys working together and dares to take difficult decisions."*

Manage change

Four of the six participants argued that the project manager has a very important role and should be experienced. The project manager should have enough knowledge about the system and be able to communicate effectively with the other project members. One participant mentioned that it is preferable if the manager stays within the organisation after the project is finished in order to keep knowledge about the project within the organisation. One participant described:

> *"The project manager has many important purposes. He or she must be able to coordinate all the activities and make sure that the goals and targets are met. The project manager has to be dedicated and should require the same dedication from other project members. The manager should also be sure of the scope of the project in order to exclude activities that are not relevant for its progress."*

Three participants emphasised that the members of the project group are also critical for the success of the project. The members of the project group should strive to accomplish a common target. They should also have enough experience to gain trust from the organisation and to pursue the necessary tasks with efficiency. The members also have to possess an inter-disciplinary understanding to drive change effectively. Four out of six participants thought that involving end-users should be highly prioritised. One practitioner also mentioned that end-users should be involved already from the beginning of a project. The lack of involvement can sometimes prevent the whole implementation:

> *"The manager handled the communication with the internal employees. Unfortunately, when the manager considered the system to be ready to "go live" the end-users had not been involved in the process. The project manager had done all the tests of the system by himself and the users had not been trained. Due to the lack of involvement the employees refused the change and it was not an option to "go live".*

Another participant argued that involvement could be critical in order to make the end-users get out of their "comfort zone".

> *"It is important to involve and train the end users, who also need to understand the underlying purpose of the implementation. It is partly*

psychological and if they do not understand the purpose they might not make an effort to get out of their "comfort zone" and consequently not change."

Four of the participants spoke about the importance of performing a structured project. This includes conducting a clear project plan and to follow it. It will help the project group to prioritise and reach the goals. The system requirements should be settled early; otherwise the development of the system could become costly, as it might not be correctly developed the first time.

Assure top management support

All but one participant emphasised the importance of assuring top management support and making top management believe in and understand the project. One participant suggested that the best way of gaining top management support is to have them initiate the project. Their support is critical in order to get necessary resources. One participant discussed:

> *"As a WMS implementation is usually a large transformational project it is crucial that top management understands the consequences and especially the benefits from the implementation."*

Another participant discussed top management support connected to employees' engagement:

> *"A success factor is to create a feeling of trust and security among top management. Their expectations have to be managed. It is important that top management show their commitment and belief in the decisions that are made towards the employees in order to increase their engagement."*

Educate and train

Four out of the six participants emphasised the need of education and training. All of these four mentioned that end-users should gain proper education. Two participants also discussed the timing of the education.

> *"The organisation has to be properly educated. Truck drivers and other warehouse staff should be trained late in the implementation process and their education is about repetition to ensure that the new processes are working as soon possible after the system has "gone live". Super-users*

and other employees working in an office environment should begin their education when the testing of the system starts."

Another participant further elaborated on how much time to dedicate to education and training:

"Concerning the education and introduction to the new system the operators of the warehouse was given a lot of time to get acquainted with the software, months before the project went live. In contrary, production operators were only given a few days, and some operators did not feel comfortable with the change. Maybe all operator should have been given a sufficient education."

Two of the participants suggested that educating the whole organisation is important. If a consulting firm is performing the majority of the implementation it is important that the organisation also learn about the system. A participant discussed how this can become an issue if not accomplished:

"As the implementing company was not part of the development of the system the company is now dependent on the consultancy firm, which is both time and money consuming. The consultancy firm and the company should have worked closer together in order to develop knowledge within the organisation."

Establish sufficient resources and competences

All but one participant argued that resources and competences are key for a successful implementation. Two participants mentioned that financial resources are critical and that the allocation of these resources should be decided upon early. One participant highlighted that SCIS projects should not be underestimated. The people involved have to understand that in some stages of the implementation a lot of time have to be dedicated to the project.

"To make sure that the project becomes successful it is important that the company or organisation dedicates enough resources, both time and money, to the project. The right people should also be dedicated to the project."

Half of the participants mentioned that it is necessary that the people driving the change have an understanding of the processes where the changes should be performed. Without an understanding of current processes it is difficult to define a new desired situation. One of the participants reflected on a failed implementation:

> *"There had been flaws in the designed solution, both technical and operational. The customer had a rapid flow of goods in their warehouse and at the same time narrow spaces, consequently causing bottlenecks. The processes had not been fully understood and the bottlenecks had not been correctly identified. No action plan for bottlenecks had been developed."*

The participant further reflected on his own contribution to the project as a project manager:

> *"I think that I had the necessary competence to manage the project and gain the necessary trust from top management. A bottleneck analysis was properly conducted and necessary changes in the system and operations were made. At the end the project became very successful and the picking efficiency was tremendously increased."*

Finally one participant thought that the people driving the change should understand the company's business. They also need to have a good understanding of how the integrated systems communicate.

Choose the right vendor and system

Two participants emphasised the need of choosing a vendor with the right competence. One of them argued that that this is much more important than the system itself: "*The systems are often commodity products"*.

Manage people and culture

Two of the participants discussed the necessity of managing expectations and make the organisation believe in the project. One of them explained:

> *"There was a great belief in the success of the implementation, probably originating from earlier successful projects. This was probably why so many worked so dedicated for such a long time."*

The other participant commented:

> *"There was initially a reluctance to the project among some colleagues. But as the project continued the changes were communicated throughout the company and the projects involved many experienced employees. The*

reluctance diminished and was turned into faith in the new system and in the end almost everyone believed in the change."

Two of the participants spoke about creating a culture of trust, engagement and participation. Another participant reflected on the importance of willingness to change:

"People involved in the warehouse operations were unwilling to change. The system had to be adapted to the existing processes even though it would have been more efficient to change some processes to fit the system needs."

Create a clear vision and build a business case

The majority of the participants thought that formulating a clear vision and well defined targets is a key factor to succeed. A participant working at a consultancy firm explained:

"The targets of the project should be clearly defined at the beginning of the project. The project manager needs to know why the customer is buying the system, which should be communicated between the consultants that are selling the system and the project manager."

The goals should guide the solution and one participant explained his thoughts:

"The logistics should be business-driven. For example, if the goal is to make picking more efficient the desired outcome can be reached by designing just-in-time oriented processes."

Some participants emphasised the need of building a business case in order to justify the initiation of the project and to gain the necessary resources.

"A background study should be performed before the start of the project to make sure that the vision and the goals are properly defined. It is important to build a business case before initiating a new project. Furthermore, there must be an understanding between the initiator of the project and the project manager. If this is not in place the process might be slow and imprecise."

Measure performance

One participant emphasised the importance of the documentation of the project. Sometimes changes in the system are needed after the project is finished. It can then be critical to have sufficient documentation to be able to make these changes. Another participant believed that it is important to develop proper follow-up processes after the project is finished. The majority of the participants highlighted the need of testing and evaluating the system. The timing and magnitude of the tests are important as well as who is performing the tests. The purpose of the tests are mainly to increase efficiency of the project and consequently decrease costs. One participant shared:

> *"The integration between information systems can be tricky and time consuming. It is therefore important to understand the business logic and how the systems communicate, which is most effectively done by testing the integration early and in many different ways."*

Another participant commented:

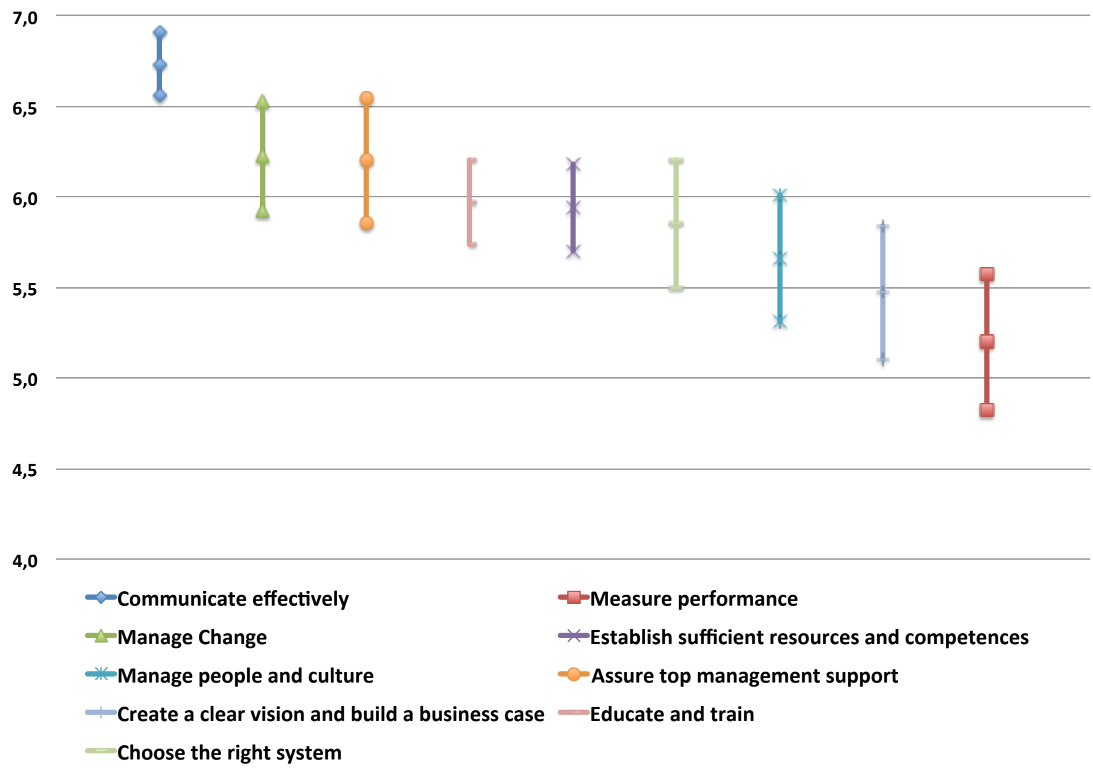
> *"The testing is an educational phase and has to be prioritised. The phase should optimally begin when both the design of the solution and the development of the system are finished. Otherwise, the testing can become costly since new tests have to be made for each time the system has been further developed."*

Results from survey

35 questionnaires were collected and the result is presented in table 12 below. The mean ratings are seen in the first column together with lower and upper bound and indicate the CSFs criticality. They are arranged from top to bottom after the mean values and the size of the confidence intervals.

The results show that Communicate effectively is considered to be the most critical factor, while Measure performance is considered to be the least critical. It is worth mentioning that all of the identified CSFs have been given a rating above five. Only three have a rating above six. The standard deviation varies from 0.5 to 1.1. Communicate effectively stands out with only 0.5 and Manage people and culture, Assure top management support and Create a clear vision and build a business case have the highest deviation of 1.1. For another visualisation see figure 9 below.

Figure 9: Mean and confidence intervals



4.2 Analysis of the findings

4.2.1 Interpreting the findings from interview study

Each CSF is interpreted and we reflect on the connections between the categories. If the findings from the interview study had shown aspects that were not connected to any of the CSF categories, derived from literature, new categories would had been created. However, no new categories were derived.

Understanding the CSF categories

Effective communication seems to have strong connections to teamwork. Everyone involved in a project, both within the organisation and along the supply chain should receive necessary information and be able to understand each other to reach desired results together. Transparency is vital to create good communication within a company and is required by both partners and employees within the organisation. When transparency is not achieved, anxiety among the employees can arise and lead to mistrust throughout the entire supply chain. Resistance to change may therefore increase. Measure performance is interpreted as a continuous evaluation of the system during and after the implementation. This includes running tests to evaluate the performance of the system and document each step of the implementation. The objective of performance measurement during the implementation is to guide the future work, and consequently contribute to an efficient project. Measure performance also goes beyond the project, and the participants argue that this factor is still important after the project is finished. It seems clear that without this factor it is difficult to know if the project has accomplished its objectives. If the project is successful it can also assist in marketing future initiatives of SCIS implementations.

Manage change are the activities, mainly performed by the project group, to manage the change that an implementation entails. This includes both activities to manage each part of the project as well as managing the people that are affected by the change. Manage change puts high demand on the project group that has to have enough experience and skills to drive the change. The group should develop a clear project plan, work in a structured way, as well as involve end-users early. The project group has to understand what changes that are needed and be able to define requirements of the system. Establish sufficient resources and competences relates to securing the right and enough resources. The right competences must be included in order to make the project manageable. The people that are involved in the project need to have the capabilities to enable an efficient implementation of high quality. It is important to not underestimate a project and enough time and money need to be dedicated.

Manage people and culture is about establishing a positive feeling and belief among the employees and a culture within the organisation that supports change. The employees should participate in and feel comfortable about the change. Assuring top management support is about decision-makers' support and belief in the project. This is essential not only to secure enough resources for the project but also to affect how the project is communicated throughout the company. Without the support from top management the project group is on its own. This support could be vital if more resources than expected are needed, if resistance to change among employees occur or if cooperation between functions does not work out as planned. Create a clear vision and build a business case means setting an overall purpose of a project and justifying it. It is essential to know how the company will benefit from the implementation and to know the long-term vision of the project. This will help the project group to focus on doing the right things and get enough resources to do it. Educate and train is regarded as how the employees and end-users are prepared for the change to the new system. Education should enable a smooth transition and make end-users comfortable with the new system. If the organisation cooperates with another company to implement the SCIS, it is important that the organisation learns from the partner to avoid becoming dependent on the partner in the future. In the last category, Choosing the right vendor and system, only the choice of vendor was emphasised. Choosing the right vendor can be specifically important if the vendor possess valuable information about the system that the company is lacking.

Connections between CSF categories

It becomes apparent that there are strong connections between the CSFs. For example, in order to accomplish one CSF, another CSF might have to be applied. Top management support seems to have an important role when establishing sufficient resources and competences. If a project has a strong support from the top management it is more likely that enough resources are dedicated to the project and that the right people are allocated to work on the project. One participant mentioned that gaining the managers trust is important as well as making them believe in the project. One subcategory includes the presence of an experienced project manager, which could help gaining trust of top management. This subcategory is related to Manage change.

Some subcategories may require other subcategories to be applied. For example, the project group should strive to accomplish a common target in order to successfully manage change, which requires effective communication within the group and a unified view on how to change. Another type of connection is when subcategories are similar but connected to two different CSF categories. For example, several of the participants argue that education of end-users is critical, which is included in the educate and train category. Involving end-users, related to manage change, can also concern training, however, it incorporates a wider approach than just education.

No new CSF categories

From the findings of the interview study, several new CSF subcategories were created. However, all of those subcategories were considered to have a natural place within one of the earlier identified CSF categories. One example of a new subcategory is the need of educating the whole organisation, which was not mentioned in the literature review. The subcategory fits within the CSF category educate and train. The findings also show that the practitioners often agree on how to perform a successful SCIS implementation. More often than not, more than one participant mentioned a certain aspect. Some aspects were highlighted by almost all participants. In the last interview no new aspects were mentioned, which indicated that a saturation of the study had been reached.

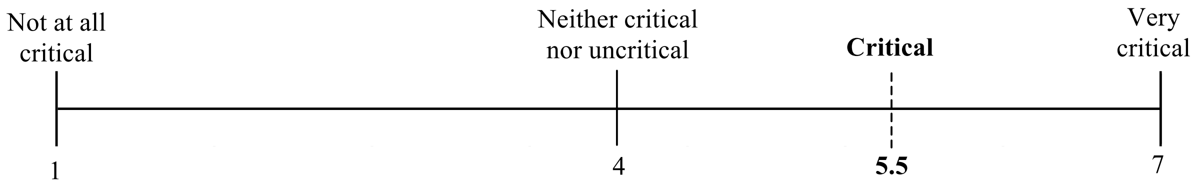
It can be argued that the CSFs derived from theory were tested on the "real world" and according to the findings almost all of the derived CSFs seem to apply. Every aspect that was mentioned by a participant was considered to fit within one of the defined categories. We believe that this is an indication that the CSFs derived from theory are exhaustive. If many of the aspects mentioned by the practitioners had fallen outside the categories, it might had been a good idea to extend the review in order to search for more CSFs. All participants mentioned aspects within four or more CSF categories and two participants even commented on aspects within all of the categories. The aspects mentioned by the practitioners connect to all nine derived CSFs. However, no participant claimed that choosing the right system was critical to succeed in a SCIS implementation. One participant even argued that SCIS are commodity products. The reason behind the difference in opinion between theory and practice can have many explanations. One explanation can be that no participant had any experience of their organisation implementing a system that did not fit. This made it difficult to discuss the consequences of such an implementation.

4.2.2 Analysis of survey statistics

The survey attempts to build knowledge about an underlying target population; practitioners working with SCIS implementations. It is obvious that, to build knowledge about this population, it is essential to analyse the mean ratings of each CSF. However, the confidence intervals for these ratings are also important. If the intervals are narrow it is likely that a result from a replicated survey, that studies the target population in its whole, would show a similar result. Examining the confidence intervals in table 12 it is possible to conclude that they are relatively narrow. It can therefore be concluded that the mean ratings are good indicators of the CSFs' criticality in general.

The result from the survey shows that the participants did not consider the nine identified CSFs as equally important. Due to the high rating, it seems clear that no one would like to run a project without the CSFs communicate effectively, manage change and assure top management support. Other CSFs did not receive as high rating. At first glance, it may seem like an implementation could still be successful without the CSFs manage people and culture, create a clear vision and build a business case and measure performance. However, if a specific project would manage without the CSFs is difficult to answer. Each project is different and the CSFs are probably not equally important in each project. Instead, the purpose of the survey is to explore the general criticality of the CSFs and potentially reduce the list. We argue that a strict definition of a CSF should be determined in order to reduce the list. This raises an important question; at what rating should the factors be considered as "critical"? If a CSF receives a mean rating of 4.0 it is neither considered critical nor uncritical. But what about a mean of 5.0? This rating indicates that the factor is more critical than not, but should it be regarded as "critical"? As a mean of 4.0 indicates that the participants neither consider the factor to be "critical nor uncritical" and a mean rating of 7.0 indicates a "very critical" factor, a rating that represents a "critical" factor would be somewhere in the middle.

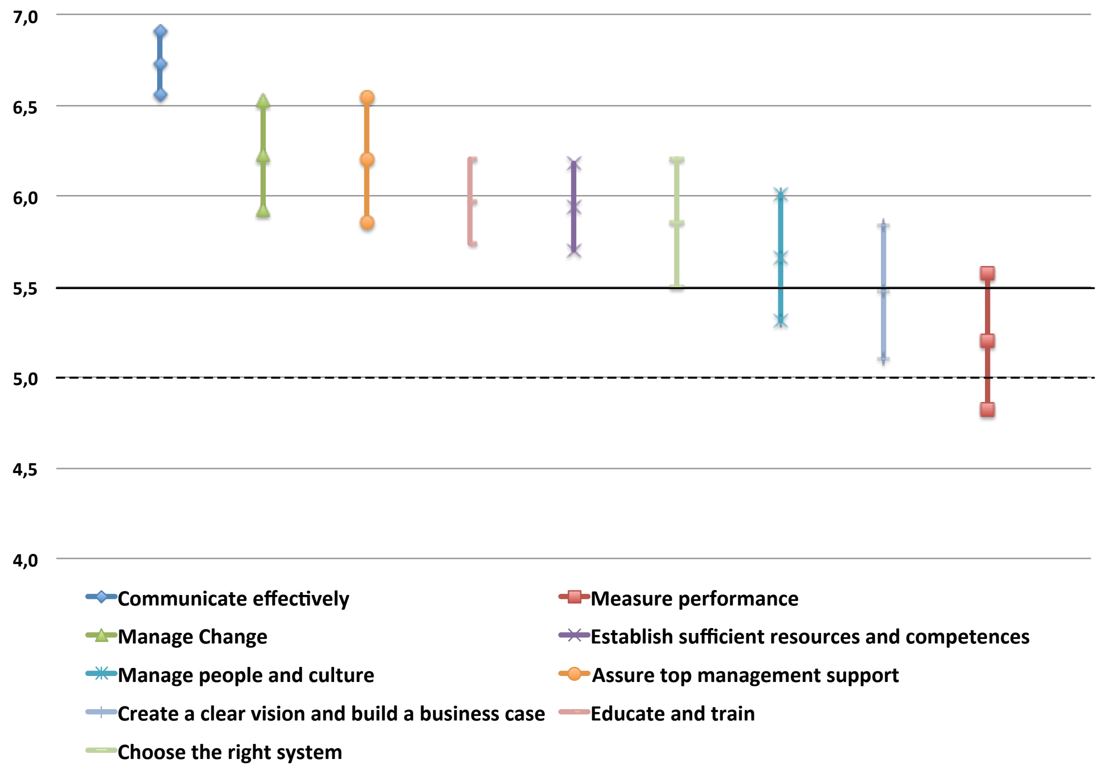
Figure 10: Minimum mean rating for a CSF



As illustrated above a minimum mean rating of 5.5 is arguably the most reasonable mean for a CSF to be considered "critical", as this rating is located between "critical nor uncritical" and "very critical". In this case the factor Measure performance, with only 5.2, would not be considered as a CSF. The factors Create a clear vision and build a business case with 5.5 and Manage people and culture with 5.7, would just be on the limit.

