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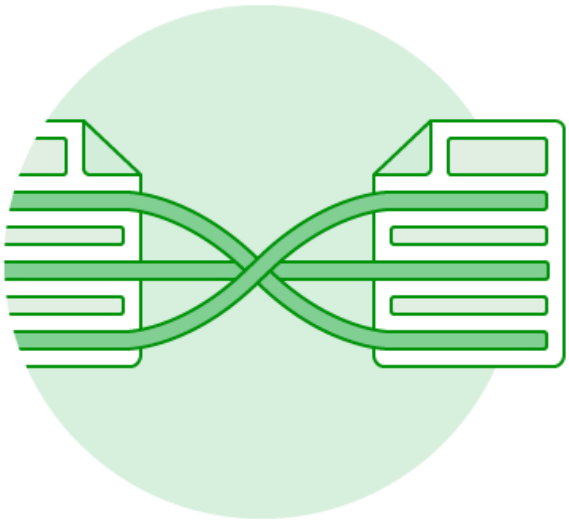

PAGERO
your financial supply chain network

Improving supply chain performance through enhanced information sharing using an EDI cloud service

Master's thesis in Supply Chain Management

OSKAR ENHÖRNING
BILL ÖSTMAN

Department of Technology Management and Logistics
Division of Logistics and Transportation
CHALMERS UNIVERSITY OF TECHNOLOGY
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Oskar Enhörning
Bill Östman

Examiner and Supervisor: Per-Olof Arnäs

Supervisors at Pagero: Pontus Hanson and Mats Ryding

Department of Technology Management and Logistics
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Department of Technology Management and Economics
Division of Logistics and Transportation
Chalmers University of Technology

SE-412 96 Göteborg, Sweden
Telephone: + 46 (0)31-772 1000

Chalmers Reproservice

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Preface

This master's thesis was conducted at Chalmers University of Technology in Gothenburg, Sweden, during the spring of 2015 as a final part of the Master Program Supply Chain Management. The thesis was performed at Pagero AB and we would like to send our gratitude to the employees of Pagero who have given us valuable input along the way and made our five month stay at Pagero's office a pleasure. Especially, we would like to thank our supervisors at Pagero, Mats Ryding and Pontus Hanson for all the inspiration, support, and exchange of ideas. Your contribution have been critical to the success of this project. A case study was conducted at one of Pagero's clients, a special thank you is sent to those who sacrificed their time being interviewed by us. We would also like to send our most utter gratitude to our supervisor at Chalmers, Per-Olof Arnäs who has given us great input and inspiration throughout the whole spring. Without your support, the final result would have looked very different from what it does today.

Abstract

Pagero is a company primarily providing scalable services for exchange of financial messages using the cloud service Pagero Online, which allows actors to connect regardless of ERP-system or message formatting used. Both the industry and Pagero have grown rapidly during the last couple of years, Pagero constantly develops new message types and services to include in the current repertoire. Pagero's by far most important message is currently the e-invoice. Instead of utilising peer-to-peer connections, all traffic is directed through the cloud and converted to whichever format is requested by the recipient. The rise of this project lies in the perception that the data stored in Pagero Online holds untapped potential for providing additional benefits to Pagero's clients and thereby increasing Pagero's competitiveness. This project brings knowledge to a field not yet explored by Pagero; how the current cloud-system Pagero Online can be used to identify, and contribute to, the increase of clients' supply chain performance by enabling enhanced information sharing. A method for identifying high potential clients in Pagero Online has been devised and used to select a case organisation which has been studied in order to confirm the existence of improvement potential. How Pagero can help the case organisation to reach the improved performance identified in the case study, and how to repeat the process with further clients has been analysed and a final recommendation to Pagero is made. This project concludes that Pagero can contribute to the increase of clients' performance, to be able to do it effectively in the future, further knowledge about clients' industries and processes must be acquired.

Keywords: *Supply chain visibility, Supply chain collaboration, Information sharing, Supply chain performance, EDI, e-invoices, cloud services.*

Contents

Nomenclature

ASN - Advance shipping notice

CoG – Center of gravity

EDI – Electronic data interchange

EDIFACT - Electronic data interchange for administration, commerce and transport

EOQ – Economic order quantity

ERP system - Enterprise resource planning system

ICT - Information and communications technology

IT – Information technology

KPI – Key performance indicator

NACE – Nomenclature statistique des activités économiques dans la Communauté européenne

OEM – Original equipment manufacturer

PO - Pagero Online

POS data - Point of sale data

RFID – Radion frequency identification

SC - Supply chain

SCOR model - Supply Chain Operations Reference model

SKU - Stock keeping unit

SNI – Swedish standard industrial classification

1. Introduction

The goal of the introductory chapter is to describe the relevance of the studied field and the chosen purpose of this project. Limitations and delimitations are presented to clarify the scope of the project.

1.1. Background

The use of EDI (Electronic Data Interchange) is today present in more or less all types of business areas and has grown rapidly during the recent years. The development continues with more and more types of messages while the knowledge of EDI is spread. The large amount of data that is interchanged lays a foundation for big data analysis and capitalisation on business information. Literature show that there is value of sharing information between actors in a supply chain. For example Arshinder et *al*. (2008) point at reduction of uncertainties if inventory status and sales data for each stage in the supply chain is shared along the supply chain. However it is of certain importance that the shared information is necessary for the intended purposes, i.e. sharing information that could be of interest does not add any value automatically, instead it could have the opposite effect (Lumsden and Mirzabeiki, 2008), (Jonsson and Mattsson, 2013).

Pagero AB was founded in Gothenburg in the year of 2000 and has today over 110 employees in offices located in Gothenburg, Oslo, Helsinki, Dublin, Sri Lanka, and Dubai. Pagero offers electronic (e) invoicing services, e-ordering services, and e-payment services through the cloud service Pagero Online (PO). The services are independent of customers´ type of ERP system, industry, and transaction volume enabling them to be usable to all types of companies. Pagero has an increasing number of customers, currently 12 000, who all can connect to each other and to an additional million other organisations worldwide through the system Pagero Online. There are numerous of providers for e-invoicing services with whom Pagero shares traffic agreements, new partners are continuously added and the base of possible connections is therefore growing. Traditional EDI solutions provided by companies such as Oracle and SAP also have the ability to send financial messages, however such solutions generally require expensive and time-consuming connections to be set up and are therefore commonly used to connect to only high volume suppliers and customers. In comparison to those solutions, Pagero's services are inexpensive and easy to set up, which makes it possible for also small companies to establish connections and send electronic financial messages. In PO, Pagero's customers can manage and set up their own connections to both customers and suppliers with only a few clicks. Pagero's customers also have the possibility to search among the other 1 000 000 organisations in the cloud network and connect to them without any extra charge.

There are numerous of different formats for electronic financial messages, e.g. PDF, EDIFACT, CSV, and XML. In addition, most ERP-systems use their own formatting for financial messages. A challenge for Pagero, acting as a hub for these messages, is the development of methods capable of accepting all different formats and formatting. Incoming messages (invoices, orders etc.) are converted to Pagero's arranged internal format and thereafter exported in a format chosen by the receiving customer.

During the last couple of years Pagero has grown quickly and the focus has been on acquiring new customers and developing the system. Meanwhile the amount of messages transferred through PO has grown and Pagero has accumulated large amounts of invoice-, order-, and payment data. A Business Intelligence department (BI) has been established to evaluate the value of the data, they have successfully been able to establish methods for identifying existing relations between customers within PO that are not fully utilising Pagero's services. Customers involved in such a relation are then

contacted by Pagero's salespeople and encouraged to increase their use of PO. Since the focus has been on growth, the BI department does not have the capacity to further investigate the possibilities of the accumulated data, its potential for value creation is therefore unknown.

This project originated at Pagero with an idea that relations between clients in Pagero Online could be used to identify supply chains. Invoices transferred in these supply chains include information about the goods being traded, such information can be useful to reduce bullwhip effects in said supply chains. If a service addressing this issue could be created, the operational performance of Pagero's clients could thereby be improved through a reduction of the bullwhip effect.

The data transferred through Pagero Online today holds value only if it can be delivered in a timely manner to a receiver who can make use of it. A challenge is therefore to decide which data is valuable, when and for whom. Except the value of the data itself the relations hold certain value. Today Pagero sends invoices and orders between the nodes in the relations, but outside of Pagero the nodes share other information. In Pagero's business model clients are charged per message delivered, increasing the amount of messages transferred is therefore desirable. Since their clients communicate additional information outside of Pagero Online, including that communication into Pagero Online would create additional sales to clients already inside the system and thus open up for new revenue streams. Actors within the same supply chain commonly have access to private information concerning their respective daily business that is not communicated to the other actors. Depending on the client, such data could be e.g. inventory level data or shipment data. If timely delivered, such information has potential to be valuable to the other actors for improved decision making, enabling better operational performance. For example shipment data could be used to deliver an advanced shipment notice to the receiver of a shipment and therefore allow for better resource planning. Information concerning a company's processes is generally found in the respective actor´s ERP-system. Since Pagero's core capability is to allow for different ERP-systems to exchange information of different formats, helping their clients to send and receive extended information fits within their core business.

1.2. Purpose

By gathering knowledge concerning Pagero Online and the way it is used by the clients, as well as which data is being transferred through it, an investigation is performed to determine if and how Pagero Online can be used to increase Pagero clients´ operational performance by increasing their supply chain visibility through sharing of extended information. A solution is not restricted to the type of service or data transfer performed in Pagero Online today, it may include extended information concerning the involved clients´ processes and daily activities. A solution must be beneficial to both Pagero and the clients. The purpose is consequently:

To evaluate if and how a cloud based EDI-system can be used to provide extended information sharing in order to increase visibility and performance for actors in supply chains.

Electronic data interchange (*EDI*) has been along for several of years and has taken different shapes, therefore several meanings are associated with the expression. In this report EDI is referred to as the direct translation indicates; connections for sending and receiving information electronically. When referring to a cloud based EDI-system the explanation is that Pagero's network Pagero Online enables electronic data interchange through the cloud. In this project Pagero Online is therefore used as a proxy for EDI-connections through the cloud.

Supply chain *visibility* is defined by Barrat and Oke (2007) as the extent to which actors within a supply chain have access to or share information which they consider as key or useful to their operations and which they consider is of mutual benefit.

An improvement in a client's supply chain performance is achieved if a positive effect is experienced in any of the five basic management processes that encompasses all actions in a supply chain, these are *plan, source, make, deliver, return* (Hudson, 2004). These are defined by the APICS Supply Chain Council in the from the SCOR-model (Supply Chain Operations Reference model) and are further described in the theory chapter. Each management process includes its own metrics, these are used to measure the operational performance.

1.3. Problem analysis

As argued by Forrester (1958), optimising each actor´s inventory separately in a supply chain does not guarantee an efficient system performance. Instead it can cause or amplify what he names as the *Bullwhip Effect*, which causes the supply chain to amplify, delay and oscillate demand information in a serial supply chain consisting of retailers, distributors, warehouses, and factories. These non-favourable distortions can be caused by considerable small variations in end consumer demand. The result is the bullwhip effect for the actors throughout the supply chain. Typically the bullwhip effect is amplified upstream in the supply chain and gives rise to well-known problems such as excess inventories soon followed by inventory shortages, poor customer service, and inefficient production- and capacity planning.

Lee et al. (1997) claims that the demand distortion arises as a result of self-optimisation behaviour among the players in the supply chain. A combination of sell through data, exchange of inventory status, and order coordination in the supply chain can help to mitigate the bullwhip effect but the true prescription requires actors to give each other access to these data. A number of studies have been conducted to find the cause of the bullwhip effect, among them are Metters (1997) who points at time delay between supply chain links as the overriding cause of the problem. A possible solution is the use of EDI to cut the information lead time. Metters (1997) also argue that such systems are expensive, which makes it difficult for managers to justify the investment. In addition, the scenario might be that the benefits of reduced bullwhip effect are unevenly distributed among the trading partners.

Perfect information about a whole supply chain system such as full information about the other supply chain actors´ processes, orders, inventories etc. can not be secured (Yu, Yan and Edwin Cheng, 2001). Every single actor in a supply chain can have perfect control over their own information, however uncertainties will still arise since perfect information about the other supply chain actors´ processes, orders, inventories etc. can not be accessed. Information sharing between supply chain actors intends to reduce this uncertainty as much as possible. Several studies have assessed the impact of formation sharing in different types of supply chains through simulations. Among them is Raghunathan (2003) who finds that a high degree of information sharing benefits the supply chain, however the benefits are not equally distributed among supply chain actors. Machuca (2004) simulates the impact of EDI in a supply chain as a whole and in each link individually, it is found that the elimination of information delay provides substantial savings in the form of reduced inventory, stable inventory management, and more stable behaviour of other measured variables. Machuca concludes that once advanced telecommunications are used in all supply chain nodes, cost reductions will be realised in all stages of the supply chain.

To summarise the above section; many researchers claim there is high potential for cost reduction when sharing information concerning processes and demand in the supply chain. However in many cases the benefits are not evenly distributed throughout the supply chain. Many also argue that implementing an information sharing system is expensive.

As previously mentioned, Pagero has access to data in the form of e-invoices, e-orders, and e-payment sent or received by their 12 000 customers. By default this data is available for the customers to review during 120 days, however the data can be stored in Pagero's system for much longer. The data is used by the proportionately small Business Intelligence department to find customers of Pagero who are presently doing business with each other without utilising Pagero's services e-order, e-payment, or e-order each other in between. Further usage areas for the data are currently unknown.

Pagero Online users can search and establish connections with existing users of PO and with users of competing networks with whom Pagero has a traffic agreement. After a simple handshake a connection has been established and the users can send financial messages to each other. Using knowledge of existing connections and the data transferred through them, it is possible for Pagero to identify chains of clients within PO. Sanders (2008) states that the use of IT for coordination among actors within supply chains is well documented with improvements in areas such as inventory planning, demand forecasting, order scheduling, and customer relationship management. Burgess (1998) is one of the first to point out IT as critical for integration between supply chain actors. Supply chain innovation is also directly positively impacted of a higher IT level presence (Stroeken, 2000). Thereof is a perception derived that organisations and supply chains with high *digital maturity* have a bigger potential for being willing to share electronic information with their partners, as well as having better capabilities for handling electronically transferred information and using it to their benefit. Digital maturity is in this project defined as an organisation´s ability to make beneficial use of digital technology in line with the organisation's strategy and vision. Identifying these digitally mature clients within Pagero Online should give Pagero access to a list of clients with an interest in sharing extended information beyond e-invoices with their supply chain partners. If a client today sends a large portion of their invoices electronically, it is an indication of digital maturity. How to use the data (such as e-invoice information) available in Pagero Online as a proxy for finding digitally mature clients gives rise to the first research question.

Q1. How can Pagero Online be used to identify digitally mature supply chain actors?

If such digitally mature supply chains can be identified where information in the form of e-invoices and orders are already transferred today, there would also be potential for increasing the repertoire of messages to include other types of information; extended information beyond what is transferred today e.g. inventory status information and advance shipping notice. Pagero Online could then be used to create a formal channel for information exchange in above Q1 mentioned supply chains. The objective would be to enable information to be available in the right form, at the right time, and at the right location thus providing the right conditions for improved supply chain efficiency. King and Griffiths (1986) suggest that the value of information equals the cost savings or other advantages that are made available by the information. The second research question is thus:

Q2. Is it possible to increase operational performance for digitally mature actors by sharing extended information through Pagero Online?

Academic literature (Forrester, 1958; Lee et al., 1997; Yu, Yan and Cheng, 2001; Machuca, 2004; Sanders, 2008) implies that information sharing in supply chains can help to decrease sub-optimisations, reduce bullwhip effect etc. In this project a case study is performed on a selected focal company in order to investigate if and then where enhanced information sharing and visibility could benefit the focal company's supply chain. The type of information that is subject to be exchanged in the future depends on

what is valuable to the clients. However, possible areas include payment notifications, payment reminders, capacity notifications, early forecasts, inventory levels etc. Information as an entity holds no value in itself, it is only valuable if the receiver can use it for decision making. To determine which type of information is relevant the above mentioned focal company is investigated.

2. Methodology

This project consists of several tasks each using different methods. The project as a whole falls under the category exploratory research where a case study is used to gather the relevant data. In this section firstly a brief review of five major research methods as well as three purposes of research (*exploratory, descriptive,* and *explanatory*) are performed. The purpose for this project is set in relation to the below described research methods and is further discussed. The research design for the project is then further described.

There can be three distinctive purposes in a social science research project, these are; *exploratory*, *descriptive,* and *explanatory* (Yin, 2009). An exploratory research is often used at an early stage to generate a hypothesis or to pose questions for further research. It often relies on secondary data, literature studies, or qualitative approaches such as interviews, case studies, or pilot studies (Shield et al., 2013). Descriptive studies are commonly used to describe something such as the market potential for a certain product (Kotler et al., 2010). Explanatory studies are used to test hypotheses or evaluate cause and effect relationships, such research projects can be very complex and the researcher can seldom be completely certain that all affecting factors are accounted for. Research methods commonly used in explanatory research are experiments and simulations.

Yin (2009) describes five major research methods in Social Sciences, these are *Experiment*, *Survey*, *Archival Analysis*, *History* and *Case Study*. Which of the methods to use is not only depending on the above described purpose of the study (exploratory, descriptive or explanatory) but rather three important conditions (Yin, 2009). These are *(a) the research question posed, (b) the extent of control the investigation has over actual behavioural events* and *(c) the degree of focus on contemporary as opposed to historical events*. The conditions and their relation to the five major research methods are displayed in Table 1.

Table 1. Five major research methods and their respective conditions, (adapted from Yin, 2009).

Method	*(a) Form of research question*	*(b) Requires control of behavioural events*	*(c) Focuses on contemporary events*
Experiment	how, why?	yes	yes
Survey	who, what, where, how many, how much?	no	yes
Archival analysis	who, what, where, how many, how much?	no	yes/no
History	how, why?	no	no
Case study	how, why?	no	yes

The first condition ("a" in Table 1) concerns the type of research question. Yin (2009) uses the basic categorisation "who", "what", "where", "how" and "why". Questions mainly using the "what" question come in two versions; either exploratory as in e.g. "what can be learned from this study", the goal is then to develop a hypothesis or a proposition for further inquiries. However exploratory purposes can be used in all research methods. The second type of "what" question comes in the form e.g. "what have been the ways for company A to perform activity B". The research is advantageous when the purpose is to describe an incident or predict a future event based on what is known today. In those cases a Survey or an Archival analysis are often advantageous. "How" and "why" questions are in general more explanatory and are likely to be used in case studies, histories, and experiments. Those two

questions of "how" and "why" often deal with operational links or processes that need to be traced over time. If e.g. the purpose was "how did company A overcome problem B", a survey or a case study is likely to be advantageous. To summarise this paragraph, the most important condition when choosing a research study is to classify what type of research question is being asked. In general there are large overlaps where several methods can be of advantage, if a certain research method is favoured by the researcher it is important to adapt how the research question is disposed to match the chosen method.

The second condition (b in Table 1) concerns the researchers´ control over behavioural events. The third condition (c in Table 1) concerns the focus on contemporary or historical events. Assuming the research question is in the "how"- or "why" form, the events studied are past events whereas there is no control over the behaviour, a History based method is beneficial (Yin, 2009). However, if the focus is on contemporary events and the behaviour can not be manipulated, a case study method is in favour. In contrast to the History method, a case study adds a source of evidence not available to the historians, i.e. direct observations. An Experiment can only be performed if a large amount of control over behaviour is present since it requires the subjects to participate in experiments.

Finally, it is possible to use several methods within the same study e.g. a survey within a case study (Yin, 2009). The methods are therefore not mutually exclusive, there are however situations where certain methods have distinctive advantages. According to Yin (2009), these situations specifically occur for Case-studies when a "how"- or "why" question is being asked, the events examined are contemporary, and when the researchers possess little behavioural control over the studied events.

Since the project is based on theory about SC improvements and simultaneously is meant to explore possible further use of current data and technology (projectory enabled for actors with no present similar solution) it is neither a strict deductive project nor a strict inductive one whereas this mix states that this is an abductive project. Input from both theory and collected empirical data will successively be used in the reasoning to render conclusions concerning the purpose and research questions. In addition analysis will be performed continuously in order to determine the upcoming steps.

2.1. Scope and Limitations

The project is treated as a case-study limited to Pagero and the selected partner client. Other currently passive stakeholders are Pagero´s clients whose stake will be exposed first when and if Pagero chooses to launch a new product or service built upon the findings of this project.

In order to identify digitally mature Pagero clients suitable for a case-study, data from Pagero Online i.e. e-invoices, e-orders, and e-payment is analysed. Additional data collection is carried out at the selected case-study company and concerns that company's processes and goals. Knowledge concerning Pagero's strengths, core business, history, and future plans is a key to enable this project's direction to be in line with Pagero's strategy.

Throughout this project, there are legal aspects to be considered concerning for instance ownership of information, visualisation of information, and transparency or non-transparency of information origin. The legal aspects are also to be considered and the result of any Business Intelligence work can under no circumstances result in bad-will side effects but rather in good-will. With the handling of such a large amount of other actors´ sensitive data, a considerable responsibility follows.

Concerning the identified focal organisation that is subject to the case study, the name Sameina is an acronym used to disguise the real identity. Two areas with possible visibility- and performance improvement possibilities in line with this project were investigated, in both areas improvement potential was found. These two areas are *the aftermarket* and *the production warehouse*, other areas

with possible improvement potential have not been considered.

The reference model (SCOR) used for defining an operational improvement includes the management processes Plan, Source, Make, and Deliver. The latest version also includes the management process *Enable*, this is however not included in this project.

2.2. Research design

This section will describe the five tasks in the work process and the research design. The working process is not linear, some of them are thus conducted simultaneously and are frequently being subject to revision based on supplementing findings. The whole process is visualised in Figure 1.

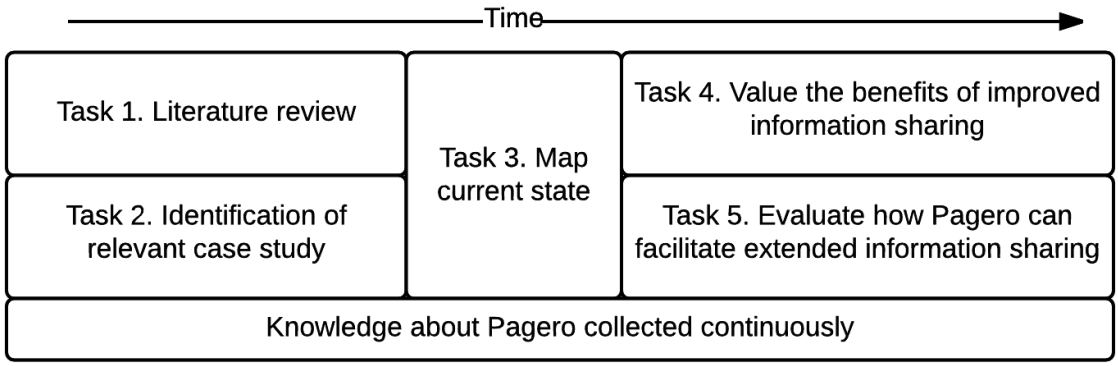

Figure 1. Shows the work-flow and research design used throughout the project

In the *Task 1* a supply chain perspective will be adopted and a thorough literature study concerning information sharing and how it can benefit supply chains is performed. The literature study will also search for methods for determining the benefits of information sharing in a supply chain. *Task 2* will describe how a relevant supply chain to be used in the case analysis is identified in Pagero's system. *Task 3* describes the current state in the focal company and which information flows affect which processes and KPIs. The *Task 4* aims to determine the how the focal organisation could benefit from and increased supply chain visibility in the areas identified in the Task 3. The output is a list of KPIs where there is potential for improvement in the investigated supply chain. Critical information flows with a possibility to positively affect the KPIs are outlined together with a quantification of how much the KPIs can be improved. In the Task 5 the findings from Task 4 are evaluated. It is analysed how PO can be used to improve the critical identified information flows and thus increase the KPIs. It is also discussed whether Pagero should engage in such activities. Table 2 describes the tasks, their respective method and their output.

Table 2. Describes the research design and the content of the tasks included.

Task #	*Task 1.*	*Task 2.*	*Task 3*	*Task 4*	*Task 5*
Activity	Literature review.	Identification of relevant case study.	Map current state.	Identify and value areas where increased information sharing would benefit.	Evaluate how PO can facilitate extended extended information sharing.
Method	Literature review.	Qlikview in PO and Analysis.	Literature review and Interviews.	Interviews and Analysis.	Interviews and Analysis.
Output	Find relevant studies and methods.	Choose a supply chain to be investigated.	A thorough description of the focal organisation's processes and current state of information sharing.	Find important KPIs that can be affected by improved information flows.	Should Pagero provide a service that facilitates the identified information flows?

2.1.1. Task 1. Literature study

The objective of the literature study in this project is to gather relevant knowledge in the topic of information sharing, and to find a method relevant for valuing the benefits of information sharing in a supply chain. The use of the word "information" in this section is deliberately vague, that is because investigating the meaning of "information" is one of the goals of the literature study. A literature review is performed with the purpose of identifying previous studies of supply chains similar to the supply chains investigated in this project and to find which information that is relevant in the context of information sharing for improving operational performance. Common areas of improvements when using information sharing are inventory management, capacity planning, production planning, and forecasting. Commonly used search phrases during the literature review was: "information sharing", "supply chain transparency", "EDI", "bullwhip effect", "value of information sharing", etc., and different combinations of them. Google Scholar was used as a tool to search among the various online academic databases available to students at Chalmers University of Technology. Most articles were accessed through the databases Emerald Insight, ScienceDirect, Jstor, Elsevier and Wiley Online Library. When an article with an interesting topic was found, the related references used in that article was also explored. In addition the functionality "cited by" in google scholar for articles referring to a specific report provided a good method for finding newer reports within the same subject.

2.1.2. Task 2. Identification of relevant case study

The objective of this task is to identify a supply chain to be used for the case study. The identified supply chain will in this project be referred to as the SC. The base for the selection are the 12.000 clients in Pagero's network Pagero Online, PO. Using the business intelligence tool Qlikview and Microsoft Excel, connections between Pagero's clients in PO are investigated with the purpose of finding a supply chain consisting of two or more clients currently active in sending financial messages between each other in PO. To reduce the amount of possible choices, a range of limitation actions are performed. Firstly, one client (a base client) is to be identified, their connections are then to be analysed in order to find direct suppliers and/or customers that are active in the same field. Further actions for reducing the list of possible base clients are:

Criteria 1. Volume and electronical message criteria. The base client must have either a large volume of incoming financial messages or a large volume of outgoing financial messages through PO. The messages must be sent electronically and not using Pagero's "print service".

Criteria 2. Inside Pagero criteria. The clients connected to the base clients must also use PO to either receive or send financial messages, powered by Pagero and not by any other financial message provider.

Criteria 3. Frequency criteria. The frequency of financial messages transferred in PO for the selected base clients and its suppliers and/or customers must be above a certain level. Clients that only occasionally use PO are therefore not considered for the case study.

Criteria 4. Related business area criteria. The businesses of which the clients are active in are of certain interest i.e. if the actors in an identified SC are within the same or related business area it is of a higher probability that they would benefit of an information sharing solution. An example of a case where the connected actors are active within different business areas and thus not relevant for an information sharing solution is a car manufacturer buying cleaning services for their offices.

Criteria 5. Geographical criteria. Since the case study requires interviews and physical visits, clients that are based abroad are not considered.

Criteria 6. Previous collaboration criteria (optional). Clients frequently wish to transfer from paper-based invoicing to fully electronic invoicing. To fully integrate this, also the base client´s corresponding receivers and/or senders must use electronic invoicing. Together with selected clients with those wishes, Pagero therefore frequently performs activation projects where the client´s suppliers and/or customers are introduced to PO. Due to the fact that these activation project´s Pagero representants already have a relation with those clients it is a belief that those clients are in general more open and mature for a case study within the area of this project. Therefore is a list of clients with a collaboration history with P participants in previous activation projects is reviewed extra carefully.

After a list of possible supply chains to be used in the case study has been prepared, a certain degree of manual investigations are performed. The manual handling includes determining if the connections represent supply chains or are mutually irrelevant. This means foremost to determine that the connections represent a flow of goods/services with corresponding messages through all actors involved. Another important factor when choosing the final case study is the selected company's possibility to participate in the study, as well as their geographical location.

2.1.3. Task 3. Map the current state

Task 3 aims to gain insight into the focal organisation's processes with a focus on information sharing which information flows are exchanged today. This is done in order to identify areas where an increased supply chain visibility could potentially benefit the focal company's processes. The interviews performed in Task 3 were carried out with one interviewer asking question and another one taking notes. The interviews were recorded and later transcribed for review purposes. The questions were initially open and the interviewees were given time to elaborate on their answers. The focus then shifted towards information flows, specifically questions of the type "If you would have access to this information from that actor, what would you be able to do?" Follow up questions were asked to thoroughly exhaust each subject and gain full input from the interviewee. The interviews performed are listed in Table 3.

Table 3. Interviews performed at the case organisation and their respective subject.

Interviewee	*Subject*	*Date*
Purchasing manager	General information about the organisation.	*2015-03-24*
Warehouse manager	Current state of the production warehouse.	*2015-03-24*
Finance manager	Financial KPIs and use of e-invoices.	*2015-03-24*
Materials planner	Daily procedures, KPIs, current visibility level, potential of additional information flows.	*2015-03-24*
Strategic purchaser		*2015-03-24*
Aftermarket purchaser		*2015-03-24*
Aftermarket director	Aftermarket set-up, information flows, improvement possibilities.	*2015-03-31*
Aftermarket product manager		*2015-03-31*
Warehouse manager	Production warehouse improvements.	*2015-03-31*
Key account manager	Sales processes, visibility level.	*2015-03-31*

Step 1: Organisation pre-study. Gather knowledge about the focal organisation without contacting them. This is mainly done online, at the company web-site and at web-pages supplying free financial statements as yearly financial reports for the recent years. Qlikview is also used to gather knowledge concerning suppliers and customers.

Step 2: Information flow pre-study and interview preparation. Cause effect maps are schematic pictures describing how an information flow affects a company's processes and KPIs. In the Information Value Assessment model by Caridi et al. (2014), generic cause-effect maps have been created for 17 different generic information flows. They are deliberately created generic so that they can be used as inspiration for a more in-depth analysis at a focal organisation. Since information flows and supply chain visibility is the focus of the case study, the maps are used as input when designing interview questions for the first interview at the focal company. To receive a fundamental understanding of the possibilities with cause-effect maps, a video interview was carried out with the main author of the cause-effect maps; Maria Caridi. An example of a generic cause effect map is shown in Figure 2.

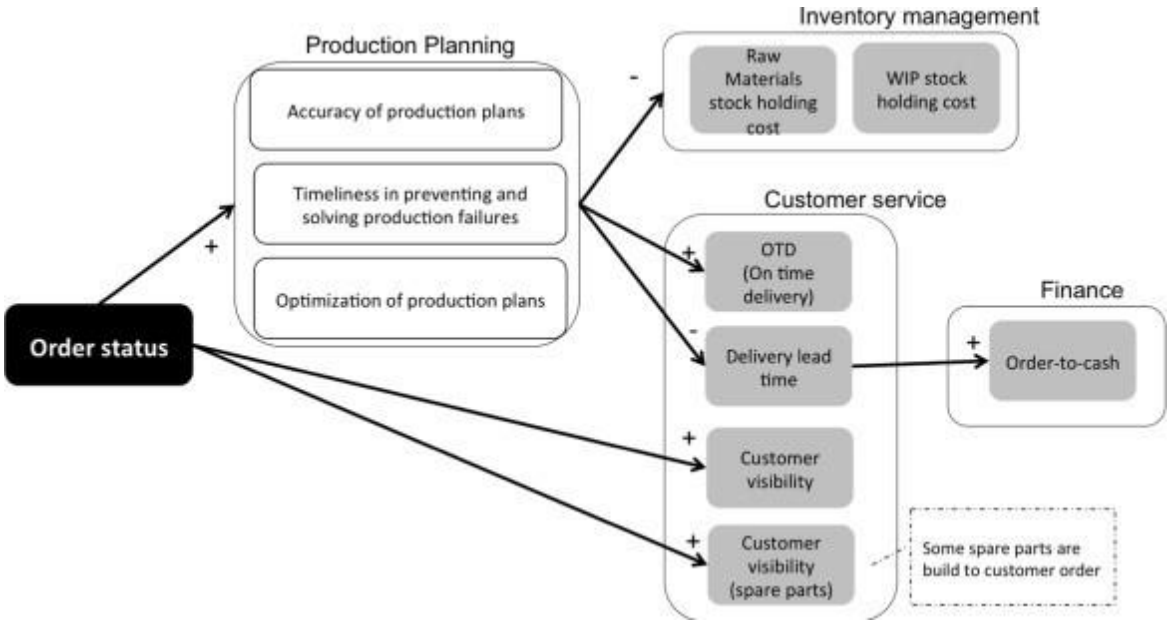

Figure 2. The generic order status cause-effect map

The black box represents the information flow order status, i.e. the supplier transmits information concerning the status of the released orders. White boxes are processes performed in the focal company, the grey boxes are KPIs. Figure 2 is generic and is not adapted to any specific focal company. The arrows with either a plus or a minus represent either a positive or a negative correlation between the two boxes. E.g. the arrow and the minus sign which connects the "Production Planning" boxes and the "Inventory management" boxes means that there is a negative correlation between all the processes inside. If the process "Accuracy of the production plans" increase, then the KPI "Raw material stock holding cost" will decrease.