When determining a strict definition of a CSF we claim that it is not only important to study the mean ratings in this specific survey. It is also important to consider potential mean ratings for replicated surveys. We believe that it is reasonable that the mean for a CSF should, to a 95% certainty, be greater than 5.0. Therefore, we define a CSF as a factor that has been given a mean rating of at least 5.5 and a lower bound of 5.0 or above. The limits can be seen in figure 11, below.

Figure 11: Limits of the mean and lower bound



It can be concluded that a higher mean allows a wider confidence interval. A factor above 5.5 could still be neglected as a CSF if the confidence interval is wider than 0.5. A factor with a confidence interval of 1.0 would still be considered as a CSF if the mean is 6.0 or greater. The mean and lower bound for Measure performance are both lower than the limits. This indicates that Measure performance is not considered to be enough critical by the practitioners to be incorporated in the list of CSFs. All of the other CSFs are above both limits. Worth noticing is that even though no participant in the interview study mentioned the importance of choosing the right system the CSF Choosing the right vendor and system has been given a relatively high mean rating in the survey. This might be due to the importance of choosing the right vendor. The strict definition helps we to make decisions regarding inclusion and exclusion in the final list of CSFs. Hopefully the result from the survey reflects each CSF's criticality independent from the ratings of the other CSFs. If the participants compared the criticality of the CSFs between each other, instead of evaluating each factor individually, the result could solely be regarded as the relative criticality among the CSFs. In this case all of the factors could be critical and measure performance just slightly less critical than the others. Then it is not obvious that any CSF should be excluded from the existing list of CSFs.

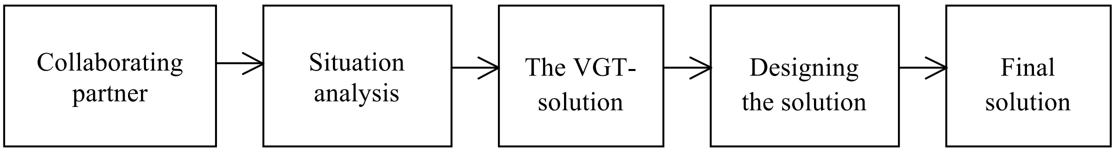
With the knowledge gained from study 1 it was possible to answer RQ1, which can be found in the concluding chapter 6.1. It was then possible to begin with study 2, a single case study of a real time video technology implementation, to answer RQ2.

5. Single case study at Axis Communications

The purpose of the single case study is to investigate how relevant the CSFs for SCIS implementations are when implementing video technology, in the shape of a VGT-solution.

The single case study enabled us to reach a deeper understanding about the implementation of a VGT-solution. The combined knowledge from the single case study and the previous study provided a strong basis for conclusions regarding CSFs for video technology. Through performing the single case study it was also possible to provide recommendations to Axis on how to implement a VGT-solution. The recommendations were summarised in an implementation plan together with a business case, ready to be presented for decision makers. The overview of the chapter can be seen in figure 12 and is further described below.

Figure 12: Process of the single case study



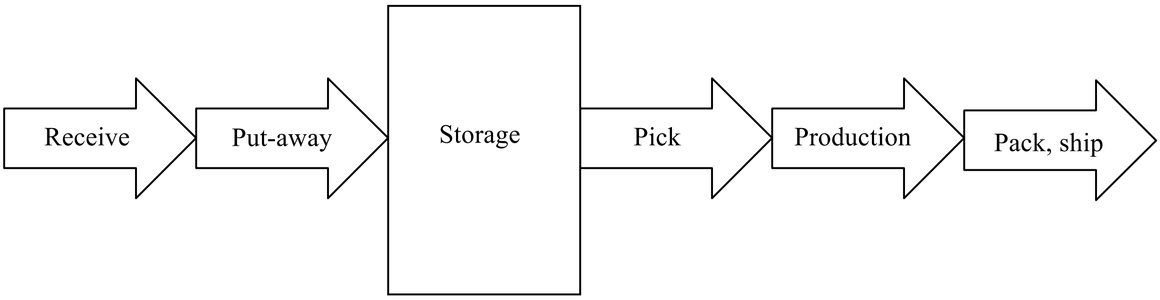
The chapter begins with a presentation of the collaborating partner and gives an introduction to the company and its industry. The second part aims to provide a good understanding about the present situation. The third part of the case study describes each component of tha VGT-solution. The fourth part is called designing the solution and includes the process of designing the VGT-solution to solve the present issues at Axis. The final solution is then presented, including recommendations to succeed with the implementation.

5.1 Description of collaborating partner

Axis Communications is a manufacturer of network cameras mainly used within the field of video surveillance and physical security. Axis is a multinational company, present in 179 countries all around the world. The company is a rapidly growing and their sales increased with 22% 2015 to the amount of 6,635 billion SEK giving a profit margin of 13,3%. (Axis Communications 2, 2016).

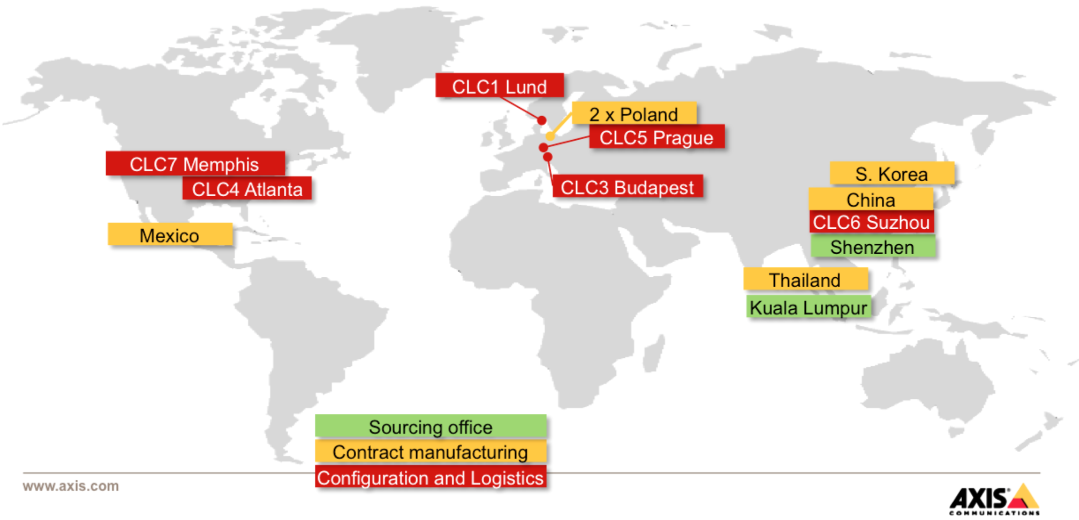
Axis technology is used in a wide range of industries. Axis cameras can be found anywhere from retail, hotel & restaurants to prisons, casinos and banks. Axis wants to provide a complete range of products and solutions to their customers for a broad spectrum of applications and industry segments **(**Axis Communications 1, 2016**).** The company has to a large extent outsourced their technology and their contracted manufacturers are spread over the world. In order to have a responsive supply chain Axis has kept some operations in their configuration and logistics centres (CLCs). Besides production the CLCs also act as distribution centres and includes a warehouse, storing both finished products as well as raw material. The general warehouse process at one of Axis' CLCs can be seen in figure 13, where production or assembly occurs between picking and packing.

Figure 13: The process of the configuration and logistics centres



Axis has six CLCs, three in Europe, two in the USA and one in China. CLC6 in China is relatively new and only a small part of the products sold are sent via that CLC. The company has a B2B sales strategy and the cameras are sold to large distribution chains. All sold products pass through their CLCs (Axis Communications 2, 2016). As can be seen in figure 14, the American market is served by CLC4 and CLC7 while the European CLCs cover the rest of the world, except CLC6 that covers parts of China (A1, 2016).

Figure 14: Geographical locations of Axis' CLCs and contracted manufacturers



5.2 Present situation at Axis

The present situation at Axis will now be described. First, an investigation of the cost of claims is presented. This is followed by a thorough description of relevant parts of CLC1, including layout, routines and processes.

5.2.1 Cost investigation

When customers make claims, Axis has to provide new products, creating costs. The cost investigation begins with determining how great the costs are today and what type of delivery discrepancies that occur. It continues with determining what markets that are affected. The last part of the investigation covers what type of products or product families that makes up today's costs. The investigation guided how to design an efficient solution. For example, if only a few types of products would have been identified as cost carriers, the solution would only have focused on those products.

From the extracted data it was possible to calculate the total yearly costs caused by customer claims worldwide, summed to 2.8 million SEK. These costs encompass the Cost of Goods Sold (COGS) and do not include any costs from claim procedures. It is clear that a claim process creates costs in terms of handling the affected customer and spending time on repairing the damage. However, as no data of these types of costs was accessible it was excluded. Therefore, the costs are only derived from Axis' loss of money from having to produce products to replace the lost ones. There are four types of claims connected to quantity discrepancies. Three of them can be derived from the shipping process. Wrong quantity, Missing goods and Wrong article concern packages not delivered or wrong packages delivered. Missing parts concerns missing pieces within a package. Pieces within packages are mainly handled in the production stage. As can be seen in figure 15, shipping mainly handles whole packages and not the smaller pieces.

Figure 15: Connecting types of delivery discrepancies to warehouse process

Shipping	Wrong quantity Missing goods Wrong article
Production	Missing parts

It was possible to conclude that 89% of the cost of claims worldwide (Wrong quantity (67%), Missing goods (9%) and Wrong article (13%)) could be derived from shipping and only 11% (Missing parts) could be derived from production. This can be seen in table 12, below.

Table 12: Segmentation of worldwide costs of claims according to type of delivery discrepancy

Wrong Quantitiy	Wrong Article	Missing parts	Missing Goods
67%	13%	11%	9%

The next step of the investigation was to study the percentages of claim costs per country. It proved the notion that the majority of the claims were connected to the American market. As can be seen in table 13, CLC4 and CLC7 serve the American market and together they accounted for 75% of all costs of claims, a total value of 2,1 million SEK. CLC1 stands for 13%, which is still a significant share of the total costs. CLC3 and CLC5 stand for 5% and 7% and CLC6 is not represented at all.

Table 13: Costs of claims per CLC

CLC1	CLC3	CLC4	CLC5	CLC7
13%	5%	39%	7%	36%

Finally, we wanted to investigate if the costs could be derived from any specific products. Table 14 shows the percentages of the costs of claims per product line. A product line is defined by a number of products that have the same or similar specification and abilities. There are four major product lines at Axis: P, Q, T and M, representing cameras and supplementary parts to the cameras. As can be seen in table 14, a large share of the costs of claims can be derived from each major product line. Products included in ACC and F concerns licenses, software packages and other parts that do not contribute to any great claim cost for Axis.

Table 14: Costs of claims per product line

ACC	F	M	P	Q	T
2%	3%	19%	31%	31%	14%

As 89% of the cost of claims can be derived from shipping the most efficient VGT-solution would only focus on shipping and exclude earlier stages in the warehouse process. As almost all product lines are included in the claim statistics the solution have to include each product flow in the shipping process. Due to these conclusions the further analysis of the present situation focused on the shipping station at CLC1, including analysis of routines, layout, and processes.

5.2.2 Shipping at CLC1

CLC1 is a low intensity warehouse. The strategy is focused on high level of customisation instead of cost efficiency (A6, 2016). The operators in shipping use manual handling of products and machines are only used for a few specific tasks (A4, 2016). Due to the low intensity there is little need for standardisation and the operators enjoy much flexibility in the shipping process. For example, there is no specific location where a pallet should be prepared. Furthermore, there is no specific place where the pallets are strapped. Instead, a movable machine is used for this task. When pallets have been prepared and strapped, they are placed in a storage area. The pallets are not wrapped in plastic until the day after, before the forwarding agent arrives (A3, 2016; A12, 2016).

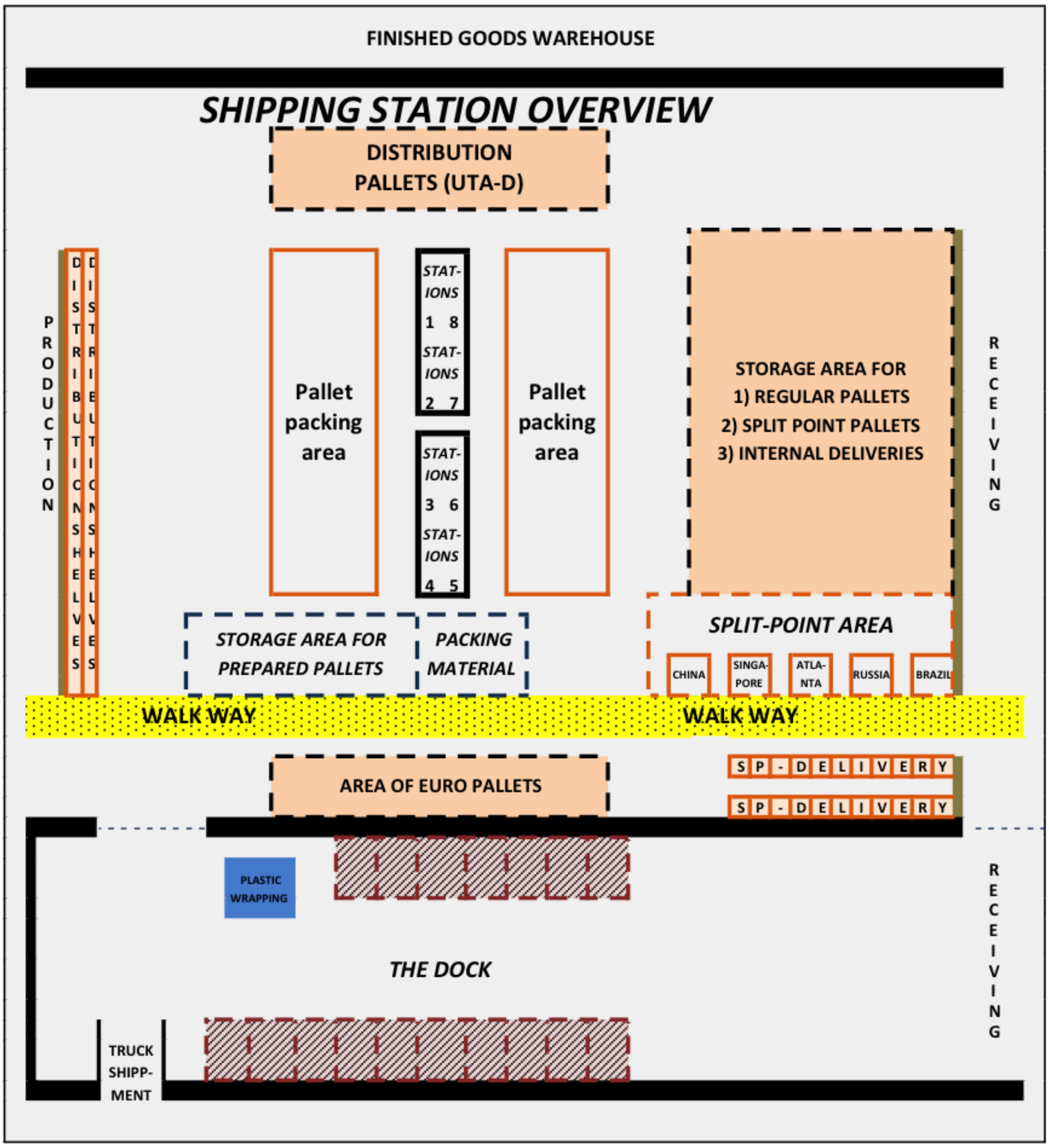
The responsibility for the shipping process is divided between two work groups. The main work group is called “Shipping” and perform the majority of the shipping process. They have the responsibility of receiving and accepting orders, scanning orders and to register that the product has changed location. They also prepare and strap pallets. Finally, they perform the plastic wrapping. The other working group is called “Transport” and transports some packages from the shipping station to the forwarding agent’s truck. The transport group is also involved in the final control of packages put on certain pallets (A3, 2016).

Sometimes throughout the year the intensity is much higher than normal. Every station used for registering of the packages can then be occupied and each available area in the shipping station could be used for storing pallets. Under more controlled circumstances, when the flow is low or normal, each designed area is used for its correct purpose (A3, 2016).

5.2.3 Identifying physical conditions

The shipping station at CLC1 is located next to production, receiving and the warehouse for both raw material and finished goods. The layout of the CLC1 can be seen in figure 16, below. As can be seen in the layout each operating station has been given a number, ranging from 1-8. Pallets are prepared at the pallet packing areas close to these stations. If a pallet is sent to a split-point location it is prepared in the split-point area. A split-point location is a location somewhere around the globe from where the packages are allocated to a final destination. The split-point locations are located in China, Singapore, Russia, Atlanta and Brazil (A4, 2016). There are several storing locations in the shipping station. Next to receiving, there is a dedicated area where prepared pallets are stored. Packaging material and euro pallets are stored on each side of the walkway. There are two shelves where packages that are not sent on pallets, but as single packages, are stored. Finally, there is a dock where pallets are wrapped in plastic. In the dock there are racks where pallets can be stored, waiting to be shipped. The dock is shared with the receiving station, using the other half of the room (A3, 2016).

Figure 16: Present layout of the shipping station at CLC1



5.2.4 Shipping process

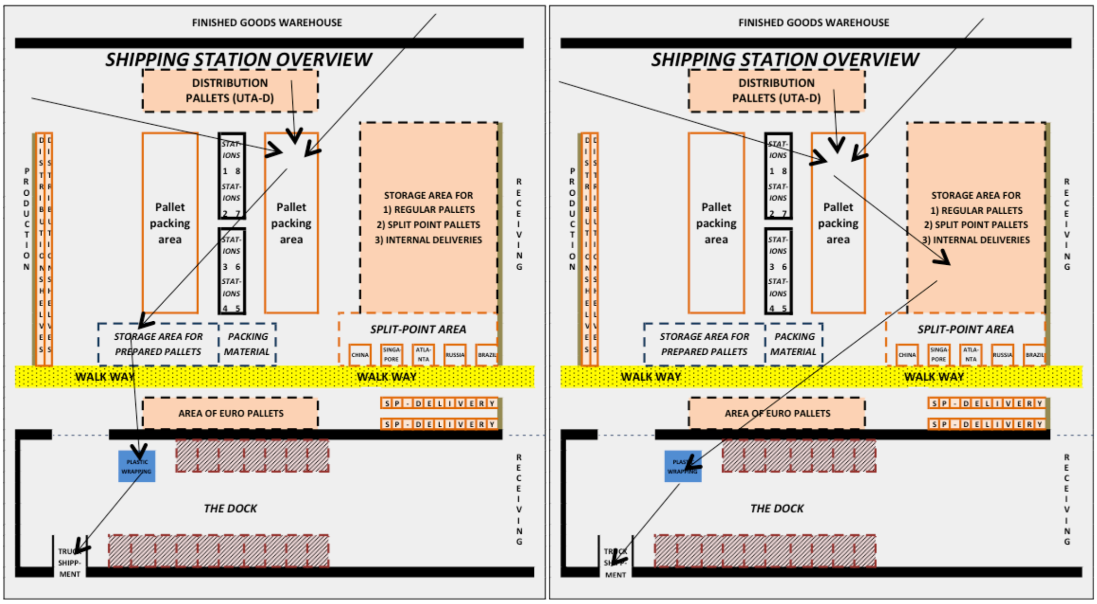
The process begins when the operator prints out an order; where after a pick list is received. The pick list consists of either products from the finished goods warehouse or from production. The full order is aggregated and controlled by the operator at one of the eight operating stations. The pick list is then reported into IFS, the ERP-system (A2, 2016; A3, 2016).

Figure 17: The four product flows in the shipping process

Flow 1: Pallets sent directly to customers	Flow 2: Pallets sent to split points	Flow 3: Single packages sent directly to customers	Flow 4: Single packages sent to split points

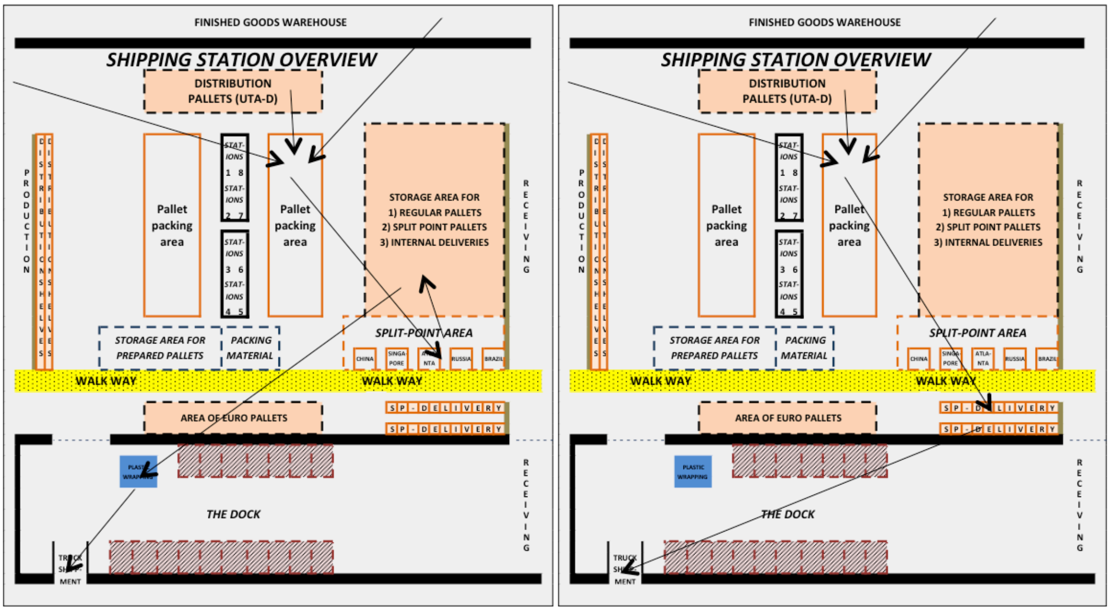
As seen above, in figure 17, there are mainly four types of product flows. The first product flow, see figure 18, concerns pallet deliveries shipped directly to a customer. These pallets are built up by packages in the pallet packing area. Delivery documents and the list of contents are then printed out. If required by the customer the pallet is strapped before it is wrapped in plastic and finally shipped. The second product flow, see figure 18, concerns pallets that are prepared in the pallet packing area but sent to split point locations. They go through almost the same process as the pallets in flow one. The only difference is that after preparation they are stored in the split point area where after they are counted and controlled (A3, 2016**).**

Figure 18: Flow 1 (left) and flow 2 (right)



The two last product flows concern single package deliveries, see figure 19, below. Similar to pallets these packages can either be sent directly to customers or to split point locations. First, each piece included in a package is scanned, where after the delivery documents for the package are printed out. This procedure is the same for both flows.

Figure 19: Flow 3 (left) and flow 4 (right)



The third product flow concerns single packages that are sent to split point locations. After the documentation procedure the single package is placed on a split point pallet in the split point area. Before the pallet is ready for delivery the packages are counted and controlled. If required by the customer the pallet is strapped before it is wrapped in plastic and finally shipped. The fourth product flow concerns packages sent directly to a customer. After registration in IFS the packages are put on one of the two SP-shelves. On the day of delivery they are put on a pallet located next to the SP-shelves. This pallet is not strapped or wrapped in plastic. It is only used for transporting the packages from the SP-shelves to the truck shipment location. The full process chart can be seen in appendix F.

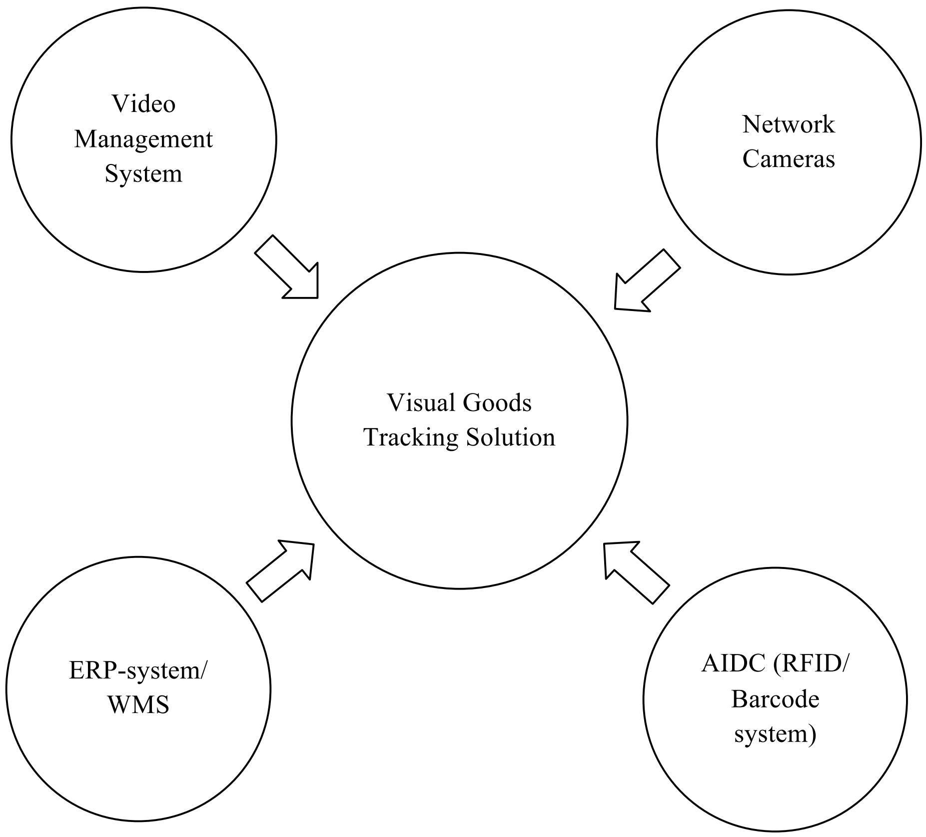
5.3 The Visual Goods Tracking Solution

When the present situation at Axis was understood, the natural step was to explore the Visual Goods Tracking Solution. In this chapter we first describe the general idea behind the VGT-solution and what technologies are required. Each of the technologies is then further investigated.

5.3.1 The idea behind the VGT-solution

The VGT-solution consists of a Video Management System (VMS) integrated with a WMS or an ERP-system, an AIDC system and network cameras, see figure 20.

Figure 20: Components of the Visual Goods Tracking Solution



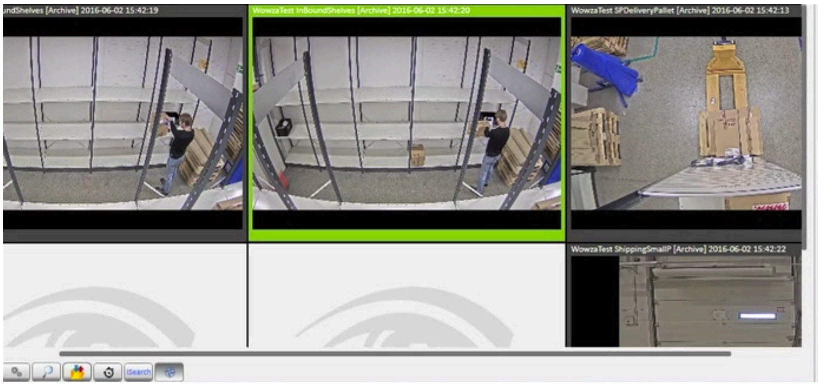
Today, it is common to integrate a Warehouse Management System with an Automatic Identification and Data Capture system (AIDC) (Axis Communications 4, 2016), such as RFID or barcodes (Axis Communications 3, 2016). These systems provide limited visibility of the warehouse processes and it is not possible to find out what has happened to a package (Axis Communications 4, 2016). The VGT-solution integrates cameras and scanners with the VMS, to capture the processes in the warehouse **(**Axis Communications 3, 2016**).** A VGT-solution allows full transparency of the warehouse processes and consequently better management of customer claims and deviations (Axis Communications 3, 2016). If a customer makes a claim, it is possible to prove what has happened by showing the recorded video. For a deeper understanding of the VGT-solution each component of the solution will be described below.

5.3.2 Video Management System

The VMS can store video sequences from network cameras and connect the sequences with timestamps generated from barcode scanning or RFID. A package can be given several timestamps. When the package finally leaves the facility the package has left a history in the shape of video sequences connected to timestamps **(**A14, 2016**).** The VMS allows a person to search through the imported video material. An example is illustrated in figure 21. As the package was transported through the warehouse it was scanned, generating four timestamps. Four images demonstrate the connected sequences in the VMS.

Figure 21: Demonstration of the VMS

Search key	Value	Location	Time stamp
Package serial number	ACC8E02C645	Camera 1	02.06.2016 08:47:13
Package serial number	ACC8E02C645	Camera 2	02.06.2016 08:50:26
Package serial number	ACC8E02C645	Camera 3	02.06.2016 13:10:40
Package serial number	ACC8E02C645	Camera 4	03.06.2016 10:52:22

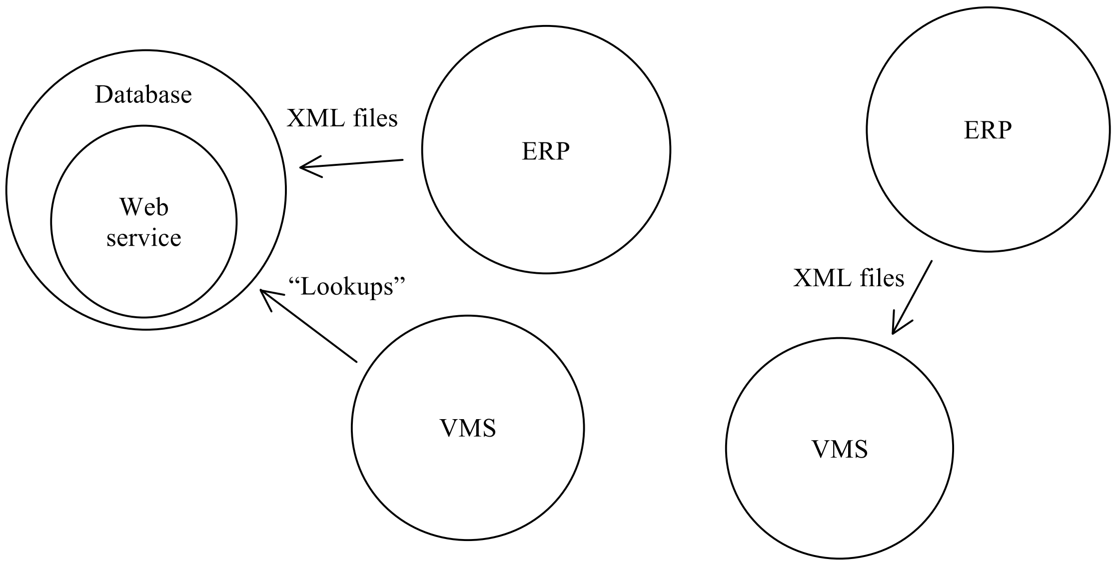


The video material is live-streamed into the VMS and stored for a certain amount of time, decided by the user. As the video recordings require a lot of memory there is an upper limit to the length of storage (A18, 2016). A partner company to Axis provides the VMS and the software have to be configured to meet the requirements of the cameras, scanners and Axis' ERP-system (A3, 2016; A14, 2016).

5.3.3 ERP-integration

In order give the VMS adequate search parameters, like the identification number of the package, the VMS has to receive necessary information from the ERP-system. Therefore, there has to be a connection between the VMS and IFS, the ERP-system used at Axis. There are certain rules and policies at Axis when dealing with their IFS. As the ERP-system is very important for most of Axis business processes the system has to be protected. IFS can communicate with other systems by sending out information in the shape of XML-files, a language for encoding documents in a certain format. Another variant is to create a database that is synced with IFS through XML file transfers and a web-service that is connected to the database. The VMS is then able to do “lookups” in that web-service without any risk of damaging IFS **(**A5, 2016**).** See figure 22 for two examples of the ERP-integration. If the operations department discovers a need of integrating a system with IFS an integration process is initiated. A business case is created to justify the project, where after the R&D team has to produce an adequate integration solution (A5, 2016)

Figure 22: Two examples of ERP-integrating solutions with a VMS



5.3.4 Network Cameras

It is vital to know what network cameras to integrate with the VMS. The choice of cameras mainly depends on where the cameras should be used, what they will monitor, distance to object and image quality needed. **(**A16, 2016; A8, 2016**)**. Camera types that are preferable to use in a Visual Good Tracking Solution are AXIS P32 and AXIS Q35, see figure 23. These are easy to handle and can be used in a warehouse context with good results (A7, 2016; A9, 2016). AXIS P32 series are cameras that work well both indoors and outdoors. They have a varifocal lens and are designed for simple and reliable installations. The cameras can be mounted on walls or the ceiling, which is useful at the CLCs (Axis Communications 5, 2016). AXIS Q35 also work well both indoors and outdoors and delivers high image quality in full HDTV. The high quality enables good image usability when the light is poor. Compared to AXIS P32 they offer a much higher image quality (Axis Communications 6, 2016).

Figure 23: Displaying the cameras; AXIS P32 (left) and AXIS Q35 (Right) (Axis Communications 5, 2016; Axis Communications 6, 2016)

5.3.5 Scanners and barcodes

Axis does not have access to RFID and therefore barcode-scanning will be used in the solution. Scanners are an essential part of the VGT-solution and therefore it is also important to have proper barcodes, containing the necessary information (A14, 2016). A scanner has to be installed at each place where a camera is mounted. In the present shipping process eight scanners are used at the eight stations in the pallet packing areas (A15, 2016).

Axis uses both 1D-codes and 2D-codes, see figure 24. The barcode label, placed on each package contains two 1D-codes. One barcode includes the serial number, which is the unique number for every package. The other code includes the part number, which is a number for a group of products that a package belongs to (A4, 2016). A new shipping module was implemented some years ago. A 2D-code is used for all orders connected to the new module, which has enabled better transfer of information. The new shipping module has enabled the ERP-system to connect a package to a certain pallet and the ambition is to transfer every order to the new module (A11, 2016). An observation in today's process was that barcodes are not placed on pallets. This means that it is only possible to scan packages until they have been placed on pallets (A3, 2016).

Figure 24: Examples of 1D-codes (left) and 2D-codes (right) (Jennie, 2016)

ABCD 12345 abcd

5.4 Designing the solution

Designing the solution consist of four parts. First, the requirements of the solution are defined. Three areas are then analysed; operating procedures, hardware and software. After the analysis we are ready to present the final solution, including an implementation plan and a business case.

5.4.1 Solution requirements

The main requirement of the solution is to be able to show if a package has been correctly delivered. Axis would then either be able to prove for the customer that the package actually was correctly delivered or discover what went wrong. A few other requirements were also formulated to guide us on how to produce a "good" solution, see table 15.

One possibility would have been to document every step of the process to ensure that no product got out of sight of the cameras. This would have required a large amount of cameras in the warehouse, which would have been very costly and inefficient. It would also have meant a tremendously decreased integrity for the employees. Therefore, a requirement of the solution is to only monitor the critical parts of the shipping process. For example, if a package is put on a pallet the packing process has to be captured (A1, 2016).

To make the solution efficient and feasible it is important to adapt the final solution to present conditions. The aim was to introduce a smooth solution that could reduce the cost of claims without demanding great changes in current processes. The solution also has to be economically feasible, which requires simplicity of the solution and that affordable technology is used (A4, 2016; A1, 2016).

Table 15: Solution requirements

#	Requirement
1	Show if a package has been correctly delivered
2	Only monitor critical parts of the shipping process
3	Adapted to present conditions
4	Economically feasible
5	Simple to implement

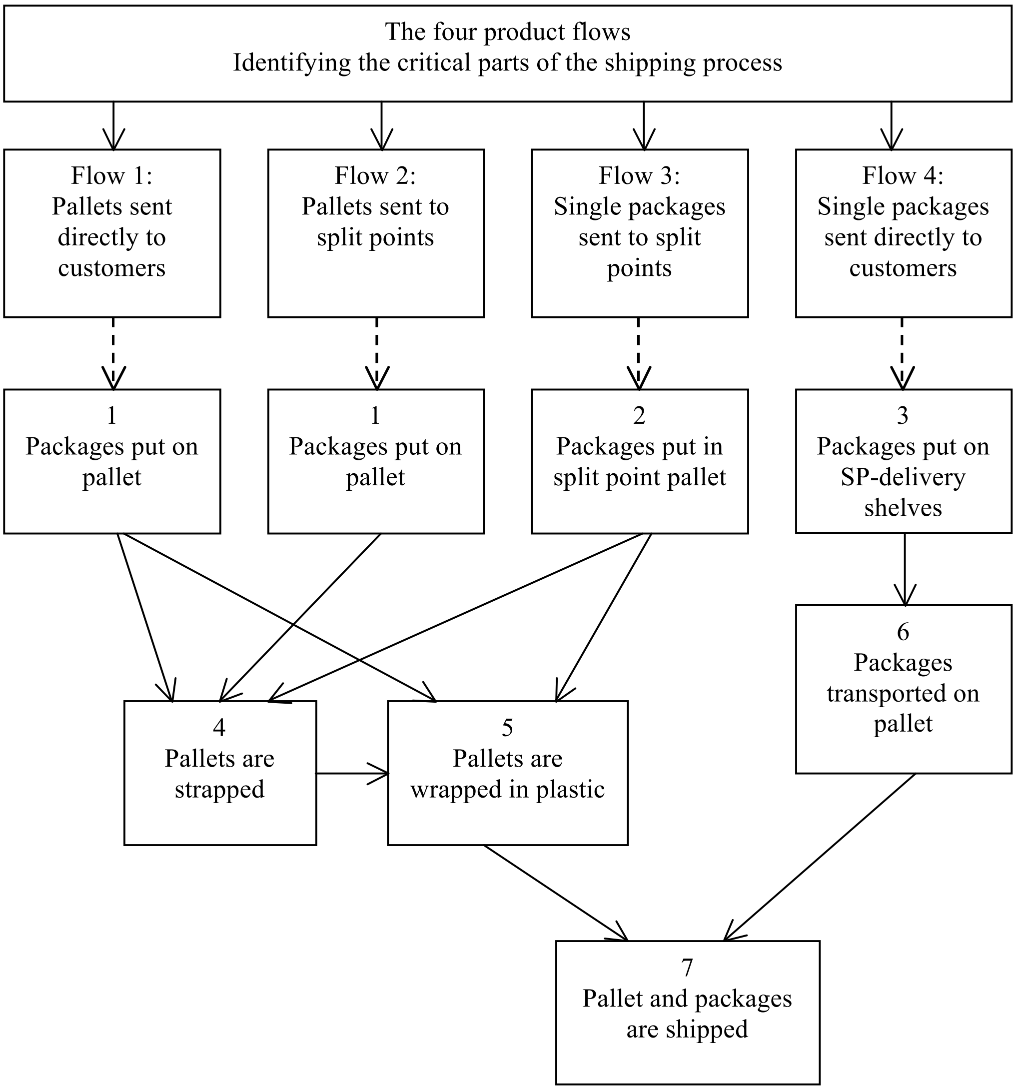
5.4.2 Operating procedures

To meet the solution requirements it was important to analyse the operating procedures in the shipping station. Required changes of processes and routines were determined. This chapter contains three parts. In the first part critical parts in the present process are identified. This is followed by a part elaborating on standardisation of the processes; why this is required and how to standardise. The last part discusses how to increase trustworthiness of the VGT-solution.

Identifying critical parts of the shipping process

When the process was mapped an identification of parts of the shipping process that has to be monitored was initiated. Seven parts in the shipping process were identified as critical to monitor. The parts of the process can be seen in figure 25. Each part has been given a number.