Similar generic cause effect maps exist for the information flows ASN (Advance shipping notice), Order status, Production residual capacity, Inventory level, Supplier internal quality, SKU features, Component features, Production plan and Demand forecast. These are attached in Appendix B. According to Caridi et al. (2014), the purpose of the maps is to allow identification of KPIs potentially affected by visibility improvements. The maps also describe whether the information flow, or the processes affected by the information flow, has a positive or negative correlation to the KPIs. A thorough description of the rationale behind the arrows and correlations in Figure 2 is available in Appendix A. Starting from these generic cause-effect maps and adapting them to the specific case allows the researchers to find case-specific connections between information flows and KPI performance faster than if they would have been created ad-hoc (Caridi et al., 2014).

Step 3: Initial interviews at the focal organisation. Interviews are performed in order to gain a broad knowledge of the nature of the focal organisation. Processes identified in step 2 are the focus areas of the interviews. The purpose is to gather enough data to make possible that certain area(s) can be selected where the next steps is carried out. Selection of appropriate area(s) is further described in Task 4.

Step 4: Revision of the cause-effect maps. Based on the initial interviews, cause-effect maps are reviewed and adapted to describe the current state at the focal company. They are constructed to describe how information flows affect the processes and KPIs at the focal company. This step is also described as Step 0 in Task 4.

2.1.4. Task 4. Value the benefit of improved information sharing

To value the benefits of improved information sharing, selected steps from a *value assessment method* created by Caridi et al. (2014) has been used. The method investigates a focal company's supply chain and identifies KPIs of strategic importance where there is a gap between the current performance and the target performance. Activities causing the lack of performance are analysed and the information flows that may positively affect those activities are identified. An assessment of the information flows ability to affect those activities is performed and quantified during a series of interviews. Interviews in Task 4 were more direct compared to the interviews in Task 3 since an analysis had already been partly performed. A more detailed description of the steps performed are described below. The interviewee represent relevant persons from the focal company. This is performed in several steps described below:

Using the Visibility value assessment model

Caridi et al. (2014) used the Visibility Value Assessment Tool in a case study of an aerospace company to evaluate which information flows that could enhance the value of selected KPIs. Below is a description of the method when used in this particular case.

Step 0: Cause-effect map customisation. As previously mentioned the model includes cause-effect maps for each generic information flow , an example is shown in Figure 2, the full list can be seen in Appendix B. They describe which processes and KPIs that are affected by each information flow. In this step the input from Task 3 is used to customise the maps to match a specific focal company.

Step 1: Identification of the strategic KPIs affected by visibility. From the final cause-effect maps a list of KPIs relevant is produced. By interviews the list of KPIs is reduced on the premises of which ones that are of interest in terms of not currently satisfying the company. If possible, financial metrics are preferable. A generic list of commonly used KPIs is shown in Table 4, those are all included in the generic cause and effect maps.

Table 4. The KPIs included in the cause-effect maps

Process	*KPI*
Inventory Management	Raw materials inventories
	WIP stock inventories
	Finished product inventories
Customer service	On time delivery
	Delivery lead time
	Finished product quality
	Product availability
Finance	Order-to-cash
Source	Supplier switching cost
	Source lead time
	Purchasing cost
Handling	Handling efficiency
	Workforce saturation
Warehouse management	Warehouse saturation
Production execution	Production lead time
	Production cost

Step 2: Prioritisation of KPIs. The KPIs identified should reflect areas of where the company see strategic relevance. Company representants (the interviewee) are asked to rank the KPIs. If the amount of KPIs is high (about 10 or more) an AHP method could be used to facilitate the ranking. For further description of suitable AHP methods, see Evaluating E-Procurement Solution by Narasimahn et al. (2003).

Step 3: Selection of the KPIs to be used in the analysis. With the ranking in mind, KPIs that are meant to carry on with are selected i.e. the KPIs with the most strategic relevance from the previous step are considered. With interviewee revise the KPIs characterised by less realistic improvement potential are sorted out and not carried on with.

Step 4: Identification of the performance gap (for each selected KPI). The current value of each KPI is determined as well is the target value of each KPI. The difference between those two values, for each of the selected KPIs, is calculated and referred to as a gap.

Step 5: Identification of the causes of the gap (for each selected KPI). By interviews the causes of the gaps are identified. Information system queries to the company systems may be used to support the

causes and the cause-effect maps may be re-analysed and revised to support possible causes. When the possible causes are identified, the company representants are asked to weigh the causes in between; giving them a percentage of out a total of 100 %. Note that this step and the three more upcoming are carried out for each selected KPI.

Step 6: Identification of information flows that can reduce the causes of the gap (for each selected KPI). With the customised and re-analysed cause-effect maps, the researchers can identify information flows that might affect the performance of the selected KPIs and thereby reduce the gaps. The interviewee is asked to estimate the reduction of the gap (in percentage) for each cause under the premises that all KPI are available and properly measured.

Step 7: Estimation of the overall improvement in the performance gap (for each selected KPI). The researchers calculate the expected gap reduction by multiplication of each cause´s weight [%] (identified in step 5) with the estimated contributing reduction of the cause [%] (identified in step 6). The final percentages for each of the causes are added up to a total perceived gap reduction for each selected KPI.

Step 8: Identification of additional benefits related to the selected information flows (optional; for each selected KPI). The researchers should review the information flows, identified in step 6, again to search for additional benefits that could be e.g. synergies for the other selected KPIs and/or unexpected other synergies of interest.

2.1.5. Task 5. Evaluate how Pagero Online can facilitate the identified information flows

The output of Task 4 describes KPIs that are not meeting the goals set by the focal company. It also describes which information flows that have the possibility to affect them and to what extent. In Task 5 it is analysed how Pagero can help the focal company to gain access to those information flows. To what extent this is possible depends on the nature of the focal company's supply chain and the barriers for creating the information flows both technically and company culturally. A possible solution for how the information flows can be created for the focal company is devised in the analysis chapter. Such solutions are not restricted to functionality from PO not available today, however the feasibility of the solution will be considered. It is then discussed how Pagero can facilitate the solution and which functionality has to be created in order to realise the solution, as well as why Pagero should engage in such activities. Factors to consider during the analysis are:

- Pagero's technical ability to facilitate the information exchange
- How should the information be delivered to Pagero´s clients?
- In which form can the information be supplied?
- What competences are required in order to make use of the shared information?
- Sensitivity of information and willingness to share information?
- What is the improved performance worth for the studied supply chain, and in the long term to Pagero?

2.2. Validity and reliability

This section discusses the issues of validity and reliability for the project.

2.2.1 Internal validity

The nature of a case study is to study a very broad topic and narrow it down into one more easily researched topic (Shuttleworth, 2008). This means that by definition, many factors are excluded which may or may not further explain the question posed. A different research method may also generate a completely different result. The interviews performed in the project provided answers and allowed the researchers to linger on interesting subjects. The level of details provided by interviewees during the interviews would not have been possible to acquire with other research methods, simply because the researchers would not have known what to ask for. Obviously it is not possible to account for all factors that may affect the observations, but the case study painted a personal picture of certain areas within the case organisation and gave the researchers plenty of unique material to analyse. A result in this project is that certain areas within the studied case organisation would benefit from higher supply chain visibility. In order to reach such results the current visibility level has been studied, as well as the organisational preconditions. Few metrics were available for analysis, it is possible that including more KPIs could have told a story different from the one told by the interviewees. That would have affected the analysis and the final recommendation of the project. Since the actors studied within the case study all belong to the same corporate group, external effects such as reluctance to cooperate are partly diminished, which reduces the amount of possible factors to affect the results, the internal validity of the study is thus increased.

2.2.2 External validity

The population validity is concerned by the sampling method which is represented in this project by the method used for selecting an organisation for the case study. Among other features, a digital mature organisation has the ability to easily utilise and benefit from new digital technology. This is reinforced by the academic community and described in "3.2. Digital maturity and ICT development in supply chains", the population validity of selection criteria are therefore strengthened. Relevant literature used in the project has been gathered from databases with academically published articles, these include Emerald Insight, ScienceDirect, Jstor, Elsevier and Wiley Online Library. Using a thorough selection process with several criteria a case study organisation was chosen based on its digital maturity measured by the factors quantified in Pagero Online. Whether the quantitative criteria used to estimate Digital Maturity are valid is subject to discussion and handled thoroughly in "5.1. Selecting a digitally mature candidate". In short, the fact that a manufacturing organisation uses e-invoices points toward a high degree of digital intensity. The volume of e-invoices exchanged is used as a proxy for transformation management intensity. Even though the use of e-invoices are only a small part of all digital activities performed in an organisation, digital maturity in one part of the organisation should be accompanied with similar digital attainment in other parts as well.

Since the results are based on a single case study at a chosen Pagero client, the exact solution presented is valid only for that organisation. However a clear need for increased visibility was found for the case study organisation. Since the case study organisation was found with the developed selection process, its validity is reinforced. This also includes the assumption that it can be used to find more organisations with similar needs. The selection criteria were initially set harshly in order to acquire a case organisation with whom the project had a high probability of success. Only a few organisations were identified, however when the criteria were slightly relaxed the amount of results increased. The number of possible organisations left on the short list shows that there are many organisations with a relative high digital maturity. The confidence in the generalisability of the selection process is thus increased.

There is a general criticism for case studies concerning how the research design affects the data collection and whether the subjectivity of the researchers can be remained. In a case study an object is studied in its natural environment, in that sense the study contains a high degree of ecological validity. However since the interviewees are asked questions where they are forced to consider subjects they do not consider on a daily basis, their answers are to a certain extent affected by the researchers and therefore subject to a certain level by interviewer bias. The interviewer bias is one of the most difficult biases to avoid (Shuttleworth, 2009). Being interviewed by representatives from academia decreases this bias since the interviewees have nothing to lose, instead they can freely elaborate around the subject.

2.2.3 Reliability

The project has been performed with Pagero's office as a base, this has given the researchers a unique insight in the processes performed at Pagero and also a possibility to continuously ask questions to the employees concerning subjects relating to the research. Throughout the project, meetings with three supervisors have been continuously performed and the ideas have been evaluated to ensure that the ideas and directions are correct. The supervisors have different specialities, two are parts of Pagero's organisation and one is a Doctor within transportation and logistics at Chalmers University of Technology. Their respective expertise have shed light over different important aspects of the project and increased the reliability of the results. In addition, meetings with selected specialists within Pagero have been performed to gain feedback on areas of the project that are within their respective expertise. The whole project has been continuously documented in a diary that has been used for review purposes to ensure that nothing is lost along the way. In addition the diary brings transparency to the working process and reliability to the rationale of decisions taken.

Yin (2009) claims that especially in open interviews as used in this study, it is stressed that the interviewees´ responses and personal values are equally valued. The researchers put a great amount of effort into separating the two and to be transparent with which one is used in each situation. Reliability of a study is also affected by possible systematic misinterpretations and general misstatements, which in an interview could be represented by e.g. systematic misstatements (Yin, 2009).

To create reliability in this project the interviews performed during the case study were performed in pairs (excluding the interviewees). The interviewers took turn in asking questions and taking notes. In addition the interviews were recorded and later transcribed for review purposes. The interviewers' perception of the issues discussed during the interviews were later compared to both the notes taken and the transcriptions in order to reach a high reliability. Possible ambiguities were questioned continually during the interviews and follow up questions were later asked in case uncertainties remained.

To gain reliability within the data collection used during the selection process, the filter processes were performed several times. The criteria used in Qlikview, the used business intelligence tool, were re-calibrated between every iteration to ensure that no mistakes were performed. The data used was derived from Pagero's database with identical results every time. Since the database used for business intelligence is only updated monthly, several common bias associated with re-tests are eliminated.

3. Theoretical framework

The theoretical framework is the first task in the research design, literature is studied with the intention of understanding how increased supply chain visibility help to increase the operational performance of affected actors. Methodologies for evaluating the benefits of information sharing as well as measuring operational performance has also been studied. Figure 3 below shows the work process used throughout the project and what will be presented in this chapter.

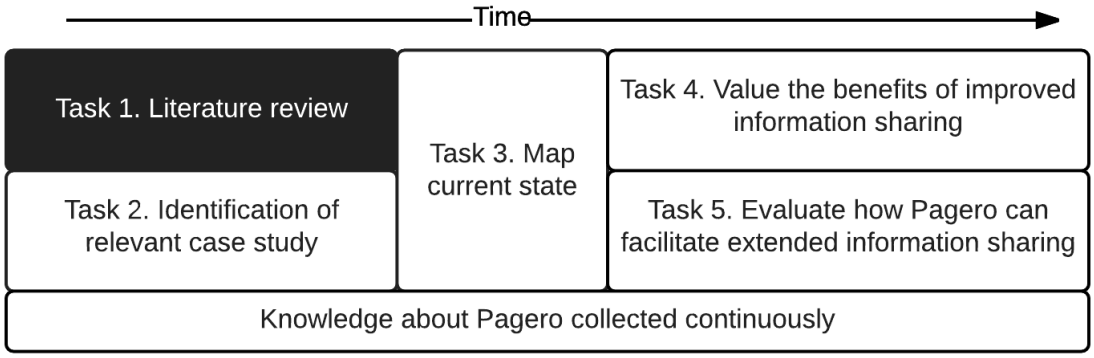

Figure 3. The work process. The literature is performed in Task 1.

Topics covered in the literature review include Supply Chain Management, ICT Development in Supply Chains and Information Sharing. "3.1. Supply chain management" shortly describes Supply Chain Management and how operational performance is measured, supply chain visibility is defined and described. In "3.2. Digital maturity and ICT development in supply chains" the role of ICT for integrating suppliers, and Digital Maturity is defined and its impact on actors in supply chains are covered. In "3.3. Information sharing" the meaning of Information sharing in a supply chain is described and its coordination effect in a supply chain. Different types of information and how it is valued is described.

3.1. Supply chain management

All actors involved, directly or indirectly, in fulfilling customers´ needs are parts of a supply chain (Chopra and Meindl, 2012). The most downstream actors are the end customers and the most upstream actors are the raw material producers. The length of a supply chain can vary a lot depending on which type and how many middle players who are involved. These middle players could be warehouses, retailers, manufacturers, third-party logistics suppliers, component suppliers etc. Important to highlight is that even though supply chains are commonly seen as a straight chain, they more often than seldom turns out to be networks. For example a component supplier having a range of sub-component suppliers and a variety of manufacturing plant customers which in their turn have many different suppliers. Chopra and Meindl (2012) states that "Supply Network Management" would be a more accurate term than "Supply Chain Management" when referring to planning and control of product-, information-, and monetary flows between actors.

3.1.1. Supply chain performance, the SCOR-model

To measure the performance of the processes carried out in a company or in a supply chain, performance measures are used. A performance measure is a set of metrics used to quantify the efficiency or effectiveness of an action (Neely et al., 1995). Efficiency measures how economically n organisation's resources are utilised when providing a pre-specified level of customer satisfaction. Effectiveness is the

extent to which customers' requirements are met. APICS Supply chain council (APICS, 2011) describes the major drivers of supply chain performance, these are:

Facilities. Performance is affected by the design and location of facilities. Network optimisation actions enables the design of networks of manufacturing sites, service areas and distribution centers to deliver low cost with optimal inventory and high capacity level.

Inventory. Can increase flexibility and act as a buffer in order to decouple supply from demand.

Transportation. Design of transportation systems and choice of modality can have a huge impact on benefits and costs. It affects speed and flexibility, which are competitive factors in the global economy.

Information. A major influencer on supply chain effectiveness and efficiency is the ease of which information can be shared through the supply chain. Collaborative efforts include joint decisions with suppliers and customers regarding costs and service risks. To manage these information sharing elements is crucial and may include demand, new product plans, product design changes and consolidation of freight into milk runs.

Sourcing. Sourcing decisions are important and changes can affect products and services all the way down to end-user level. Changes must therefore be communicated throughout the supply chain.

Pricing. Whether price is high or low sends a signal to all supply chain members, competitors, customers and potential new entrants. The price should be set in line with the organisation's overall strategy.

There are several systems for measuring the performance of a supply chain, commonly they include a set of metrics used to quantify both effectiveness and efficiency. The most important metrics are key performance indicators (KPI), they should measure an organisation's value adding processes that have a direct impact on the core business and creates wealth for customers. A main challenge to any organisation is to identify and measure the relevant KPIs that are in line with the organisation's strategic goals (Gunasekaran and Kobu, 2007). Data collection and analysis are major tasks for monitoring the KPIs, this is especially evident if the organisation is global and there is parity among the data. However transparent communications such as web based information systems can help to overcome some of the barriers. Among the systems for measuring supply chain performance are balanced scorecard, the performance matrix and the performance measurement questionnaires (Neely et al., 1995). Common criticism of many performance measurement systems is that they encourage short termism, lack strategic focus, encourage local optimisation and does not take competition into account. The most comprehensive and well known answer to this criticism is the SCOR model which has been used by companies to measure and improve their supply chain performance. The SCOR-model contains five basic management processes; Plan, Source, Make, Deliver and Return (Figure 4), each process has their own measured performance elements (Huan et al., 2004) (Hudson, 2004). Every basic supply chain is a "chain" the four execution processes Source, Make and Deliver and Return, Plan sits on the top and manages them.

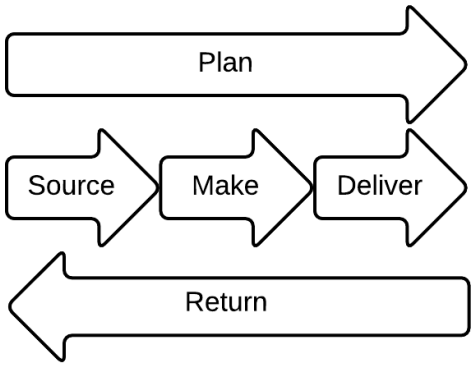

Figure 4. The five basic management processes in the SCOR model.

The SCOR model contains three levels of process details with separate performance metrics, Level I deals with process types, Level II is the process level and configures the processes, Level III handles the lowest level performance metrics. In the list below, the management processes Plan, Source, Make and Deliver have been summarised by Stewart (1997). Return has been added later to the SCOR model, in the list below it is derived from Hudson (2004):

Plan:
Demand/supply planning: Assess supply resources; aggregate and prioritize demand requirements; conduct inventory planning; assess distribution requirements; determine production, material, and rough-cut capacity for all products and all channels.

Plan infrastructure: Make/buy decisions; supply chain configuration; long-term capacity and resource planning; business planning; product phase-in/phase-out; manufacturing ramp-up; end-of-life management; product line management.

Source:
Sourcing/material acquisition: Obtain, receive, inspect, hold and issue material.

Source infrastructure: Vendor certification and feedback; sourcing quality; inbound freight; component engineering; vendor contracts; initiation of vendor payment.

Make:
Production execution: Request and receive material; manufacture and test product; package; hold and/or release product.

Make infrastructure: Engineering changes; facilities and equipment; production status; production quality; shop scheduling/sequencing; short-term capacity.

Deliver:
Demand management: Conduct forecasting; plan promotions; plan projects; plan sales campaigns; collect and analyse point of sale (POS) data and actual customer orders; promote products; price products; measure customer satisfaction; execute efficient customer response (ECR).

Order management: Enter and maintain orders; generate quotations; configure product; create and maintain customer database; manage allocations; maintain product/price database; manage accounts receivables, credits, collections and invoicing.

Warehouse management: Receive and stock finished goods; pick and pack; configure products; ship

products; create customer specific package labelling; consolidate orders.

Transportation management: Manage traffic; manage freight; manage product import/export. I*nstallation management*: Schedule installation activities; perform installation; verify performance.

Deliver infrastructure: Channel business rules; order rules; management of deliver inventories; management of deliver quantity.

Return:
Return infrastructure: Preparation to handle return of containers, packages and defective products. *Return management:* Management of business rules, return inventory, assets, transportation and regulatory requirements.

A change within an organisation that results in a positive effect in any of the above described management processes is characterised as an improvement in the organisation's *operational performance.* Since each management process includes performance metrics on several levels, changes in the metrics indicate a change in the process performance.

3.1.2. Supply Chain Visibility and Transparency

In this section supply chain visibility and supply chain transparency is used to describe the same phenomena. Common definitions are outlined and a metaphor of the different levels of supply chain transparency is described. There are many definitions for supply chain visibility, Barrat and Oke (2007) define it as the extent of which actors within a SC have access to or share information which they consider as key or useful to their operations and which they consider will be of mutual benefit. Tohamy (2003) defines it as capturing and analysing SC data that allows for informed decision-making, mitigated risk and improved processes. A similar notion is information transparency between two actors, it is defined by Lamming *et al.* (2004) using a metaphor of light shining light shining through a mineral as an analogy for the transfer of information or knowledge in relationships. The metaphor consists of three levels of transparency, these are Opaque, Translucent and Clarity, and their descriptions are outlined in Table 5 below.

Table 5. The visibility metaphor of light shining through a mineral. Adapted from Lamming et al. (2001).

The metaphor of transparency: The behaviour of light as the analogy of information or knowledge in relationships

Geological case (light shining through a mineral)	Light cannot even penetrate the surface of the substance.	Light can enter and exit the surface of the substance, but with distortion.	*Light enters and exits the surface relatively undisturbed.*
In supply management: (information existing in or shared between two organisations)	*For any of a variety of reasons, no information is shared between the parties; even operational day-to-day information is obscured.*	*Outline information only is shared interface conditions or partial data.This can be similar to "blackbox" collaborative design.*	*Information is shared on a selective and justified basis. Development of information leads to shared knowledge and collaborative abilities.*

In reality, relationships are likely to include variations of all three levels of transparency (opaque, translucent, clarity) distributed over several interface processes such as purchase managers to sales managers and design engineers etc. They are also expected to vary over time. Lamming *et al.* (2004) suggests that the concept of transparency is to be used for specific purposes and highlights the importance of clear goals with all attempts to improve the transparency.

Valuation of supply chain visibility

Since the adoption of Information and Communication Technology used for information sharing purposes often can be quite expensive it is important to be able to evaluate its achievable benefits. Caridi et al. (2014) describes a value assessment model which measures the benefits of supply chain visibility. Caridi et al. (2010a) describe a setup of four information categories that are of interest for a focal company.

- Transactions/events: information communicated when an event takes place.
- Status information: information describing the status of some resources/ processes.
- Master data: information related to product features.
- Operational plans: information about future company plans.

Under these information categories generic information flows are described, they are constructed so that they can be customised to fit several industries (Caridi et al., 2010a). Each information category includes several information flows, which can if timely delivered to the right place allow for more informed decision making. Such improvement have a positive effect on the affected processes performed in a supply chain, and thus the corresponding performance metrics. The following is a brief description of the key steps in Caridi et al.'s (2010a) model. To be able to act on the information flows properly, KPIs with a lacking performance and of strategic importance to the focal company are identified. Since the analysis of each KPI is time consuming it is recommended that only a few are selected for further evaluation. For each of the selected KPIs a performance gap should be identified. This gap represents the difference between a present KPI value and a target value. The unit used could be in percent, monetary terms, time, etc. With the gaps in mind, the causes of the gaps are to be found followed by identification of information flows that have possibilities of reducing the gaps. Interviews are conducted and the reduction possibilities using the identified information flows for the selected KPIs are quantified (Caridi et al. 2014).

3.1.3. Supply chain collaboration

Supply chain collaboration is central for effective supply chain management, it is considered to be a core capability to be competitive in today's business environment (Bowersox et al. 2000). A collaboration occurs when participants works together with an activity or a project (Bartlett et al 2007), or when as implied by Anthony (2000); "*two or more companies share the responsibility of exchanging common planning, management, execution, and performance measurement information" and that "collaborative relationships transform how information is shared between companies and drive change to the underlying business processes*". For relations between firms to work well changes and adaptation must be made, Håkansson and Gadde (1992) suggest that the willingness and preparedness of firms to partake in adaptations benefit the relation and show that they are committed for the future. Such adaptations can be technical, knowledge-based, economic or legal. Information sharing is considered to be the basis of effective collaboration in a supply chain (Lee 2000a, Bowersox et al. 2003), but to leverage the benefits collaborative supply chain initiatives must be implemented. Kulp et al. (2004) studies the benefits of information sharing in supply chains and shows that the best performers do not only share information with their partners, but also work together with them in a close relation to fully realise the benefits of activities such as collaborative planning and product development. However studies on information

sharing have shown that all partners do not equally enjoy the benefits, Yu et al. (2001) found that manufacturers often gain more than the retailers. Clark and Hammond (1997) have similar findings and argue that an unbalanced distribution of benefits will discourage some partners to share information. Agreements for sharing the benefits are therefore of importance for a lasting collaboration. High degree of information sharing will not bring any significant improvements to a company's or a supply chain's performance unless it is accompanied by a high degree of collaboration (Baihaqi and Sohal, 2012).

3.2. Digital maturity and ICT development in supply chains

The digital maturity level is the result of an organisation's usage of digital technology. To understand why digital maturity is important and what it does for an organisation, the role of ICT in an organisation for information sharing and supplier integration will first be presented. It is followed by a thorough description and definition of digital maturity.

3.2.1. The role of ICT for supplier integration and information sharing

Rapid development of ICT has been acknowledged as a driver of supply chain management (Simchi-Levi et al. 2003). A wide range of information technologies are available such as RFID, EDI, the Internet, and mobile computing. ICT has enabled real-time, online communication with the potential to link all supply chain members disregarding of location (Li et al. 2006). The largest potential lies in collaborating information flows that require a high amount of data exchange. Prajogo and Olhager (2012) describe ICT as critical to supply chain management in three aspects; First it enables higher volume and higher complexity of information transferred. Second, it can contribute with real-time information regarding the supply chain. Third, ICT enables better arrangement between forecasts and operations, both intra-organisational and inter-organisational. Paulraj and Chen (2007) points out at that ICT can reduce the often occurring supply chain coordination problems´ origins of time- and geographical barriers.

The technical elements of ICT solutions are important (Prajogo and Olhager, 2012). However, even more important is the frequency, the the quantity, and the quality of the shared information. There must be a willingness from all involved actors to share information, otherwise investments in ICT could result in less benefits than expected. To succeed with an ICT investment, the shared information should contain more than just transactional data; it is of high importance to share also strategic data. Klein et al. (2007) explain that greater mutual trust between the involved actors lays a foundation for greater ICT customisation. Greater ICT customisation in turn lays a foundation for greater strategic information flows within the ICT systems.

Qrunfleh and Tarafdar (2015) highlights a possible problem with the numerous supply chain information technologies and supply chain practices. Subsequently it is of high importance that the chosen ICT tools correspondingly support the chosen supply chain practices. Lack of ICT capabilities can hinder companies from participating in information sharing partnerships (Stefansson, 2002), as well as hinder their ability to exploit the knowledge gained from such partnerships (Siau and Tian 2004). Qrunfleh and Tarafdar (2015) point at their findings from an investigation of 205 American manufacturing companies and highlight the importance of a fit between the usage of ICT systems and SCM practices for achieving superior supply chain performance.

3.2.2. EDIFACT, a standard for electronic data exchange

EDIFACT (Electronic Data Interchange For Administration, Commerce and Transport) is one of the international EDI standards supported by Pagero. It was developed in 1987 by United Nations, EDIFACT provides a set of syntax rules to structure data, it includes an interactive exchange EDI protocol and a set of standard message types. A few of them are mentioned here:

- *Invoice documents* (INVOIC) are one of the message types supported by EDIFACT, INVOIC is used in EDI nationally and internationally and is based on universal practice related to administration, commerce and transport and is not dependent on the type of business or industry (Unece.org, 2015b).
- *Dispatch advice* (DESADV) specifies details for goods dispatched or ready for dispatch under agreed conditions. It serves both as a delivery dispatch advice and return dispatch advice nationally and internationally (Unece, 2015c). Dispatch advice is also referred to as Dispatch note and Advance shipping notice (ASN).
- *Inventory report* (INVRPT), it is a message specifying information relating to held inventories and is intended to be sent in either direction between trading partners. It can be used for both national and international application and is universally related to administration, commerce and transport, in addition it is not bound to any specific industry. INVRPT can be exchanged between e.g. manufacturers, distributors, consignment holders, etc. It includes functionality to differentiate between classes of inventory, allows for financial valuation, planning production and deliveries and much more (Unece.org, 2015a).
- *Sales report* (SLSRPT) is also available in the EDIFACT standard.

3.2.3. Digital Maturity

Organisations of all sizes are at different levels of maturity in their efforts to digitise to take advantage of today's current and emerging technologies. The organisations that succeeds in becoming digital leaders experience significant benefits over those that do not (Valentine, 2014). Result from Westerman et al.´s (2012) research show that digitally mature organisations financially outperform less digitally mature organisations, regardless of industry.

Digital maturity is defined by Westerman et al. (2012) in two dimensions; *Digital intensity* and *Transformation management intensity*. Digital intensity tells about an organisation's investments in technology-enabled "*initiatives to change how the company operates – its customer engagements, internal operations, and even business models".* A high degree of digital intensity is present if an organisation is working with different and new investment in digital initiatives. However, if these initiatives are not combined with some degree of Transformation management intensity they could tend to be uncoordinated and maybe duplicative. Transformation management intensity tells about "*leadership capabilities necessary to drive digital transformation in the organisation".* Ability to lead the organisation with technology-based change and have a clear vision of the future is a measure of high transformation management intensity. Also, having a top-down leadership combined with bottom-up innovation is in line with transformation management intensity.

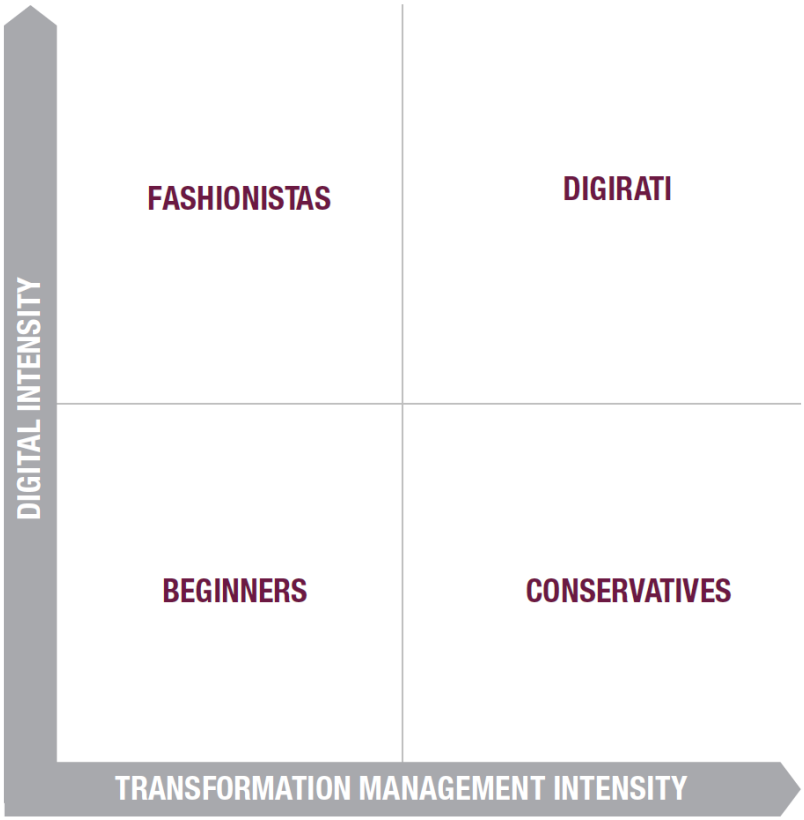

Figure 5. Digital maturity classified by two dimensions; Digital intensity and Transformation management intensity. (Westerman et al., 2012)

The two dimensions create the axis of a two-by-two matrix (Figure 5 above) into which organisations are put and thereby classified (Westerman et al., 2012). The four fields represent certain characteristics about how an organisation relates to digital maturity where Digirati is the most mature classification and Beginners is the least mature one. Fashionistas and Conservatives are in the middle of digital maturity on this classification but of different kind. The four fields are however not separated by waterproof borders.