Figure 25: The critical parts of the shipping process

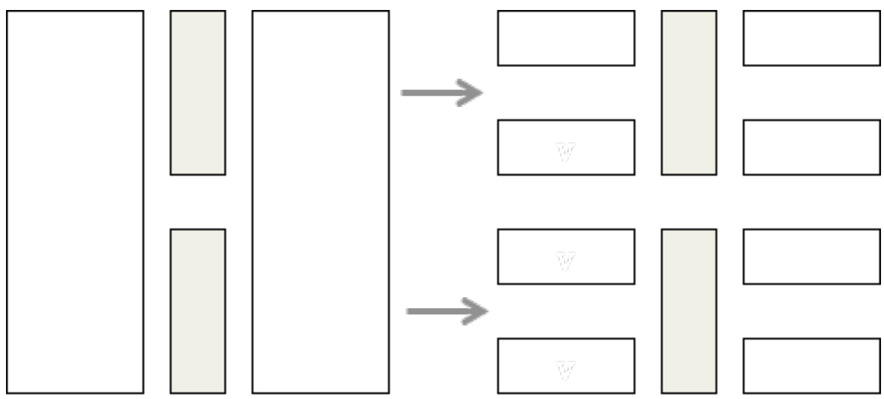


The first critical part is when pallets are prepared in the packing area, which is essential to monitor in order to prove that a package has been shipped on a specific pallet. The third part is when the packages are put on split point pallets, which also connect the packages to a specific pallet. The fourth critical part is when single packages are put on the SP-delivery shelves. The fifth part is when the pallets are strapped. If the pallet is identical to when it was prepared the customer would be ensured that no packages have been taken of the pallet. Monitoring the strapping process would then enable proof that this was the final condition of the pallet before it was shipped. The sixth critical part is when all types of pallets are wrapped in plastic in the dock. Monitoring this part is especially important for pallets that are not strapped as it would assure that nothing had happened to the pallet between the pallet was prepared and when the pallet was wrapped in plastic. The seventh part is when the packages on the SP-delivery shelves are placed on a pallet for the transport to the forwarding agent outside the dock. The final critical part is when the pallets finally are shipped. The following sections of the chapter further elaborates on what changes that are required in order to successfully implement a VGT-solution at the CLC1. In the remaining chapter the identified critical parts are referred to with numbers. The corresponding numbers can be found in figure 30, above.

Standardisation

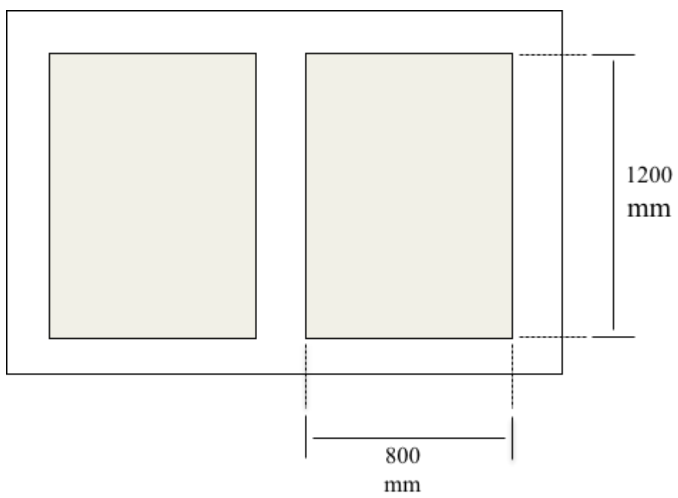
Camera surveillance decreases the integrity of the warehouse staff and it was necessary to determine how to handle conflicts between flexibility and integrity. In order to minimize decreasing integrity standardisation of some processes are needed, as less area has to be monitored. However, with more standardisation the flexibility is reduced. Three procedures in the shipping process was considered to require standardisation. Cameras would then be able to capture these procedures, without compromising the integrity of the staff. The first procedure is when the pallets sent to customers are prepared (1). In order to reduce monitored space a dedicated area would be needed, where the operators perform the pallet preparation, see figure 26 below for a visualisation. The area would be monitored by one or potentially two cameras. The second procedure that requires a dedicated location is the strapping procedure (4). Today strapping can be performed anywhere in the shipping station.

Figure 26: Standardisation of the shipping process



Based on observations and interviews with the operating staff they sometimes prepare two pallets at the same time. Therefore the size of the preparation area at each station should be large enough to include two pallets (A3, 2016). Packages are packed on euro pallets. As the size of a standard euro pallet is 800x1200 mm the minimum required area is 1600x1200 mm (EPAL, 2016). The area should of course be a little bit bigger than the minimum size, see figure 27 for a visualisation (A6, 2016). The last procedure that has to be standardised is the preparation of the pallet next to the SP-delivery shelves (6). The pallet is used for transportation of single packages to the forwarding agent. The needed area is then only 800x1200mm as only one pallet is used.

Figure 27: Required area of the pallet packing area



Trustworthiness

As pallets can be stored at many different locations in the shipping station storage will be very difficult to monitor. Pallets are prepared one day, stored during the night and wrapped in plastic the following day. If a pallet is not strapped the customer could become suspicious that something has happened with the pallets during the night. It would therefore be preferable to perform the plastic wrapping shortly after the pallet preparation. Considering the pallets that are strapped shortly after they have been prepared the delay is not considered to be a problem. To strap all pallets would therefore be another option.

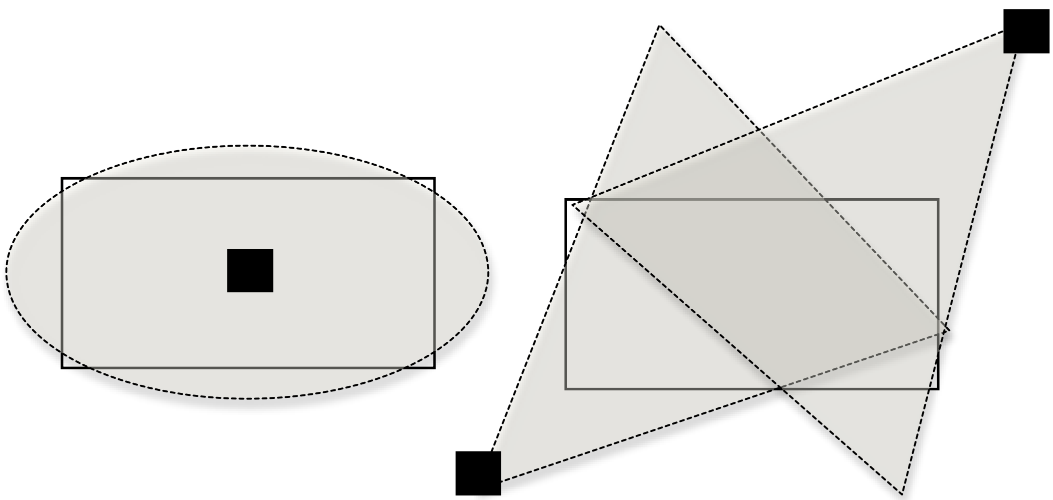
5.4.3 Hardware

The analysis of hardware focuses on how to use cameras and scanners to meet the solution requirements. The first part includes decisions regarding cameras and angles. The second part concerns how and where new scanning procedures should be included in the shipping process.

Determining cameras and angles

An important part to reach conclusions concerning hardware was a testing day at CLC1. During this day cameras were mounted and it was possible to determine type, number and angles of cameras and where they preferably should be mounted. The main factor to consider when choosing what cameras to use is if the cameras are able to capture the packages and pallets. As long as no other packages are blocking the view the packages has to be clearly visible in the video. Concerning the pallet packing area either one or two cameras can cover the area, see figure 28, below. If only one camera is used it should be placed strictly in the middle of the area. If two cameras are used they could complement each other and capture the packing area from two angles. The benefits from using one camera are lower costs, easier image handling and less need of computer storage capacity. The benefit from using two cameras is a potentially less questionable video sequence. The question to be answered is if only one camera is able to meet the system requirements. One camera would then be a more simple and less expensive option.

Figure 28: Visualisation of using one or two cameras



From observations during the testing day it was concluded that one camera attached to the ceiling, with a 90 degrees vertical view, is able to cover an area including at least two pallets. This was considered to be enough for each pallet packing area (1) as well as for a strapping area. Two cameras were considered to be enough for the split point area, covering the five split point pallets (2). With only one camera it was possible to cover a whole SP-delivery shelf (3). In the dock, one camera attached to the wall was able to capture the wrapping process (5). Another camera, also attached to the wall, was able to capture the shipping of pallets and packages (8) (A18, 2016).

New scanners and barcodes

At each monitored area a scanner is required. In total six new scanning procedures have to be added to the present shipping process. The first new scanning procedure has to be added before the pallet is strapped (4). The second procedure is the scanning of single packages when they are put on the split point pallets (2). The third and fourth procedures are the scanning of single packages when they are put on respectively taken off from the SP-delivery shelves (3) (6). A fifth scanning procedure is required before the pallets are wrapped in plastic (5) and the last one when the pallets and single packages are finally shipped (7). When the pallets are prepared the operators already scan the packages before putting them on the pallet. Therefore no new scanning procedure is required when performing the preparation. No barcodes for pallets are printed out today. However for the solution to work properly, attaching barcodes on pallets are required.

An important observation is the need for stationary barcodes (A11, 2016). A stationary barcode is not attached to a package or a pallet but is instead attached to a wall or fixed location. Its purpose is to enable the creation of timestamps in the VMS when a package or a pallet do not have an attached barcode. This is especially important when the single packages are transported between the SP-delivery shelves (6) and the truck shipment (7). The pallet used for the transportation is taken back to the warehouse; hence no barcode can be attached to this pallet. A solution would therefore be to attach a stationary barcode to the wall next to the SP-delivery shelves (6) that could be scanned each time the single packages are transported.

5.4.4 Software

The last part of designing the solution concerns the software integration. It begins with describing how the ERP-system should be integrated with the VMS. It is followed by a description of the computer requirements. Finally, the length of video storage is discussed.

ERP-integration

In order to track the products the serial numbers of the packages put on a pallet have to be connected to the serial number of the same pallet. This is only possible if an integration between the VMS and the ERP-system is created, as the shipping module in IFS creates such connections today. This is needed as the VMS must be able to create a video sequence with the help of timestamps derived from the scanning of both the package and the pallet the package is put on (A5, 2016; A6, 2016).

As described in the empirical study the VMS is not able to access the ERP-system as it is protected. The VMS can instead be given information by the ERP-system at certain times during the day sent as XML-files containing all necessary information. This means that the information is not sent in real-time. There is always a risk for time delays in real-time information transfers, which could create wrong timestamps.

In order to enable the integration between the ERP-system and the VMS it will be necessary to configure the VMS according to the XML-files sent by the ERP-system (A14, 2016).

Computer specifications

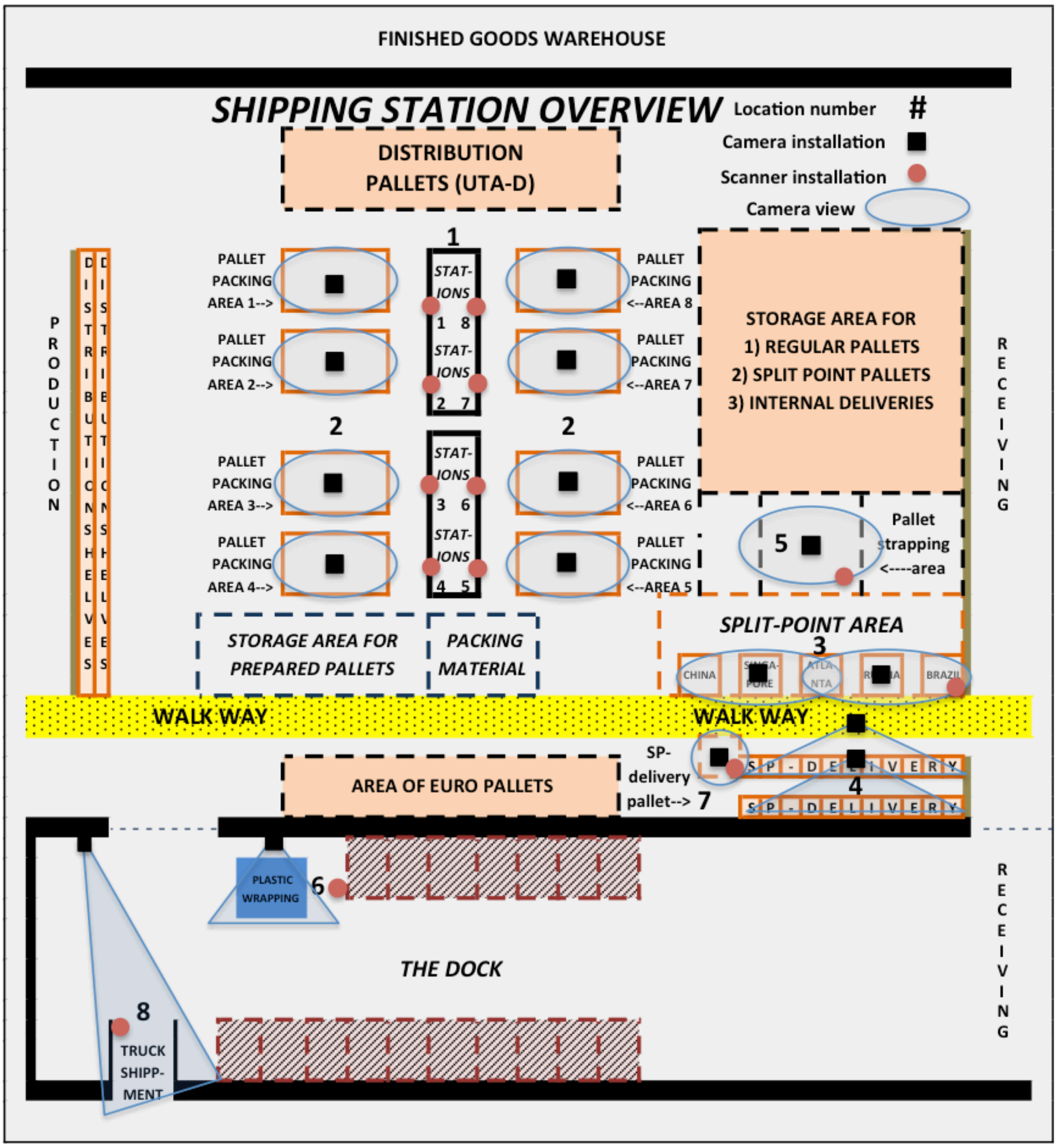
When video streaming is performed from several cameras into a VMS there is a need for a large storing capacity. The extent of capacity depends on the amount of cameras and the time that the videos must be stored. The VMS requires a hard-drive with a large memory capacity and approximately one terabyte of storage capacity is required **(**A19, 2016**)**. The amount of time that the videos have to be stored need to be at least equal to the time a customer has to report a claim. Today that time is set to ten days and therefore the videos have to be stored the same amount of time, maybe even longer. This is of course something that needs to be revised as the system is up and running. The time should be adapted to the behaviour of the customers. Cost of storage capacity should also be considered. Also worth to consider is that storing the images for a long time will affect the warehouse staff. Storing the images for a long time will affect their integrity and might cause resistance to the implementation **(**A20, 2016; A15, 2016**).**

5.5 Final solution

This chapter presents the recommendations on how to succeed with the implementation of a VGT-solution. The chapter presents the proposed layout, seen in figure 29, of the shipping station and the required changes in the shipping process. The solution is translated into 12 recommendations, considered as either critical or preferable. The chapter ends with presenting a project description, including what resources that are required and a time plan. Lastly, a cost/benefit analysis is presented, estimating the costs, the savings potential and the profitability from implementing the VGT-solution.

5.5.1 Layout and process of the solution

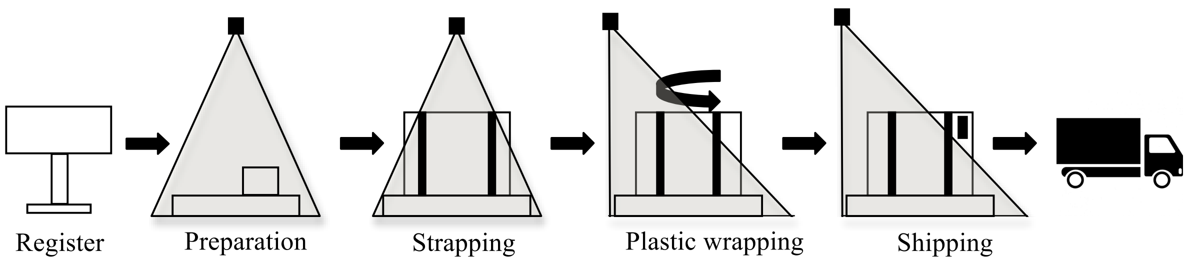
Figure 29: Recommended layout for the Visual Goods Tracking Solution



According to the requirements the recommended Visual Goods Tracking Solution is adapted to most of the existing processes. The solution is adapted to monitor the four product flows in the process and the description of how the solution is designed is described below. The numbers (#) indicate the locations where the procedures take place and can also be seen in the layout, see figure 29.

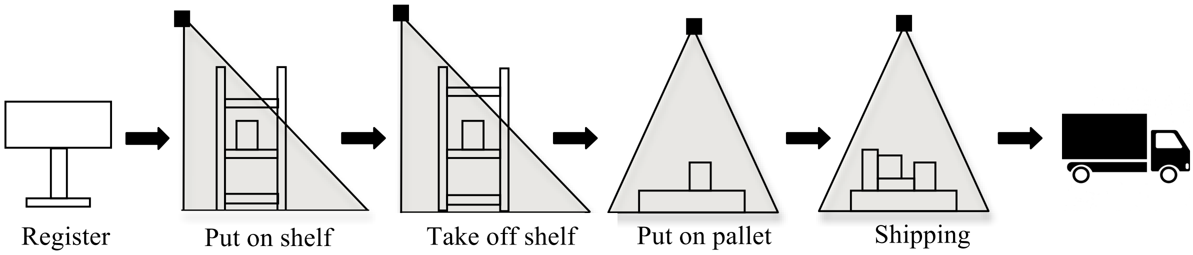
Concerning where the packages and pallets are monitored and scanned, the first product flow (pallets shipped directly to customers) and the second product flow (pallets shipped to split point locations) are treated in the same way by the VGT-solution. A visualisation of the shipping process and what procedures the cameras should monitor can be seen in figure 30 below. The first step of the process is when a package is registered into IFS (1). The package is then put on a pallet in a dedicated pallet packing area, see figure 30 (2), and the process is captured by a camera located directly above. Both package and pallet is scanned and the package is connected to the same pallet. Consequently, all pallets need to have a barcode attached. Pallets are then strapped before they are wrapped in plastic, which is either performed at the pallet packing area (2) or at the pallet strapping area (5). If the strapping procedure is performed at the strapping area the customer is able to compare the appearance of the pallet to when it was prepared at the pallet packing area. If the pallet is not strapped the customer is able to compare the appearance of the pallet right before it is wrapped in plastic (6). In both cases the appearance of the pallet should be identical to when it was prepared. A final video is taken when the pallet is shipped (8). At each monitored stage in the shipping process the operator scans the barcode of the pallet to create a timestamp in the VMS. By knowing the serial number of a disappeared package it will become easy to follow all the steps in the process, from placing the package on a pallet until the pallet is shipped.

Figure 30: Monitoring the critical steps of flows 1, 2 and 3 in the shipping process



The third flow includes single packages sent to split point locations and is visualised in the same way as the two first product flows, see figure 30. First, the package is registered in IFS (1) where after the process of putting the package on the split point pallet is captured (4). To import a timestamp into the VMS the package is scanned before it is put on the pallet. When the split point pallet has been prepared, and is moved, a stationary barcode attached to the wall is scanned enabling another time-stamp. This is done in order to be able to compare its appearance to when it is strapped (5) or wrapped in plastic (7). The strapping of split point pallets containing single package deliveries is performed in the pallet strapping area (5). Lastly, a video is captured when the pallet is shipped (8). Once again the operator scans a stationary barcode on the wall before delivering the goods to the forwarding agent.

Figure 31: Monitoring the critical steps of flow 4 in the shipping process



The fourth and last flow includes single packages sent directly to customers and is visualised in figure 31. After the package has been registered in IFS the package is scanned and captured on video as it is put on any of the two SP-delivery shelves (3). A video is then captured when the package is scanned and taken off the SP-delivery shelves (3). The operator also scans the package when it is put on the SP-delivery pallet (7). Once the pallet is full and about to be transported another timestamp is created by scanning a stationary barcode connected to the pallet (7). The pallet is then transported to the dock where a video of the pallet is taken before the package is shipped (8). Since the pallet does not posses any serial number a stationary barcode is once again attached to the wall next to the door. Before the pallet is delivered to the forwarding agent the stationary barcode is scanned, adding the last time-stamp.

5.5.2 Recommendations

Eleven recommendations are presented in table 16 on how to successfully implement the Visual Goods Tracking Solution and to enable the described solution. The recommendations have been divided into three main categories; hardware, software and operating procedures. The level of importance for each recommendation is indicated. A critical recommendation is required for the solution to work, while preferable recommendations will increase the quality of the solution. In some recommendations we refer to locations in the layout, see figure 29.