Digirati represent the most digitally mature organisations who have understood the possibilities that lies behind well adapted digital technology investments simultaneously knowing what means with sufficient investment combined with careful government and engagement (Westerman et al., 2012). *Beginners* are as the name says; beginners. In most cases that is not a choice, instead the organisation has developed less digital adaptability. These organisations might be relatively mature in terms of e.g. ERP-system but other digital initiatives might have failed or have not been present due to lack of effective transformation management. *Fashionistas* are eager to adapt to new technological innovations but necessarily with the organisation´s strategy in line. These organisations typically experiment with new digital applications where some may create value but some do not. The bottom right field contains the organisations referred to as *Conservatives* who are relatively digital mature but are a little conservative at adapting to new technologies. A drawback is that they might miss opportunities in the strive for traditional and prudent solutions. However, conservatives understand the importance of governance and culture for a technological project to succeed.

Westerman et al. (2012) show in a study of 400 large traditional companies that digital maturity matters in every industry. Out of the 400 companies studied, 184 were publicly traded and studied with an extra depth. The result shows that Digirati classified companies financially outperformed the others (Fashionistas, Conservatives, and Beginners) regardless of industry. The Beginners performed

financially less while the Fashionistas and Conservatives performed relatively intermediate, the figure below describes the general digital maturity of each industry.

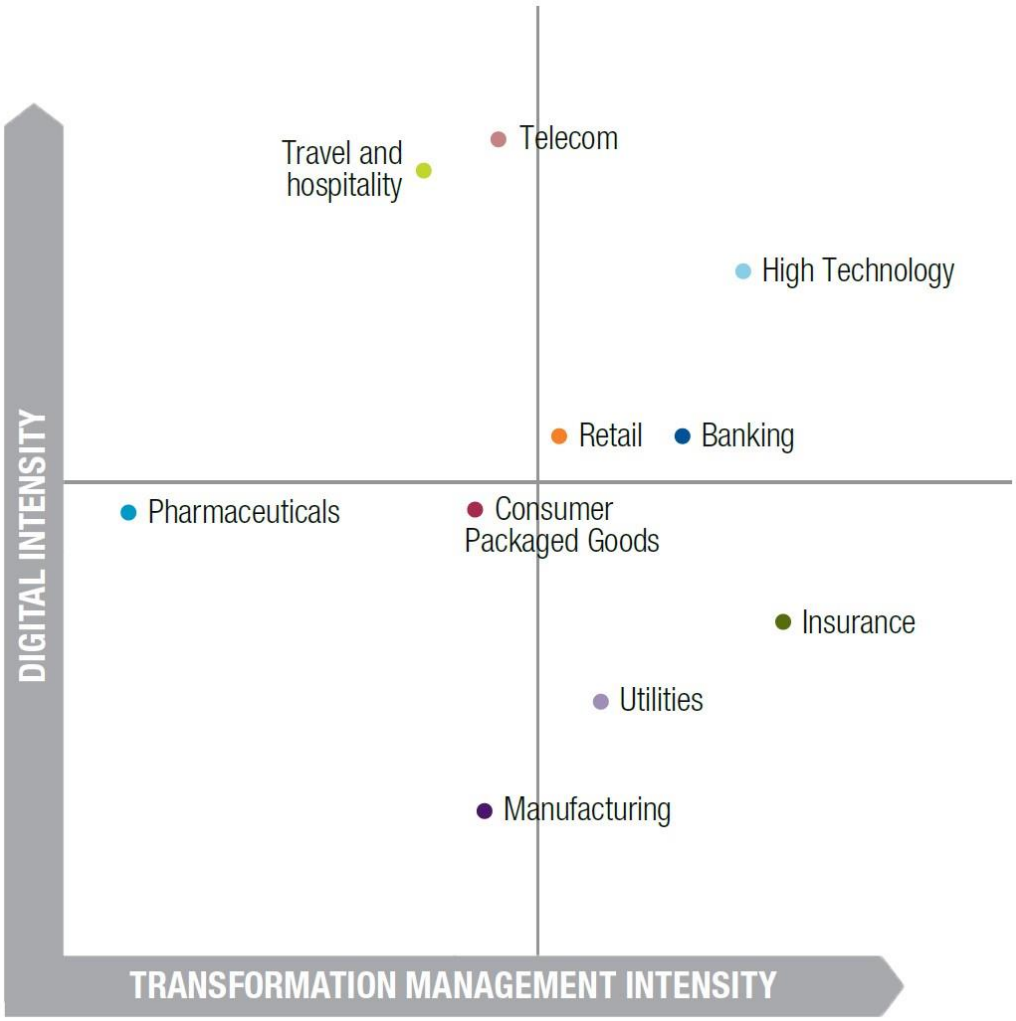

Figure 6. Different industries spread over a 2x2 digital maturity matrix. (Westerman et al., 2012)

The Manufacturing industry, which is frequently mentioned in the literature (Qrunfleh and Tarafdar, 2015; Bourland et al., 1996; Sahin, 2002 etc.), is located in the Beginners field close to the Conservatives field but is moving towards the conservative field according to Westerman et al. (2012). The base data for the location of each industry in the matrix above is collected from 400 large companies worldwide and their location in the matrix represents the industry average.

3.3. Information sharing

This section will first describe different information types and their value for actors in different situations. It is followed by a review of academic research performed for supply chains with varying levels of information sharing, and the respective information sharing has on supply chain coordination and performance.

3.3.1 Information types and their shared value

A certain type of information may be valuable for decision-making for one actor in a supply chain but worthless for someone else. King and Griffiths (1986) suggest two methods for evaluating the value of information. The first one considers an organisation's willingness to pay for the information, the second measures the cost saving or other advantages that are made available by the information. In order to

generate knowledge, raw data in a database must be synthesised and made available for communication, modelling or analysis in a timely manner (Lumsden 1997). Figure 7 below illustrates how the value of data increases as it is refined from data to information to knowledge.

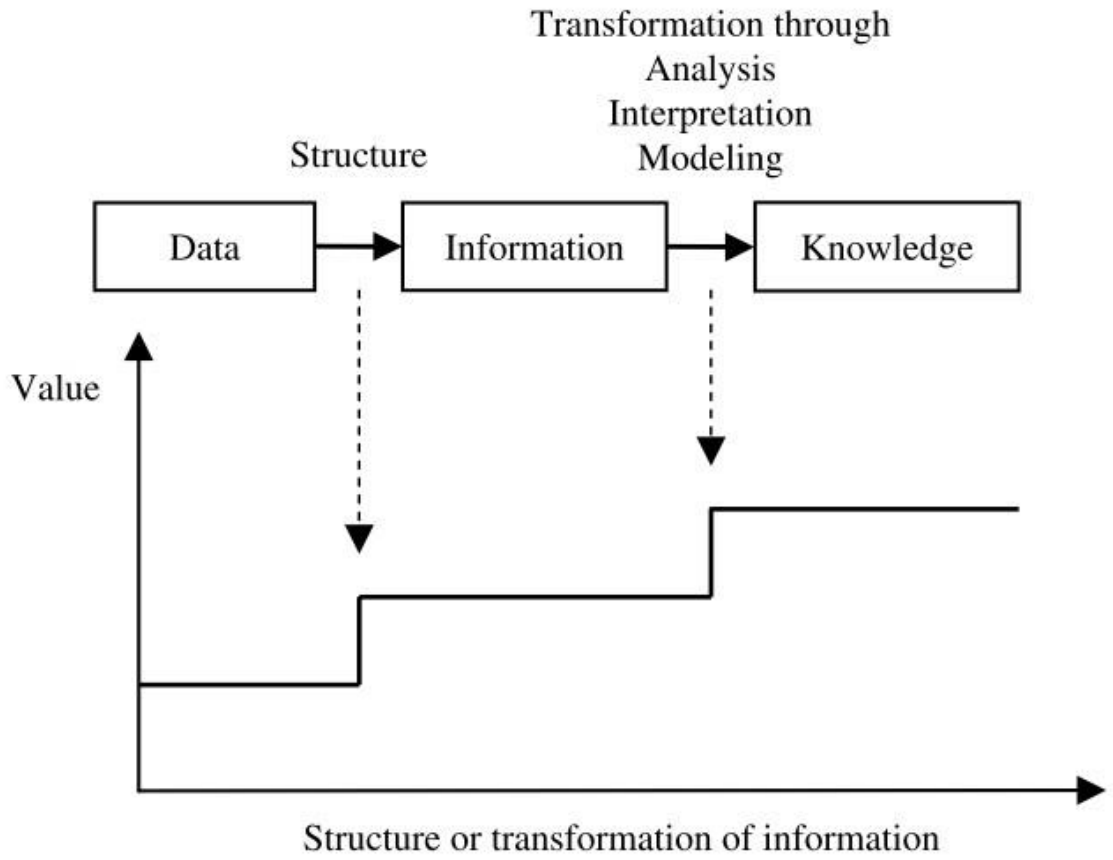

Figure 7. How the value of data grows as the data is refined. (Lumsden 2008).

Lumsden (2008) describes common types of information available for sharing in a supply chain and analyse their value for different partners in a supply chain.

Information concerning the *location of the product* in a supply chain allows improved decision making when locating available resources, getting idle assets back into service and to verify billing or subcontractor activities. Technologies like radio frequency identification (RFID) or bar code scanning allows logistics providers to gather this data. Shippers can utilise this type of information to improve record keeping, management of resources and increase efficiency in time and cost. Sharing information concerning the product location can lead to better shipment traceability and higher service levels since customers have access to real time information. Warehouse operators benefit from this information by allowing enhanced the inventory control, order preparation and processing of shipment. Manufacturers can plan their resources better and reduce their inventory (Lumsden 2008).

Information concerning the *condition of products in the shipment* can create value for a supplier who sends raw materials, manufacturers who send the final product and both retailers and customers at different levels. In cold chains such as for chemicals, medicine of perishable food, a lack of knowledge about temperature and condition can prove to be costly.

Position and sequencing of products in shipment or inventory can help warehouse operators to improve time efficiency, order preparation and processing and labour cost by providing accurate

inventory control. Whether a player in the supply chain can take advantage of this type of information depends on the type of product being delivered and its application (Ketzenberg et al., 2007).

Inventory level and point-of-sale of retailer (POS) for each SKU benefits retailers, suppliers, and manufacturers by lowering inventory-keeping cost, obsolescence cost, back-order cost and lost order cost (Lumsden, 2008). If this information is shared among retailers it can increase the availability for end customers whereas costs of lost orders can be decreased (Simchi-Levi et al., 2002). Lumsden (2008) argues that the biggest advantage for sharing POS information in the supply chain is decreasing the bullwhip effect and thus reducing stock keeping cost, and back-order costs.

History of sales is useful for creating forecasts and identify operational exceptions. Manufacturers get improved ability to plan production, retailers achieve support for better decision-making concerning batch sizes and frequency and number of orders (Simchi-Levi et al. 2002).

Warehouse operation information includes physical activities such as materials movement, storage, order selection, and product receipt. This information create value for warehouse operators since it improves their possibility of tracking storage locations, inventory cycling counting, labour scheduling, equipment scheduling, lot control, order selection, replenishment and receiving, and storage and performance measurements (Lumsden, 2008).

If information about *shipment quantity information in the supply chain* is not shared with customers it causes shipment quantity uncertainty, the customer responds to this uncertainty by increasing safety stocks. If instead the shipment quantity information is shared, customers have more time to adjust future order decisions and value is thus created for both retailers and manufacturers (Zhanga et al., 2006).

E-invoices are primarily used by clients due to the decreased handling time required. Nyvelius (2009) argue that cost savings when changing to electronic invoicing is commonly around 25-50% of the manual handling cost. Norway and Denmark have already prohibited the use of physical invoices in the public sector. In the beginning of 2015 the Swedish Government ordered an investigation for the possibility of a complete transfer to electronic invoices in the Swedish public sector (Elverheim, 2015). The background is an EU-initiative that will enforce the use of e-invoices for public procurement by 2018. Still, e-invoicing constitutes only a small share of the total amount of invoices in Sweden. A major challenge is that there are no common agreement on the format for electronic invoices, an e-invoice service provider therefore has to be able to handle a bunch of different formats. There is also no central register of organisations that accepts e-invoices, service provider therefore needs to have service agreements with each-others to be able to reach more clients (Elverheim, 2015).

3.3.2. Coordination of Supply Chains based on degree of shared information

A supply chain is considered to be fully coordinated when all decisions are aligned to accomplish global system objectives i.e. supply chain objectives (Sahin and Robinson, 2002). A lack of coordination occurs when decision makers base their decisions on incomplete information or have incentives that are not compliant with the system-wide objectives. Even when full information is available, the performance of the system can be sub-optimised if decisions are based on the goals of single objectives. Two methods for coordinating supply chains are available, centralised- and decentralised coordination (Lee and Whang 1999). In a centralised system, a single entity optimises the network. In a decentralised system, mutual coordination mechanisms are established to create incentives for decentralised decision makers to act in the best interest of the system. These decision makers have access to private information, which commonly is not shared with others, thus resulting in suboptimal system performance (Sahin and Robinson, 2002). Information sharing is often regarded as a generic cure for supply chain illness

(Lee et al. 1997). The most frequent suggestion for improving system performance is therefore often to provide each channel member with point-of sale (POS) data and inventory data of all adjacent channel members. However further studies show that such a solution does not completely solve all the problems of players being evaluated based on personal performance instead of system performance (Sahin and Robinson 2002).

No information sharing and no system coordination - Bullwhip Effect

In the 50s and 60s, single installation inventory models were popular for balancing ordering and setup costs with inventory holding costs and to provide optimal ordering policies. Harris´s (1913) economic order quantity model are among the most famous methods. However, as argued by Forrester (1958), optimising each actor´s inventory separately does not guarantee an efficient system performance. Instead it can cause or amplify what is referred to as the Bullwhip Effect, which causes the supply chain to amplify, delay and oscillate demand information in a serial supply chain consisting of retailers, distributors, warehouses, and factories. When a supplier first receives an order, a replenishment decision is made based on the the order-quantity. The replenishment should be large enough to cover the ordered quantity, safety stock and an additional pipeline inventory to compensate for possible shifts in demand. The adjustment is passed down the chain to the distributor in the form of an overstated order, which is interpreted as a shift in demand. The distributor's perception of system demand is thus amplified. This replenishment process is repeated and the perception of system demand is amplified further as the information moves upstream the supply chain (Forrester, 1958). Figure 8 below shows an example of the bullwhip effect in a supply chain consisting of a retailer, manufacturer, wholesaler and a supplier.

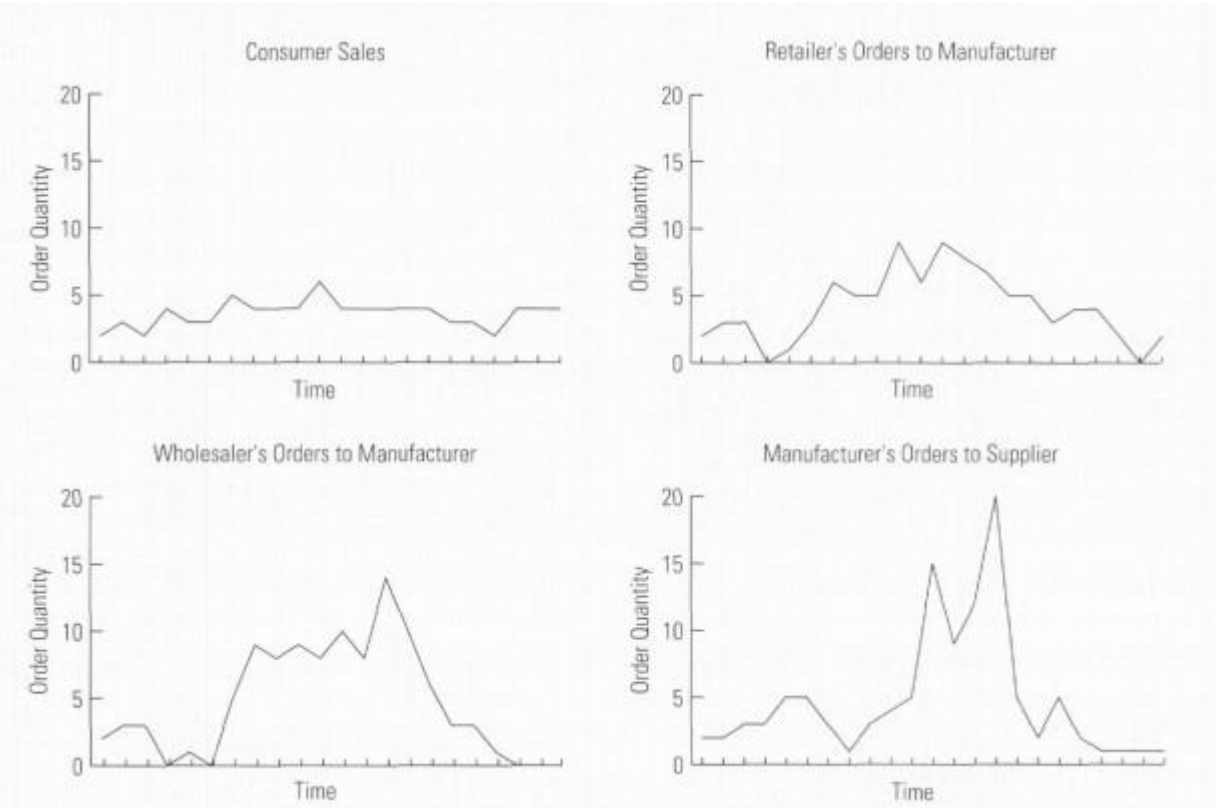

Figure 8. An example of the bullwhip effect in a supply chain consisting of consumer, retailer, wholesaler, manufacturer and supplier. (Source: Lee et al. 1997)

Possible causes for an amplified demand (which triggers the bullwhip effect) are seasonal demand variations, random sales fluctuations, price discount policies, policies that encourage over-ordering in times of shortage, long order lead time with delayed transmission of demand information, and traditional purchasing policies that over-react to demand changes. Lee et al. (1997) shifts the focus towards a supply chain´s infrastructure and identifies four major causes for the Bullwhip Effect; Demand forecast updating, Order batching, Price fluctuations, Rationing and shortage gaming. Lee et al. (2004) provide a mathematical simulation of the effects of the Bullwhip Effect in a single retailer environment and shows that rational local decision making creates demand distortion.

Forrester (1958) argues that the Bullwhip Effect can be managed by shortening of order-cycle lead-times, sharing of retailer's POS data, and changing in ordering policies to generate more gradual adjustment to changes in demand. Lee et al. (2004) suggests that the problem can be mitigated by the exchange of POS data, order coordination, and simplified pricing schemes. The benefits of information sharing is not per say equally distributed in the supply chain and the retailer is usually not the one who benefits the most. A major challenge is therefore to convince retailers to agree on sharing their POS data, the gains can theoretically be split among the supply chain members, in reality this subject deserves attention on its own.

Metters (1997) argues that identification of the effects of the Bullwhip Effect in monetary terms will make it more likely to receive managerial attention. A serial supply chain consisting of manufacturer, wholesaler, and retailer in a seasonal environment is examined and it is found that elimination of amplified self- induced seasoned variability due to bullwhip effect can improve profits by 10-20%, while elimination of forecast error due to bullwhip effect increases profits by 5-10%. Taylor (1999) attempts to quantify the bullwhip effect in a case study of an automotive steel supply chain using value stream mapping. It is found that demand variability increases as it moves up the supply chain by 0.88, 1.63, 2.17, 3.05 and 13.76 standard deviations of the real OEM demand. Existence of the Bullwhip effect is well documented and mitigating techniques are known. However, its impact and variations are depending on the studied supply chain's environment, ordering policies, demand process etc. (Sahin, 2002).

Partial and full information sharing without system coordination

Electronic Data Interchange (EDI) technologies makes it less expensive to capture and share POS data within a supply chain. Such sharing allows each player to make forecasts based on actual consumer demand. Bourland et al. (1996) investigates two cases in a two level supply chain made up by a supplier and a customer. In the first case the customer transmits POS data at the end of each day, in the other case no information is shared, it is assumed that both the customer and the supplier uses periodic review inventory policies. The study shows that the value of the shared information increases as the service level at the supplier, inventory holding cost and offset times increases, and as the length of the order cycle decreases. The effect on the customer shows that when POS data is shared the supplier can provide the customer with better service at a lower cost in form of higher fill rate, with unchanged cycle level service. The research shows for an inventory reduction between 26.2 - 62.2% at the supplier and an inventory increase at the customer between 0% - 4.4%. The increased inventory at the customer side is attributed to the specific inventory policy used in this specific simulation.

Gilbert (1999) models advance order commitment with a continuous review inventory policy in a make-to-order environment and attempts to develop pricing strategies that encourage advance order commitments. Such order commitments benefit manufacturers by reducing raw materials inventory and overtime production cost. The findings show that when a larger portion of the demand is committed on an earlier basis, the larger the cost saving potential is for the manufacturer. Such advanced notices

require downstream members of a supply chain to share early notices about their needs to r upstream members. However such early order commitments reduce the flexibility at the upstream actor, incentives must therefore be provided. The increased cost at the upstream actor due to loss of flexibility is not analysed in the study.

Lee et al. (2000b) use analytical models to evaluate the value of information sharing in a two level supply chain consisting of a retailer and a manufacturer. The results show that information sharing alone can provide significant inventory reductions and cost savings to the manufacturer. To incentivise downstream members to participate, cost savings should optionally be shared by negotiating agreements such as e.g. VMI (Vendor Managed Inventory). Price reduction or lead time reductions can also be negotiated before sharing information. The effects on the manufacturer's processes are largest in the cases when demand correlation over time is high, demand variance between periods is high, or when lead times are long. These descriptions fit for most high-tech products and it is therefore suggested that higher degree of information sharing can contribute most in such industries (Lee et al., 2000b).

Full information sharing with system coordination

Bartlett et al. (2008) performed a case study at Rolls Royce (RR) to investigate the value of information sharing to coordinate operations. Included in the case was RR, a supplier and a mill which supplied the supplier, these were chosen based on their measured performance for selected KPIs. A lack of visibility was confirmed and the measured performance gaps were jointly discussed among with the RR management. A visibility pilot project was set up, since the players in the supply chain used different ERP systems a separate web portal was used, where selected information relevant to the chosen KPIs was shared. The results of the case study showed improvements in capacity planning and material ordering. The overall performance of the supplier as measured by RR improved from 27 to 100 percent for the parts included in the pilot project. There was initially a reluctance to share sensitive information, it was overcome by agreeing that each party had the right to withhold information commercially sensitive or important to maintain competitive advantage. At the end of the pilot project RR realised that sharing information had a positive impact on on their role and became less reluctant. The supplier also realised the benefits of improved schedule adherence. The delivery performance from the mill to the supplier increased and the supplier felt more involved in in the supply chain. As the whole supply chain had traditionally focused on short term planning horizons, it took a number of weeks before the whole chain started using long-term planning and started to act more in unison. Bartlett et al. (2008) concludes that leveraging an internet-based platform to facilitate exchange of information between supply chain partners has proved powerful to reduce the complexities associated with integrating the IT systems between partner organisations.

Prajogo and Olhager (2011) uses confirmatory factor analysis to investigate the relation between information integration, logistics integration, long term relationships and their impact on total performance. They find that the intensity of logistics integration has a positive relation to total performance. Both the intensity of information system integrations and the intensity of communication between firms have positive relations to logistics integration. Long term relations have a positive relation to both the intensity of communication and IT integration. Prajogo and Olhager (2011) argues that the results indicate that by integrating supply chain information, supply chain partners can work more as a single entity and respond better to market demand and create better value for customers.

3.4. Theory summary

All actors involved in fulfilling customers' needs are part of a supply chain, the length and shape of the chain can vary. The performance of actors and supply chains are measured with KPIs (key performance indicators), these should be constructed to measure an organisation's value-adding processes that have a direct impact on the core business, and they should create wealth for customers. The SCOR model is a performance measurement and improvement system designed by the Supply Chain Council, it contains five basic management processes that encompass all activities performed in a supply chain; *Plan, Source, Make, Deliver* and *Return.* Each one of them includes its own performance measurements. Improvement to an actor's or a supply chain's *operational performance* is defined as a change that positively affects any of the five management processes.

Supply chain visibility is defined by Barrat and Oke (2007) as the extent to which actors within a supply chain have access to or share information which they consider as key or useful to their operations and which they consider is of mutual benefit. It is emphasised that different parts of an organisation can have different levels of visibility and that all visibility improvements should be performed with a clear goal in mind. Collaborative efforts are important to be able to realise the benefits and increase supply chain visibility.

Prajogo and Olhager (2012) describe ICT development as critical to achieve superior supply chain management and visibility. *Digital maturity* is defined by Westerman et al. (2012) in two dimensions; *Digital intensity* and *Transformation management intensity*. Results from Westerman et al.´s (2012) research show that digitally mature organisations financially outperform less digitally mature organisations, regardless of industry. Four categories of organisations are defined based on their digital maturity; *beginners, fashionistas, conservatives* and *digirati.* Digitally mature organisations are more prone to work with and benefit from digital investments.

King and Griffiths (1986) suggest that the *value of information* corresponds to the cost savings possible through the use of it. Various information types that can be transferred bring different benefits depending on the situation and the receiver of the information.

A considerable amount of academic research has been performed within the area of information sharing as a driver of performance and supply chain coordination. Several reports have shown through simulations and case studies that information sharing has high potential for improving the performance and coordination of supply chains. Common problems such as bullwhip effect are to be mitigated by sharing of POS data. When more information is shared further cost savings can be realised. The results improve even further when coordinative efforts to the system are combined with a high level information sharing.

4. Empirical data

This chapter first presents Pagero and their cloud service Pagero online as well as the data available today in Pagero online. Such data has been gathered throughout the whole project as seen in Figure 9. The second part of the chapter presents the empirical data found in Task 2 and describes the process of selecting a focal organisation to be used in the case study. The third part performs Task 3 and describes the findings from the case study. The focal company is described with the intention of shedding light upon areas where an increased supply chain visibility would benefit the case-organisation's operational performance.

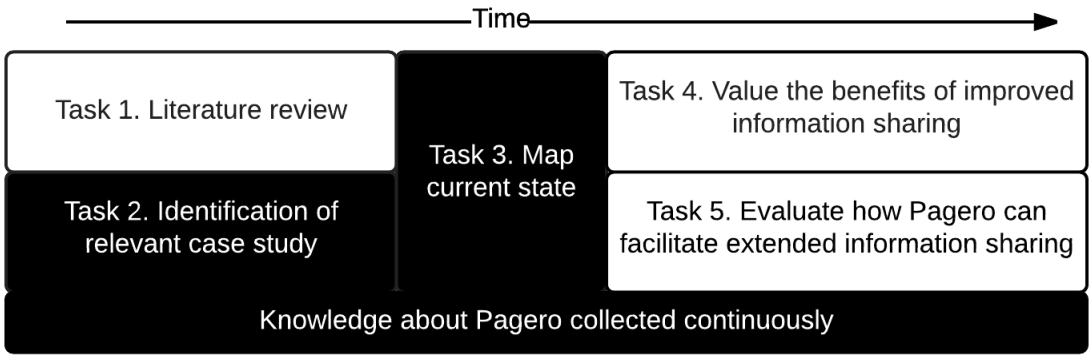

Figure 9. The work flow, empirical data about Pagero, Task 2 and Task 3 are presented in the Empirical data chapter

4.1. Pagero

Pagero AB has today over 110 employees in their offices in Gothenburg, Oslo, Helsinki, Dublin, Sri Lanka, and Dubai. Pagero offers electronic (e) invoicing services, e-ordering services, and e-payment services through the cloud service Pagero Online (PO). The services are independent of customers´ type of ERP system, industry, and transaction volume whereas it is usable to all types of companies. Pagero has an increasing number of customers, currently over 12 000, who all can connect to each other and to an additional one million other organisations worldwide, through the system Pagero Online. There are numerous of providers for e-invoicing services with whom Pagero shares traffic agreements, new partners are continuously added and the base of possible connections is therefore growing. Traditional EDI solutions provided by companies such as Oracle and SAP can also send financial messages. These connections are of another type than Pagero's and generally require expensive and time-consuming connections to be set up. Such connections are therefore commonly used only to connect to high volume suppliers and customers. Pagero's services are of another type and allows the clients by themselves to set up a connection to anyone in Pagero's network or reachable through a traffic agreement. Compared to traditional EDI solutions Pagero's services are generally inexpensive and easy to set up, which makes it possible also for small companies to easily connect and send electronic financial messages. In PO, Pagero's customers can manage and set up their own connections to both customers and suppliers with only a few clicks. They can also search among the other one million organisations in the cloud network and connect to them without any extra charge.

4.1.1. Pagero Online

Pagero Online (PO) is the cloud network provided by Pagero where all traffic take place. Customers within PO can independently set up connections between each other and start sending financial messages. A simple handshake between two clients in PO is required before any messages can be sent.

To meet the various needs of companies in terms of automation needs, invoice volume, and company structure there are five different setups of PO that can be adapted to the clients' situations. The most simple solution is Pagero Web Portal which is mainly used by clients with a low volume of e-invoices sent or received and does not requires the client to make any software investments. Such clients have often received a request from their customers or suppliers to start sending or receiving electronic invoices to/from them. Municipalities frequently make such demands from their suppliers. With the Pagero Web Portal the client logs in and manually inputs their outgoing invoices which can be sent to their established connections. The layout of such invoices is according to Pagero's own blueprint.

PO supports more advanced setups, a setup for clients using advanced ERP-systems in their business is a dedicated server setup which lets the ERP-system directly communicate with Pagero. Such clients will not be in direct contact with Pagero when sending or receiving invoices (except during the installation process).When invoices are exported by an ERP-system, Pagero Online analyses the invoices and derives the relevant information, converts it into Pagero's internal XML based invoice format and delivers it to the receiver in the requested format. Invoices can be exported by ERP-systems in several formats (e.g. XML, PDF, EDIFACT, CSV), some formats allow for easy conversion to Pagero's internal format, some require processing for deriving the relevant information. PDF formats are scanned according to predefined templates that define where in the document each piece of information is located. These templates are constructed manually for each sender of invoices. If the layout of the invoices change, a new template is constructed and a fee for constructing the new template is debited to the sender. Pagero Online must have the ability to handle all formats preferred by their clients. If the receiver of the invoice does not accept e-invoices, Pagero has a printing service which lets the sender use e-invoices which are printed and sent to the receiver by Pagero. In such occasions the receiver does not have to be a client to Pagero. Email solutions are also supported by PO.

Pagero supports exchange of also other types of financial messages than e-invoices for example ordering messages and advance shipping notice which have been in use for a few years. Order messages is on a deep increment in message volume and advance shipping notice is still used to a relatively limited extent. For more information about Pagero's other services, see www.pagero.com.

Data in a Pagero E-Invoice

By default, data is stored in PO for 120 days, longer storage is available for a fee. The full list of data included in an invoice are shown in Appendix C. The data includes article, quantity, unit price, discount, charge, and article description. From Pagero Online it is also possible to derive company information from public company indexes. From the connections between clients, one can derive the relations between clients. Pagero also saves the frequency of invoices sent for every client and relation.

Data analysis in Qlikview

Data is exported to from Pagero Online to a customised Qlikview application used for data analysis on a monthly basis. In the version used in this project only the usage of invoices are tracked. The following Table 6 is a description of available parameters:

Table 6. Selection parameters used in Qlikview

Parameters	*Explanation*
Invoice category	How invoices are transferred, e.g. scanning, e-invoice, e-mail
Date interval	Date interval should be selected
Sender service provider	Service provider used by message sender, e.g. Pagero, In Exchange, etc.
Receiver service provider	Service provider used by message receiver, e.g. Pagero, In Exchange, etc.
Sender Company group	Company groups to be included in the selection as sender
Receiver Company group	Company groups to be included in the selection as receiver
Sender Companies	Companies to be included in the selection as senders
Receiver Companies	Companies to be included in the selection as receivers
Relation type	How the selected actors are connected connected
In use	Is the organisation's relation active or passive
Customer to Pagero	Is the company or company group a customer of Pagero
# Sent documents	The amount of sent documents
# Received documents	The amount of received documents
Country of registration	Where the organisations are registered
Message destination	To which country/countries the documents are sent

The parameters can be combined to specify a relation, all actors that fit within that relation are shown in either the sender list or the receiver list. Another relation can be added so that a chain of relations are shown. The parameters can be set separately for each relation. The actors that fit within the specified relation selection are presented as a list and the amount of sent documents is presented. It is possible to see the value of all parameters for each actors and relation.