Table 16: Recommendations to implement the VGT-solution

Category	#	Recommendation	Importance
Hardware	1	Mount and install 16 cameras according to the layout, where one black square represents one camera	Critical
	2	Cameras AXIS P3225-LV should be installed at locations 2-7 and AXIS Q3505-V 9MM at location 8	Preferable
	3	Scanners should be installed at locations 4-8 according to the layout, where one red dot represents one scanner	Critical
Sofware	4	An integration between the VMS and IFS is needed to transfer information obtained at location 1 to the VMS	Critical
	5	All orders should preferably be registered in the new shipping module in IFS	preferable
	6	Barcodes should be printed out for pallets prepared at location 2 and for split point pallets at location 4. This demands a configuration in IFS	Critical
Operating procedures	7	A pallet prepared at location 2 should be prepared within its dedicated pallet packing area	Critical
	8	A pallet should be strapped within a pallet packing area or in the pallet strapping area	Critical
	9	The pallet transporting single packages from the SP-shelves shoule be prepared within its dedicated area	Critical
	10	A package should be put on the pallet as soon as possible after it has been scanned	Preferable
	11	A pallet that is not strapped should preferably be wrapped in plastic as soon as possible after it has been prepared	Preferable
	12	Seven new scanning processes should be included in the shipping process; when pallets are strapped (5), when putting single packages on split point pallets (4), when putting single packages on the shelves (3), when taking single packages of the shelves (3), when transporting single packages from the shelves to the dock (6), when wrapping pallets in plastic (7) and lastly when shipping packages and pallets (8). The numbers (#) indicate where the process take in the shipping station.	Critical

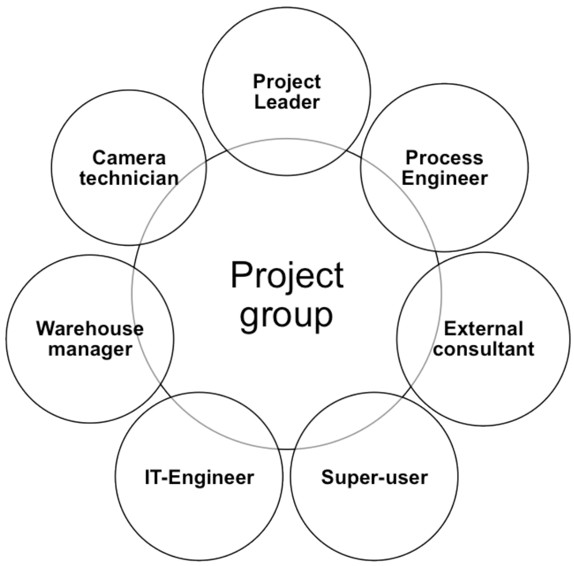
5.5.3 Project description

The project description gives an understanding of what resources that are required and how much time that has to be dedicated to the VGT-implementation. The chapter then presents a cost/benefit analysis with the costs and savings potential of the VGT-implementation.

Human resources

Seven persons are needed in the project group in order to succeed with this VGT-implementation, see figure 32.

Figure 32: The project group



One person needs to be knowledgeable in IT-solutions and ERP-system integrations. For example, integration between the VMS and the ERP-system needs to be configured and the files sent by ERP-system need to be converted to a readable format. The ERP-system and the shipping module need to be updated according to the new requirements, making it possible to put barcodes on pallets. There is also a need to include a process development engineer that has knowledge about the warehouse processes. Preferably this person also knows how the shipment module, scanners and barcodes are used in the warehouse and how these procedures can be changed and developed. Concerning procedures and routines within the shipping station knowledge from both the warehouse manager and one super-user will be needed. This is important in order to evaluate the development of the solution and to make sure that the solution is feasible. They will also be needed in order to communicate the changes to the remaining staff within shipping.

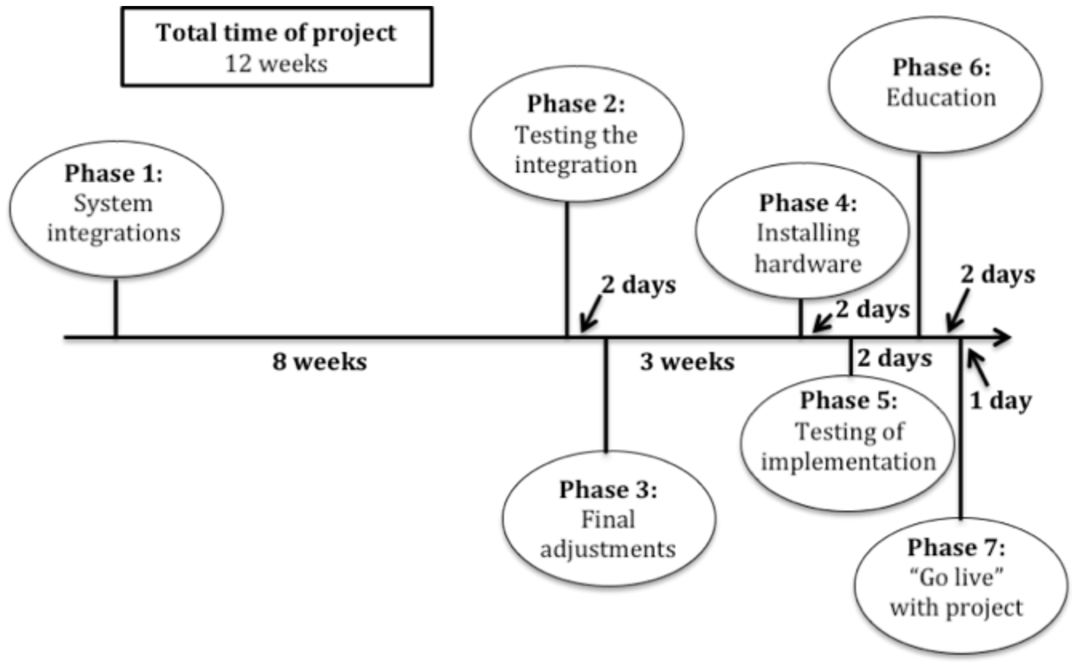
One expert on network cameras with knowledge about camera installations needs to be a part of the project group. This person will not only be present as an expert on questions related to the cameras but will also mount the cameras during testing days and the final installation. There is a need of an external consultant to help with the integration between the VMS and the ERP-system, the cameras and the scanners. This person also needs to educate the staff that handles claims in how to use the VMS when receiving claims. Finally a project manager is needed to manage the project from the start until it “goes live”. This person needs to have certain knowledge of how a VGT-solution works and have the knowledge and capacity to lead and to communicate with the different experts within the project group.

As the VGT-solution is a small change project it will not require that seven persons are fully dedicated to the project. Several of the participants will only be needed at some meetings in order to be briefed about the development of the project and to communicate their perspectives. The time plan will be presented below, but it can be pointed out that the project will not be done in a couple of weeks, more likely two or three months due to lead times. Therefore an assumption is that during the time of the project the camera expert and the process development engineer dedicate 10% of their time. The warehouse manager and super-user dedicate 5% of their time. The IT-engineer can be assumed to dedicate 50%, and finally the project manager is assumed to dedicate 30% of the time (A21, 2016).

The time plan

The total time of the project is assumed to be 12 weeks and should begin with a start-up meeting with all the project members to communicate the purpose of the project. A visualisation of the time of the project is found below in figure 33.

Figure 33: The project time plan



After the start-up meeting eight weeks will be needed to configure the ERP-system and to integrate the VMS, the cameras and the scanners. Meanwhile, the shipping staff needs to be prepared for the change and new routines and procedures needs to be analysed and discussed. New scanners and cameras should also be purchased well in time before they are needed.

When the system has been configured and all necessary hardware is at hand the first test should be initiated. It will then be a good idea to install the VGT-solution for only one of the identified product flows. This should preferably be the flow of pallets sent to customers, as this is the most common product flow. Two full days for the testing of the system needs to be dedicated in order for the staff to understand the new routines and to test if the software and hardware configurations work as expected. After the testing days it is important to take one step back and to analyse the results. Three weeks should be dedicated to the final adjustments in order to fine-tune the system. When the identified problems are solved and the final solution is determined the full installation of cameras and scanners can be performed. To not interfere with the daily work and cause downtime at the shipping station cameras and scanners can be installed during a weekend.

When the hardware is mounted and installed the full solution needs to be tested. If not used, the cameras and the scanners will not interfere with the normal procedures. Therefore it is possible to test the solution during a normal workday. During this day it is essential to analyse the full potential of the VGT-solution and to test that everything works as it should. When the testing day is finished, with hopefully good results, the operating staff needs to be educated in the new solution before the project "goes live". To enable the staff to experience the new procedures and to try for themselves two full days should be dedicated. This is partly done to make everyone feel comfortable about the change but also to make sure that the operations is running as usual. The solution should then finally "go live" and everyone at Axis, especially all employees in the warehouse, should be informed.

Cost/benefit analysis

The cost investigation indicated that costs caused by customer claims during 2015 were 2.8 MSEK. 2.5 MSEK (89%) of these costs can be derived from Shipping. We estimate that 80% of the costs derived from Shipping can be reduced through a worldwide VGT-implementation, which gives a savings potential of 2 MSEK per year. From interviews with employees that had experience from other implementations of Visual Goods Tracking it became evident that a large part of the customer claims would likely disappear (A1, 2016; A12, 2016).

The costs to implement the proposed solution were estimated to 1 MSEK. The costs include salary for the project group, hardware costs, costs for the VMS and costs for educating the staff, see table 17. This gives a return on investment (ROI) of 100% and a pay-back time of 0.5 years for a worldwide implementation (table 18). In table 19 it can be seen that the ROI and pay-back time is remarkably better for CLC4 and CLC7. CLC3 and CLC5 have a negative ROI the first year and a pay-back time greater than a year. After an implementation at CLC1 we therefore recommend Axis to implement the solution at CLC4 and CLC7. To read the full business case, see appendix G.

Table 17: Cost of the VGT-implementation

Type of cost	Cost
Project group	320 000 SEK
Hardware	260 000 SEK
VMS	400 000 SEK
Education	20 000 SEK
Total cost per CLC	200 000 SEK
Total cost worldwide	**1 000 000 SEK**

Table 18: ROI and Pay-back time for a worldwide implementation

Savings potential worldswide	2 000 000 SEK
Cost of implementation worldwide	1 000 000 SEK
Return on Investment (ROI)	**100%**
Pay-back time (years)	**0.5**

Table 19: ROI and Pay-back time per CLC

CLC#	1	3	4	5	7
Savings potential	260 000 SEK	100 000 SEK	780 000 SEK	140 000 SEK	720 000 SEK
Cost of implementation	200 000 SEK	200 000 SEK	200 000 SEK	200 000 SEK	200 000 SEK
ROI	**30%**	**-50%**	**290%**	**-30%**	**260%**
Pay-back time	**0.8**	**2.0**	**0.3**	**1.4**	**0.3**

5.6 Analysis of the VGT-project

This chapter aims to determine the relevance of the SCIS CSFs when implementing a VGT-solution and discover how barriers that prevent implementation can be overcome. First, we discuss the importance of each derived SCIS CSF category for a VGT-implementation. Second, we establish a strict definition for a VGT CSF. Finally, the relevant CSFs are connected to the identified barriers when implementing video technology in a warehouse.

5.6.1 CSFs for the VGT-implementation

Communicate effectively

Effective communication is essential when implementing a VGT-solution. Time is money and communication is critical to accomplish the right things, within the decided time frame. Even though the project is relatively small and limited long lead-times can occur due to badly organised project groups and slow and inefficient communication. Effective communication between the company and the distributor is essential. The distributor has the knowledge about the VMS and needs to know how to correctly configure the VMS according to the solution. Transparency is also important and the vision of the project has to be communicated throughout the organisation. This is especially important as the solution incorporates the implementation of cameras, which can decrease the integrity of the staff.

Manage change

To manage change is essential when implementing a VGT-solution. The success of the project highly depends on the project group's capability to drive change. Even though the VGT-implementation is relatively small and does not affect the whole organisation the project requires a significant amount of technical and financial resources as well as time dedicated to the project. The project also affects people, mainly the warehousing staff. The project requires a project manager who knows how to set clear goals, communicate effectively and build acceptance of the project. A project group would consist of several different specialists and therefore it is important that the project leader knows how to communicate with people with different competences. The manager would also need to know how to use the different competences in the project. To conduct a situation analysis in order to learn the processes and to understand how to drive the change is important. This will have a significant effect on the speed and quality of the project. As cameras are installed, monitoring people, change management could be very critical. The project group has the responsibility to make the end-users feel comfortable about the change and their potentially reduced integrity. At least one end-user should be included in the project group to let the end-user affect the solution. This will make them feel involved and will potentially reduce their unwillingness to change.

Assure top management support

Like most of the SCIS implementations examined, it is essential to assure top management support when implementing a VGT-solution. Support from top management makes it easier for the project group to make decisions. It would increase the capacity for action and the engagement among employees would become higher. To create a positive attitude among the warehouse staff the warehouse manager has to believe in the project. Top management support will also affect the extent of recourses that is dedicated to the project. As the project is small, the amount of resources needed are less than for many other SCIS implementations. Hence, the support might not have to come all the way from the CEO. However, the support from a middle manager will have a similar effect on the project.

Educate and train

To make the staff feel comfortable about the change involvement in the project is important. Training can be a good approach to involvement. However, the VGT-implementation does not require any major changes of the current processes and to use the VGT-solution is not a difficult task. Consequently, the necessary training of end users is limited. The users still need to understand how the solution works, how they can affect the quality of the solution and why they should perform tasks in a certain way. For example, they should understand why and where they have to scan packages and pallets and the reason behind the change. However, this is easily communicated and no thorough training is needed.

Establish sufficient resources and competences

A VGT-implementation is considered to be a rather small project. The solution can be implemented within a few months, compared to a WMS implementation that could take years. The business case showed that the cost of implementing the solution is relatively low. Other SCIS implementations, such as ERP-systems can take up a large part of the company's budget. Consequently, the requirements of resources and competences are less. Still, sufficient resources and competences are needed to succeed with the project, especially concerning the integration of the VMS. The integration requires people with good knowledge in software integration and the vendor of the VMS has to be committed and dedicate enough time to the project. Establishing sufficient resources is heavily depending on management's belief in the project and their willingness to support the project.

Choose the right vendor and system

Developing long relationships with business partners is considered to be important for many companies. It does not only make it easier to finish joint projects successfully but it can also increase the competitiveness of the organisation. Concerning the VGT-solution the VMS might be considered as a commodity product but it is still essential that it possesses the necessary functions to fulfil the needs of the buyer. Furthermore, to have an experienced vendor of the VMS can be important in order for the solution to work properly. With an experienced vendor it will probably also be possible to develop the system in a joint collaboration, which could enable new and unforeseen possibilities.

Manage people and culture

Manage people and culture is deeply connected to the values shared between the employees and the atmosphere within the organisation. In a change project people and culture is almost always important to consider. Without the affected peoples' willingness to change nothing will happen. Managing people and culture becomes of course more important in a bigger project. The VGT-implementation is relatively small, mainly affecting the staff within the shipping station. However, even for a small project it is difficult to manage change if the culture within the organisation does not support change. The project group needs to understand the culture of the organisation and have the capability to reach out to the concerned people. It is important to involve the end-users from the beginning and make them believe in the project. It is also important that the operating staff does not become suspicious to the idea behind the VGT-solution. The purpose of the solution, to monitor goods and not people, must be clearly understood by the staff.

Create a clear vision and build a business case

It is important to determine why the solution should be implemented and what benefits and costs that would come with it. If the project is not justified it will not be prioritised and sufficient resources will not be dedicated. Therefore it is essential to build a business case in order to financially justify the project. The purpose and vision of the project will guide the project group in how to allocate the dedicated resources, to determine the requirements of the solution and finally how to design the solution. The requirements and design of the solution are critical for a successful implementation. Communicating a clear vision of the project will also affect the engagement and belief in the project among of the employees.

5.6.2 A strict definition

In order to determine the relevance of the CSFs when implementing a VGT-solution we used a more structured approach. Atkinson (1999) explains that three criteria are often used when measuring the success of a project: time; cost and quality. Based on our own experience from the project we determined how critical each CSF is to fulfil the criteria.

1. On time; meaning that the implementation project finishes within the planned timeframe
2. Quality of solution; meaning that the solution achieves its purpose
3. Cost of solution; meaning that the solution comes with low costs or within the desired budget.

Initially, we gave the three criteria different levels of importance. Quality of solution was considered as the most important criteria when evaluating a VGT CSF. If the solution does not meet a certain level of quality it does not matter if the implementation was completed in a short amount of time or if the costs were low.

Cost of solution was regarded as less important than Quality of solution but more important than if the project is finished on time, the third criteria. A project is always constrained by its resources and if the costs increase too much a company has to stop or change the project. For each criteria, the CSFs were given points between 1 to 10 depending on how important the CSFs were considered to be to meet the criteria. The points were weighted according to the relative importance among the criteria. Quality of solution stood for 50% of the points given, Cost of solution for 30% and On time for 20%. Finally the weighted points for each criteria were summarized, with a maximum score of ten points. To be considered as a VGT CSF it had to receive a score of more than eight points. If a CSF was given a number below eight it was not considered to be critical, but instead supplementary. See table 20 for the whole table of points.

Table 20: Evaluation of CSFs for the implementation of the VGT-solution

#	Critical Success Factor	Criteria Weight	On time 20%	Quality of solution 50%	Cost of solution 30%	Average score	Critical / Supplementary
1	Communicate effectively	Rating	10	10	9		
		Weighted point	2	5	2.7	**9.7**	Critical
2	Manage Change	Rating	9	9	9		
		Weighted point	1.8	4.5	2.7	**9**	Critical
3	Assure top management support	Rating	10	9	8		
		Weighted point	2	4.5	2.4	**8.9**	Critical
4	Educate and train	Rating	4	7	5		
		Weighted point	0.8	3.5	1.5	**5.8**	Supplementary
5	Establish sufficient resources and competences	Rating	9	9	7		
		Weighted point	1.8	4.5	2.1	**8.4**	Critical
6	Choose the right vendor and system	Rating	8	8	8		
		Weighted point	1.6	4	2.4	**4**	Critical
7	Manage people and culture	Rating	4	9	7		
		Weighted point	0.8	4.5	2.1	**7.4**	Supplementary
8	Create a clear vision and build a business case	Rating	10	8	8		
		Weighted point	2	4	2.4	**8.4**	Critical

As can be seen in table 20 the result from the evaluation shows that the amount of CSFs were reduced from eight to six. The six CSFs identified when implementing a VGT-solution based on experiences from the single case study performed at Axis are:

1. Communicate effectively
2. Manage change
3. Establish sufficient resources and competences
4. Assure top management support
5. Create a clear vision and build a business case
6. Choose the right vendor and system

There are a number of reasons why all eight CSFs identified for the implementation of SCIS were not identified for the implementation of VGT-solutions. The CSF Manage people and culture seems to be a more important CSF for implementations of extensive systems, affecting whole companies and organisations. This specific implementation of a VGT-solution was performed at only one station in a warehouse affecting a very small part of the organisation. Furthermore, the project group does not encompass a large group of people and the timeframe is relatively short. Concerning the CSF Educate and train, the reason to its exclusion from the final list is mainly due to the rather low complexity of the VGT-solution. Education and training is very important for extensive systems generating big changes to organisations or departments. It enables ramp-up before the project "goes live" and makes the employees comfortable about the change. As the preparation before the VGT-solution "goes live" is so small education and training is not considered critical for the success of the implementation.

5.6.3 Connecting CSFs to barriers

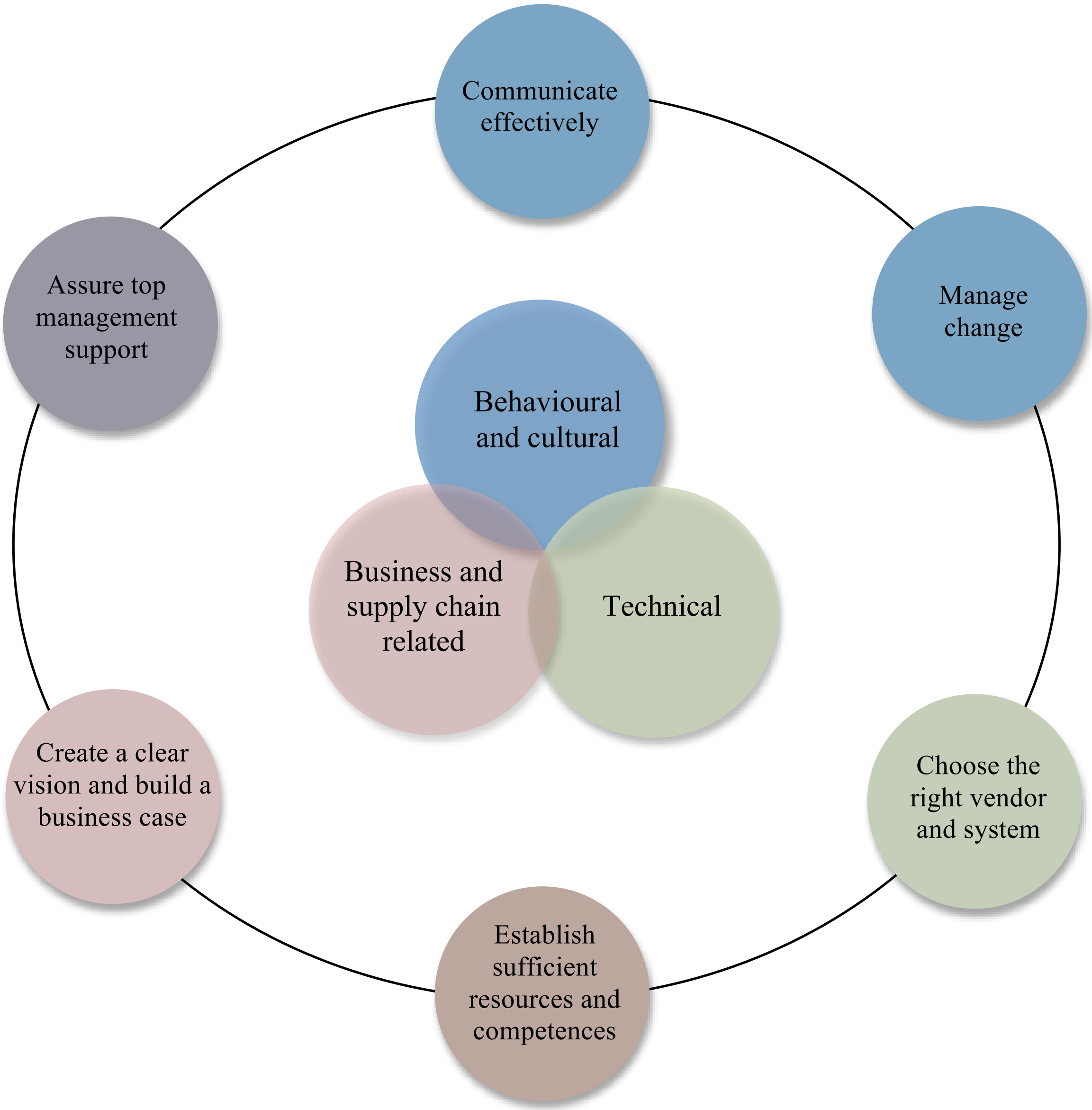
Before our project started Danielsson and Smajli (2015) identified barriers that prevent implementation of video technology in warehouses. Danielsson and Smajli (2015) suggest that there are three main categories of barriers: Behavioural and cultural; Technical and Business and supply chain related. We believe that these can be overcome by applying the identified CSFs. The CSFs Effective communication, Manage change and Assure top management support seem to be connected to Behavioural and cultural barriers. These barriers typically concern soft issues such as resistance to change and change in culture. Several examples of how to manage the resistance were found during the literature review and interview study. Manisha *et al.* (2015, p. 250) elaborate on how to manage change: *"as part of the change management efforts, users should be involved in design and implementation of* *business processes"*. Furthermore, *"to earn the support of all stakeholders, the project objectives should be communicated across the whole organization"* (Manisha *et al.*, 2015, p. 250). Saade & Nijher (2016, p. 81) claim that *"with complete top management support the initial phase can be dealt with less resistance"*. One participant in the interview study stated that educating the end-users solved initial resistance to the implementation. Educate and train is not considered as critical for the VGT-implementation but might be included for larger video technology implementations. In our project we managed these types of barriers partly by including the end-users. A seminar was held with the users, demonstrating the solution and its purpose. The end-users had been involved when designing the solution and they highly influenced the end result. Throughout the project we also had support from the warehouse manager and the supply chain manager, decreasing resistance to change among employees.

Business and supply chain related barriers concern recourses, uncertainties of benefits and problems that can occur in the supply chain due to the implementation. Support from top management, creating a vision and building a business case as well as establishing sufficient resources could possibly help practitioners to overcome these barriers. Manisha *et al.* (2015) argue that an implementation is more likely to succeed with top management support, as more resources will be allocated to the project. Additionally, *"the involvement of top management is also vital to the effective re-engineering of the supply chain and logistics processes"* (p. 250). Furthermore, with a clear vision *"resources will be allocated according to the importance of the area, and only those areas that have a leverage effect on the implementation results will be given the required resources*" (Ting *et al.*, 2013, p. 3619). Some participants in the interview study suggested that the project should be justified by building a business case. Ngai *et al.* (2011) agree and propose that management should evaluate and justify costs/benefits of the implementation. In our project we managed these types of barriers by building a business case, which justified the implementation. Furthermore, the support from the supply chain manager will increase the possibility of receiving enough resources to succeed with a future implementation.

Choosing the right vendor and system as well as possessing the right technical expertise can contribute to overcome the last barrier category. Technical barriers concern integration and reliability of the system. The vendor can assist in the integration process and by assuring a good fit of the system the integration becomes much easier. Ting *et al.* (2013, p. 6) suggest that the system should be tested before it is selected *"to understand the characteristics of each element of hardware and software and to decide which option is more suitable for the current environment"*. Manisha *et al.* (2015, p. 252) emphasise the importance of *"in-house ability to maintain and to change/update hardware and software"*. Furthermore, Ting *et al.* (2013, p. 10) explain that experts are able to *"give constructive advice on the adjustments that need to be made"*. The need of choosing the right system is not emphasised in the interview study. However, the participants mentioned the need of having a competent vendor as well as sufficient technical support within the company. We managed technical barriers by cooperating with a competent vendor of the VMS. Through their support we were able to test the system, create a demonstration of how the system will work when implemented and assure that the integration of the system will be smooth.

All of the CSFs can be considered to contribute to overcome the three types of barriers. However, the CSFs seem to have a stronger connection to one or two of the barrier categories. The framework below, figure 34, visualizes the connections between the CSFs and the barriers.

Figure 34: Framework of CSFs and barriers for video technology implementations



6. Conclusions, contributions, limitations and further research

6.1 Conclusions: Answering RQ1 and RQ2

The purpose of this thesis was *to investigate critical success factors when implementing supply chain information systems in warehouse operations and how these factors can contribute to overcome barriers that prevent implementation of video technology in warehouse operations.*

First, we performed a literature review. Additionally, a study on SCIS CSFs was conducted, including an interview study and a survey. The purpose of the literature review was to develop a list of CSFs for SCIS implementations. The purpose of the interview study was to gain a deeper understanding of the CSFs derived from the literature review. Finally, the purpose of the simultaneously conducted survey was to validate the results from the literature review, examine the CSFs general relevance and potentially reduce the list of SCIS CSFs. The single case study at Axis Communications built on the findings from the previous study. By answering RQ1 we discovered how a SCIS implementation becomes successful and how critical the success factors are in general. The purpose of the single case study was then to investigate how relevant the CSFs for SCIS implementations are when implementing video technology, in the shape of a VGT-solution. Combining the knowledge from the literature review and the two studies enabled us to answer RQ2.

Table 21: Connecting methods to research question

RQ	Description	Literature review	Interview study	Survey	Single case study
1	How can a SCIS implementation become successful and how critical are the success factors in general?	X	X	X	
2	How can existing barrier be overcome when implementing video technology in warehouse operations?	X	X	X	X

RQ1: How can a SCIS implementation become successful and how critical are the success factors in general?

By answering the first question we laid the foundation for our further research. The literature review was conducted by carefully selecting 11 articles on CSFs for the implementation of different types of SCIS. More than 250 CSFs were found, analysed and grouped into nine general CSF categories. The interview study then contributed to a deeper understanding of the derived CSFs. The study consisted of six interviews and more than 90 CSFs were identified. Through a deductive thematic analysis the CSFs were categorised according to the previously derived CSF categories. The results from the literature review and the interview study were strikingly similar. Each aspect mentioned by the participants connected to one of the CSF categories, which indicates that the CSF categories are exhaustive, and validated the result from the review. Several subcategories are connected even though they are not identified within the same category. Additionally, some of the categories are linked. However, each CSF is considered to have such a different focus compared to the others that an independent CSF is justified. No new CSFs were derived from the interview study, as all aspects mentioned related to the existing categories. The derived CSFs can be seen in figure 34.

Figure 35: Critical success factors to successfully implement SCIS

Communicate effectively	Establish sufficient resources and competences	Measure performance
Manage people and culture	Educate and train	Create a clear vision and build a business case
Manage change	Assure top management support	Choose the right vendor and system

The results from the survey further validated the categories. In the survey study the participants were asked to grade, on a scale from one to seven, the general criticality of each CSF. Questionnaires were sent to 112 participants, giving 35 responses. From the extracted data it was possible to determine the general relevance of the CSFs, see figure 36 below.

Figure 36: The general criticality of the critical success factors on a scale from one to seven

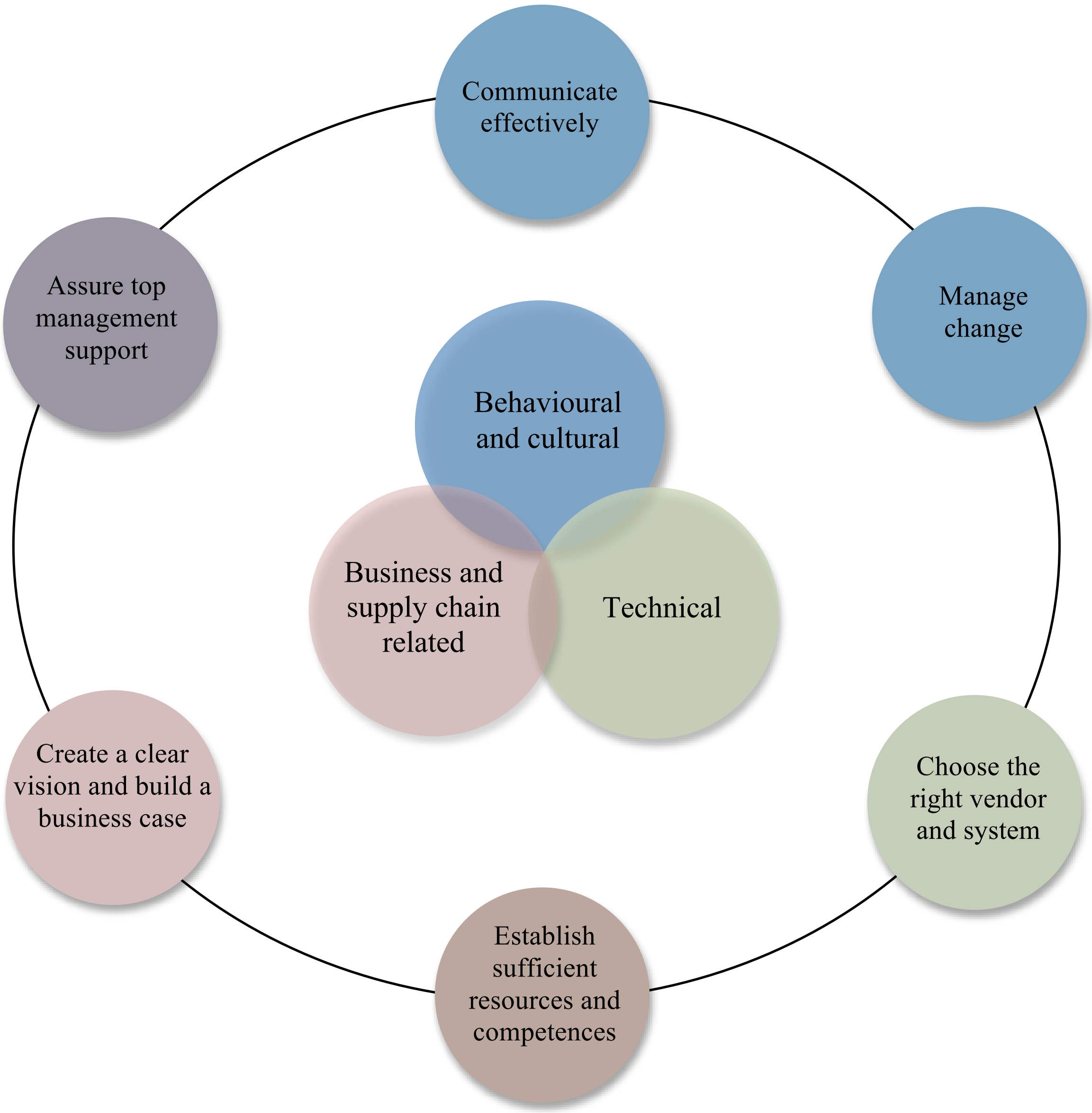
CSF	Communicate effectively	Manage change	Assure top management support	Educate and train	Establish sufficient resources and competences	Choose the right vendor and system	Manage people and culture	Create a clear vision and build a business case	Measure performance
Mean	*6.7*	*6.2*	*6.2*	*6.0*	*5.9*	*5.9*	*5.7*	*5.5*	*5.2*

The mean ratings in the survey result indicate the criticality of the CSFs, ranging from 5.2 to 6.7. Communicate effectively was ranked as the most critical factor and Measure performance the least critical. As the confidence intervals, at a 95% significance level, is relatively narrow for all CSFs, the means are considered to be good indicators of the criticality of the CSFs. To establish a strict definition, it was decided that a CSF had to have at least a mean rating of 5.5 and lower bound of 5.0, at a 95% significance level. With this definition the CSF Measure performance is excluded from the list, generating an updated list of only eight CSFs. The result from the survey validated the criticality of the CSFs identified in the literature study. The final eight CSFs can be regarded as essential to apply in order to succeed with an implementation of a supply chain information system.

RQ2: How can existing barriers be overcome when implementing video technology in warehouse operations?

The second research question concerned the identification of CSFs for video technology implementation and connecting the CSFs to the existing barriers that prevent implementation. During one and a half month an in-depth case study was performed at Axis. The outcome of the study was a recommended implementation plan of a VGT-solution in Axis' warehouse operations, and a business case. As a VGT-solution is a video technology we were able to draw conclusions regarding video technology implementations in general. The project gave insights to challenges and requirements to succeed with an implementation of video technology in a warehouse. When analysing the derived CSFs from the literature review and the previous study it was concluded that six of the CSFs would be essential when implementing a VGT-solution: Communicate effectively; Manage change; Establish sufficient resources and competences; Assure top management support; Create a clear vision and build a business case and Choose the right vendor and system. The CSF categories were connected to the three earlier identified barrier categories. The final framework can be seen in figure 37 below.

Figure 37: Framework of CSFs and barriers for video technology implementations



Communicate effectively, Manage change and Assure top management support can contribute to overcome Behavioural and cultural barriers. In our project we managed these types of barriers partly by including the end-users. A seminar was held with the users, demonstrating the solution and its purpose. The end-users had been involved when designing the solution and they highly influenced the end result. Throughout the project we also had support from the warehouse manager and the supply chain manager, decreasing resistance to change among employees.

Top management also plays an important role when managing Business and supply chain related barriers. Create a clear vision and build a business case as well as Establish sufficient resources and competence can also contribute to overcome these types of barriers. In our project we managed these types of barriers by building a business case, which justified the implementation. Furthermore, the support from the supply chain manager will increase the possibility of receiving enough resources to succeed with a future implementation.

Finally, Establish sufficient resources and competence and Choose the right vendor and system help to manage Technical barriers. We managed technical barriers by cooperating with a competent vendor of the VMS. Through their support we were able to test the system, create a demonstration of how the system will work when implemented and assure that the integration of the system will be smooth. The six CSF categories that were identified as relevant when implementing video technology in warehouses are very general. They are connected to soft aspects such as how people should interact with each other. Creating trust, motivation and participation is emphasised as well as involving people in the implementation process. They are also connected to hard aspects such as building a business case and establishing the right and sufficient resources. The categories apply for all types of SCIS implementations and not specifically for video technology. However, the categories include aspects that are essential when implementing video technology.

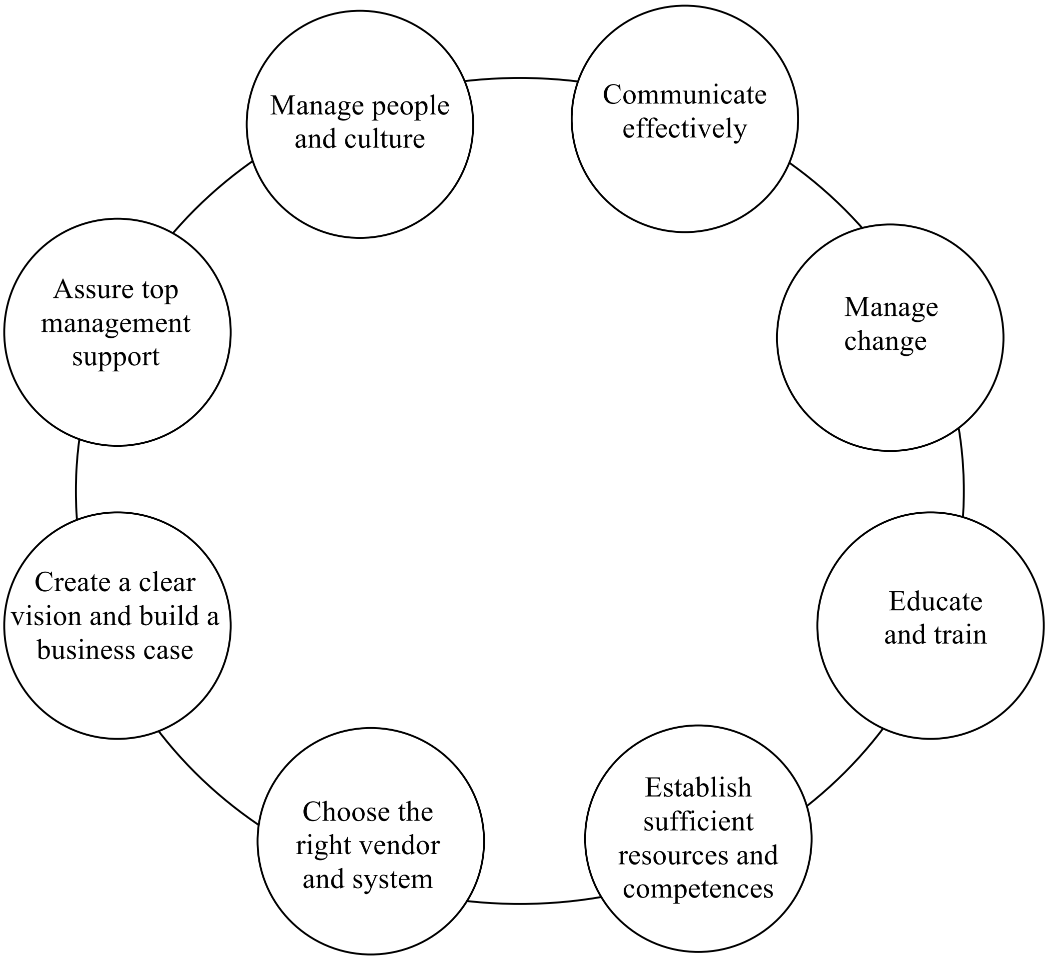
6.2 SCIS CSFs

This study has discovered and built understanding of nine CSFs when implementing supply chain information systems in a warehouse: Communicate effectively; Manage change; Establish sufficient resources and competences; Manage people and culture; Assure top management support; Create a clear vision and build a business case; Educate and train and Choose the right vendor and system. The CSFs were revealed through a literature review. Measure performance was included among the CSFs in the review but was then disregarded as a CSF in the survey study. Many of the reviewed articles highlighted similar CSFs, why we were able to combine more than

250 mentioned factors into only nine created categories. These created categories are general and include several much more specific factors. For example, Ngai *et al.* (2011) elaborate on the importance of the organisation's past experience, which is included in the category manage people and culture. *"Past experience served as a model of the benefits of adoption and helped to secure the support of top management and potential users"* (Ngai *et al.*, 2011, p. 123). Manisha *et al.* (2015, p. 251) suggest that *"user involvement and participation should start much before the implementation takes place",* which is included in the category Manage change.