4.1.2. Strengths of Pagero (as a company)

Pagero's vision is to be the connection between different ERP-systems used by companies of different sizes and of different lines of businesses and in the long run support the transfer of all types of messages sent between ERP-systems. Such connections have traditionally been set up individually between each system in a peer-to-peer manner. Pagero's strength is to make these inherently expensive connections generic and therefore scalable. A major competitive advantage for Pagero is their ability to handle the different formats used by different ERP-systems and to convert these to whichever format is requested by the receiver. The result is a less costly alternative than the traditional peer-to-peer connections, in addition it is usable to organisations of different sizes and industries. Innovation is a large focus for Pagero and new products are constantly under development.

4.1.3. EDI standards used

EDIFACT as described in "*1.2.2. EDIFACT, a standard for electronic data exchange"* is only one of

various standards with support for inventory status and sales reports. Pagero Online supports the exchange of EDIFACT, as well as various types of XML formats and many more standards, some of these are Odette, UBL, Svefaktura etc. An important competitive advantage for Pagero is the ability to accept messages of several formats and convert them to the customer preferred format.

4.2. Selecting a focal organisation for the case study

A case study of an organisation is used in this project to show that Pagero Online can be used to find organisations that would benefit from increased supply chain visibility. In later chapters it is analysed how Pagero can contribute to increase the case-organisation's supply chain visibility by enabling extended information sharing. This chapter describes how the process for selecting Sameina AB as the focal organisation in the case study was carried out. The steps and selection criteria are described as well as the result for each step.

As described in the Methodology chapter, the data mining software tool Qlikview has been used to identify an organisation suitable for the case study. The 12.000 unique clients and 15.000 accounts of Pagero have been funneled down by several selection criteria into a manually manageable amount of organisations. From this manageable group one final organisation is selected for the case study.To identify possible supply chains, prospective focal companies were set up by three different approaches in Qlikview. The first approach (A1) is based on a criteria of that both inbound and outbound e-invoices must be sent through Pagero Online, PO. The purpose of this would be to make it possible to identify an interesting value adding supply chain through three actors. However, limited findings within this area were found whereas the research was continued to the second approach (A2).

The second supply chain identification approach (A2) is based on inbound invoices to one organisation from several of other organisations. The methodology for this approach is described in Table 7 below where the start value in Qlikview is around 500.000 organisations (inside and outside of Pagero´s network) who all have either sending-into-PO- or receiving-in-PO-characteristics. A2 is the approach that was carried on with and is further described below, after a short presentation of the third approach (A3).

The third approach (A3) is based on that the prospective focal organisation should use Pagero Online to send e-invoices to several other organisations who also use Pagero Online for at least receiving e-invoices. The client base after these limitations shown to lack enough substance in terms of number of organisations, organisation size, and e-invoices transferred.

Limitation 1 is made with a criteria that the prospective focal organisations must be receiving customers in PO i.e. they must receive e-invoices by Pagero´s system. This limits the sample size to around 15.000 clients. The receiving clients´ invoices are in the last limitation set by Pareto which means that the amount of received e-invoices within the sample group corresponds to 80 % of invoices sent.

Limitation 2 is set up to be that the prospective clients should also send documents in PO. This criteria is set due to the fact that clients of Pagero that use both inbound and outbound services are in general more digitally mature and have a higher probability of seeing the benefits of, and being more adaptable to, new digital services. Also, there could be a higher inclination of further projects to be carried out in the future where the prospective organisations´ outbound activities might also be investigated.

Limitation 3 concerns the prospective organisations´ senders of e-invoices. The criteria is set to be that those sender organisations must use Pagero´s services to send e-invoices to the prospective focal

organisations whereas the sample size is shrunk to 662 organisations. This criteria lays a foundation for the researchers to be able to have full insight in the electronic document handling.

Limitation 4 is made with the Pareto 80/20-principle. Out of the companies in the sample group, the largest ones representing 80 % of the documents received are carried on with. The sample size has shrunk to 36 organisations.

Limitation 5 is set to that all prospective case study organisations should be located domestic (Sweden in this case). This reduces potential barriers for the case study in terms of geographical location for interviews as well as in terms of language and other cultural differences. This criteria reduces the sample size to 26 organisations.

Table 7. Shows the steps and criteria used to select a focal company. Approach two (A2) limits the sample size to the right with the actions in the middle.

Limitation #	*Selection Criteria description*	*Sample size*
0	Start value	*499083*
1	Focal organisations receive e-documents in PO	*15425*
2	Focal organisations send e-documents in PO	*697*
3	Focal organisations´ senders send e-documents in PO	*662*
4	By Pareto limit to organisations representing 80 % of messages left.	*36*
5	All organisations in the prospective SCs are based domestic.	*26*

The final list of 26 organisations was reviewed and cross referenced to the list of organisations with whom Pagero have previously performed collaborative projects with. According to the Project leader's at Pagero, the organisation Sameina's AB were easy to collaborate with and the contact between them and Pagero was good. They were also among the remaining companies in the short-list, they were thus chosen as the focal organisation for the case study.

4.3. Identifying general areas of potential improvement in the selected case company

In the case study certain areas of Sameina's processes are described in an attempt to find areas where enhanced information sharing and supply chain visibility would be beneficial. This section describes the findings from the interviews performed at Sameina. General information important for understanding the analysis are first elaborated. Furthermore the areas investigated thoroughly are *the aftermarket* of spare parts for Sameina's products, and the *production warehouse* where all goods bound for the production are handled, those two areas are described in the two upcoming sections. It has been found that there is high potential for improvement in both areas.

4.3.1. Focal Organisation Sameina

This section introduces Sameina AB, from here on referred to as Sameina, by describing their history, organisation and relevant parts of their processes. Sameina AB is a Swedish company that produces

farming machinery, the Headquarter is located in the Swedish village of Farmville. Since the start in 1962 the driving ambition has remained the same; to develop agricultural machinery capable of performing several tasks simultaneously, at a high working pace.

Sameina develops tillage methods and produces machinery such as seed drills, cultivators, harrows, and rollers which are exported all over the world. Testing is a central part in the Sameina business; the machines are developed in close collaboration with farmers nearby the production facilities in the Sameina village but also in close collaboration with farmers operating in very different conditions of the world. High quality is a key in Sameina machinery; the founder Mr. Strong's saying "Make it to last" still influences the mindset and processes at the company.

The company is growing and has currently around 1000 employees and had a turnover of almost 2000 MSEK for the last financial year. In 1962 when it all started, the founder Mr. Strong had had enough of building a new rigid tine harrow every season. At this time it was standard to use a wooden rigid tine harrow but Mr. Strong began to construct his new one in steel. The word spread about Strong's new durable steel construction and farmers around asked him to build more of it and sell. A business started that continued with more agricultural machines. Today Sameina is still a private family owned limited company.

4.3.2. The Organisational Structure

As mentioned in the Sameina description, this is an old family owned company that has evolved towards bigger turnovers during many years. This transformation from a small family industry to a medium sized enterprise has been remembered through a range of undertakings, there of the latest reorganisation. Today, after the reorganisation, Sameina consists of a managing team with eight managers below the managing director; the sales and marketing director, the parts director, the product & service director, the supply chain director, production director, the HR director, the finance director, and the IS/IT director. For this project the organisation around the supply chain director and the parts director are of certain interest. The management team structure is visualised in Figure 10.

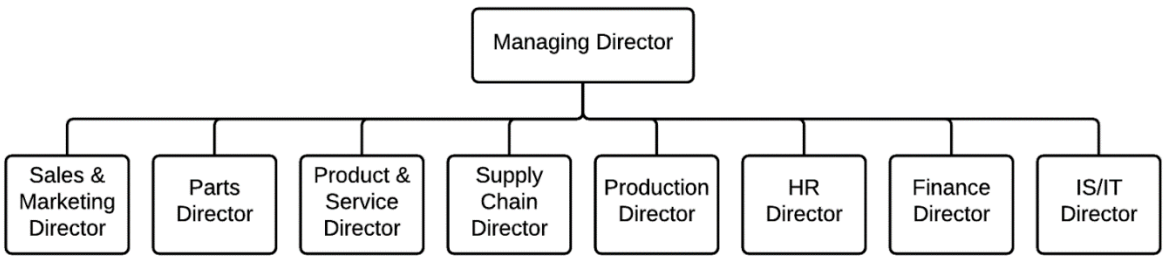

Figure 10. Sameina's management team after the reorganisation

Sameina has twelve fully owned international daughter companies who runs sales, marketing, forecasting, and keeps inventories for their specific market. The biggest markets where daughter companies are active are Germany, England, France, and Russia. Both machine selling and aftermarket are included in the daughter companies´ responsibility. The daughter companies act either through external resellers or directly towards end customers or with a mix of the two approaches, they represent 60 % of Sameina´s total sales. The remaining 40 % of turnover, for which the daughter companies are not part of, other setups are used. For the international sales besides of the daughter companies there are third party importers who act through resellers and/or directly towards end customers. For the Swedish home market most sales are carried out through the external partner Countrymen. The turnover spread is visualised in Figure 11.

Figure 11. Sameina´s total turnover and its spread through daughter companies, importers, direct retailers, and the Swedish home market (Countrymen).

As a result of the daughter companies´ relative large amount of turnover, the eight directors presented in Figure 10 are all, more or less, involved towards the daughter companies. For the aftermarket the daughter companies also represent 60 % of sales whereas they are added to the Sameina functions of certain interest in this project beside the supply chain director´s area and the parts director´s area.

4.3.3. Innovative focus

Sameina are and have historically been very focused on providing machines adapted for the customers' specific needs. The R&D department is therefore an important and powerful part in the company. During the years this has led to Sameina- having a very wide portfolio of machines and adaptations that are possible. During 2014, 3000 new articles were created in the R&D department to be used in the production. Each of these require 1.2 pallet locations out of the total 7000 available, very few of the old articles were removed. According to Sameina's Warehouse Manager, the owners of Sameina have always prioritised customer service and the logistic processes have therefore not been able to keep up with the development. This has resulted in a numerous product mix, and a saturated warehouse which now is now considered to be one of the biggest bottlenecks in the factory.

4.3.4. Purchasing Process

The trigger for a new item purchase and/or a new supplier is released from the marketing department as a revised or updated prognosis. The material planners handle the call offs, divided into four different areas and four different material planners. As foundation for the call off decisions there are rolling 12-months prognosis based on the daughter companies´, importers´, direct retailers´, and Countrymen´s prognosis. These prognosis are revised by the marketing department and released to the material planners once a month. Small changes are automatically released each week after weekend runs of the system. A large excel macro called inPrognos splits the prognosis among suppliers before the prognosis are sent to the respective supplier. Sharp orders are made when the production schedule has been frozen, which is ten days before the actual production will take place. Some items can not be delivered that fast, the suppliers then have to deliver according to the prognosis. For suppliers delivering

sequenced parts, sharp orders are automatically released using Sameina's homemade portal Sameina Supplier Ordering Portal (VSOP). The supplier has to log in to the portal and fetch the order. For other suppliers that are not using VSOP, orders are generated in the form of a PDF, these are e-mailed to the supplier.

For the aftermarket the purchasing procedure is similar. The base data use by material planners is supplied from the daughter companies, importers, direct retailers, and from Countrymen. This base data consists of sales history and sales prognosis which are revised by the marketing department and forwarded to the aftermarket material planners. The material planners use a Jeeves module called Amaze that calculates recommended call offs. Amaze uses EOQ for items that have a high frequency. The aftermarket material planners have limited dialogue or contact with the daughter companies. The only information shared are rush orders, which seldom occur. The aftermarket material planners have no insight into the daughter companies´ inventories or point of sale data.

4.3.5. Performance measurements

Sameina has just performed a re-organisation and have very few measures. They are currently trying to decide what they want to measure and how to do that. In the current distribution setup between Sameina and the daughter companies, *returns* from daughter companies to Sameina are allowed two times per year on specified dates. Upon arrival the returns are stored at Sameina's warehouse and either re-sold or scrapped. Not all articles are allowed to be returned, excluded are perishable goods such as rubber seals. The value of the returns is not continuously measured and there is no initiative for how to decrease the return stream.

The amount or value of *scrapped goods* at Sameina or the daughter companies is not measured, however the spare part director argues that since most parts are time-resistant the scrapped value is low.

The *inventory on hand* in the parts warehouse in Sameina is around 50 MSEK, the yearly inventory turnover is around 4. The total inventory on hand at the daughter companies is valued to 50 MSEK, however neither their individual nor aggregated inventory turnover is measured. Using simple calculations an estimation is performed that the aggregated yearly inventory turnover is around 2.4, the calculation is elaborated in appendix D.

Sameina defines *service level* as the amount of orders that leave Sameina's warehouse in the promised time. When Sameina receives an order they reply with the delivery lead time, this time varies among the different parts and is based on the current situation. A delivery is successful if the part leaves the warehouse in Sameina before the delivery lead time is due. Data concerning service level is available only at Sameina and not at the daughter companies. Sameina's service level is around 94 % when calculating it as described above. The daughter companies´ service level towards the retailers is thus not measured.

4.4. Description of the aftermarket segment of the case company

The aftermarket was chosen as an area for further studies due to four primary reasons:

- The interviewed personnel expressed an opinion that the aftermarket in general would benefit from an increased visibility.
- Sameina has a special type of distribution set-up for the largest part of the aftermarket, daughter companies act as both sales channels and warehouses. However the visibility between Sameina and the daughter companies is low, the visibility between the daughter companies is even lower.
- The interviewees named the aftermarket as an area with high general profitability. However the distribution set-up with the daughter companies is relatively immature, coordinating the aftermarket distribution has not been prioritised. The potential for improving the visibility is therefore of interest.
- Since Sameina owns the daughter companies they have a unique chance to affect their processes. In addition they have more insight in the daughter companies compared to the retailers, importers and Countrymen.

After Sameina's reorganisation, the aftermarket is located under the Supply Chain department. It has three dedicated purchasers and its own warehouse in Sameina. The aftermarket has around 300 MSEK in yearly turn-over, and is generally more profitable than selling machines. A spare parts warehouse is kept in Sameina, its inventory holds a value of around 50 MSEK, and according to the spare parts director the yearly inventory turnaround is around 4. Among the 12 daughter companies, 11 of them have spare parts in stock, the Danish daughter company has no inventory of its own and is served directly from Sameina. The total value of the daughter companies´ inventories is around 50 MSEK. A visualisation of this is seen in Figure 12.

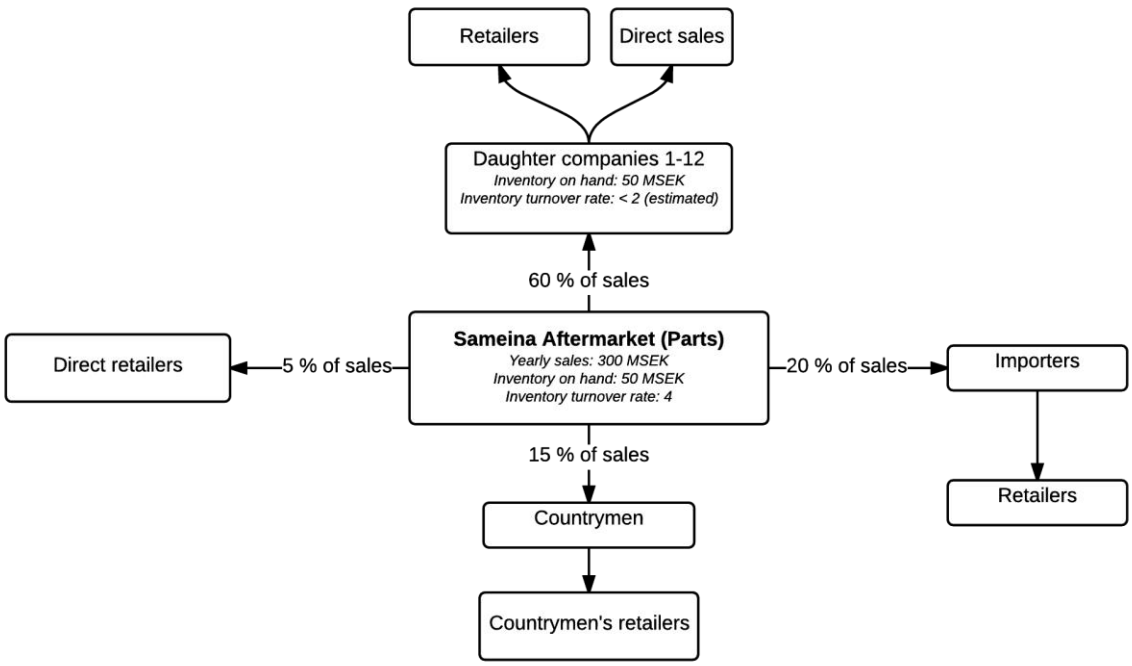

Figure 12. The value of each aftermarket channel.

Sameina have four different setups for their distribution network depending on the type of market. These are shown in Figure 13 below. Sameina have daughter companies in the large markets, for example England, France, Germany, and Poland. In these markets retailers order spare parts from daughter companies who either deliver directly from stock or order from Sameina. Farmers are the final customer, these order the spare part in most cases through a retailer. The retailer uses the internal web platform *Partslink* (PL in the picture) to replenish from daughter companies. The goods are sent from Sameina either directly to the retailers or through the daughter company. It depends on the structure of the distribution system in that particular country.

In some markets Importers perform the same job as the daughter companies, in these markets the Importer handle all contact with the retailers. In smaller markets (for example Estonia, Hungary, Bulgaria) daughter companies perform direct sales to the farmers. Russia is a special case where Sameina both perform direct sales through a daughter company and sell to an importer. In the Swedish market Countrymen is the major reseller of spare parts, they have a distribution centre in Malmö to where orders are shipped from Sameina. Landmännen have their own retailers throughout Sweden who sell Sameina's products as well as agricultural equipment from other producers. Sameina also sell products to private retailers not associated with Countrymen. Around 60 % of all aftermarket sales are performed by daughter companies, large markets with daughter companies is the focus of the next paragraph. These are represented in Figure 13 below as "Large Markets (England, France, Germany, Poland)".

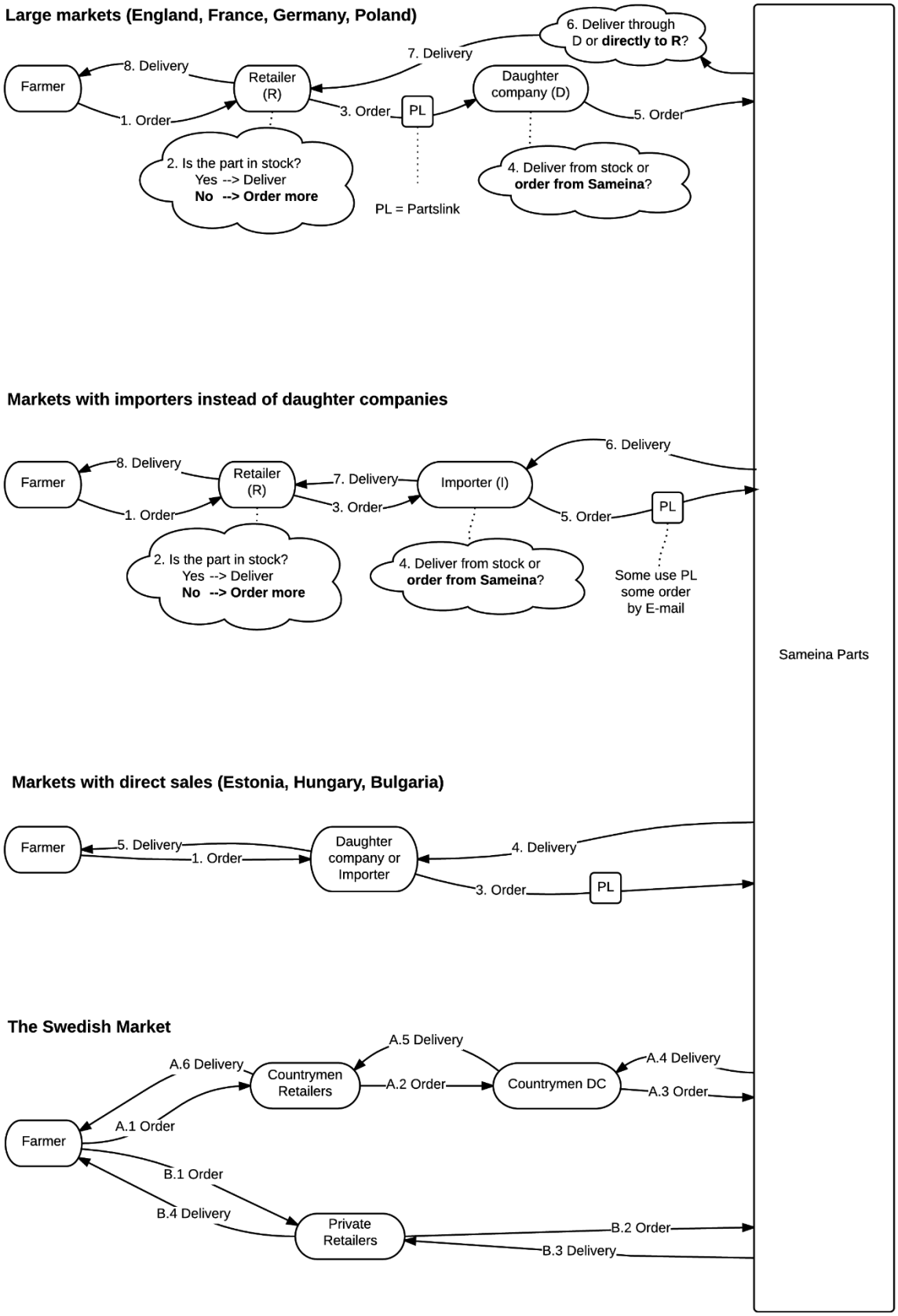

Figure 13. The distribution set-up in the four types of markets where Sameina is present.

4.4.1. Distribution in large markets with daughter companies

The largest markets where sales is performed by the twelve daughter companies are England, France, and Germany. Daughter companies are themselves responsible for structuring their distribution network in their respective country, which have resulted in different setups in different countries. The English daughter company distributes spare parts (and machines) through 25 retailers, the German counterpart uses 220 retailers. Both of those markets are relatively similar in size, the English retailers are thus much larger than the German ones. When an end consumer purchases a spare part in a large market with daughter companies, one of four scenarios might occur. In the first scenario (as seen in Figure 14) the Retailer has the spare part in stock and chooses to deliver it directly to the farmer is the end consumer.

Figure 14. Scenario 1, a retailer delivers from stock.

In the other scenarios (Figure 15, Figure 16 , Figure 17) the retailer does not have the spare part in stock and has to make a replenishment order. Such orders are made through the web based ordering portal Agroparts with the Sameina specific section Partslink. The daughter company receives the order and must make a decision whether the part should be delivered from stock or if it should be ordered from Sameina. This decision is not always based on whether the part exists in stock or not, there might be special customers that require them to keep certain parts in stock or future needs that must be accounted for.

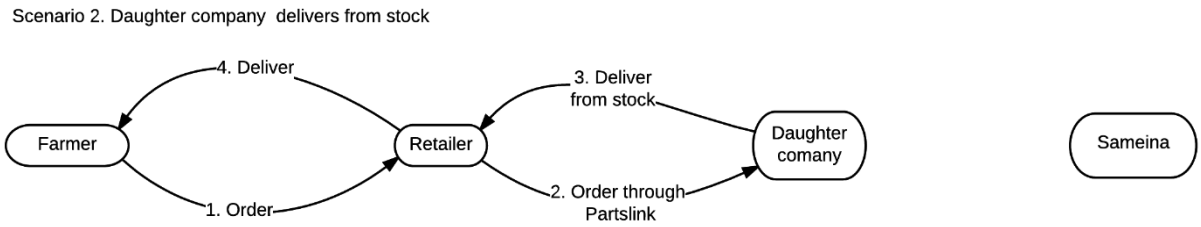

Figure 15. Scenario 2, a daughter company delivers from stock.

In Scenario 2 (Figure 15) the daughter company has the part in stock and chooses to deliver the part to the retailer from stock. In scenario 3 and 4 the daughter company does not deliver from stock, instead it places an order through their ERP system iScala which is connected with an EDI connection to Sameina's ERP system Jeeves. The order is handled by Sameina and shipped either to the daughter company or to the retailer directly.

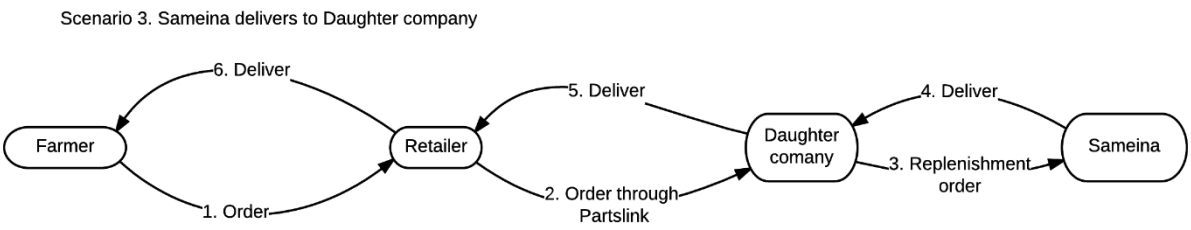

Figure 16. Scenario 3, Sameina delivers to the daughter company.

In (Figure 16) scenario 3 the part is shipped to the daughter company before it is further directed to the retailer and finally delivered to the farmer. This scenario is common in Germany where there are 220 small retailers. Shipments from Sameina have to be split at the daughter company before being distributed to the small retailers who holds a very low inventory. To maintain the service level, the daughter company must hold a large inventory. In Scenario 4 (Figure 17) Sameina delivers the order directly to the retailer.

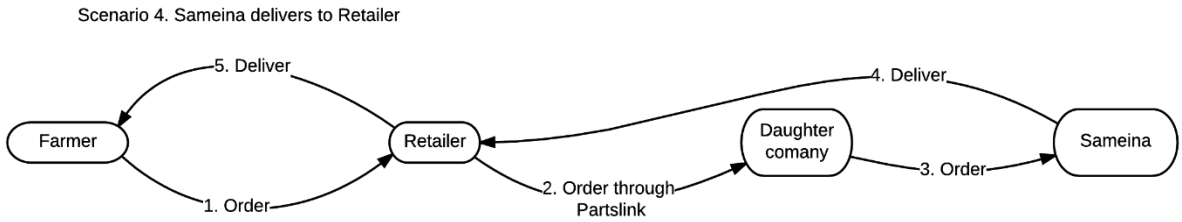

Figure 17. Scenario 4, Sameina- delivers directly to the retailer.

Scenario 4 is common in the English market where there are only 25 retailers. Each retailer covers a large portion of the market and must therefore hold a substantial inventory to be able to maintain the required service level. Shipments are rather large and are therefore directed directly from Sameina to the retailers.

4.4.2. IT-systems used at Sameina Aftermarket

Sameina uses the ERP system *Jeeves* which is a Swedish based ERP system founded in 1992. Jeeves is designed mainly for SME (small- and medium-sized enterprises) companies within retail, manufacturing and service sector and has today over 200 customers in over 40 countries in Europe, North America and Asia (Jeeveserp.com, 2015).

The daughter companies use different ERP systems, but the predominant one is *iScala*. iScala is owned by Epicor and is designed for multinational companies or large local companies with high frequency of international business (Epicor.com, 2015). iScala combines country-specific locations and several languages with an ability to handle global business models. Retailers perform their orders using the web-interface *Partslink* which is a part of the larger portal Agroparts. *Agroparts* is an electronic spare parts catalogue for agricultural machinery for a range of competing brands including Sameina itself. Partslink is dedicated only to Sameina and the orders are sent to the daughter companies.

Crystal reports is an SAP reporting tool that presents data from various sources to the viewer in an actionable way. These could be used to receive an update of the status of specific item numbers at the daughter companies´ sites. The crystal reports are, according to the aftermarket material planners, too time consuming to extract on a daily or even weekly basis and are therefore used seldom.

There have been discussions about to replace the various range of IT systems, used by the daughter companies, with Jeeves. However, Sameina has found an IT-system normalisation to be too costly. All of the IT-systems used at Sameina HQ as well as at the different locations of the daughter companies are based with servers etc. in Sameina HQ.

4.4.3. Current visibility level

The daughter companies´ IT systems is physically located in Sameina and is managed from there. The purchasers and managers at Sameina's aftermarket department can export information concerning the daughter companies' inventory status using the system Crystal Report, which is a separate system outside of Jeeves (Sameina's ERP system). This information can be reviewed when making strategic decisions. The information is updated every 24 hours and before making a decision based on the exported information, a phone call to the relevant daughter company is performed in order to verify

the accuracy of the information. Since the above described procedure for reviewing the inventory status information at the daughter companies' takes a certain effort, it is seldom reviewed at all. Since the daughter companies' inventory information is not integrated in the same ERP system as Sameina's it can not be used for performing advanced optimisation algorithms in Jeeves. It is however exported to excel and analysed using a macro created by the parts director. Historic sales data is collected on a monthly basis and used for the sales prognosis. The prognoses for the aftermarket is according to Sameina better than the one for production, however it is not measured. Sameina has no contact with the retailer, real point of sale (POS) data is therefore not available.

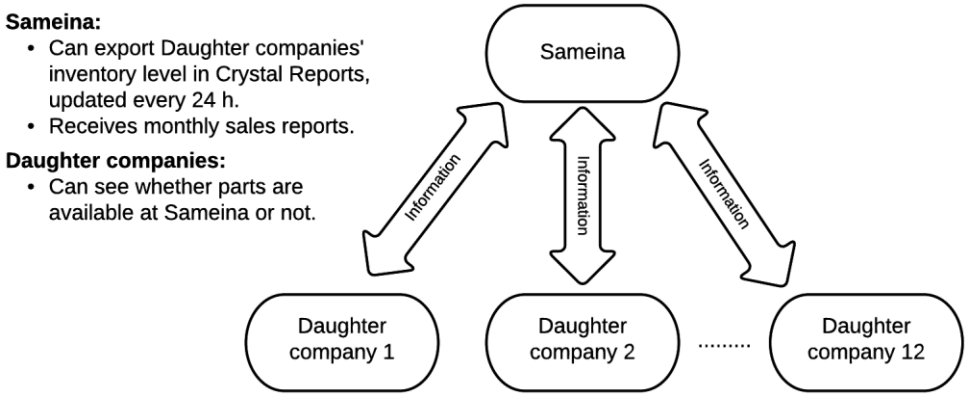

Figure 18. The information flow between Sameina and the daughter companies.

From the daughter companies' point of view, their visibility level includes being able see whether a certain part is available or not when making an order. The order is performed in their ERP system iScala which has an EDI connection to Jeeves that handles orders. If the part is not available longer delivery lead-times can be expected. The daughter companies have no visibility into each other's businesses. Figure 18 describes the information and communication flows among Sameina and Daughter companies.

4.4.4. Purchasing and prognoses in the aftermarket

Historic sales data is exported to the Jeeves module Amaze, which uses an ABC classification of goods to deliver a sales prognosis. The prognoses are used when purchasing parts to Sameina, an EOQ is used for most products. Some of the goods are not purchased on prognosis using an EOQ, instead they are purchased when a sharp order from a customer has been received. According to parts-purchasers at Sameina, the prognosis system Amaze will not be around for long since the only person servicing it at Jeeves will soon retire. Sameina production is Sameina Part's largest supplier of spare parts but the total amount of suppliers are 210, almost double the amount of suppliers used for the production. One of the reasons for the high amount is that Sameina have decided to supply spare parts for both current and previous models, many of the suppliers are therefore not frequently used.

4.5. Description of the production warehouse segment of the case company

The production warehouse was chosen as an area for further studies due to three primary reasons:

- Several of the interviewed employees described the production warehouse as an area with great improvement potential.
- A new production warehouse manager has recently been appointed, he is actively searching for ways to improve the production warehouse.
- The ability to perform capacity planning is limited due to low visibility regarding incoming

deliveries.

- The registration process for incoming goods was quickly identified as a major bottleneck with great improvement potential.

There are two different warehouses in Sameina, one is dedicated to goods bound for production and consists of; the component warehouse, the raw materials warehouse (7000 pallet locations), and the outdoor warehouse, and has a total value of 100 MSEK stock on hand. The other warehouse is dedicated for spare parts bound for the aftermarket and binds a value of 50 MSEK. These warehouses frequently trade parts from one another depending on the current needs. This section discusses the production warehouse, the spare parts warehouse is described in the aftermarket section above. The production warehouse saturation has during the recent year (2014) alone increased from around 60 % to above 90 % and the newly appointed production warehouse manager emphasises that this is a huge problem. The inventory turnover-rate is around 6 times per year for external material while the target value is 12-15. 13 % of the goods in the production warehouse have such low turnover that they are in essence mere shelf warmers. Every year goods worth of several MSEK expires and in those cases normally around 20 % of that material is sold to the spare parts warehouse and the rest is scrapped. Several reasons for the problems in the warehouse are mentioned, the largest problem being the prognoses delivered by the marketing department which have shown to be correct only 60 % of the times. Another issue that is derived from the purchasing department is the EOQ policies. These do, according to the Warehouse Manager, not take the stockholding cost into consideration, the warehouse is therefore continuously being supplied with too much material. There are three separate areas where goods bound for the production are stored; the component warehouse, the raw materials warehouse, and an outdoor warehouse. The outdoor warehouse stores components that are too large to be stored in the regular racks. These goods are relatively low in volume but have a value higher than the regular components.