The findings in the interview study were coded and categorised according to the previous derived CSF categories. The findings were strikingly similar. For example, Ting *et al.* (2013, p. 12) suggest that *"to resolve fears within the operation team, communication with all the people concerned is substantial and at the same time supporting evidence should be provided to prove its truthfulness".* At the same time one of the participants in the interview study shared: *"Communication is important. Rumours can create concern and the project can experience unnecessary resistance".* Only one major difference was found; practitioners did not emphasise the importance of careful system selection, which was considered critical by most articles. Through the survey, the general relevance of each CSF was investigated. Communicate effectively (6.7/7) was considered to be the most critical CSF, while Measure performance (5.2/7) was considered the least critical. This result differs from many previous studies, where top management support has been ranked as the most important factor (Shaul & Tauber, 2012). However, Shaul and Tauber (2012, p. 270) explain that in *"studies in which inner aspects were examined such as C-level project champion, dedicated resources, business vision and timeframe, the overall importance of top management support decreases".* Although no practitioner mentioned careful system selection in the interview study, the CSF Choosing the right vendor and system received a relatively high rating (5.9/7), which was a surprising result. The result can possibly be explained by the importance of choosing the right vendor. Although Measure performance (5.2/7) was mentioned by both literature and the practitioners it was removed from the list of CSFs, as its rating from the survey indicated that is was not considered critical. Consequently, the final list of CSFs consists of eight CSF categories, which can be seen in figure 38, below.

Figure 38: Framework of CSFs for implementations of SCIS



SCIS implementations are often large projects that affect not only many functions within the company but possibly the whole supply chain. The failure rate of these implementations is high. As the projects take up a large part of the company's budget a failed project can severely damage the performance of the whole company (Denolf *et al.*, 2015). However, as described by one participant in the interview study successful implementations can increase the competitiveness by increasing the warehouse efficiency. Denolf *et al.* (2015, p. 23) claim that *"identifying and understanding critical success factors (CSFs) is crucial for successfully implementing a supply chain information system"*. Studies of the CSFs are therefore important. However, only being aware of the CSFs is not enough to succeed. Practitioners should also possess an understanding of how to apply the CSFs and who should be responsible for applying them. Unfortunately, concrete guidance to how to apply the CSFs has not been provided by the literature or by the interviewed practitioners.

6.3 Video technology CSFs

Six of the nine SCIS CSFs have been identified as critical when implementing video technology in a warehouse: Communicate effectively; Manage change; Establish sufficient resources and competences; Create a clear vision and build a business case; Assure top management support and Choose the right vendor and system. The reason behind the exclusion of the remaining three CSFs is partly the limited scope of the VGT-implementation. The remaining CSFs would possibly be of importance for more extensive video technology implementations. When searching for prior theory, no research was found on video technology. Therefore, we had to be creative and discover video technology CSFs in another way than investigating prior theory. The case study gave us key insights on important aspects of a VGT-implementation. Identification of CSFs among the SCIS CSFs was considered to be the most valid method to discover video technology CSFs. However, the method has limitations. For example, specific CSFs for video technology might be neglected. By investigating one application of video technology we were able to draw conclusions for video technology in general. However, other applications might require other CSFs, thus more CSFs for video technology might exist.

One interesting discussion concerns the distinction between soft and hard CSFs. It can be concluded that the final framework, figure 39, includes both soft and hard CSFs. We define soft CSFs as factors that concern interactions among people and how to make people adapt to change. Hard CSFs concern quantifiable aspects such as cost/benefit analysis or how much resources are needed for the implementation. Generally the CSFs are neither only soft nor hard, but somewhere in between. Communicate effectively and Manage change is clearly more soft, as they concern how people work together effectively and how to get people comfortable with change. Top management support includes both soft and hard aspects. The support affects the engagement of the employees, but also allocation of recourses to the projects. The remaining three CSFs are considered to be more hard than soft. Create a clear vision and build a business case includes justification of the project through quantified costs/benefits. Establishing sufficient resources and competences is more hard as it concerns allocation of resources. Choosing the right vendor and system is also regarded as more hard than soft as it includes defining technical specifications.

It seems reasonable to discuss a similar distinction between the three barriers. The Behavioural and cultural barrier category is considered to include soft barriers as they relate to interactions between people. The Business and supply chain related barrier category is considered more soft than hard as it encompasses barriers related to resources and costs/benefits issues. Finally the Technical barrier category seems to be fairly hard as it concerns technical issues. It becomes apparent that the soft barrier category is connected to soft CSFs. In turn, the two harder barriers are connected to harder CSFs. The survey shows an interesting result regarding soft and hard CSFs. It seems as if the soft CSFs have received higher ratings, which is shown in table 22 below. The correlation is not significant and therefore it would not be possible to prove. However, the result raises an important question: are soft CSFs more critical than hard CSFs?

Table 22: Criticality of soft and hard CSFs

Barrier	Behavioural and cultural		Business and supply chain related		Technical	
CSF	Communicate effectively	6.7	Create a clear vision and build a business case	5.5	Choose the right system	5.9
	Manage change	6.2	Establish sufficient resources and competences	5.9	Establish sufficient resources and competences	5.9
	Assure top management support	6.2	Assure top management support	6.2		
Average		6.4		5.9		5.9

6.4 Contribution to practice

The research has given light to the use of a VGT-solution in warehouse operations. Insights have been presented on how to succeed with such an implementation and how a company can benefit from the solution. The solution is designed for a specific warehouse, but since many warehouses use similar processes many of the recommended changes can be translated to work at other companies. Considering that many of the recommendations concerned standardisation of processes a company that already has standardised processes will probably experience an even easier implementation. Implementing a VGT-solution in a warehouse using a conveyor belt would be much easier than the implementation at Axis, with much more flexible processes and multiple product flows.

6.5 Contribution to theory

As SCISs are increasingly recognised as an important element in enabling efficient supply chains, there is a need of identifying CSFs for the implementation of SCIS. This thesis has identified more than 340 CSFs through a literature review and an interview study. We have grouped the CSFs into nine easily understood categories. The categories were validated through a survey enabling trustworthiness and rigor. Extensive research has been conducted on CSFs concerning SCIS implementations but none or very little concerning video technology. This research has contributed to unique insights on how to successfully implement video technology in the shape of a VGT-solution. Furthermore, the thesis has contributed to insights on how to overcome barriers that prevent implementation of video technology. The reader will gain understanding on how to overcome a certain barrier with a specific CSF.

What technology that is being used is naturally constantly changing as well as the CSFs when implementing technology. Therefore, the literature on CSFs for the implementation of SCIS must be up to date to ensure validity. This research has contributed with the newest insights from practitioners that are working with SCIS implementations today. Some differences can be seen compared to prior research, which could possibly be explained by the freshness of the research.

6.6 Limitations

Like all research studies, there are of course some limitations behind the results of this research. To begin with it is always hard to draw any general conclusions from a critical single case study. We try to find answers on how to succeed with video technology implementations in a warehouse by only studying a VGT-solution. Including studies of more types of SCIS, where video technology is used, would make the research more trustworthy. One weakness considering the identification of CSFs for the implementation of video technology in a warehouse is the source behind the conclusions. The decisions of whether a SCIS CSF was critical or supplemental for a video technology implementation were based on our own subjective observations from conducting the single case study. The conclusions might have been stronger if the views of the warehouse staff and other employees in the organisation had been included. Considering the implementation plan, the proposed VGT-solution is supposed solve today's delivery discrepancies. Being able to send documented proof that products have been delivered, Axis would put pressure on dishonest and careless customers. However, it must be pointed out that the proof would not hold up in court. Employees of Axis could for example remove products from packages while outside camera zones.

6.7 Further research

This thesis has identified CSFs for the implementation of SCIS in warehouses but has not given concrete ideas on how to apply these CSFs. Therefore further research could study how different companies are working with the CSFs and how they successfully apply them. New and highly valuable insights in how to become successful with SCIS implementations could be generated. Our research has also been able to present a number of CSFs for the implementation of video technology in warehouse operations. However, this has been achieved by only analysing a specific implementation of video technology. Further research on other video technology solutions would be of interest, as a more complete picture on video technology CSFs could be developed. It might then also be possible to identify specific CSFs for video technology.

Furthermore, it would be interesting to study new types of video technology. As more interest is put on how logistical processes can be tracked and supervised, new and promising video technologies arise. Further research could focus on identifying these new technologies and study how they can contribute in making supply chains more efficient. Further research could also compare companies that are using video technologies to track goods in their warehouses. This would enable a "best-in-practice" study. A multiple case study could be performed at these companies and CSFs could be derived from a cross-case analysis. Finally, future research can investigate the financial impact from implementing video technology in a warehouse. The research would further develop understanding of the benefits of using video technology, especially on how much the costs from customer claims could be reduced. It would require further research on companies that have been using video technology for some years in order to examine how the technology have affected their performance and competitiveness.

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A12. (12 April 2016). Evaluating a Visual Goods Tracking business case.

A13. (12 April 2016). Evaluating an internal camera solution.

A14. (25 April 2016). Installing the Video management System and configuring it to the ERP-system.

A15. (26 April 2016). Discussing preparation of test-day concerning scanners and barcodes.

A16. (27 April 2016). Preparation of the test day, discussing installation procedures.

A17. (28 April 2016). Discussing the Video Management System.

A18. (2 May 2016). Installing cameras to test the design solution with anlges and technical specifications.

A19. (3 May 2016). Finalising the Video Management System integration.

A2. (5 April 2016). Introducing shipping and transport department to single case study.

A20. (5 May 2016). Discussing the final layout.

A21. (5 May 2016). Discussing changes to the process.

A3. (6 April 2016). Following the shipping staff and documenting the procedure.

A4. (7 April 2016). Following the shipping staff and documenting the procedure.

A5. (7 April 2016). Investigating the integration between the ERP-system and the Visual Goods Tracking solution.

A6. (7 April 2016). Discussing warehouse layout and camera installation procedure.

A7. (8 April 2016). Exploring different types of cameras and camera solutions.

A8. (8 April 2016). Discussing camera types and business integration.

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8. Appendices

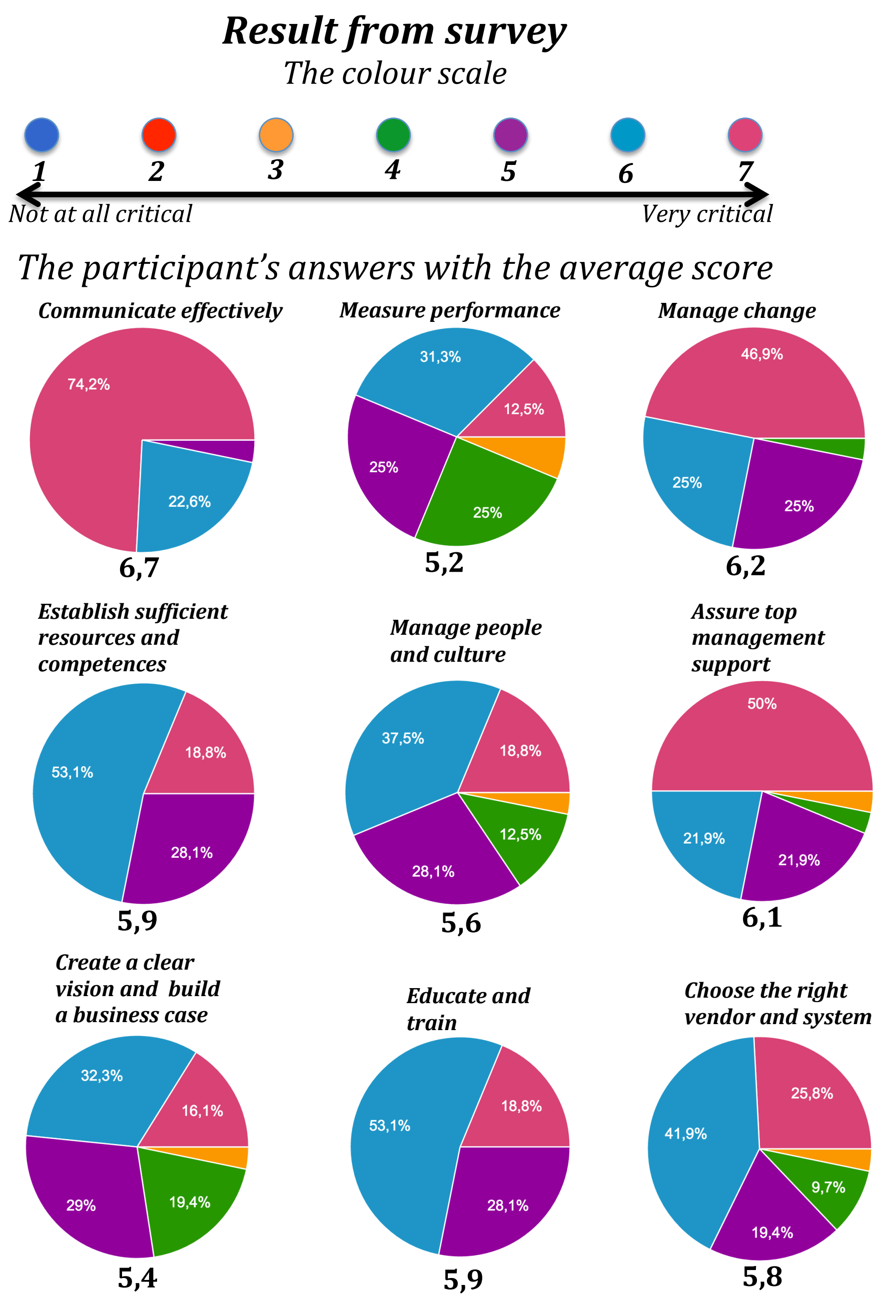
8.1 Appendix A – Meeting schedule interview study

#	Type	Date	Time	Duration	Present Title	Participants	Interviewer	SCIS Experience
M1	Semi-structured	14.04.16	10:00	1h30m	ERP-manager	Interviewee, Philip Åhlin, Fredrik Luttropp	Fredrik Luttropp	ERP, EDI
M2	Semi-structured	18.04.16	09:00	1h	Managing director	Interviewee, Fredrik Luttropp, Philip Åhlin	Philip Åhlin	WMS, RFID
M3	Semi-structured	22.04.16	08:00	1h30m	Consultant	Interviewee, Philip Åhlin, Fredrik Luttropp	Fredrik Luttropp	WMS
M4	Semi-structured	26.04.16	09:00	1h	ERP-manager	Interviewee, Philip Åhlin, Fredrik Luttropp	Philip Åhlin	ERP
M5	Semi-structured	26.04.16	15:00	1h	System developer	Interviewee, Philip Åhlin, Fredrik Luttropp	Fredrik Luttropp	ERP, EDI
M6	Semi-structured	29.04.16	09:00		Supply planner & Warehouse manager	Interviewee, Philip Åhlin, Fredrik Luttropp	Philip Åhlin	ERP

8.2 Appendix B – Meeting schedule single case study

#	Type	Date	Time	Duration	Department	Participants	Reason to interview/observation/meeting
A1	Meeting	31.03.16	13:30	1h30m	Supply Chain Mangement	Philip Åhlin & Fredrik Luttropp	Discussing requirements of Visual Goods Tracking Solution
A2	Meeting	05.04.16	10:00	1h30m	Shipping	Philip Åhlin & Fredrik Luttropp	Introducing shipping and transport department to the single case study
A3	Observation	06.04.16	08:00	4h	Shipping	Philip Åhlin & Fredrik Luttropp	Following the shipping staff and documenting the procedure
A4	Observation	07.04.16	07:00	2h	Shipping	Philip Åhlin & Fredrik Luttropp	Following the shipping staff and documenting the procedure
A5	Semistructured interview	07.04.16	09:45	1h30m	ERP-manager	Philip Åhlin & Fredrik Luttropp	Investigating the integration between the ERP-system and the Visual Goods Tracking Solution
A6	Meeting	07.04.16	13:30	1h15m	Supply Chain Management	Philip Åhlin & Fredrik Luttropp	Discussing warehouse layout and camera installation procedure
A7	Semistructured interview	08.04.16	10:00	1h	Product Concept New Ideas	Philip Åhlin & Fredrik Luttropp	Exploring different types of cameras and camera solutions
A8	Meeting	08.04.16	16:00	1h	Director Business Development	Philip Åhlin & Fredrik Luttropp	Discussing camera types and business integration
A9	Semistructured interview	11.04.16	10.00	1h	Global Video Expertise	Philip Åhlin & Fredrik Luttropp	Exploring different types of cameras and camera solutions
A10	Semistructured interview	11.04.16	13:30	1h15m	It-Solutions	Philip Åhlin & Fredrik Luttropp	Exploring the bridge between video technology and in-house solutions
A11	Meeting	12.04.16	12:00	1h30m	Warehouse Management	Philip Åhlin & Fredrik Luttropp	Exploring the warehouse looking at camera implementation solutions
A12	Semistructured interview	12.04.16	14:00	45min	Sales Engineering	Philip Åhlin & Fredrik Luttropp	Evaluating a Visual Goods Tracking Solution Business Case
A13	Semistructured interview	12.04.16	15:00	30min	Intern-Post	Philip Åhlin & Fredrik Luttropp	Evaluating an internal camera solution
A14	Meeting	25.04.16	13:00	2h	External consultant	Philip Åhlin & Fredrik Luttropp	Installing the Video Management System and configuring it to the ERP-system
A15	Meeting	26.04.16	11:00	45min	Transport department	Philip Åhlin & Fredrik Luttropp	Discussing preparation of test-day concerning scanners and barcodes
A16	Meeting	27.04.16	09:00	45min	Global Video Expertise	Philip Åhlin & Fredrik Luttropp	Preparation for the test-day, discussing installation procedures
A17	Meeting	28.04.16	13:00	1h	External consultant	Philip Åhlin & Fredrik Luttropp	Discussing the Video Management System
A18	Observation/ meeting	02.05.16	09:00	7h	Global Video Expertise	Philip Åhlin & Fredrik Luttropp	Installing cameras to test the design solution with angles and technical specifications
A19	Meeting	03.05.16	13:00	1h	External consultant	Philip Åhlin & Fredrik Luttropp	Finalising the Video Management system integration
A20	Meeting	05.05.16	13:30	30m	Supply Chain Mangement	Philip Åhlin & Fredrik Luttropp	Discussing final layout
A21	Meeting	05.05.16	13:30	30m	Shipping	Philip Åhlin & Fredrik Luttropp	Discussing changes to the process

8.3 Appendix C – Results from survey



8.4 Appendix D – The interview study protocol

Interview guide

The purpose with this case study is to give deeper insight on the success factors when implementing Supply Chain Information Systems in warehouses.

Introduction of interview procedure

a. Introducing ourselves
b. Explaining the purpose of the case study
c. Inform the interviewee that the interview will be recorded

Date____

Time____

Meeting duration________________________________

Participants____________________________________

Experience_____________________________________

Languague_____________________________________

Questions

1. What SCIS do you have experience of implementing in a warehouse? (ERP, EDI, WMS, RFID, Barcode-scanning,)
____
____

2. Can you describe the implementation process of these SCIS and your role in the projects? ________________________________
____

3. Have the implementation of these systems been successful? And if so, why**?** _____
____

4. Can you identify any specific Critical Success Factors (CSFs)? ______________
____

5. After how long time was the implementation considered successful**?** __________
____

Anonymous contact details of interviewee
Full Name ____________________________________

Email address __________________________________

Telephone number _______________________________

The interview will be transcribed and sent to the interviewee for comments and approval.

8.5 Appendix E – Survey questionnaire

Survey on Critical Success Factors when implementing Supply Chain Information Systems

This survey is a part of a master's thesis in the field of logistics, more specifically warehousing, conducted by Fredrik Luttropp and Philip Åhlin. We are students at the Faculty of Engineering at Lund University doing our final semester. The purpose of the thesis is to design a solution for implementating of a Visual Goods Tracking System in a warehouse. A Visual Goods Tracking System belongs to the family of Supply Chain Information Systems and helps to track, document and control the flow of goods through a supply chain. As a part of the thesis we conducted a literature study to investigate the Critical Success Factors for implementation of Supply Chain Information Systems. Nine factors have been identified.

The purpose of this survey is to create an empirical benchmark to the theoretical framework and evaluate the identified Critical Success Factors. Your participation of this survey would be highly appreciated and we hope that you would like to give us just a few minutes to fill out our questionnaire.

If you feel interested in reading the thesis afterwards please submit your email address to the questionnaire and we will send the thesis to you.

Thank you so much for your participation and please do not hesitate to contact us if you have any questions concerning the survey.

Best regards
/Fredrik Luttropp and Philip Åhlin

Q1. Contact information (optional)
Name, email, phone number

____

Q2. Would you like to take part of the survey result?

- **Yes**
- **No**

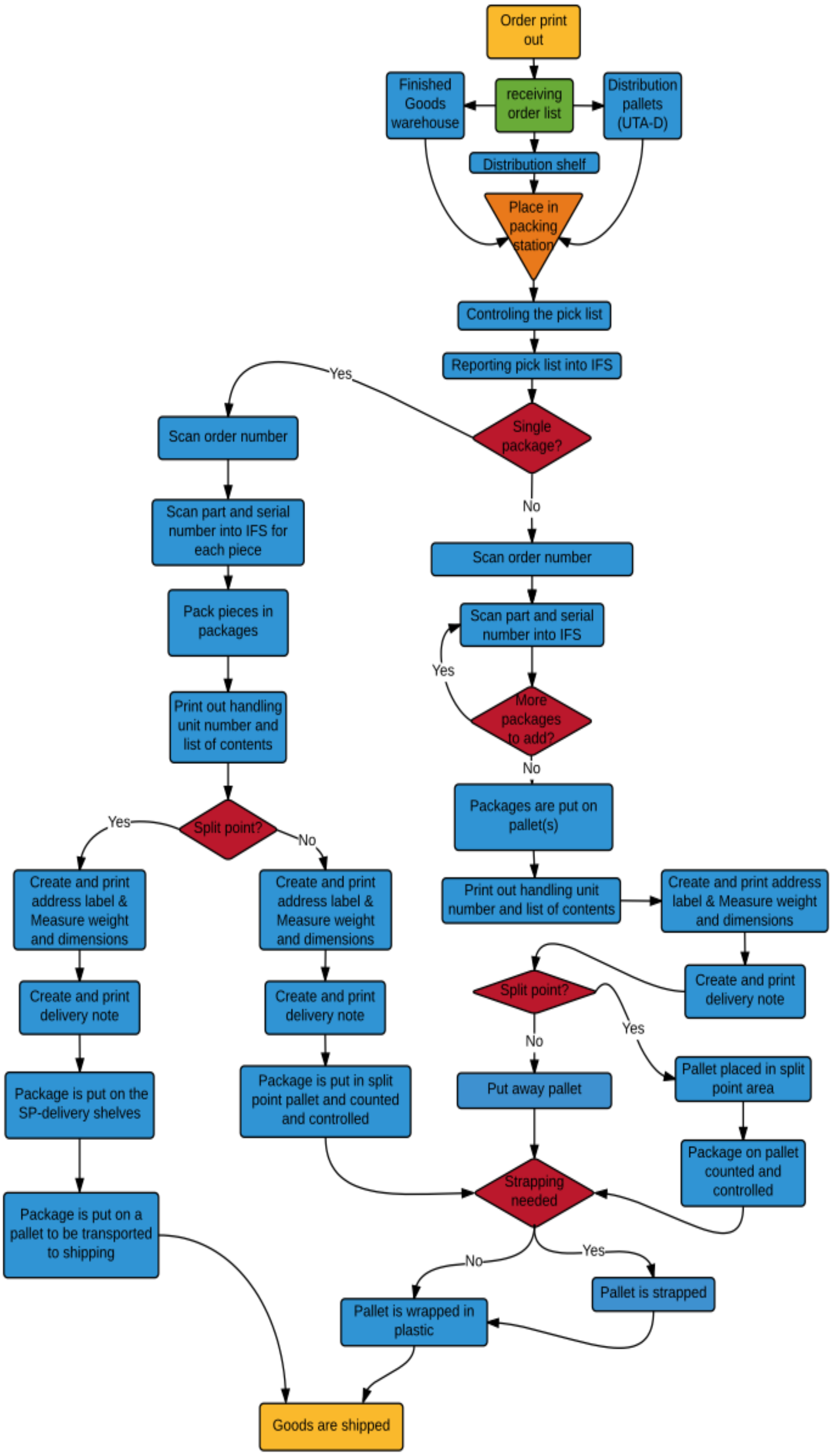
Q4. Have you participated in implementation of any Supply Chain Information Systems (SCIS)? If yes, what SCIS?

- **Enerprise Resource Planning (ERP) system**
- **Electronic Data Interchange (EDI)**
- **Radio-frequency Identification (RFID)**
- **Barcode-scanning**
- **Warehouse Management System (WMS)**
- **Other**
- **No (end survey)**

Q5. How critical or uncritical do you consider the following factors when implementing a Supply Chain Information System?

	Not at all critical						Very critical	Do not know/No opinion
Communicate effectively (with supply chain partners and within organisation)	o	o	o	o	o	o	o	o
Measure performance (monitor and evaluate performance)	o	o	o	o	o	o	o	o
Manage change (project management, change management, involve end users, select project champion)	o	o	o	o	o	o	o	o
Establish sufficient resources and competences (financial and technical support, competency among staff, support from vendor)	o	o	o	o	o	o	o	o
Manage people and culture (motivated organisation, culture of trust, social security)	o	o	o	o	o	o	o	o
Assure top management support (involement and support, understands project benefits)	o	o	o	o	o	o	o	o
Create a clear vision and build a business case (Build a business case, shered belief of costs/benefits, clear business plan and vision, well defined goals and objectives)	o	o	o	o	o	o	o	o
Educate and train (ensure system is properly used)	o	o	o	o	o	o	o	o
Choose the right vendor and system (select vendor carefully, assure strategic fit of the system, ensure compability with existing systems)	o	o	o	o	o	o	o	o

8.6 Appendix F – Process flowchart of present shipping process



8.7 Appendix G – Business case

Business case –

Visual Goods Tracking Solution

A report on the costs/benefits of a worldwide implementation of a Visual Goods Tracking Solution at Axis Communications

Fredrik Luttropp & Philip Åhlin
Operations department, Axis Communications

The executive summary

Axis is experiencing difficulties in discovering why delivery discrepancies occur, which gives their customer an advantage when making a claim. Consequently, Axis has to provide new products to the customers even though the products might have been correctly delivered. This creates unnecessary costs and much time is spent on handling customer claims. The proposed solution, to solve the problems concerning the delivery discrepancies, is called a Visual Goods Tracking (VGT) solution (integrating a Video Management System (VMS), an ERP-system, network cameras and scanners). A VGT-solution can visually trace products in the warehouse and prove correct product deliveries. Hopefully, if Axis is able to prove correct deliveries, claims will drastically decrease from customers.

There are seven persons needed in the project group in order to succeed with the implementation that should dedicate sufficient amount of their time to the project; a project manager (30%), an IT-engineer (50%), an installation technician (5%), a process development engineer (5%), a super-user (5%) and the CLC manager (5%). External consultants from the provider of the VMS are also expected to be needed. The project is expected to be completed within a total amount of 12 weeks. The total cost of the project is 800 000 SEK for a world wide implementation. The cost of the implementations is built up by costs connected to the people working in the project group, the cost of hardware, the cost of the VMS and the cost of education in the new system. The savings potential is 2 000 000 SEK, which gives a final ROI of 100% within a year and a pay-back time of 0.5 years.

Cost of VGT-solution implementation

Type of cost	***Cost***
Project group	320 000 SEK
Hardware	260 000 SEK
VMS	400 000 SEK
Education	20 000 SEK
Total cost per CLC	***200 000 SEK***
Total cost world wide	***1 000 000 SEK***

Key Performance Indicators world wide	
Savings potential world wide	2 000 000 SEK
Cost of implementation world wide	1 000 000 SEK
Return on Investment (ROI)	***100%***
Pay-back time (years)	***0,5***

We believe that Axis would benefit from a world wide implementation of the solution due to three main reasons:

1. The cost/benefit analysis shows a significantly positive ROI and a short pay-back time
2. Axis competitive advantage will increase through more satisfied customers
3. Possibility of marketing the use of the VGT-solution in a warehouse, creating new areas of sales for network cameras

Therefore we recommend Axis to implement the Visual Goods Tracking Solution world wide.

Table of Content

1.0 The problem statement

Axis is experiencing difficulties in discovering why delivery discrepancies occur, which gives their customers an advantage when making a claim. Consequently, Axis has to provide new products to the customers even though the products might have been correctly delivered. This creates unnecessary costs and much time is spent on handling customer claims.

Having a responsive supply chain requires a high level of service. As Axis is delivering premium products lost sales or dissatisfied customers comes with a great cost. If the delivery discrepancies would continue the reputation of Axis could be affected as a consequence of dissatisfied customers. Solving the problem is essential in order to increase the level of service and to reduce the cost of claims.

2.0 Proposed solution

The proposed solution to solve the problems concerning delivery discrepancies is called a Visual Goods Tracking (VGT) Solution. A VGT-solution can visually trace products in the warehouse and prove correct product deliveries. Hopefully, if Axis is able to prove correct deliveries, the claims will drastically decrease from that customer.

The idea behind the VGT-solution is to integrate network cameras, barcode scanners and a Video Management System (VMS) together with the Enterprise Resource Planning (ERP) system. The VMS needs to be integrated with the ERP-system in order to receive information concerning the identification of products. To ensure customers that products have been correctly delivered video recordings of critical steps in the delivery process are streamed into the VMS from the network cameras. For example, a video must be captured when a package is put on a pallet. The customer must then be ensured that the package was still on the pallet when it was shipped. When the operator handles packages or pallets their unique serial numbers are scanned and time-tags are imported into the VMS. The serial numbers of the packages are connected to the serial numbers of the pallets, enabled by the new shipping module software. If a customer makes a claim, it is possible to search for a specific serial number in the VMS and access the critical video sequences when the package or the connected pallet was handled.

3.0 Project description

3.1 Human resources

There are seven persons needed in the project group in order to succeed with the implementation. One person needs to be knowledgeable in IT-solutions and ERP-system integrations. For example, integration between the VMS and the ERP-system needs to be configured and the files sent by ERP need to be converted to a readable format. The ERP-system and the shipping module need to be updated according to the new requirements, making it possible to put barcodes on pallets. There is also a need to include a process development engineer that has a good knowledge of the warehouse processes. Preferably this person also knows how the shipment module, scanners and barcodes are used today in the warehouse and how these procedures can be changed and developed. For knowledge concerning procedures and routines within the shipping station both the warehouse manager and one super-user will be needed. This is important in order to evaluate the development of the solution and to make sure that the solution is feasible for the physical conditions and staff routines. It will also be important in order to communicate the changes to the remaining staff within shipping.

One expert on network cameras with knowledge about how they are installed needs to be a part of the project group. This person will not only be present as an expert on questions related to the cameras but will also mount the cameras during testing days and the final installation. There is a need of an external consultant to help with the integration between the VMS and the ERP-system, the cameras and the scanners. This person also needs to educate the staff that handles claims in how to use the VMS when receiving claims. Finally a project manager is needed to manage the project from the start until it "goes live". This person needs to have certain knowledge of how a VGT-solution works and have the knowledge and capacity to lead and to communicate with the different experts within the project group.

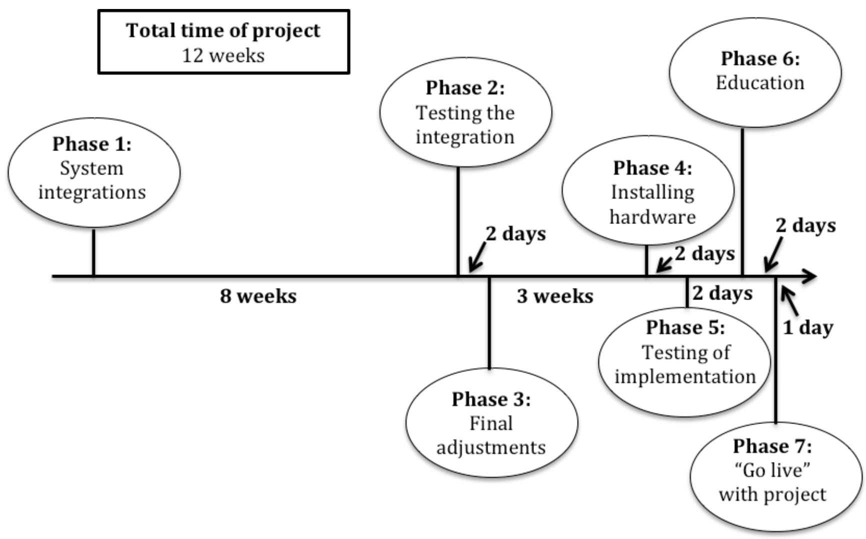
As the VGT-solution is a small change project it will not require that seven persons are fully dedicated to the project. Several of the participants will only be needed at some meetings in order to be briefed about the development of the project and to communicate their perspectives. The time plan will be presented below but it can be pointed out that the project will not be done in a couple of weeks, more likely two or three months due to lead times. Therefore an assumption is that during the time of the project the camera expert and the process development engineer dedicate 10% of their time. The warehouse manager and super-user dedicate 5% of their time. The IT-engineer can be assumed to dedicate 50%, and finally the project manager is assumed to dedicate 30% of the time.

3.2 Time plan

The total time of the project is assumed to be 12 weeks and should begin with start-up meeting with all the project members to communicate the purpose of the project. Following this, eight weeks will be needed to configure the ERP-system and integrate the VMS, the cameras and the scanners. Meanwhile the shipping staff needs to be prepared for the change and the new routines and procedures needs to be analysed and discussed. New scanners and cameras need to be purchased.

When the system has been configured and all necessary hardware is at hand the first test should be initiated and it might be a good idea to install the VGT-solution for one of the identified product flows. This could preferably be the flow of pallets sent to customers. To dedicate two full days for the testing of the system seem reasonable in order for the staff to understand the new routines and to test if the software and hardware configurations work as expected. After the testing days it is important to take one step back and to analyse the results. Three weeks should preferably be dedicated to the final adjustments in order to fine-tune the system. When the identified problems are solved and the final solution is at hand the full installation of cameras and scanners can be performed. To not interfere with the daily work and create any downtime at the shipping station cameras and scanners can be installed during a weekend.

When the hardware is mounted and installed the full solution needs to be tested. If not used, the cameras and the scanners will not interfere with the normal procedures after they have been installed. Therefore it is possible to test the solution during a normal workday. During this day it is essential to analyse the full potential of the VGT-solution and to test that everything works as it should. When the testing day is finished, with hopefully good results, the operating staff needs to be educated in the new solution before the project "goes live". To enable the staff to experience the new procedures and to try for themselves two full days should be dedicated. This is partly done to make everyone feel comfortable about the change but also to make sure that the work is running as usual. The solution should then finally "go live" and everyone at Axis, especially all employees in the warehouse, should be informed.



4.0 Cost/benefit analysis

4.1 Assumptions

The assumptions in the cost/benefit analysis are listed below:

- Only claims concerning quantity have been considered

- The cost of the project group is expected to decrease for each CLC implementation. Therefore the cost of the project group for a world wide implementation has been assumed to be two times the cost of the implementation at one CLC
- The salary of each employee is 46 000 SEK/month including social costs.
- As a partner company axis will get a 50% discount on the price of the VMS
- 80 percent of the total savings potential can be reached
- All product are included in the new shipping module

4.2 Cost of the VGT-solution implementation

Cost of project group

Member	***Time in project***	***Total project time***	***Hours in project***	***Salary/month (incl. SC)***	***Salary/hour***	***Cost***
Project manager	30%	480h	144	46 000 SEK	288 SEK	41 400 SEK
IT-engineer	50%	480h	240	46 000 SEK	288 SEK	69 000 SEK
Installation technician	10%	480h	48	46 000 SEK	288 SEK	13 800 SEK
CLC manager	5%	480h	24	46 000 SEK	288 SEK	6 900 SEK
Super-user Shipping	5%	480h	24	46 000 SEK	288 SEK	6 900 SEK
Process development engineer	10%	480h	48	46 000 SEK	288 SEK	13 800 SEK
Total cost CLC 1						160 000 SEK
Total cost world wide						***320 000 SEK***

Time of project

Phase in project	***Time***
System integration	8 weeks
Testing the integration	2 days
Final adjustments	3 weeks
Installing hardware	2 days
Testing of implementation	2 days
Education	2 days
"Go live" with project	1 day
Total project time	**12 weeks**
Project time in hours	**480 hours**

Cost of hardware

Category	***Type***	***Units***	***Cost per unit****	***Cost***
Scanners	Standard data matrix scanner	5	2 000 SEK	10 000 SEK
Cameras	P3225-LV	15	2 000 SEK	30 000 SEK
	Q3505-V 22mm	1	2 000 SEK	2 000 SEK
Computers	PC with high capacity	1	10 000 SEK	10 000 SEK
Total cost per CLC				52 000 SEK
Total cost world wide		5		***260 000 SEK***

*The costs per units are not the real costs

Cost of VMS

Category of cost	***Type of cost***	***Units***	***Cost per unit***	***Cost per CLC***
Basic packages	VMS Basic Package	1	300 €	300 €
	VMS for up to 10 interfaces	1	1 995 €	1 995 €
	Project Engineering	1	995 €	995 €
Interfaces	Interface cameras	16	160 €	2 560 €
	Interface scanners	13	495 €	6 435 €
Training	Basic seminar (two days)	4	1 295 €	2 266 €
Maintenance	Cost before maintenance			14 551 €
	Cost of maintenance 17% yearly			2 474 €
	Total costs for all CLCs	5	17 025 €	85 123 €
	Axis partner reduction of 50%			**42 562 €**
	Exchange rate (1:9.349) (24.05.16)			
Total cost world wide				***400 000 SEK***

4

Cost of education

Person	*Amount*	*Salary/month (incl. SC)*	*Salary / hour*	*Cost*
Operator	6	46 000 SEK	288	1 725 SEK
Consulting operator	4	46 000 SEK	288	1 150 SEK
Team leader	2	46 000 SEK	288	575 SEK
Warehouse manager	1	46 000 SEK	288	288 SEK
Total cost per CLC				3 738 SEK
Total cost world wide	5			***20 000 SEK***

Cost of VGT-solution implementation

Type of cost	*Cost*
Project group	320 000 SEK
Hardware	260 000 SEK
VMS	400 000 SEK
Education	20 000 SEK
Total cost per CLC	***200 000 SEK***
Total cost world wide	***1 000 000 SEK***

4.3 Savings potential of the VGT-solution implementation

Savings potential

Yearly cost of claims					2 800 000 SEK
Type of claim	*Wrong Quantity*	*Missing goods*	*Wrong article*	*Missing parts*	
Percentage of cost	67%	9%	13%	11%	
Savings potential	1 876 000 SEK	252 000 SEK	364 000 SEK	- SEK	2 500 000 SEK
Expected savings potential (80% of total)					***2 000 000 SEK***

Savings potential per CLC

Yearly expected savings potential		2 000 000 SEK
CLC #	*Cost of claims*	*Savings potential*
1	13%	260 000 SEK
3	5%	100 000 SEK
4	39%	780 000 SEK
5	7%	140 000 SEK
7	36%	720 000 SEK

4.4 Profitability indicators of the VGT-solution implementation

Key Performance Indicators world wide

Savings potential world wide	2 000 000 SEK
Cost of implementation world wide	1 000 000 SEK
Return on Investment (ROI)	***100%***
Pay-back time (years)	***0,5***

Key performance indicators per CLC

CLC #	*1*	*3*	*4*	*5*	*7*
Savings potential	260000	100000	780000	140000	720000
Cost of implementation	200 000 SEK	200 000 SEK	200 000 SEK	200 000 SEK	200 000 SEK
ROI	***30%***	***-50%***	***290%***	***-30%***	***260%***
Pay-back time	***0,8***	***2,0***	***0,3***	***1,4***	***0,3***

5.0 Risks/uncertainties

There are some identified risks/uncertainties connected to the implementation.

Reluctance by the operators to the new solution

Including the end-users in the implementation process is key to manage the change.

Uncertainty of customer behaviour

Will the customers accept the video-prof? Communication and transparency is important to gain the customers' trust.

Underestimating the scope of the project

The scope of the project is relatively small, but to succeed with the implementation the resources needed should not be underestimated.

6.0 Recommendations

The problems Axis have today concerning the delivery discrepancies can be solved by implementing a VGT-solution. We believe that Axis would benefit from a world wide implementation of the solution due to three main reasons:

1. The cost/benefit analysis shows a significantly positive ROI and a short pay-back time
2. Axis competitive advantage will increase through more satisfied customers
3. Possibility of marketing the use of the VGT-solution in a warehouse, creating new areas of sales for network cameras

Therefore we recommend that Axis to implement the Visual Goods Tracking Solution world wide.