4.5.1. Inbound deliveries and registration

Inbound goods arrive mostly early in the week, around half of it is delivered by milk runs. The truck collects parts from Sameina's suppliers and delivers them to Sameina. These trucks have no slot time and the staff at the warehouse does not know what time the shipments arrive, how much material it holds, or what will be delivered. The same lack of information is eminent in the case of inbound deliveries coming directly from suppliers, i.e. not through the milk runs. Only the international suppliers give advance shipping notice communicating what they will deliver. According to the Warehouse Manager, this lack of information makes it extremely difficult to plan the capacity needed in the warehouse.

When a truck arrives to the component warehouse the goods are unloaded and put on the floor. Before it is visible in the ERP-system as inventory it must be registered. Due to the high volume of goods arriving on Mondays and Tuesdays, it often takes 2-3 days to register all goods and clear the floor. In order to be registered, the pallets are put on a conveyer belt and transported to a desktop where a worker is waiting to manually cross reference each pallet with its released purchase order, the conveyer belt and the desktop is shown in Figure 19 below.

Figure 19. The conveyer belt and the terminal where inbound goods are registered

The pallet id and quantity delivered is manually entered in the ERP system. The information is derived from the pallets´ waybills, depending on a pallet's origin these waybills can look differently. The Warehouse Manager argues that due to the various design of the waybills it takes time to learn where to find the right information. This registration process is the same regardless if the delivered quantity deviates from the ordered or not. When the waybill and the pallet have been cross-referenced and the correct delivered quantity has been entered to the terminal, the waybill is stored for three months in the shelves beside the terminal, these are shown in Figure 20. Every shelf stores one type of waybill. Waybills must be stored for three months according to Swedish law.

Figure 20. The shelves where waybills are stored for three months.

The same process has to be performed within the inbound goods for the outdoor warehouse, the problem is that those goods can not be physically moved to the desktop. The waybills are therefore manually collected and manually registered in the desktop. According to the Warehouse Manager, the registration process is the bottleneck for all three warehouse areas. Since registration can sometimes

take 2-3 days, the production frequently asks for specific parts which have been delivered to the warehouse but not yet registered to the ERP system and therefore do not show up as available inventory. The warehouse personnel then manually searches the arrival hall for pallets with the required parts.

4.5.2. Link to the production facility

The takt-time for the production facility is eight hours and the safety buffer in the factory should cover for one takt. The order picking in the warehouse must therefore be ready to deliver eight hours before time of production. The schedule for the machines in production is always frozen for the next upcoming ten days.

4.6. Summary of Empirical data

Pagero is a Swedish company offering electronic invoicing, ordering and payment services through their cloud service Pagero Online. They have 12 000 unique clients who can set up their own connections to each other and over one million other organisations reachable through Pagero's shared traffic agreements. After a simple handshake they can begin to send financial messages. The ERP systems used by clients use different formats for different messages, Pagero Online accepts almost any format and can export to the format preferred by the receiver. This makes it possible for clients to send financial messages to all clients within the system disregarding of the ERP system used. The connections between clients in Pagero Online today as well as the invoices sent through these connections form the basis for the selection criteria used to choose the focal organisation for the case study.

Sameina AB was chosen as the focal client for the case study after being subject to several selection criteria. These are described in section 4.2 above and includes a review of the volume and origin and receiver of e-invoices sent to and from them through Pagero Online, their geographical location, and the amount of previous collaboration with Pagero, etc.

Sameina AB is a Swedish company manufacturing farming and tillage equipment, they are present in several countries mainly in Europe. The distribution setup is different in every country but there are four main categories; *Large markets with daughter companies*, *Markets with importers*, *Markets with direct sales* and the *Swedish market*. Sameina has traditionally been an innovative company with a high customer focus, which has led to them having a large portfolio of products, in addition they provide spare parts to all their current and past products. The purchasing process, the production warehouse and the aftermarket has been described, though the focus has been on the production warehouse and the aftermarket.

The *aftermarket* has an annual turnover of 300 MSEK and the warehouse in Sameina carries 50 MSEK worth of stock on hand, the yearly inventory turnover rate is 4. Most parts are sold in large markets through daughter companies. There are four different scenarios for such markets, which one is used depends on the type of distribution that the daughter company has developed in its respective market, the scenarios are visualised in the Figure 14 to Figure 17 . When a replenishment order is sent to Sameina, they either ship from stock, produce or order the required parts, no goods are shipped between the daughter companies. Sameina measures service level out from Sameina, the result is 94 % when calculated as described in the section *Performance measurements* above. Service level is defined by Sameina as to what extent goods leave Sameina in the appointed time, i.e. on time delivery from Sameina. For each received order, an individual delivery lead time is decided. Orders are received through EDI connections between the ERP system iScala which is used by most daughter companies and Jeeves which used by Sameina. Parts are replenished to Sameina on the basis of a prognosis which is generated in the Jeeves module Amaze using historic sales data. As for the visibility the daughter companies have no insight into each other's business and communicates only with Sameina. When

placing the order they can see whether the part is currently available at Sameina or not. Sameina can export the daughter companies' inventory status for review, the inventory status is updated once per week.

In the *production warehouse* section it has been identified that there is a general lack of information for the warehouse manager to act on. The personnel does not know when goods arrive or what will be delivered, this makes planning difficult. Incoming goods does not show in the ERP systems inventory until it has been registered, this process is performed manually as all incoming pallets are registered in a terminal located in the warehouse. At the same time information on all waybills is manually cross referenced with the order information. The registration process commonly takes 2-3 days. Since the goods are not visible as inventory before registration is complete, other departments frequently call to ask if certain items are in stock. This forces the warehouse personnel to manually search among the not yet registered pallets. The production warehouse carries 100 MSEK worth of stock on hand and has 7000 pallet locations.

5. Analysis

The research questions in this project are:

Q1. How can Pagero Online be used to identify digitally mature supply chain actors?

Q2. Is it possible to increase operational performance for digitally mature actors by sharing extended information through Pagero Online?

Both research questions are discussed in the analysis section, Figure 21 shows the work process and which tasks are performed in the analysis.

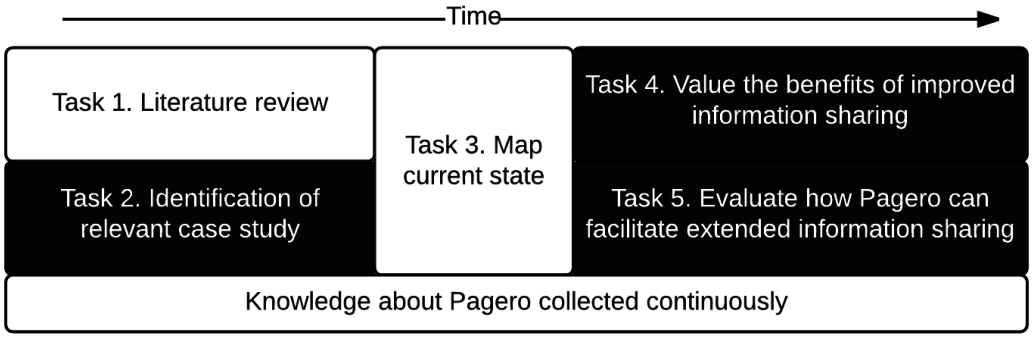

Figure 21. The work process, the tasks touched upon in the Analysis are highlighted in black

Q1 has been incorporated in the research design as Task 2. How Pagero Online can be used to identify high potential clients, i.e. clients within Pagero online with high digitally maturity, is analysed in the section "5.1. Selecting a digitally mature candidate". This discussion is a part of Task 2 (described in the Methodology section).

Q2 has been incorporated in the research design as Task 4 and Task 5. Both of these are discussed throughout the analysis. A case-study has been performed at one of Pagero's clients with the intention of finding areas where increased supply chain visibility could benefit the client's operational performance. Two improvement areas within Sameina are found and analysed, these are the aftermarket (described in "5.2. Improvement potential in Sameina's aftermarket") and the production warehouse (described in "5.3. Improvement potential in Sameina's production warehouse"). The derived analysis is a part of Task 4 (described in the Methodology section).

Task 5 constitutes the last part of the analysis and discusses (in the section "5.4. Pagero") Pagero's ability to help clients achieve a higher level operational performance in the improvement areas identified in Task 4. With respect to the findings in Task 4, two example solutions are presented for the specific case of Sameina. The practical implications for Pagero and how they can facilitate the proposals are analysed. This discussion concludes in a recommendation to Pagero. Finally, the method used for gathering information is analysed to determine whether it is optimal in this particular case.

5.1. Selecting a digitally mature candidate

The aim of the selection process is to quantitatively identify organisations that are above a certain level of digital maturity. The results of the selection process is a short-list of organisations with relatively high digital maturity, a final choice of an organisations to be subject to the case study is made based on qualitative criteria. The link between digital maturity and selection criteria is elaborated below.

High degree of digital maturity has been described in the theory as a characteristics with a large benefit, not the least in financial terms. An organisation's level of digital maturity is visualised (Figure 22) by Westerman et al. (2012) in four categories; the most digitally mature category *Digirati*, the intermediate digitally mature categories *Fashionistas* and *Conservatives*, and the least digitally mature category *Beginners*. Important to highlight is that the borderlines between the fields (Figure 22) are not crucial borders but rather an indication. An organisation moving from the Beginners field into the Conservatives field is for example is not making a revolutionary journey, instead it is a part of a continuous development. The following discussion concerning treats the categories as extremities.

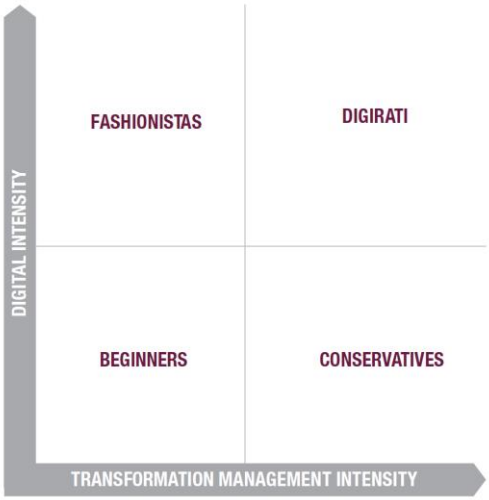

Figure 22. Digital maturity classified by two dimensions; Digital intensity and Transformation management intensity. (Westerman et al., 2012)

Westerman et al. (2012) have, through an investigation of 400 large companies world-wide, classified the average manufacturing company to be categorised in the Beginners field, close to Conservatives. The investigation also points out that the manufacturing industry is on its way into the Conservatives category. A large part of the organisations found through the selection process handle physical goods, among them many are manufacturing companies.

The generic description of Beginners are considered to have a digital maturity level too low for being targeted with a project like this, or with solutions that come with this project. Their ability to commit to information sharing projects is premature due to their currently low digital maturity, achieving the same visibility level with a Beginner is therefore more costly than reaching the same level with any of the other categories. Digirati have already come far in their digital utilisation, while the other three categories appear to have more space for digital enhancements e.g. increased supply chain visibility. Fashionistas and Conservatives have a middle level of digitally maturity and are both seen as suitable targets for this project. Also organisations close to be Fashionistas or Conservatives are considered suitable.

5.1.1. Parameters in Pagero Online as a proxy for Digital Maturity

The researchers argue that clients' behaviour within Pagero online can be used as a proxy for their level of digital maturity. To identify digitally mature clients, parameters in Pagero Online have been analysed through the data mining tool Qlikview. The parameters available through Qlikview include *invoice category, date interval, sender service provider, receiver service provider, receiver organisation(s)* etc. The full list is found in the Empirical data chapter. How the two axis in the digital maturity diagram translates into the parameters in Pagero Online is highlighted in Table 8 below. *Digital intensity* is foremost translated to an organisation's presence in both sending and receiving e-documents. *Transformation management intensity* is translated to an organisation's amount of e-documents transferred and is also highlighted to the right in Table 8. A visualisation of Digital intensity related to data in Pagero Online is found in Appendix E.

Organisations that have started to use Pagero´s services such as e-invoices have taken steps on the *Digital intensity-axis* in Figure 22 above. The mere fact that they support the transfer of e-invoices suggest that they are not absolute beginners. If they support electronic exchange of invoices, chances are that other areas of the organisation are also increasingly digitally intense. When those organisations increase the volume of e-documents transferred, they increase their rating on the *Transformation management intensity-axis.* A conclusion is thereby drawn that organisations with a relatively high usage of Pagero´s services are either about to move out of the Beginners quadrant or have already done so.

Table 8. Selection criteria based on parameters from Pagero Online and handled in Qlikview. The relation to digital maturity is highlighted to the right.

Selection Criteria	*PO parameters concerned in QV*	*Parameter explanation*	
Start value	In use	Is an organisation's relation active or passive?	
Focal organisations receive e-documents in PO	Receiver service provider	Service provider used to receive messages, e.g. Pagero or one of its competitors.	Translates to high *Digital intensity*.
Focal organisations send e-documents in PO	Sender service provider	Service provider used to send messages, e.g. Pagero or one of its competitors.	
Focal organisations´ senders send e-documents in PO	Sender service provider	Service provider used by message sender, e.g. Pagero.	
By Pareto limit to organisations representing 80% of messages left	# Received documents	The amount of received documents compared to the other clients in PO.	Translates to high *Transformation management intensity.*
All organisations in the prospective SCs are based domestic	Country of registration, Message destination	Where the organisations are registered and to which country/countries documents are sent.	

Westerman et al. (2012) have through an investigation of 400 companies worldwide classified different industries in a digital maturity matrix, see Figure 23 below. Important to note is that the industries represented in Figure 23 are calculated based on averages meaning that there could be exceptions for individual organisations. Industries discussed in information sharing literature mostly concern those including handling of physical goods. Most information flows discussed also bring improvements to organisations' handling or administration of physical goods. Organisations handling physical goods thus seem to have several areas where they may benefit from enhanced information sharing and visibility.

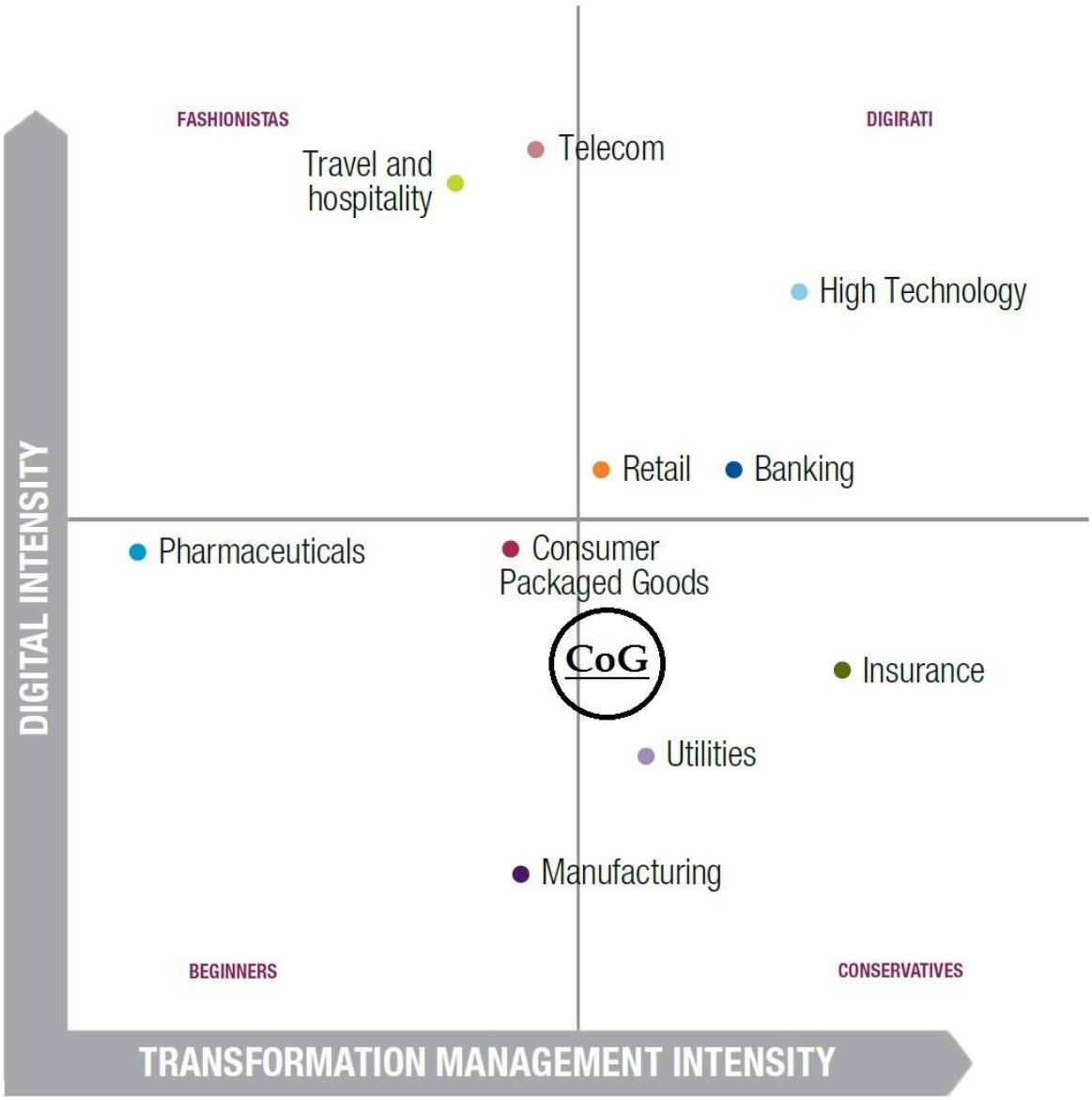

Figure 23. Different industries spread over a 2x2 digital maturity matrix. Center of Gravity, CoG, points out the area of where clients with the highest potential are to be found. (Adapted from Westerman et al., 2012)

Interpreting Figure 23 some industries are of higher interest than other for this project. The Telecom-, High Technology-, and Banking-industries are of less targets for this project due to their already very high digital maturity. The Travel and Hospitality-, and Insurance industries have a limited amount of physical goods and are therefore less targeted. Remaining industries with a certain interest are then the Pharmaceutical-, Retail-, Consumer Packaged Goods-, Utilities-, and Manufacturing industries. A large part of the organisations found through the selection process are active in those four industries, among them many manufacturing companies. A manufacturing company was also the type of company finally chosen for the case-study.

The Center of Gravity, CoG in Figure 23, represents a point around which the most interesting organisations to be targeted for this project are located. Organisations nearby CoG have been identified to be the most suitable to be targeted with enhanced information sharing and visibility. As mentioned above, important to note is that the industries represented in Figure 23 are calculated based on averages meaning that there could be exceptions for individual organisations. Thereby could organisations far away from the Center of Gravity also be suitable but that is of a lower probability, hence should also further selection processes take the Center of Gravity in consideration. The manufacturing

industry is classified to a lower digital intensity than where the Center of Gravity is located. Organisations using Pagero's services are considered to have gained increment on the digital intensity axis. Organisations within the sample group are all using Pagero's services, thereof a range of manufacturing companies which are then considered to have a higher digital intensity than the average. The manufacturing companies considered in this project are therefore considered to be closer to the Center of Gravity than the average manufacturing company represented in Figure 23.

5.1.2. Evaluation of the selection process

After the selection process it is clear that the number of organisations within Pagero's network with the same characteristics as the chosen focal company is limited. However, if the selection criteria are alleviated with for instance a less tight limit than the Pareto 80% (see "4.2. Selecting a focal organisation for the case study" for further details), more organisations appear. Of those organisations, there are certainly a higher number of organisations which could benefit of increased supply chain visibility. For example if the Pareto limitation is raised from the criteria that the documents received should represent 80 %, to instead 92 %, 85 organisations are left in the selection group instead of 36 organisations. Of the additional 49 organisations that came up with the 92 % filter there are many with similar characteristics as with the 80 % filter; municipalities/townships, medium- and small sized producing companies. The common denominator for those additional 49 organisations is though that they send and receive less e-documents through Pagero´s network, especially receive less. Other types of organisations that arose are temporary employment agencies and a few larger enterprises. Those two types of companies were discarded due to a perception of limited demand for supply chain visibility improvements and organisation inertia, respectively. In addition, the visibility level might vary in different departments within large enterprises.

The reason for the relatively tight criteria for selecting a focal organisation in this project is that this is the first time this type of project is carried out and due to practical purposes only one organisation is to be investigated in the case study. Future selection criteria for finding organisations which would benefit from increased supply chain visibility are not necessary equal as the criteria used in this project. Further organisations in need of supply chain visibility improvements, as those presented in this project, are with a high certainty possible to identify with lighter search criteria.

Being a current Pagero client actively sending and receiving e-invoices is not a prerequisite for a greater need of supply chain visibility, it is likely that there are further organisations outside of Pagero's network in need of greater supply chain visibility, although they are harder to identify as Pagero has no unique data about them. The future demand for supply chain visibility improvements outside of Pagero's network is therefore currently unknown.

5.1.3. Next generation selection process

A possible tool to use when identifying high potential organisations, within and outside of Pagero Online, is to use SNI codes (Swedish Standard Industrial Classification). This is the Swedish version of the European industry standard classification system NACE (in French: *Nomenclature statistique des activités économiques dans la Communauté européenne*). SNI- and NACE codes are used to classify in which industry or industries an organisation is active. These codes are relatively easy to connect to Pagero's database of clients and could thereby be a useful selection criteria. SNI codes as selection criteria would allow for a step towards automatic identification of prospective organisations both inside as well as outside of Pagero´s network. Automatic identification in terms of sorting out certain industries which might be less suitable for supply chain visibility improvements and then continue a selection process with fewer prospective organisations targeted for enhanced information sharing and visibility. However, these classification possibilities should be seen as a possible continuation beyond

this project's scope.

If the selection criteria are relaxed with for example a less tight percentage than the Pareto 80 %, further types of organisations arose thereof temporary employment agencies and a few larger enterprises. Those two types of companies were not primary subject to this study due to a perception of limited demand for supply chain visibility improvements and organisation inertia, respectively. However, that perception is valid for this project's selection process and might be re-evaluated for the next generation of selection process.

5.1.4. Summary of the selection process

Digital maturity consists of two dimensions; *Digital intensity* and *Transformation management intensity* (Westerman et al., 2012). Clients' usage of Pagero Online is used as a proxy for their digital maturity. Organisations that have started to use Pagero´s services such as e-invoices have taken steps in the *Digital intensity-dimension*. If those organisations consciously use Pagero´s services in line with their strategy, i.e. increasing their usage, they take steps in the *Transformation management intensity-dimension.* In the selection process, Pagero Online has been used to quantitatively filter clients based on their activity in sending and receiving financial messages. This has resulted in a short list with relatively digitally mature clients as candidates to be subject to the case study. From this list one client is chosen based on qualitative conditions; previous projects with Pagero have been carried out and the client's business is found in one of the preferred industries e.g. the manufacturing industry. The chosen client to be used in the case study is Sameina. Further organisations that could possibly benefit of enhanced information sharing and visibility have been found within Pagero Online. A larger number of organisation are with a high certainty possible to identify within Pagero Online if the limitation criteria would be relaxed. Such organisations could also be found outside of the preferable industries. Finding even more organisations that could benefit from enhanced information sharing and visibility could be carried out if the selection process is even more developed.

5.2. Improvement potential in Sameina's aftermarket

The aftermarket is one of the areas within Sameina where it was found that enhanced information sharing has high potential. This section describes how so.

The Aftermarket, has 300 MSEK in yearly turnover, its decentralised distribution set-up was thoroughly described in "4.4. Description of the aftermarket segment of the case company". 60 % of the spare parts are sold and handled by daughter companies, their individual national set-up varies but each of them has its own warehouse and controls its own actions similarly to individual companies. The total amount of inventory on hand in the daughter companies´ inventories is around 50 MSEK. After the initial interviews in *Task 3 (Map the current state)* the aftermarket, markets where daughter companies are available was chosen as an area to be further studied. Three persons active within the aftermarket have been interviewed, the aftermarket director, a purchaser and a product manager. The face-to-face interviews were followed up by telephone interviews and mail conversations. The focus of the interviews was within the interviewees' area of expertise.

5.2.1. Metrics

As previously mentioned Sameina is in the middle of an organisational restructuring, practically this means that the interviewees are not sure of what their future areas of responsibility will be and how they will be measured. Devising new metrics and departmental goals is a priority for the new organisation. The interviewees agree that Sameina is still an immature organisation when it comes to supply chain management and does not measure enough. The focus has traditionally been on other areas than supply chain management, such as innovation and R&D. Few reliable metrics were thus secured and the

analysis focuses on the areas where information was available. Figure 24 below describes Sameina's set-up with their daughter companies and shows the measured KPIs.

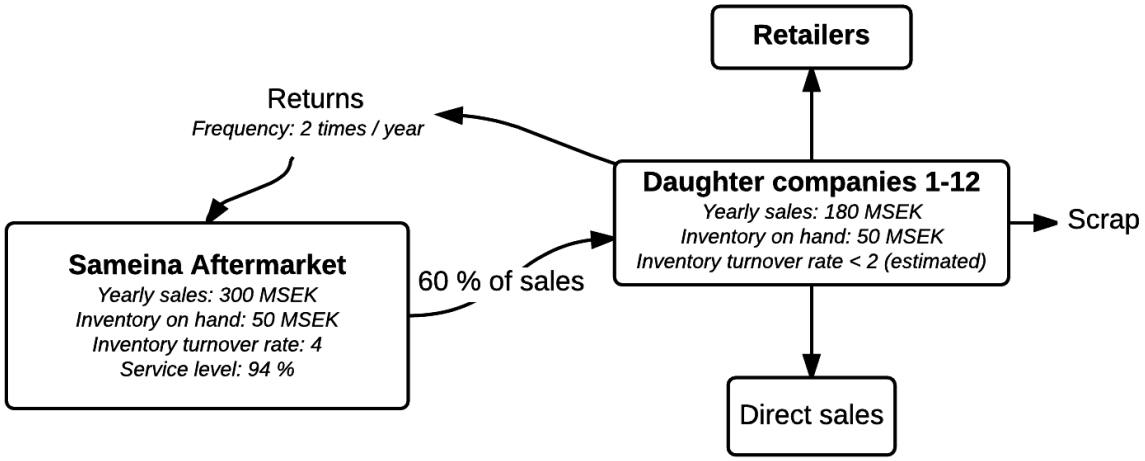

Figure 24. The aftermarket set-up and the measured KPIs.

The aftermarket KPIs are derived from Figure 24 above and listed in Table 9 below, these will be referred to as the measured *KPIs*.

Table 9. KPIs measured at Sameina.

Process	*KPI*	*Value*
Inventory Management	AM. Finished product inventory on hand (Sameina central inventory)	50 MSEK
Inventory Management	AM. Inventory turnover rate (Sameina central inventory)	4 / year
Inventory Management	AM. Finished products inventory on hand (Daughter companies)	50 MSEK
Customer Service	Service level *	94 %

** Defined by Sameina as the percentage of deliveries that leave the warehouse in Sameina on or before the time promised by Sameina for that particular order.*

Other measured KPIs and data to calculate additional KPIs was requested during the interviews, however to derive them required large amount of manual labour from specialists within the company. They were therefore not calculated even by Sameina. Such data or KPIs included:

- Value of returned goods from daughter companies
- Value of scrapped goods
- Cases where service level was not reached
- Delivery lead time
- Prognosis accuracy
- Fill rate service level (percentage of orders delivered directly from stock)
- Product availability

The purpose of metrics is to measure important processes in an organisation and to be used for decision making purposes. If the information is too troublesome to derive from the system, it is

likely that it will not be derived at all. Lumsden (2008) argues that information is transformed in three levels; from data to information to knowledge, the value increases with each step. Even if the metrics can be calculated in the system with the help from specialists, it is not usable if it is not timely delivered in the right form and to the right place where it can be used for informed decision making.

Most of the measured KPIs concern *inventory management* and how the distribution is set up. The measured KPI referred to as *service level* is also directly connected to inventory management as it is greatly affected by the inventory level at hand. Sameina defines service level as the percentage of orders that can be delivered from a Sameina warehouse at a time decided by Sameina. For each order a delivery lead time is decided individually. If the product is available in stock, delivery lead time for that individual order will be shorter than otherwise since it can be shipped instantly. Two traditionally conflicting KPIs are *safety stock* versus *fill rate service level*, the latter specifies the part of the demand that can be delivered directly from stock.

There is a positive correlation between safety stock and fill rate service level where an increased safety stock increases the fill rate service level. However an optimal safety stock level is not available, organisations with an efficient distribution and inventory management can manage to hold a lower safety stock and still reach the same service level as companies with less efficient distribution or inventory management. There is thus a correlation between the distribution- and inventory management, and the measured KPI Service level. By focusing visibility improvements on inventory management which is the area where most measured KPIs are included (Table 9), the Service level KPI is also affected. Based on the nature of the measured KPIs it was decided to focus the analysis on visibility improvements within inventory management and the information flows affecting the measured KPIs. During the interviews it was not possible to estimate future target values for the measured KPIs (in Table 9). Instead the KPIs are qualitatively analysed based on the interview results.

5.2.2. Visibility

The setup of the aftermarket distribution is thoroughly described in "4.4. Description of the aftermarket segment of the case company". The visibility between Sameina and the daughter companies when it comes to *inventory management* is limited to Sameina being able to export information concerning the daughter companies inventory at hand through the SAP tool Crystal Report. However according to the interviewed aftermarket purchaser this is a troublesome process and the information is seldom correct, therefore it is not frequently used. The day-to-day communication between the aftermarket purchasing department at Sameina and the daughter companies is very limited, it was described by an interviewee as; "We never call each-other". Daughter companies place their orders to Sameina via EDI connecting their ERP systems iScala and Jeeves, when doing that they can see whether the part is available in stock at Sameina or not. Sales reports are communicated to Sameina on a monthly basis to be used for prognostic purposes. The visibility the daughter companies in-between is virtually non-existent. Daughter companies are the contact points to retailers who handle the final customer contact. The communication channels are visualised in Figure 25 below.

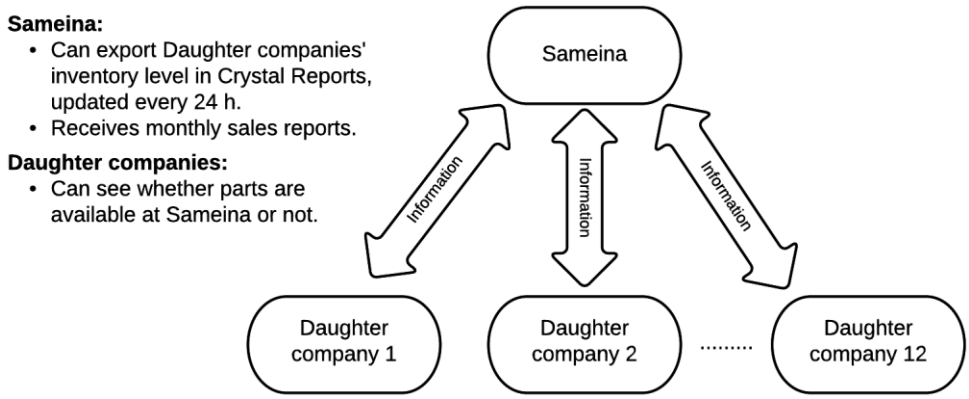

Figure 25. The communication channels between Sameina and the daughter companies.

Barrat and Oke (2007) define supply chain visibility as the extent to which actors within a supply chain have access to or share information which they consider key or useful to their operations and which they consider will be of mutual benefit. Tohamy (2003) defines it as capturing and analysing SC data that allows for informed decision-making, mitigated risk and improved processes. Since the information that can be derived by Sameina from daughter companies is limited to inventory information described as not trustworthy, and monthly sales report, it is argued that the visibility is rather low. The information is mostly one-sided where Sameina can see what is performed in the daughter companies, while the daughter companies have limited insight in Sameina's processes.

The daughter companies handle both sales and warehousing, but work alone in silos with limited access to information from the mother company or the other daughter companies. They are also the contact points with the retailers who have the final consumer contact. Lee et al. (2004) argues that rational local decision making creates demand distortion in a supply chain, which potentially can lead to bullwhip effect. Since few metrics are available it was not possible to measure whether the bullwhip has a large effect in the aftermarket supply chain or not. Due to the relative isolation of the daughter companies it is not unlikely. King and Griffiths (1986) suggest that the value of information equals the cost savings or other advantages that are made available by the information. Metters (1997) argue that the elimination of amplified self-induced seasoned variability due to bullwhip effect can improve profits by 10-20%, while elimination of forecast error due to bullwhip effect can increase profits by 5-10%. Bullwhip effect is commonly treated with a higher degree of information sharing in the supply chain. It is suggested that even if the effect of the bullwhip effect is not effectively quantified with KPIs in the aftermarket, the winnings from reducing it may be substantial. The value of information sharing reducing the possible bullwhip effect thus potentially possess high value.

Local process information in one daughter company is not usable to Sameina or another daughter company until it is conveyed in a manner so that the receiver can use it to make an informed decision and realise a cost saving. The benefits that could have been achieved in a system by sharing of process information can thus not be realised if the receiver of the information deems it not to be trustworthy, i.e. lacks quality. If it is not trustworthy it will not be used to realise cost savings or other advantages. Decision makers in a decentralised system often have access to private information, which is not shared with others, thus resulting in suboptimal system performance (Sahin and Robinson, 2002). Since the visibility level between daughter companies is virtually non-existent today, information is not shared between their decision makers which results in a suboptimal system performance. The private information inside each daughter company is thus not used to its full potential, i.e. to realise cost savings or other advantages in the other daughter companies or for the organisation as whole.

5.2.3. Processes

For the aftermarket no parts are transported between the daughter companies, instead everything is shipped from Sameina. When daughter companies order parts where the current inventory level at Sameina is insufficient, new parts must be purchased from Sameina's suppliers whereas long order lead times occur. This is the case even if another daughter company would have the requested parts in excess inventory. This insufficient allocation of resources that occurs when requested parts are available at other daughter companies originates in lack of coordination, visibility and communication, i.e. there is no system for sharing inventory information or physical goods the daughter companies in-between. The communication between Sameina and the daughter companies is inadequate and between the daughter companies the communication is virtually non-existent. The type of IT-systems used at the daughter companies vary and there is no predefined solution to enable communication them in-between.

When there is a shortage at the Sameina warehouse an order from a supplier is performed. In cases like this, the requested spare part could be in stock at another daughter company and thereby be available with short notice. However the possibility for such transfer of stock is not attainable due to lack of visibility. All actors (Sameina, the daughter company with backlog, and the other daughter companies) are unaware of either one or both of (1) where inventory of the requested spare part might exist or (2) the end-customer demand of the spare part. Due to present ICT solutions, the barrier that must be overcome in order to pull out information about the daughter companies´ warehouses is high and daughter companies have no insight in each other's warehouses. The information exist but it is not available in terms of frequency, quantity, and quality which are prerequisites for having use of it (Prajogo and Olhager, 2012). The inventory management in the supply chain thus suffers from a lack of visibility, coordination between the actors in the supply chain is therefore not possible.

5.2.4. Information flows affecting the production warehouse

It has been described that the areas of where metrics and knowledge are available mostly concern the processes of inventory management. Concerning *Visibility*, it has been argued that there exists potential for improved visibility between Sameina and the daughter companies, as well as between the daughter companies themselves. It has been argued that an area where there is room for increased visibility is inventory management. Orders are always shipped from Sameina to daughter companies. The warehouses at the daughter companies are in essence their own islands without contact with each other. How the distribution is performed deeply affects the inventory management process.

Sales data and inventory status is an information flow where all sales and inventory updates are frequently communicated from one actor to another. Sales updates and inventory updates are connected into a single flow since a sale always triggers an inventory update. A cause-effect map of the *Sales data and inventory status* information flow has been created where daughter companies are the senders of the information and Sameina is the receiver, the cause-effect map is found in Figure 26. In a perfect world the same information should be communicated also by the retailers, however such a suggestion would be premature considering it has not even been established between Sameina and their fully owned daughter companies. Retailers are therefore not further analysed at this stage.

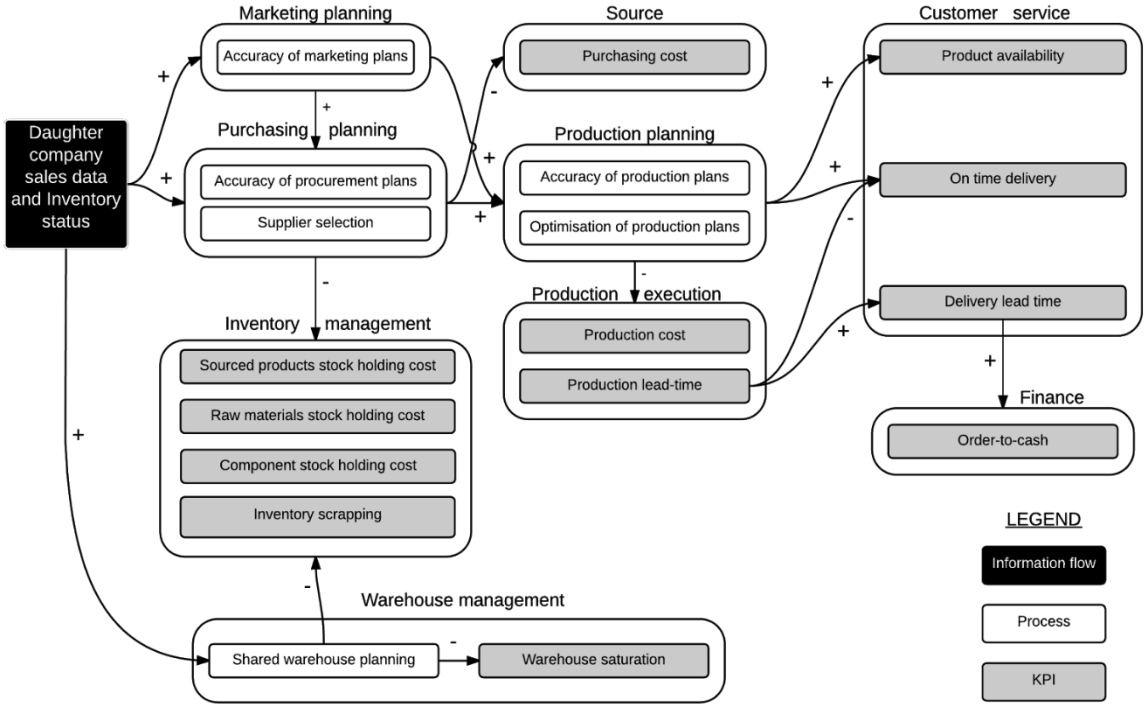

Figure 26. Cause effect map with the information flow sales data and inventory status.

The cause effect map was created with inspiration from Caridi et al. (2014)'s generic maps but further adapted to Sameina and their specific setting, only the Sameina aftermarket is considered. The correlations in the cause-effect map are elaborated in Table 10 below. The arrows are marked with positive (+) and negative (-) correlations. That e.g. the arrow between "Shared warehouse planning" and "Inventory management" down to the left in Figure 26 has a negative correlation does not mean that something is degraded. Instead, when shared warehouse planning is increasing, the KPIs of inventory planning as various stock holding costs and scraping are decreasing which is positive for the company, but still has a "negative" *correlation* in the cause effect map.

Table 10. Correlations between the KPIs and processes in the inventory status cause-effect map. The colours of the cells correspond to the colours of the boxes in Figure 26.

Arrow beginning	*Impact*	*Arrow tip*	*Description*
Daughter company sales data and Inventory status	+	(Marketing planning) Accuracy of marketing plans	The marketing department can develop more reliable prognoses and adjust the current ones when they know in real time what is sold and what is in stock.
Daughter company sales data and Inventory status	+	(Purchasing planning) Accuracy of procurement plans Supplier selection	By knowing in real time the actual inventory status and sales at a daughter company a purchaser can perform adjustments to procurement plans that matches what happens in real time. .
Daughter company sales data and Inventory	+	*(Warehouse management)* Shared warehouse planning	If several warehouses exists, the sharing of inventory status is a prerequisite for them to be able to act as one large inventory.
(Marketing planning) Accuracy of marketing plans	+	*(Production planning)* Accuracy of production plans Optimisation of production plans	Marketing planning creates the prognosis for what is to be produced, more reliable prognosis improves the accuracy of production plans since they will be based on more reliable information. Reliable decision basis also increases the potential for optimisation since fewer late changes will have to be performed.
(Marketing planning) Accuracy of marketing plans	+	*(Purchasing planning)* Accuracy of procurement plans Supplier selection	Since procurement plans are based on the prognoses at Sameina, there is a positive correlation between accurate marketing plans and accurate purchasing plans. Since accurate marketing plans stipulate what is required by suppliers, the possibility to selecting appropriate ones increase.

(Purchasing planning) Accuracy of procurement plans Supplier selection		*(Source)* Purchasing cost	Accurate procurement plans reduces costly late changes and gives stability to suppliers, which increases the purchasers possibility to decrease costs when sourcing. An appropriate supplier selection can decrease the costs of purchasing.
(Purchasing planning) Accuracy of procurement plans Supplier selection	+	(Production planning) Accuracy of production plans Optimisation of production plans	Better accuracy of procurement plans and better ability to select appropriate suppliers increases the accuracy of production plans due to a reduction of unexpected stock-outs of raw materials and components. High quality suppliers allows for more specialised and optimised production planning optimisation. This information flow allows for faster recognition of changed demand and the production plans can thus be changed and optimised accordingly.
(Purchasing planning) Accuracy of procurement plans Supplier selection		*(Inventory management)* Sourced products stock holding cost Raw materials stock holding cost Component stock holding cost Inventory Scrapping	Accurate procurement plans and appropriate supplier selection gives rise to orders that are a closer match to the actual demand. More accurate procurement plans makes it possible to keep lower safety stock, the stock holding costs are thus reduced. More accurate procurement also reduces the amount of excess items that has to be scrapped.
(Warehouse management) Shared warehouse planning		*(Inventory management)* Sourced products stock holding cost Raw materials stock holding cost Component stock holding cost Inventory Scrapping	Shared warehouse planning enables many warehouses to share safety stock and cover for each other´s shortages whereas less inventory must be kept to remain on the same service level. Less inventory reduces the obsolescence risk.
(Warehouse management) Shared warehouse planning		*(Warehouse management)* Warehouse saturation	Shared warehouse planning enables many warehouses to share safety stock and cover for each other´s shortages whereas the saturation is reduced.
(Production planning) Accuracy of production plans Optimisation of production plans	+	*(Customer service)* Product availability On time delivery	When the ability to plan and optimise production increases there will be less interruptions and higher productivity in the production, the product availability and the on time delivery KPIs will thus increase.
(Production planning) Accuracy of production plans Optimisation of production plans		*(Production execution)* Production cost Production lead time	Accurate and optimised production planning reduces production cost and production lead time due to less wasted time and more efficient usage of resources.
(Production execution) Production lead time		(Customer service) On time delivery	With shorter production lead time planning for deliveries become easier, the two KPIs thus have a negative correlation.
(Production execution) Production lead time	+	(Customer service) Delivery lead time	Production lead time is a part of the delivery lead time. Increased production lead time therefore increases the delivery lead time.
(Customer service) Delivery lead time	+	(Finance) Order to cash	Increased delivery lead time therefore increases the order to cash time.

It has been argued that improving the information flow where *sales data and inventory status* is transferred from daughter companies affects the KPIs stock holding cost, warehouse saturation, purchasing cost, production cost, production lead time, product availability, on time delivery, delivery lead time, order to cash. However only a few of them are measured directly or indirectly by the aftermarket and size of the effect is difficult to quantify.

5.2.5. Suggestions for improving performance

In the above sections the aftermarkets inventory management process has been analysed, it has been argued that to improve the inventory management processes, a greater degree of visibility between Sameina and the daughter companies and the daughter companies in between is needed. The information flow with potential to affect the visibility in inventory management and the currently measured KPIs is *sales data and inventory status from daughter companies.* In this section a potential solution for how such an information flow can be designed in Sameina´s supply chain is presented. It is suggested that

the inventory at hand could be greatly reduced if all the warehouses (daughter companies´ and Sameina´s) would be seen as a single inventory instead as of today, where the daughter companies' inventories are tied to their respective market. A conceptual picture of how the information would be available is visualised in Figure 27 below. The solution is summarised as following:

Connect all warehouses by introducing the real-time information flow sales data and inventory status, which makes the current inventory in every warehouse visible to the other warehouses.

Connected warehouses improves visibility

To improve inventory management visibility, the information flow *sales data and inventory status* should be made visible to both Sameina and all the daughter companies. This implies that either one of them should be able to view the inventory of all the others in real time. This stands in contrast to the current solution which is barely used at all, where only Sameina, and not the daughter companies, can see at best a few days old inventory status for the daughter companies. Today it also requires several systems to be used and a large effort to be put in, resulting in a very finite usage. To create the suggested solution there must be a connection established between the actors´ respective ERP systems. The potential solution is to virtually connect all the daughter company warehouses and the central Sameina warehouse into a single warehouse, split at the current several different geographical locations. The visibility level is conceptually represented in Figure 27 below.

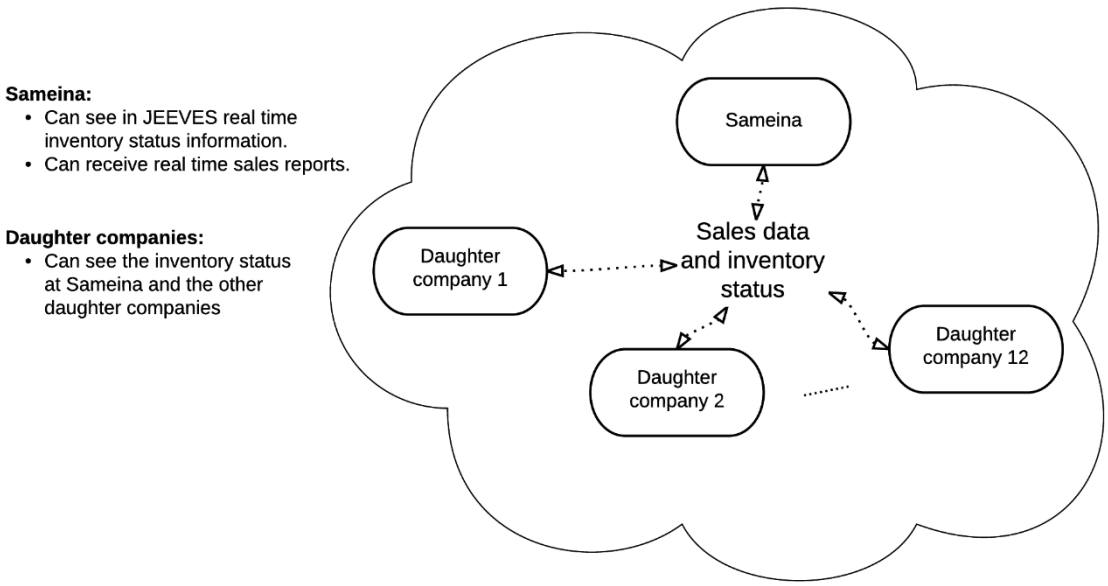

Figure 27. All involved actors should have access to the same inventory information.

The information in the system must be updated in real time which implies that there must be a direct connection between the systems. Every time an inventory change is made (e.g. a sale, scrap, or a replenishment) in any warehouse, the change should also be visible to the others since the warehouses are connected. By this procedure every warehouse knows exactly what is available of inventory in the other warehouses.

Improved inventory management

A setup where both Sameina and daughter companies have insight into all warehouses would introduce the possibility for them to check whether a certain part is available not only at Sameina, but also at a neighbouring daughter company. Spare parts could then be physically sent between the daughter

companies´ local warehouses, enabling the local warehouses to administratively act as one big warehouse split at different. This provides preconditions for spare parts to be sent to the location where they are most likely to be needed. This stands in contrast with today's set-up where all spare parts are sent from Sameina regardless of their inventory status in the neighbouring daughter company's warehouse. Allowing for intra- or inter-company trade have the potential to reduce lead times towards customers, as well as the tied up capital in the form of stock at hand. If the warehouses could work together as a single warehouse, the amount of unique parts that needs to be kept in stock at every location would be reduced, instead one of the neighbouring daughter companies with the best preconditions could keep it in stock and send to the others when needed. In that sense the solution would in essence be a large step towards a centralisation of the distribution, which is mentioned by the parts director at Sameina as a goal for the future.

The capital tied-up in the aftermarket inventory of today is 100 MSEK. Qualitatively estimations made by aftermarket managers at Sameina say that the visibility improvements presented here could improve the aftermarket inventory management considerably. The reduction of the tied-up capital is estimated by the aftermarket manager to around 20 MSEK, with remained service level. A rule of thumb when calculating the reduction of tied-up capital, with maintained service level points at a reduction of 72 % when 13 warehouses are reduced to one (Jonsson and Mattsson, 2011). A description of the rule of thumb and the calculation is found in Appendix D. 72 % corresponds to a reduction of tied up capital corresponding to 72 MSEK, it is however not to be seen uncritically due to that the centralisation is virtual and not geographical. Also to be considered when looking at this number is that one of the warehouses, the Sameina central warehouse, represents half of the inventory (50 MSEK out of 100 MSEK). What this calculation contributes with is that the spare parts managers´ estimation of possible reduction of 20 MSEK is not optimistic, rather pessimistic.

Remained user experience

For the inventory- and sales information flow to be useful it must be delivered in a manner so that it can be used for decision making. A problem for the current aftermarket purchasers and material planners at Sameina is that the accessible inventory information from the daughter companies is not reliable enough, nor is it easy to access, and therefore it is not used. Human nature calls for a resistance to fundamental changes (Kotter, 1995) and it is commonly said that around 70% of organisational changes fail (Beer and Nohria, 2000). In fact, those who are most reluctant to the change are the ones most affected, the everyday users. Due to the risks of failure when it comes to making organisational changes, it is of importance for the suggested solution to change the everyday user experience as little as possible. It is essential that the new information is reachable and presented in the same environment as is used today, where the personnel are already familiar. A prerequisite is therefore that the information must be delivered directly into the ERP-systems used, Jeeves at Sameina and iScala etc. at the daughter companies. The typical end users (e.g. purchasers and material planners) should therefore not experience any changes to their everyday routines, except the enhanced information base available for more informed decision making. In addition the information must be conveyed in real time for it to be reliable enough to act upon.

Further benefits

Further benefits include improvements in KPIs and processes affected by the suggested information flow *sales data and inventory status*. When studying the cause-effect map presented above, correlations with the KPIs purchasing cost, production cost, production lead-time, product availability, on time delivery and delivery lead-time are shown. The reasoning can be read in Table 10 above. Although these correlations are not the focus of this project, it is evident that other areas than only inventory management are affected by the increased visibility provided by the information flow *sales data and*

inventory status. As an example, prognosis work are today performed strictly using historic sales data. If instead real-time sales data would be available, it gives potential for improved prognosis work by the marketing department. Improved prognoses increases the accuracy of the purchasing plans and the accuracy of the production plans.

Obstacles

As mentioned above about the general reluctance to change, considerable effort has been put on minimising the need for change and thus reducing that obstacle. Another obstacle concerns the ownership of products and the organisational structure of the corporate group. In the specific Sameina case, the daughter companies are fully owned by Sameina but operate independently with their own performance targets. Because of this there could be a risk of sub-optimisation activities arising when the daughter companies are bound to send spare parts to other daughter companies on request. Driven by the risk that the spare parts in stock would regardless be "snatched" by neighbouring daughter companies, a possible result is less ordering and holding of spare parts inventory at the daughter companies. The equation becomes even more complicated as Sameina sells parts to the daughter companies at different rates. It is possible that the central warehouse in Sameina could exercise a larger power in terms of controlling the supply. In line with this power movement lies also the spare parts managers´ perception that Sameina would benefit by maintaining the ownership of the daughter companies´ spare parts until they are finally sold to a retailer or a final customer. There have also been speculations at Sameina about a total centralisation of spare parts material planning and distribution where daughter companies only need to concern themselves with sales. With this concluded, the possible obstacle of ownership is a Sameina internal politics obstacle that lies beyond the scope of this project. Another obstacle lies in the warehouses respective routines, introducing real time sharing the inventory status would put pressure on them to maintain a certain level of inventory accuracy. If such level can not be upheld, the new information is not trustworthy enough to be used.

5.2.6. Summary of the aftermarket

By introducing the real-time information flow sales data and inventory status into Sameina´s daily business, there is a potential to increase Sameina's operational performance within several processes, summarised in Table 11 below. One of the processes is inventory management, which is improved by connecting warehouses and improving visibility, remained user experience reduces possible implementation obstacles. The suggestions simultaneously allowing further benefits.

Table 11. The solution is summarised in the table with its properties to the left and a short description of their realisation to the right.

Connect all warehouses by introducing the real-time information flow sales data and inventory status, which makes the current inventory in every warehouse visible to the other warehouses.	
The solution gives	*How?*
Improved Visibility	Every warehouse accesses inventory status of every warehouse.
Improved inventory management	Access to every warehouse covers for shortages and reduces the need of tied-up capital.
Maintained user experience	The new information flow reaches the end user in the present IT-systems.
Further benefits	Real-time sales- and inventory information enhances the decision base for purchasing, production plans, and prognosis.
Obstacles	Risk of sub-optimisations with too low inventory. Higher demand for warehouse precision.

5.3. Improvement potential in Sameina's production warehouse

The production wareshouse is the second area within Sameina where it was found that enhanced information sharing has high potential. This section describes how so.

The second area with improvement potential is the production warehouse, as described in "4.5. Description of the production warehouse segment of the case company", it suffers from a range of inefficiencies. For all the three areas of the production warehouse (the component warehouse, the raw materials warehouse, and the outdoor warehouse), incoming goods are registered manually (see Figure 28). The purpose of the registration procedure is to check whether there are any discrepancies between the released order and delivered order, if a discrepancy exists it is manually corrected.

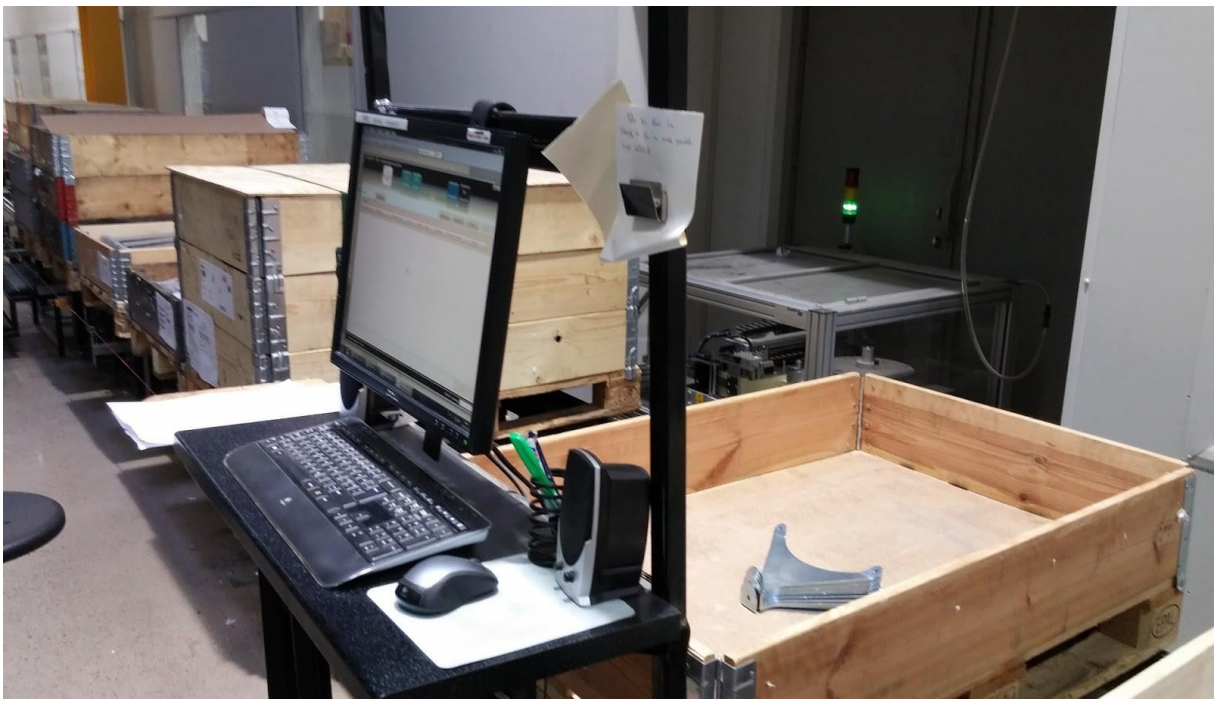

Figure 28. The conveyer belt and the terminal where inbound goods are registered

The information about the specific order-lines for each released order is already in Sameina´s ERP system, the information one the suppliers´ waybills is not. The suppliers´ waybills do however exist electronically in the suppliers' ERP systems. There is no automatic check whether the delivered quantity corresponds to either the ordered quantity or the on the waybills stated quantity.

For all three warehouses of the production warehouse, no goods are registered in the ERP-system as available for the production until the goods is placed in its warehouse slot. This results in delays until goods is available which results in shortage problems for production who need material that is physically in storage but for them not visible as in stock. In a situation like this the goods could be located at four different places; first, the goods could be unloaded from the delivering truck and placed on the warehouse floor due to a full queue for the conveyor belt. Secondly, the goods could be stuck on the conveyor belt waiting for either registration or to be moved to its final storage slot. Thirdly, the goods could be in a queue after the conveyor belt, on the warehouse floor, waiting for its final storage location. This after-the-conveyor-belt-queue is a sub-optimisation with its root in the need of freeing up space on the congested conveyor. The fourth possibility of where goods could be is in the outdoor warehouse but unregistered.

The possibility for the warehouse manager to plan for incoming goods is also limited since the arrival of the trucks nor their content are known in advance. According to the warehouse manager, these delays add on average 2-3 days to the lead-time of all incoming goods.

5.3.1. Metrics

Sameina uses some metrics concerning the production warehouse. These are currently used more for an overview purpose rather than decision basis. What is measured is foremost the following KPIs:

1. Inventory value.
2. Inventory turnover-rate.
3. Warehouse saturation.
4. Forecast accuracy.

The inventory value is currently 100 MSEK for the production warehouse. Currently there is no target value for this KPI nor any specific plan to decrease the value. The inventory turnover-rate is currently 6 times a year which is seen by the warehouse manager as too low. The warehouse manager has a vision that the turnover-rate should be around 12-15 times a year and is currently investigating how to improve this KPI. The warehouse saturation has during the last year risen from about 60 % up until above 90 % much due to the recent high increment of new parts produced by the R&D department.

The greatest problem in the production warehouse is however, according to the production manager, the congestion of unregistered goods as a result of the inefficient registration process. There is no metric used for this, more than a qualitatively approximation from the warehouse manager of an additional lead-time due to the congestion of 2-3 days on average and that this congestion is the root of a large number of warehouse workers´ overtime. This congestion of unregistered goods is handled below.

5.3.2. Areas of improvement

As mentioned above, the largest problem in the production warehouse is the congestion of unregistered goods. The root of this, according to the warehouse manager, is found in the inefficient registration system where an operator must register goods manually on a terminal typing in information from the delivered goods´ waybills. Goods that is meant to be stored in the component- and raw materials parts of the production warehouse must currently be registered manually as they pass the registration part of the conveyor belt. The conveyor belt is drawn from the indoor truck unloading area via the registration terminal and to an area where forklifts can pick up the goods. The registration terminal is as mentioned the bottleneck which causes that material must be temporarily stored on the warehouse floor. For the outdoor part of the production warehouse the situation is relatively similar except from the conveyor belt; when goods is unloaded the waybills are currently manually released and brought inside the production warehouse for the same procedure as the goods for the other two parts. The warehouse manager highlights the importance of direct registration after unloading from trucks in the outdoor warehouse; waybills can be lost on the way to the registration terminal, it is time demanding, and the goods can not be used before registration is complete.

Another inefficiency connected to the unoptimised registration process is the uncertainty of delivery time for ordered goods. Also the number of pallets is subject to uncertainty for the warehouse personnel; the arrival time of trucks is not known in advance, each truck's content is known first when it is opened. *Advance shipping notice* including information about estimated shipping/arriving time, type and quantity for each delivery would decrease these uncertainties for the warehouse personnel and lay a foundation for better capacity planning.

5.3.3. Information flows affecting the production warehouse

To decrease the congestion of unregistered goods, the manual registration time must be reduced. An automatic registration would cut out the manual part of it and secure that registration is made directly every time a new pallet occurs at the registration spot of the conveyor belt, visualised in Figure 28 above. To enable an automatic registration the information on the waybills should not be read manually, it should be in Sameina´s ERP-system beforehand of the goods delivery. *Advance shipping notice* is a type of information flow carrying information about what is planned to be delivered. *Advance shipping notice* including order identification, item identification, and quantity of each item should be an information flow from each suppliers´ ERP-system into Sameina´s ERP-system simultaneously as goods leave a supplier. This would eliminate the manual terminal registration work. The only procedure necessary would be to make a match, for every incoming parcel, against information in Sameina´s ERP-system. Figure 29 below shows areas within Sameina that would be affected by the information flow *advance shipping notice*. The benefits are further elaborated in Table 12 afterwards.

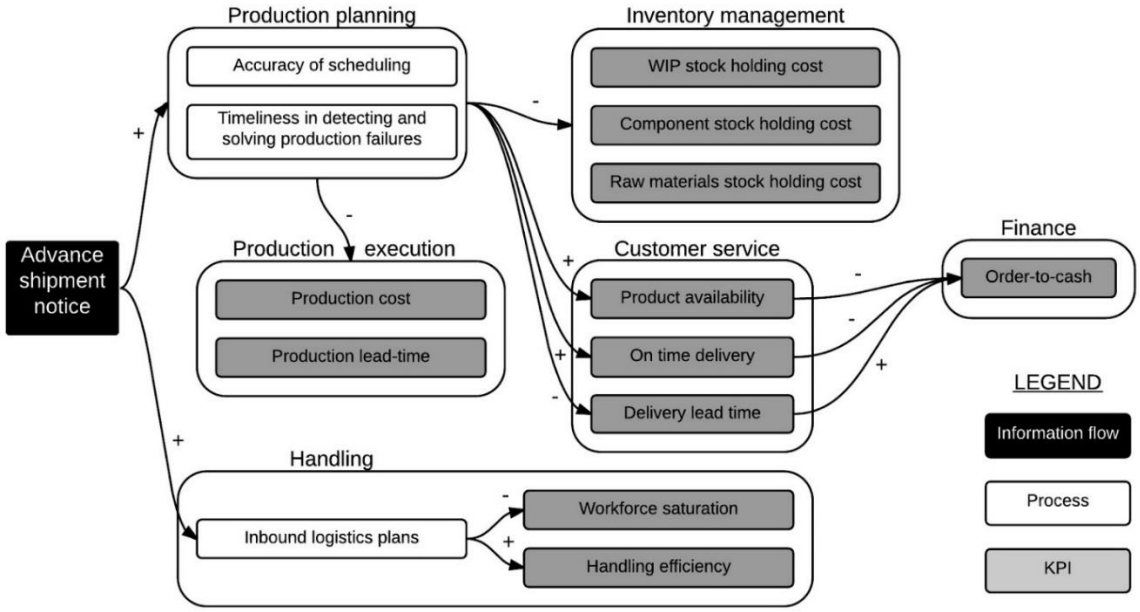

Figure 29. Cause-effect map with the information flow advance shipping notice (ASN)

The correlations in the cause effect map above are elaborated in Table 12 below. The arrows are marked with positive (+) and negative (-) correlations. For example that the arrow between "Production planning" and "Inventory management" at the top in Figure 29 has a negative correlation does not mean that something is degraded. Instead, when production planning is increasing with e.g. better accuracy of scheduling, the KPIs of inventory planning as various stock holding costs are decreasing.

Table 12. Correlations in the advance shipping notice cause-effect map. The colours of the cells correspond to the colours of the boxes in Figure 29.

Arrow beginning	*Impact*	*Arrow tip*	*Description*
Supplier advance shipping notice	+	(Production planning) Accuracy of scheduling Timeliness in detecting and solving production failures	Including information about goods that is on its way into the warehouse gives decision makers would have more accurate information of what articles will be available when production takes place.
Supplier advance shipping notice	+	(Handling) Inbound logistics plans	Knowing what is expected to be delivered, the inbound logistics can be planned accordingly. Lays a foundation for an automatic registration process.
(Handling) Inbound logistics plans		(Handling) Workforce saturation	The workforce schedules could with higher precision be planned according to what will be delivered and when. The saturation of the workforce could to a higher degree be controlled.
(Handling)Inbound logistics plans	+	(Handling) Handling efficiency	By having plans and information of what is expected to be delivered the registration process can be planned accordingly. Lays a foundation for an automatic registration process.
(Production planning) Accuracy of scheduling Timeliness in detecting and solving production failures	+	(Production execution) Production cost Production lead time	If the production planning is enhanced, the production execution can be more efficient (lower cost and lower lead time) if producing accordingly to the plans.
(Production planning) Accuracy of scheduling Timeliness in detecting and solving production failures		(Inventory management) WIP stock holding cost Raw materials stock holding cost Component stock holding cost	If the production planning is enhanced, the production can rely on less inventory levels with remained or better service level.
(Production planning) Accuracy of scheduling Timeliness in detecting and solving production failures	+	(Customer service) Product availability On time delivery	If the production planning is enhanced, the production can offer final products to customers on promised dates with a higher probability. When information concerning availability of components can be taken into account earlier in the process resulting in lower probability for unforeseen shortages.
(Production planning) Accuracy of scheduling Timeliness in detecting and solving production failures		(Customer service) Delivery lead time	If the production planning is enhanced, the production can more often offer final products to customers earlier. When information concerning availability of components can be taken into account earlier in the process resulting in lower probability for unforeseen shortages. Accuracy of scheduling also allows for lower time buffers without interruptions, thus lowering the delivery lead time.
(Customer service) Product availability On-time delivery		(Finance) Order to cash	Having products available to the customers when they want them instead of later leads to payments earlier than later.
(Customer service) Delivery leadtime	+	(Finance) Order to cash	Delivery lead time is a part of the order to cash time. Increased customer service in terms of decreased lead time therefore decreases the order to-cash time.

5.3.4. Suggestions for improving performance

Instead of printing order information only as physical waybills, the suppliers should also send order information electronically and directly into Sameina´s ERP-system. This information flow would enable for Sameina to make an automatic match between delivered goods and released order, this is visualised in the simplified Figure 30 below.

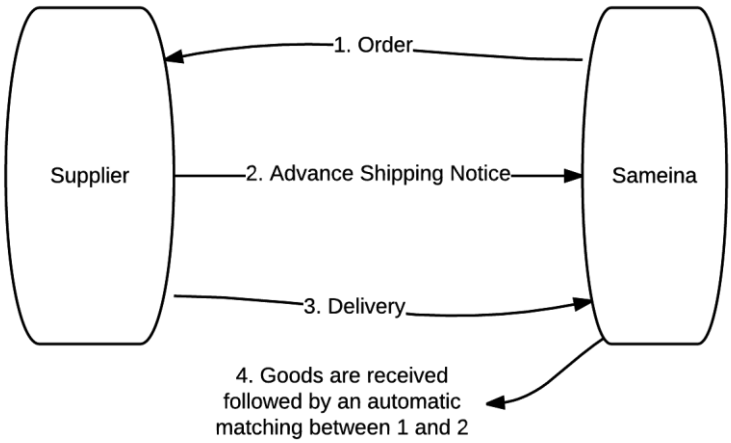

Figure 30. A simplified solution where the quantities of released orders are automatically compared with the quantities delivered.

Information required on the the parcels are order identifications as order numbers in the form of preferably barcodes. The barcodes can then be scanned by a barcode reader; either by a handheld reader device or even more preferable for the majority of the goods that is carried by the conveyor belt, scanned automatically when passing the current registration terminal. The largest problem according to the warehouse manager would thereby be eliminated and the new bottleneck would then be the warehouse workers´ ability to move pallets from the arriving trucks to the conveyor belt and from the conveyor belt to the storage slots which is a target of the production manager.

The earlier information concerning time and quantity and type is delivered to the warehouse, the better plans can be performed by the warehouse manager. This includes capacity planning in the form of e.g. time slots for deliveries and staffing.

5.3.5. Obstacles

A challenge is however to enable for the warehouse personnel to be susceptible for the introduction of the changed working procedures and the hardware introduction of barcode scanners. Another challenge is to set up the required collaborations with suppliers to ensure that they use ASN on a regular basis.

5.3.6. Summary of the production warehouse

By introducing the information flow *advance shipping notice (ASN)* from Sameina's suppliers to Sameina, there is a potential to increase Sameina's operational performance within several processes, summarised in Table 13 below. The solution improves warehouse management by enhanced visibility where the production warehouse beforehand knows what is about to be received. An automatic matching between released orders and received order lines have the potential to remove a major bottleneck and considerably reduce the registration time of incoming goods. Challenges to overcome are initial reluctance from personnel, and setting up the required collaboration with suppliers.

Table 13. The solution is summarised in the table with its properties to the left and a short description of their realisation to the right.

Introduce advance shipping notice for incoming goods to the production warehouse enabling automatic registration, enhances the warehouse planning, and reducing the warehouse congestion.	
The solution gives	*How?*
Improved Visibility	Sameina knows when and what is about to be received to the production warehouse earlier than the current situation of when the goods is delivered.
Improved inventory management	Less congestion of warehouse space and less tied-up capital due to shorter lead-time from delivery until storage at the shelves.
Improved personnel management	Advance shipping notice provides the support needed for efficient allocation of warehouse personnel.

5.4. Pagero

Accessibility of information is described by APICS (2011) as a major driver of supply chain performance. The ease of which information can be transferred throughout the supply chain determines the performance of several other processes. Since Pagero´s core business is to allow for easy and scalable exchange of information, a solution for improving client's operational performance should have its foundation within that area. In this section it is analysed how Pagero can meet the requirements for the solutions presented for the aftermarket and for the production warehouse. A brief discussion about what is Pagero's core and strengths is held, the respective requirements for each solution is then discussed in relation to Pagero´s strengths. Abilities and possibilities for Pagero to find more clients also help them is discussed in relation to the used method. Finally a recommendation is made. This section handles *Task 5* in the work process, (Figure 31).

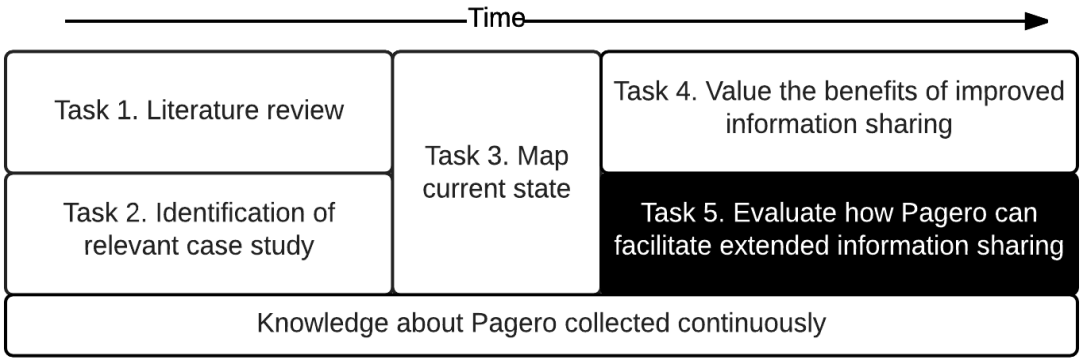

Figure 31. In task 5 it is evaluated how Pagero can facilitate the extended information sharing required for the exchange of the information needed by Sameina.

5.4.1. Strengths of Pagero

Pagero's vision is to be the connection between different ERP-systems used by companies of different sizes and of different lines of businesses and in the long run support the transfer of all types of messages sent between ERP-systems. Such connections have traditionally been set up individually between each system in a peer-to-peer manner. Pagero's strength is to make these inherently expensive connections generic and therefore scalable. A competitive advantage for Pagero is their ability to handle the different formats used by different ERP-systems and to convert these to whichever format is requested by the receiver. The result is a less costly alternative than the traditional peer-to-peer connections that is usable to organisations of different sizes and industries. Innovation is a large focus for Pagero and new products are constantly under development. Finding additional message types that can be transferred between two actors using Pagero's cloud service Pagero Online is therefore in line with both Pagero's vision and strengths. A challenge is to find message types that can be implemented into Pagero Online without too large investments and at the same time provide value to Pagero's customers, i.e. the senders and receivers of the message.

5.4.2. Possibility for Pagero to provide performance improvements at Sameina's aftermarket

This section provides a discussion of what Pagero has to commit to fulfill the visibility improvements at the focal organisation´s aftermarket.

As described in "5.2. Improvement potential in Sameina's aftermarket", it is suggested that Sameina's aftermarket can improve the performance of their inventory management by allowing for greater visibility between the daughter companies' warehouses. The information flow that with helping potential to Sameina and the daughter companies is *sales data and inventory status*. Sameina and their twelve daughter companies use a variety of different IT-systems, implying that there is a considerable challenge for Pagero to connect this variety of different IT-systems while still letting Sameina´s current work-routines remain intact. Two different solutions of where Pagero supports the integration of Sameina's warehouses by enabling the transfer of sales data and inventory status are presented, both solutions affect Sameina´s inventory management processes but still allows for a preserved end-user experience. In the first solution displayed in Figure 32, Sameina has control over the distribution of replenishment orders among the daughter companies and has the potential to play a large role in the materials planning. All arrows passing through a cloud in the figure represent messages that are sent through Pagero Online. Note that only the inventory update arrows are critical for the solution to work, see visualisation Figure 32 below. To fully benefit from the solution and reach a high degree of automatisation in the message flow, it is recommended that all messages visualised in Figure 32 are handled through Pagero Online. The manual work needed would then be reduced to a minimum.

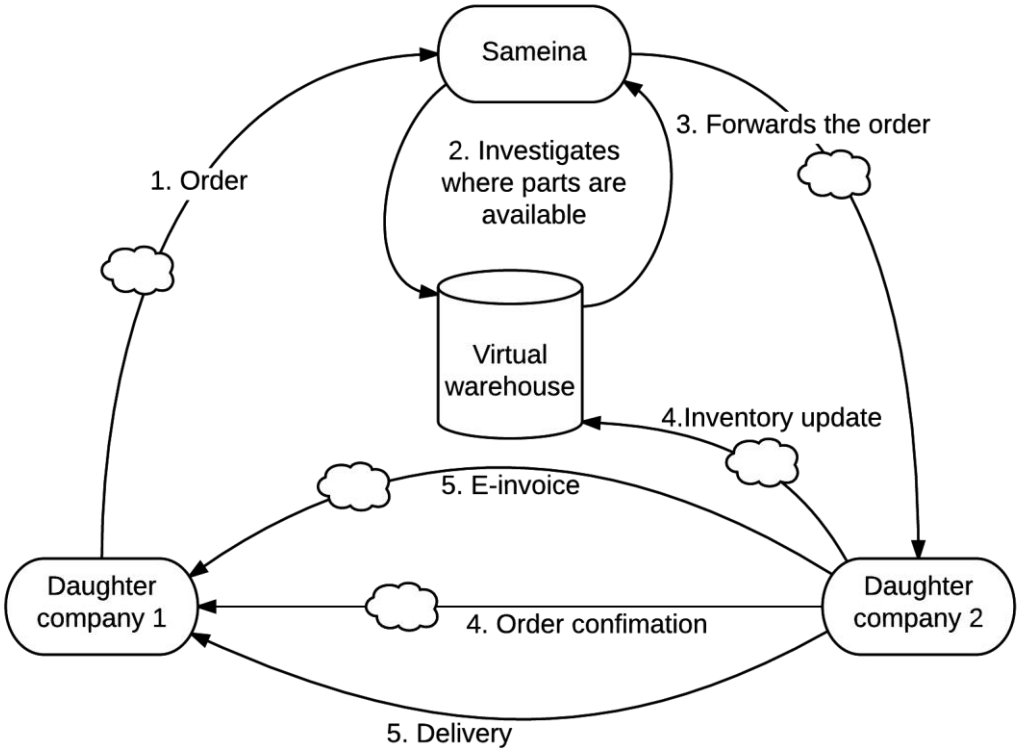

Figure 32. Sameina controls the material planning. In this example Sameina receives an order from Daughter company 1 followed by planning and distribution to fulfil it.

The Figure 32 shows on an example where Daughter company 1 is in need of certain spare parts not available in its own inventory and therefore sends an order to Sameina. The steps are described as follows:

1. Daughter company 1 sends an order to Sameina.
2. Sameina investigates from where parts should be sent to Daughter company 1. An inventory check is performed. The choice depends on the properties of the order and the current situation in terms of urgency, quantity in order, which part, current inventory value, etc.
3. The order is forwarded to the warehouse most suited to handle the order.
4. Daughter company 2 confirms the order and simultaneously updated their new inventory status.
5. An invoice is sent to Daughter company 1 at the same time as the delivery is performed.

The second solution is similar, the only difference is that Sameina does not decide from where the order will be fulfilled. The ordering is instead decentralised i.e. the Daughter companies can choose for themselves where to direct the order. The solution is visualised in Figure 33 below.

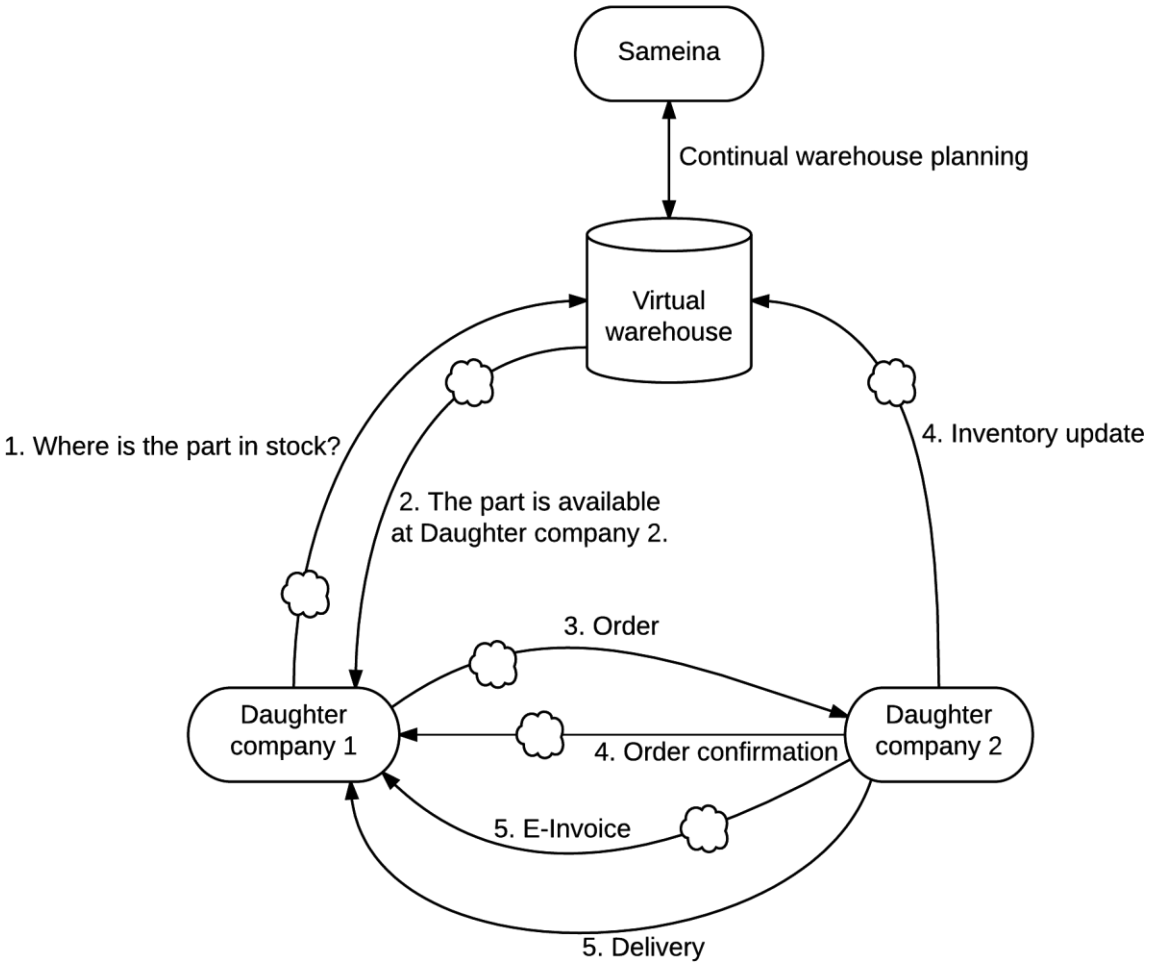

Figure 33. Each Daughter company controls its own material planning.

In this example Daughter company 1 has a certain spare parts need and checks against the virtual warehouse where a suitable supply exists.An example of how this solution works is as follows; Daughter company 1 needs a certain spare part urgently and after checking in the virtual inventory they know that the spare part is available at daughter company 2 and at Sameina. Daughter company 1 also see in the virtual warehouse that Daughter company 2 can deliver the spare part faster than Sameina can, but to a higher price. Since Daughter company 1 in this case urgently needs the part, the higher cost is of low relevance in comparison to the delivery lead time. A judgement call is made and the part is ordered from Daughter company 2.

The steps in the Figure 33 are described as follows:

1. Daughter company 1 checks where among the daughter companies and Sameina a certain part is available.
2. Daughter company 2 is deemed to be the most suited to deliver the part according to the order prerequisites.
3. An order is sent to Daughter company 2.
4. Daughter company 2 confirms the order and simultaneously is their inventory status updated.
5. The delivery is made and an e-invoice is sent.

To enable the transfer of sales data and inventory status, a prerequisite is that the local information is available and reliable at each respective daughter company and at Sameina. In this area Pagero can not

largely affect the outcome, instead it is up to Sameina. Since each actor can review their own inventory status it is likely that it is available at least in their system, which in turn can be connected to Pagero Online. While Sameina uses the ERP-system Jeeves which is in general quite adaptable, the daughter companies use different ERP-systems where iScala is the most common. It is within Pagero's strengths to make connections between different ERP-systems and capture the information required and deliver it as demanded. Both iScala and Jeeves are currently supported for Pagero's e-invoice services.

Technical qualifications

Message types for sales reports and inventory status are already available within the EDIFACT standard and several other standards used today by Pagero. Development of the technical prerequisites to enable visibility improvements by sharing *sales data and inventory status* for Sameina would not require any major investments, an estimation from a Pagero IT Manager is that a few hundred to a maximum of thousand development hours are required. This would result in a solution that works for Sameina but it would also lay a foundation for additional organisations to adapt to a similar solution. A more broad scalable solution could be created where less focus would be on the specific Sameina case and the main focus would be the adaptability for a wide range of organisations. However, such a solution would require substantial development with the structure and relations in database and should therefore not be attempted until the demand and the buoyancy of the solution has been confirmed.

Business case and Scalability

Both solutions presented above (Figure 32 and Figure 33) would mean more business to Pagero in the form of additional messages transferred, which fits Pagero's payment model where clients are charged per message. The exact payment model for inventory update messages is however not within the scope of this project. Nevertheless, if one message type is already in use by a client, there is a chance of landing additional sales and capture more of the client's messages.

If sharing of *sales data and inventory status* information would lead to a system where the warehouses could share inventory, the reduction of tied up capital is estimated by the aftermarket manager to 20 MSEK. The rule of thumb used when calculating the reduction of tied up capital due to a centralisation points towards a reduction of 72 MSEK worth of goods in the system with remained service level. Since the solution is not a centralisation in geographical terms, this rule of thumb calculation is probably not precise. However it gives an indication that the estimation performed by the aftermarket manager is not unlikely.

As discussed in Technical qualifications above, the solutions to enable visibility improvements by sharing *sales data and inventory status* should be created with the starting point in the Sameina case with a relatively low degree of scalability i.e. a relatively customised Sameina solution. A fully scalable solution requires more development hours to be put in and should be considered only when a customised solution has been implemented and validated, possibly at Sameina. A fully scalable solution is in the long term needed to access a sustainable development of the technological back office assignments simultaneously as it lies in line with Pagero´s core business; scalable cloud services.

5.4.3. Possibility for Pagero to provide performance improvements at Sameina's production warehouse

This section provides a discussion of what Pagero has to commit to fulfill the visibility improvements at the focal organisation´s production warehouse.

As argued above, the production warehouse suffers from a range of inefficiencies, the largest inefficiency according to the warehouse manager; the congestion of unregistered goods as a result of

the inefficient registration process. The registration process is today manually handled for all three parts of the warehouse; the component warehouse, the raw materials warehouse, and the outdoor warehouse. The manual handling has its root in the present solution where information from delivered goods´ waybills is typed in manually for each parcel.

The solution includes the use of the information flow *advance shipping notice* from the suppliers directly into Sameina's ERP-system *Jeeves*. The solution aims is to eliminate the time consuming manual labour required during the order registration process, an automatic matching between released orders and delivered orders should be performed instead. An example solution is visualised in Figure 34, the arrows piercing a cloud represent messages that could be sent through Pagero online and thus generate revenue.

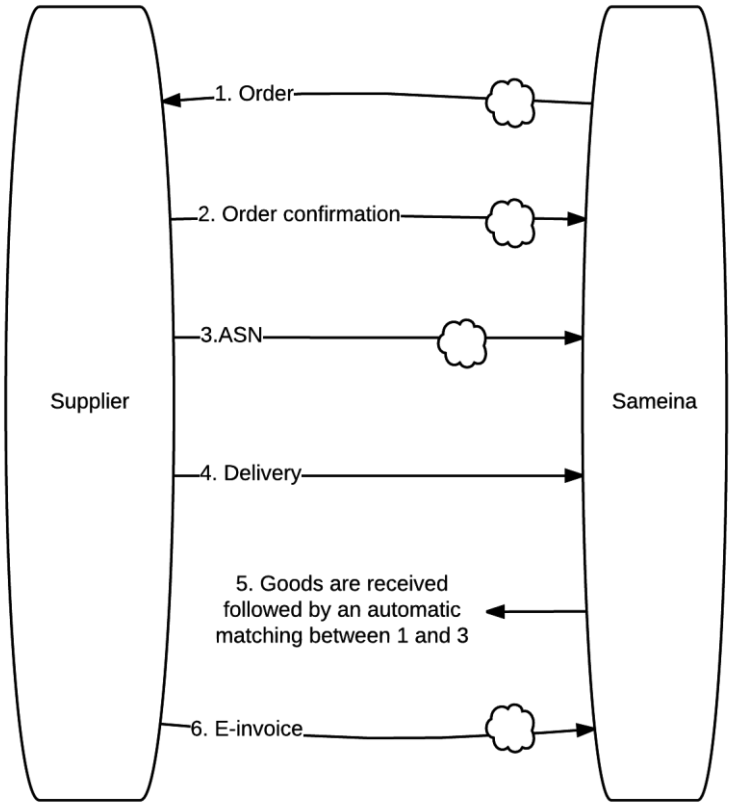

Figure 34. Pagero can increase the performance of the Production Warehouse by enabling exchange of advance shipping notice messages from suppliers to Sameina.

Pagero provides the necessary conversion of the messages to fit them to Sameina´s ERP-system disregarding of their system's origin. The procedure is similar to Pagero's currently most common message type e-invoice. As for e-invoices Pagero will receive advance shipping notices in the cloud and forward them to Sameina in the format that Jeeves supports. Advance shipping notice will be complemented by the currently used printed waybills used by Sameina and their suppliers.

Technical qualifications

There is a range of standards for advance shipping notice (ASN) e.g. the EDIFACT standard message type DESADV. For example Pagero is currently supporting the EDIFACT for invoices (INVOIC). Pagero has today support for the message type advance shipping notice but to a more limited extent than for e-invoices. Pagero currently handles a few thousand ASN messages per month compared to the volume of e-invoices for the same time period that is over a million messages. The procedure of forwarding advance shipping notices is similar to the procedure of forwarding

e-invoices; Pagero has the technical qualifications needed to support different formats and standards for converting advance shipping notices as they already have it for e-invoices. The knowledge of mapping and structuring the different files from different ERP-systems is already in-house at Pagero. The technical qualifications to make further use of the message type advance shipping notice is therefore not a hindrance.

To reach a more automated process of registration of incoming goods to Sameina´s production warehouse there are some hardware solutions needed additionally to the software- and cloud services. Incoming parcels will need a barcode attached by the supplier containing information that can be matched against the parcel´s specific order. At the Sameina production warehouse these barcodes are read by scanning devices connected to the ERP-system, such scanners are already mounted on the forklifts used in the warehouse. When reading a barcode a match against the earlier placed order for the parcel´s content is performed, followed by a match against information from the advance shipping notice corresponding to the current order and parcel. If the quantity delivered mismatches the quantity ordered, the quantity is corrected automatically.

Barcode reader devices, either handheld ones for the outdoor warehouse or a stationary one mounted for the conveyor belt, are not part of Pagero´s core business and is something that has not yet been involved in their undertakings. Before engaging in this project, Pagero should search for a partner capable of providing this expertise.

Business case and Scalability

According to King and Griffiths (1986) the value of information corresponds to the cost savings made available by it. In this particular case the direct cost savings affect the staff currently performing the manual matching who will no longer be necessary. But also the decreased tied up capital waiting on the floor to be registered. Simple estimation are shown below to shed light on some of Sameina's direct cost savings:

If one person less would be required to manage the daily activities, the cost savings would be at least the cost of that person's paycheck including employer contributions. The time spent at the monitor registering goods is summarised to eight working-hours per day, the cost for Sameina (fees included) is thus roughly 400 000 SEK per year.

As of today it takes approximately 2-3 days to complete the registration process, this means that Sameina always has 2-3 days worth of additional stock on hand than what is registered. If those days can be reduced, so will the tied up capital. The tied up capital required to satisfy one day in the production warehouse is estimated to around 1.6 MSEK. Depending on how many days (1 - 3) the registration process can be reduced, one-time cost savings of 1.6 - 4.8 MSEK can be realised. The calculations are shown in appendix D.

There are other areas also affected by the introduction of the information flow ASN, the value of them are however more difficult to estimate. One of them is better possibility for capacity planning in the warehouse, additional effects are described in above in Table 12. This solution is not specialised to Sameina alone, instead it can be up scaled and further developed to be used also with other clients.

5.4.4. It is possible for Pagero to increase clients' operational performance

It has been found in this project that Pagero has the potential to help clients increase their operational performance. This section connects the identified improvement potential to the definition of operational performance established in this project. A payment model for a new type of service is discussed. Finally the prerequisites for Pagero´s continuation in increasing clients´ operational performance

through supply chain visibility are discussed.

The definition of an operational improvement used in this project is a positive change to any of the five major management processes used in the SCOR model "3.1.1. Supply chain performance, the SCOR-model" these are plan, source, make, deliver, and return. The case study at Sameina yielded two concrete examples of how Pagero can contribute to improve Sameina's operational performance. Both in the aftermarket and in the production warehouse, clear improvements can be achieved within the inventory management, which is located in the the management process *deliver*. In the aftermarket Pagero can enable the transfer of the information flow *Sales data and Inventory status*, which affects foremost the inventory management processes in the form of less tied up capital in the warehouses and improved service level. However a certain level of commitment is required by Sameina in order to succeed. In the production warehouse Pagero can enable the exchange of the information flow *Advance shipping notice* which can be used to improve the warehouse capacity planning, reduce the congestion and reduce tied-up capital.

Capabilities required for Pagero to use the method

To repeat the process (Figure 35 below) that has been performed in this project and find more clients where Pagero can contribute, the used research design should be used as a guideline. Task 3, Task 4 and Task 5 (Figure 35) include the steps performed after a relevant client has been identified. Each task is described in chapter "2. Methodology". For Task 3 and Task 4 the steps included are described in detail, the generic information flows should be used as support when gathering knowledge. They are helpful since the combined goal of Task 3 and Task 4 is to find information flows that can benefit the operational performance of the client. Task 5 translates the information flows to Pagero's perspective.

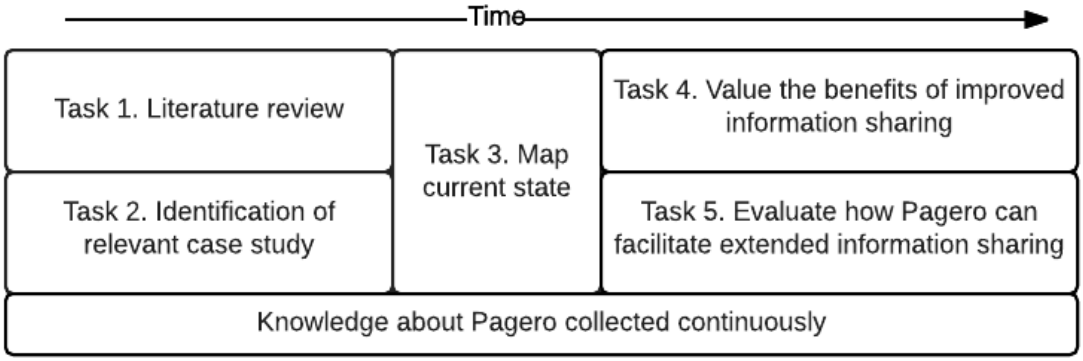

Figure 35. The process used in this project to find a relevant case study, and investigate how Pagero can improve the case organisation's operational performance by enabling extended information sharing.

For Pagero to be able to perform the overall process used in this project (Figure 35) and increase the operational performance of their clients, they must possess three capabilities. Firstly, Pagero must have a *method for identifying high potential clients* where extended information sharing and improved visibility can help to achieve better operational performance. Pagero must also be able to determine how to help clients to improve their operational performance by allowing for extended information sharing. The second requirement is therefore the capability to identify improvement areas in the client's processes and to decide how such an increased visibility can support improvements to clients' operational performance. Pagero must therefore possess *Domain knowledge* i.e. knowledge of the client's industry. The third requirement is the capability to connect the identified improvement possibilities to Pagero's capabilities and develop an implementation plan based on Pagero's strengths. *Pagero knowledge* i.e.

knowledge about Pagero's capabilities and limitations is therefore of high relevance. Summarised there are three capabilities required by Pagero to be able to improve clients' operational performance, the elements are shown in Figure 36 below. Only when those three exist, Pagero can repeat the process (Figure 35) and increase client's operational performance. Figure 36 below provides an allegory of a surgeon where the

Figure 36. The three capabilities required for Pagero to improve clients' operational performance.

Identify high potential clients

The client selection process used in this project is a first iteration of how the data within Pagero Online can be used to identify high potential clients currently within Pagero's network. This selection process is capable of being used for a number of further clients with similar improvement possibilities as those characterising the client studied in this project. However, the number of those clients is not infinite, future adjustment of the criteria and further development of the method would be required to yield additional suitable clients in the long run. In addition, not all suitable organisations are currently within Pagero´s network. Further investigations should therefore be performed in order to develop a method for finding them. Presumably such a method will come easier when more knowledge has been gathered during early visibility improvement projects with clients currently within Pagero.

Domain knowledge

The generic information flow maps created by Caridi et al. (2014) that are used as support in this project provide a rough cut guide for how the different processes performed within an organisation and their respective KPIs are connected, however relying on the maps alone is not enough to achieve good results. The persons in charge of upcoming projects derived from this project must meet the clients and get to know their processes. To achieve a good understanding of the clients and their processes and to be trustworthy towards the clients, the persons in charge must possess a high level of domain knowledge (i.e. knowledge of the client's industry and processes), the results of Task 3 and Task 4 will otherwise not be reliable enough to act upon. The information flows identified as relevant in this project was

the result of a thorough analysis of the client's processes and current visibility level. Analysis was performed between each interview to gradually zone in towards specific areas of improvement possibilities, this analysis could not have been performed without domain knowledge. If direct questions are asked to the client's personnel concerning what is required to improve the client's performance, the answer would be coloured by their reality and their experiences. When a materials planner at Sameina was asked this specific question concerning the Production Warehouse, the answer was "another forklift and more staff". Such improvements may very well be required in some cases, but it is not a solution that solves underlying efficiency problems, neither is it a solution where Pagero can contribute. A person in charge of future projects must possess the ability to apply a holistic view towards the challenges and see how different activities in the organisation and in the supply chains affect each other, and how information flows between the activities affect their respective performance. High domain knowledge is therefore of high importance to be able to make such connections.

Pagero knowledge

Task 5 makes the connection between the combined output of Task 3 and Task 4 and Pagero, it reviews how Pagero can use their strengths to enable the clients to achieve higher supply chain visibility and improve their operational performance. Assumed that knowledge concerning which information flows would benefit a client is known, knowledge concerning Pagero's strengths and capabilities is crucial to reach a good solution. It is assumed that this capability is already available within Pagero.

5.5. Usability of method

The method is constructed with the prerequisite that focal organisations measure their KPIs. Without reliable KPIs, as in the case of Sameina, it is still possible to point towards certain information flows with a need for improvements, however the analysis will then be based on the perception of the interviewees and not on measured KPIs as originally intended. A result gained without relying heavily on KPIs can however still be valuable since it gives an indication of areas where more investigation is required, and where KPIs should be put in place. The valuation of the goals and current performance of selected KPIs was originally intended to be performed by interviewees. As this turned out to be impossible, it was up to the researchers to evaluate the current KPI performance based on the interviews. That evaluation was then used as a base of analysis. Consequently, cases where KPIs are unavailable have more unknown parameters and therefore requires more of the researchers in terms of domain knowledge. If KPIs are available, that part could possibly be performed in the form of a survey, which could be used to improve the selection process and reduce the need for domain knowledge.

6. Conclusions and recommendations

This project brings knowledge to a field not yet explored by Pagero, how they can use their current cloud-system Pagero Online to find clients with potential to increase supply chain performance by further information sharing. And also that how they can use Pagero Online to realise an improved operational performance for said clients.

The purpose of the project is:

"To evaluate if and how a cloud based EDI-system can be used to provide extended information sharing in order to increase visibility and performance for actor's supply chain."

The intended cloud based EDI system is Pagero Online which today is used by Pagero to connect actors and allow them to send foremost e-invoices disregarding of the type of ERP system used. To increase actors' visibility and performance by sharing extended information through Pagero Online, three capabilities are required. Clients with improvement potential must be identified, it must be decided which type of extended information that has the potential to benefit a client's performance. Finally an information flow providing the required information must be implemented into the client's processes. An organisation's degree of digital maturity affects its possibility and willingness to adopt and make use of new digital technology, e.g. sharing extended information (the sharing of information that is not shared today) through Pagero Online. This paper can be used as strategic input to Pagero when devising future services. The following two research questions are used to reach a conclusion:

Q1. How can Pagero Online be used to identify digitally mature supply chain actors?

Q2. Is it possible to increase operational performance for digitally mature actors by sharing extended information through Pagero Online?

A method was developed for using the data in Pagero Online to find digitally mature clients (Q1). The digital maturity of a client was measured using the level of data exchange performed in Pagero Online as a proxy. The total sample size was put through a number of quantitative selection criteria in order to remove clients with low digital maturity. The final shortlist contained 26 clients, qualitative criteria were used to choose a final client suitable to take part in the case study.

During the case study, interviews were used for the data collection, several steps of the method used were derived from Caridi et al. (2014). Information concerning the processes of the selected client and their current level of visibility was collected with the intention of finding areas where increased visibility and extended information sharing would benefit their operational performance. During interviews two distinct areas with improvement potential were identified, these are the *Aftermarket* and the *Production warehouse*. In the aftermarket it was found that exchanging *inventory information and sales data* have the potential to greatly improve the inventory management. In the production warehouse the exchange of *advance shipping notes (ASN)* have the possibility to remove a major bottleneck, as well as improve the capacity planning.

Pagero already supports exchange of ASN, with minor adjustments and collaborations with other actors Pagero can create a solution for the production warehouse high potential solving several of the problems identified in the production warehouse during the case-study. As for the aftermarket, Pagero does not currently support the exchange of the message types needed to improve the aftermarket performance. Earlier introductions of new message types and information flows have been driven customers' needs. The development time for introducing inventory status and sales reports as new message types is estimated to a few of hundred to maximum thousand hours. For the aftermarket to be

able to use the enhanced information exchange to increase their performance, commitment from Sameina is required. The improvement potential within the aftermarket is larger than in the production warehouse, however realising it is a larger undertaking.

By studying only parts of one case-organisation two areas have been identified where Pagero by enabling the exchange of extended information can help to increase actor's operational performance. For Pagero to find further similar possibilities three capabilities are required. These are *Identify high potential clients* (find clients with areas where increased information sharing would benefit their performance), *Domain knowledge* (knowledge of the client's industry), and *Pagero knowledge* (knowledge of Pagero's processes and strengths).

Identification of high potential clients can initially be performed with the supplier selection method devised in this project, in the future further development and refinement is required for it to be more accurate. It is assumed that Pagero knowledge is already present within the company. Domain knowledge is where Pagero should develop their capability, the process of finding areas where extended information sharing would increase client's performance will otherwise prove difficult.

Based on the conclusions in this project, the researchers have four recommendations for Pagero and how they should proceed and use the results from this project. The following *recommendations* are sorted in chronological order.

Initiate a business area where Pagero by enabling enhanced information sharing can contribute to clients' increased operational performance.

By enabling enhanced information sharing, i.e. the exchange of message types beyond what is possible today, Pagero will be able to offer clients increased supply chain visibility and help them increase supply chain performance. Such information sharing has previously been exclusive to larger enterprises, Pagero has the possibility to bring the same level of visibility also to smaller enterprises. Intended message types are not determined since different organisations have different needs. This project has shown a need for the information flows (message types) inventory status and sales data and advance shipping notice. Determining which message types are relevant requires time spent with the clients to get to know their processes and finding areas that can be improved by enhanced information exchange. Solving problems for clients also gives rise to a new payment model for Pagero where the cost of a problem can be used as a base for the payment. Time spent with important clients is also an opportunity to develop a personal connection and increase the client's use of Pagero's other services.

Validate the business area by performing a pilot project at Sameina where Pagero implements the information flows identified in this project.

The pilot project should be to implement the information flow *advance shipping notice* (ASN) for Sameina's production warehouse and suppliers. This should be combined with a consulting effort in collaboration with a partner supplying a suitable barcode solution. An automatic match between released order and received delivery should be possible at the end of the project. The solution would remove a major bottleneck saving 400 000 SEK yearly and reduce the tied up capital in the warehouse to a value between 1.6 MSEK - 4.8 MSEK, as well as provide further benefits. After proven success for the production warehouse, the information flow *inventory status and sales data* should be implemented for the Sameina aftermarket. Such an information flow requires development time to be spent at Pagero. For Sameina to fully benefit from the suggested information flow a strong commitment from Sameina is required. The benefits are initially in the form of reduced tied up capital to a value of at least 20 MSEK, but also in the form of increased service level, increased visibility and more accurate purchasing

procedures. Pagero has a history of changing course of business; the company started with providing payment solutions but after a while complemented with e-invoice services that has grown to be the largest product. Enhanced information sharing and visibility should be seen by Pagero as a potential large part of the future business and with decent validation by pilot projects it can be a large contributor to Pagero.

Identify additional high potential clients by using and further developing the selection method presented in this project.

Using the selection process devised in this project, clients with high potential of being able to benefit from enhanced information sharing can be identified based on their usage patterns in Pagero Online. The method should be further tested and developed to acquire increasingly accurate and rich results.

Secure domain knowledge within clients' industries and processes.

To identify areas where clients can benefit from enhanced information sharing and visibility, and thereafter perform suitable implementations, Pagero must possess *domain knowledge*, i.e. Pagero employees or partners must have knowledge about the clients' respective industries and processes. Enhanced information sharing and visibility should be seen by Pagero as a potential considerable part of the future business. To fully benefit from this potential Pagero must secure the right domain knowledge, sourced internally and/or externally.

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Appendix A. Information flows considered in the Order status cause-effect map

Table 14. Descriptions of the correlations in the generic Order status cause-effect map (Caridi et al., 2014).

Information flows considered in the model – Order status links.

Arrow beginning	Arrow tip	Type of impact	Description
Order status	(Production planning) • Accuracy of production plans • Timeliness in detecting and solving production failures • Optimisation of production plans	+	More information available about suppliers' order status allows the focal company to improve the accuracy of production plans due to a reduction in unexpected stock-outs of raw materials and components. Should a failure occur (e.g. due to the lack of a required component/raw material), this information flow allows the failure to be recognised in advance, and therefore the company can immediately work to find a solution. Finally, the focal company can prepare the production plan on the basis of real data, instead of using average values, thus anticipating or postponing production accordingly.
(Production planning) • Accuracy of production plans • Timeliness in detecting and solving production failures • Optimisation of production plans	(Inventory management) • Raw materials stock holding cost • WIP stock holding cost • Finished products stock holding cost	–	A firm can improve its inventory management process, thus reducing the average inventory level, due to a better understanding of production needs since it can buy, produce and stock exactly what it needs. Better timeliness in detecting and solving production failures implies a reduction in the use of safety stock of raw materials and finished products. As a consequence, the likelihood of missing parts in the assembly line decreases, as does, in turn, the WIP (work-in progress) level. When production plans are not optimised, the WIP level increases in order to avoid stock-outs in case suppliers' lead time is longer.
(Production planning) • Accuracy of production plans • Timeliness in detecting and solving production failures • Optimisation of production plans	(Customer service) • OTD (On time delivery)	+	Provided that production plans respect customers' needs, the higher their quality (i.e. optimisation, accuracy), the better the company punctuality (i.e. on time delivery). Moreover, timeliness in detecting and solving production failures improves OTD because of a reduction in internal lead time uncertainty.
(Production planning) • Accuracy of production plans • Timeliness in detecting and solving production failures • Optimisation of production plans	(Customer service) • Delivery lead time	–	A firm can reduce its delivery lead time by reducing the amount of time wasted in manufacturing because of planning failures. If an error occurs, detection timeliness reduces internal lead time.
(Customer service) • Delivery lead time	(Finance) • Order-to-cash	+	The order-to-cash, i.e. the amount of time from arrival of the customer order to payment, includes the delivery lead time. Therefore, a reduction in delivery lead time leads to an improvement in the order-to-cash KPI.
Order status	(Customer service) • Customer visibility	+	Better visibility on order status allows the focal company to provide more reliable information to customers.
Order status	(Marketing planning) • Accuracy of marketing plans	+	The marketing department can develop more reliable plans because of the possibility of more accurately estimating the capability of the SC to meet the proposed plans.
(Marketing planning) • Accuracy of marketing plans	(Customer service) • Product • Availability	+	More accurate marketing plans help increase product availability, thus reducing or possibly eliminating gaps between service level and customer expectations.
(Customer service) • Product • Availability	(Finance) • Order-to-cash	–	If a stock-out occurs, the order-to-payment (i.e. cash) time increases, because the customer usually pays for the product only once it has been received. Therefore, higher product availability ensures shorter order-to-cash time.

Appendix B. The generic cause-effect maps in the used method, by Caridi et al. (2014)

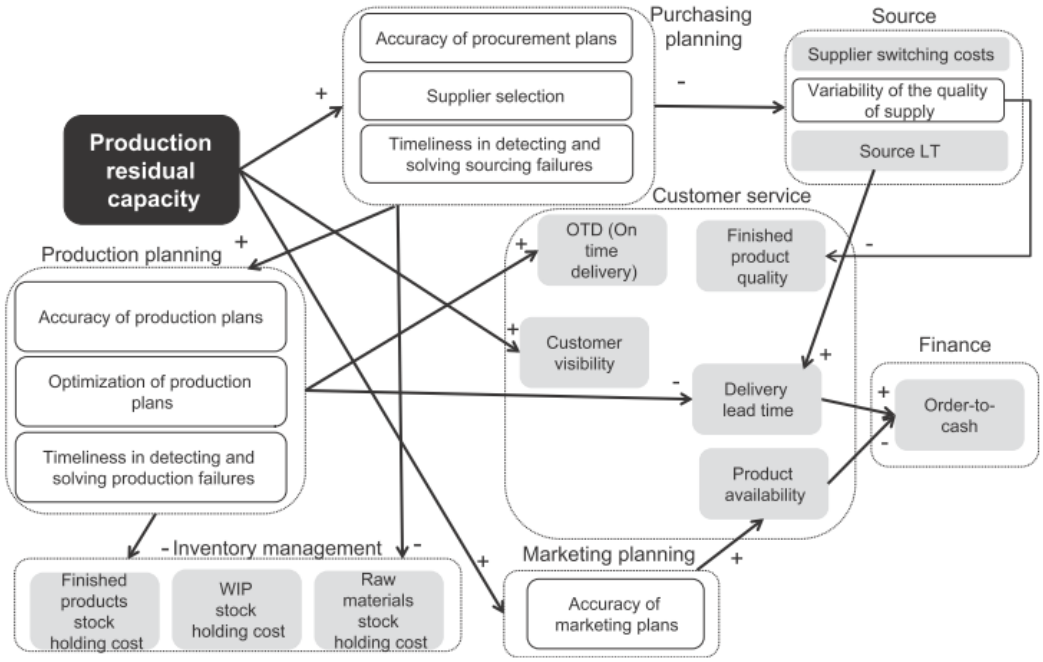

Figure 37. Production residual capacity (Caridi et al. 2014)

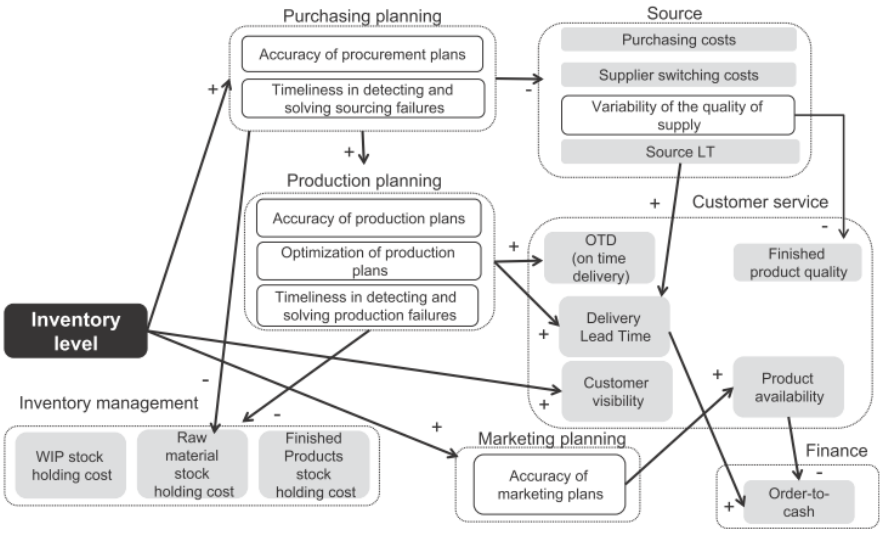

Figure 38. Cause-effect map - Inventory level (Caridi et al., 2014)

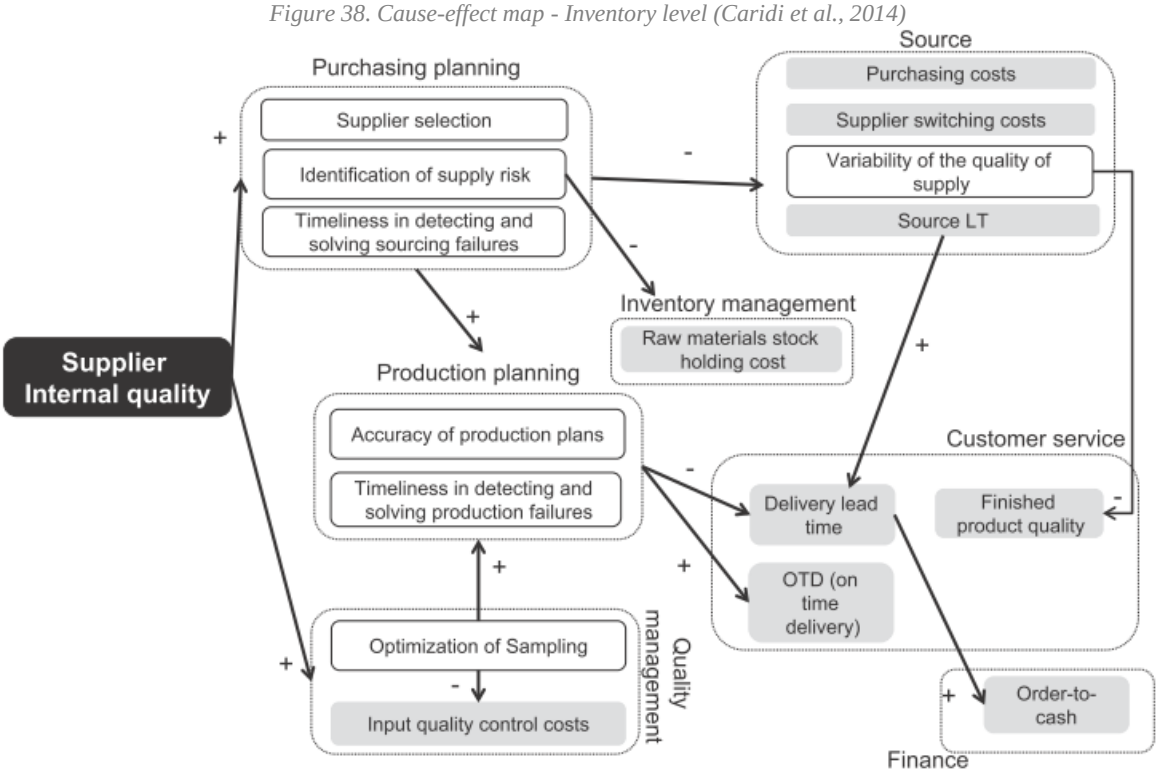

Figure 39. Cause-effect map – Supplier internal quality (Caridi et al., 2014)

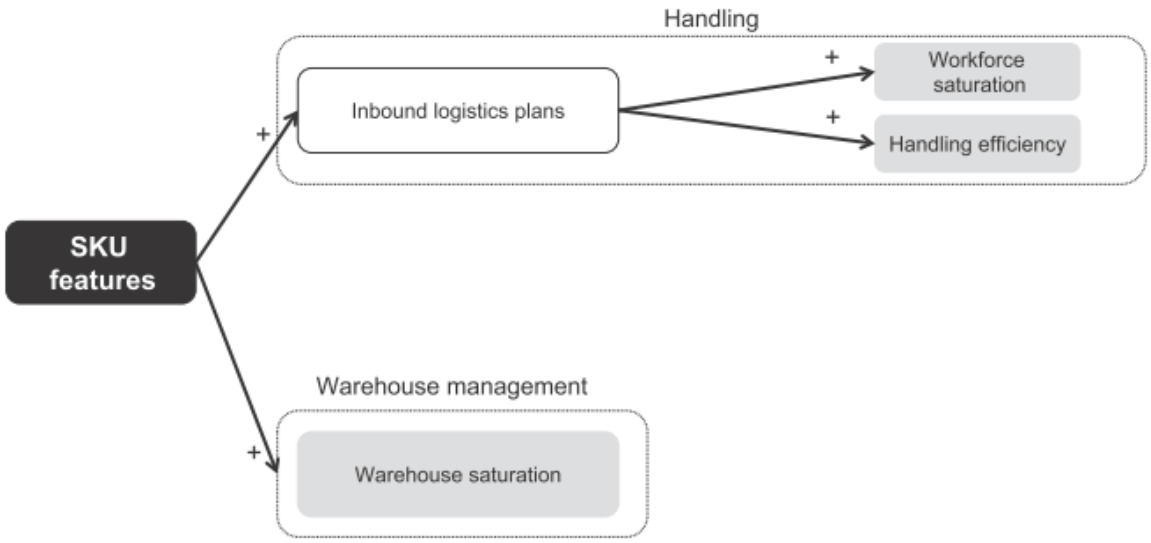

Figure 40. Cause-effect map - SKU features (Caridi et al., 2014)

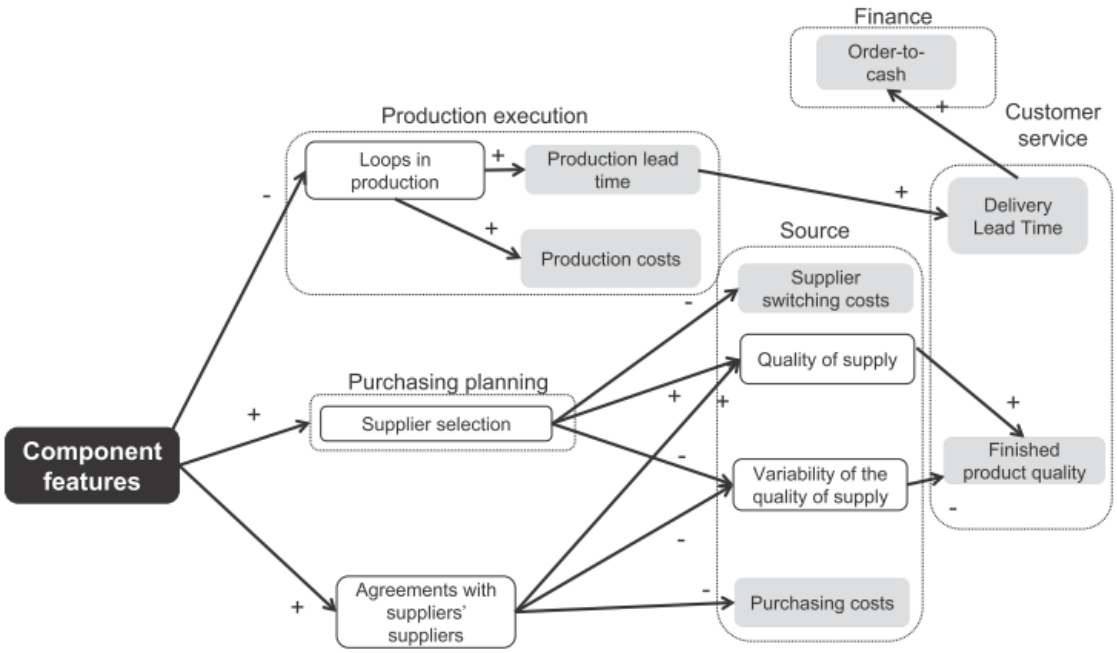

Figure 41. Cause-effect map - Component features (Caridi et al., 2014)

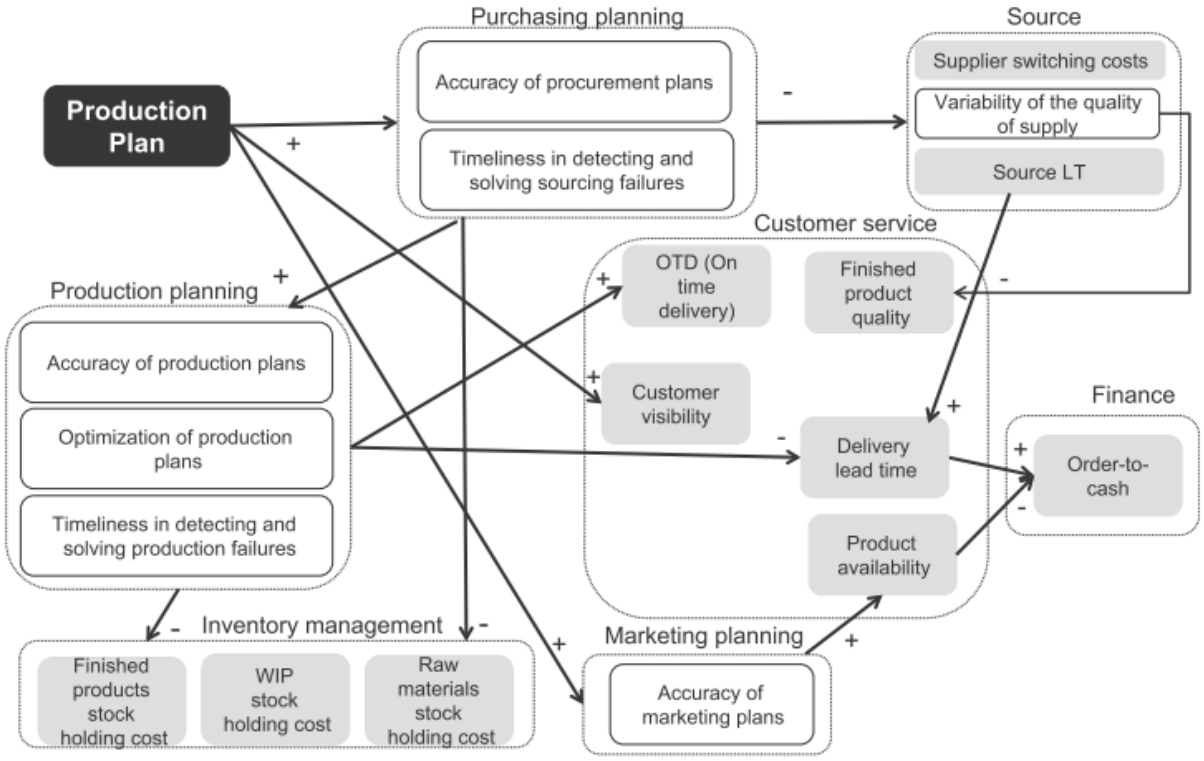

Figure 42. Cause effect map - Production plan (Caridi et al., 2014)

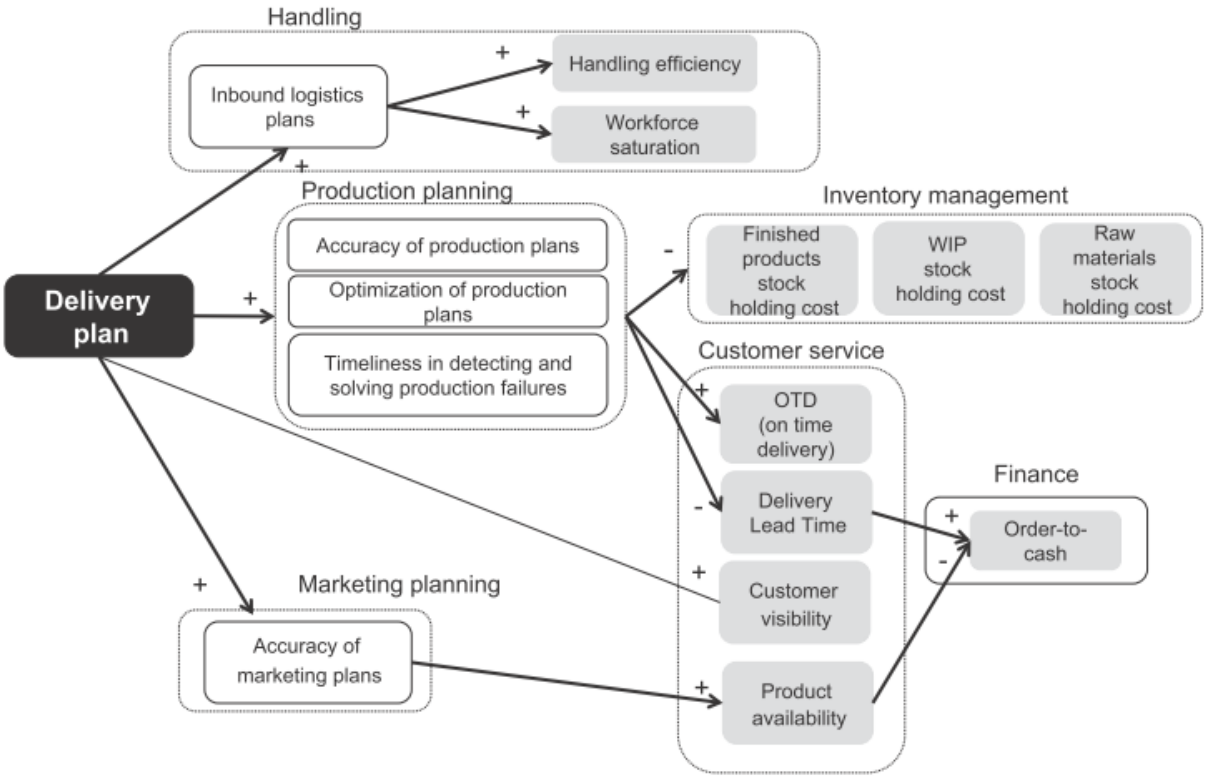

Figure 43. Cause-effect map - delivery plan (Caridi et al., 2014)

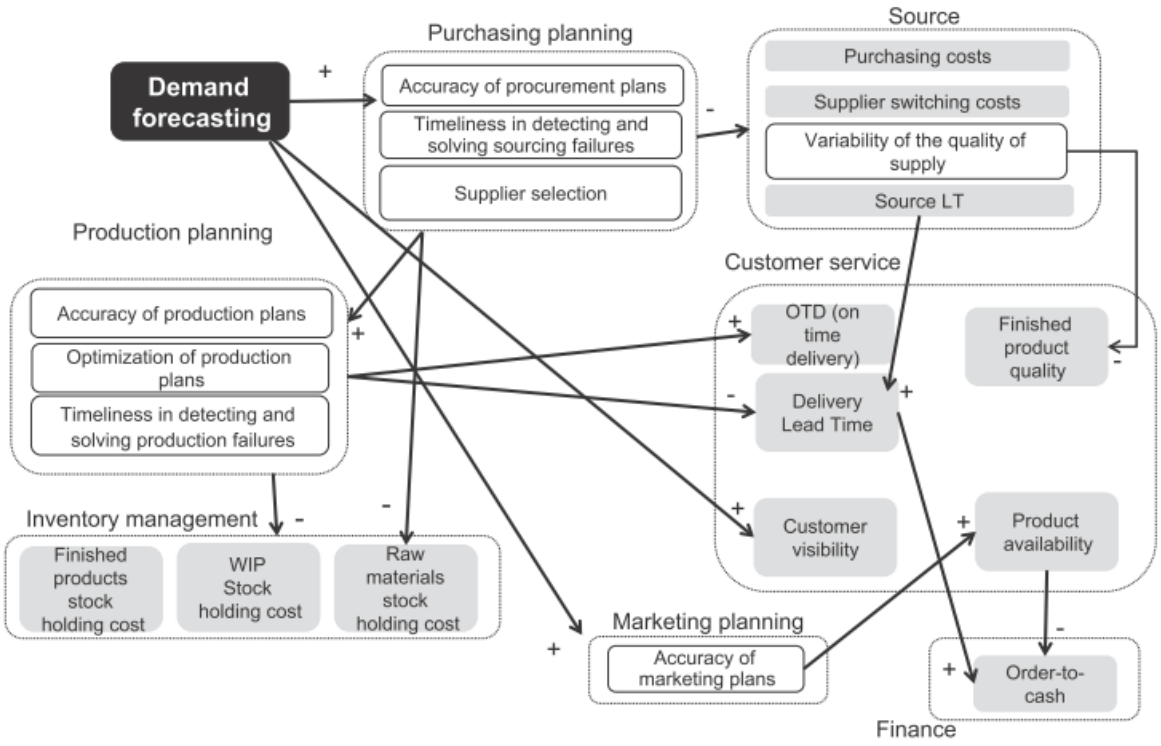

Figure 44. Cause-effect map - Demand forecasting (Caridi et al., 2014)

Appendix C. E-invoice content requirements and EU directives

Table 15. E-invoice content requirements and EU directives.

Invoice level	**Invoice row level**
Invoice number	Article
Invoice date	Quantity
Due date/Payment terms	Unit price (net amount)
	Invoice row total (net amount)
Invoice issuer information	Discount
Address information	Charge
VAT number	Article description
F-tax information	Unit
Invoice receiver information	Recommended additional content
Address information	Bank account number
Receiver's VAT number if reverse charge is applied	Orderer reference/cost center
	Unique receiver identifier (customer number)
VAT specification per tax class	VAT amount on article level
Net amount	VAT rate (%) on article level
VAT rate	Invoice total VAT
VAT amount	Sum of invoice row net amount
	Invoice total net amount incl. discount and charges
If reverse charge there must be a text that implies this	Rounding amount
Discount	Invoice total including VAT
Charge	Currency code

Appendix D. Calculations

Calculation of tied-up capital reduction in the Sameina production warehouse if incoming goods is available for production one day earlier with all other parameters untouched:

Total inventory value: 100 MSEK.
Inventory turnover rate: 6 times/year.
Inventory run-out time: 365/6 = 61 days.
Daily inventory usage: 100 MSEK / 61 days = 1.6 MSEK

Calculation of inventory turn-over rate, average for Sameina's daughter companies:

Average inventory value at the central aftermarket warehouse: 50 MSEK.
Inventory turn-over rate for the central aftermarket warehouse: 4 times/year.
Average total inventory value at the daughter companies' warehouses: 50 MSEK.
The daughter companies' share of the aftermarket: 60 %.

All aftermarket goods go through the central aftermarket warehouse -> 4*50 = 200 MSEK worth of inventory passes through the central aftermarket warehouse per year.

60 % of the 200 MSEK goes through the daughter companies; 120 MSEK.

120/50 = 2.4 times per year, the daughter companies' warehouses are turned.

Rule of thumb calculation for centralisation of warehouses:

A reduction of warehouses from n to m gives an inventory reduction of $1 - \sqrt{m}/\sqrt{n}$ [%].
Sameina has 12 warehouses within the daughter companies and one central warehouse; 13 in total.

If all 13 warehouses would be physically centralised into one warehouse, the rule of thumb says that an inventory reduction of $1 - \sqrt{1}/\sqrt{13} = 0{,}72265$ = 72 % is possible.

Appendix E. Visualisation of selection criteria used as base for Digital Intensity.

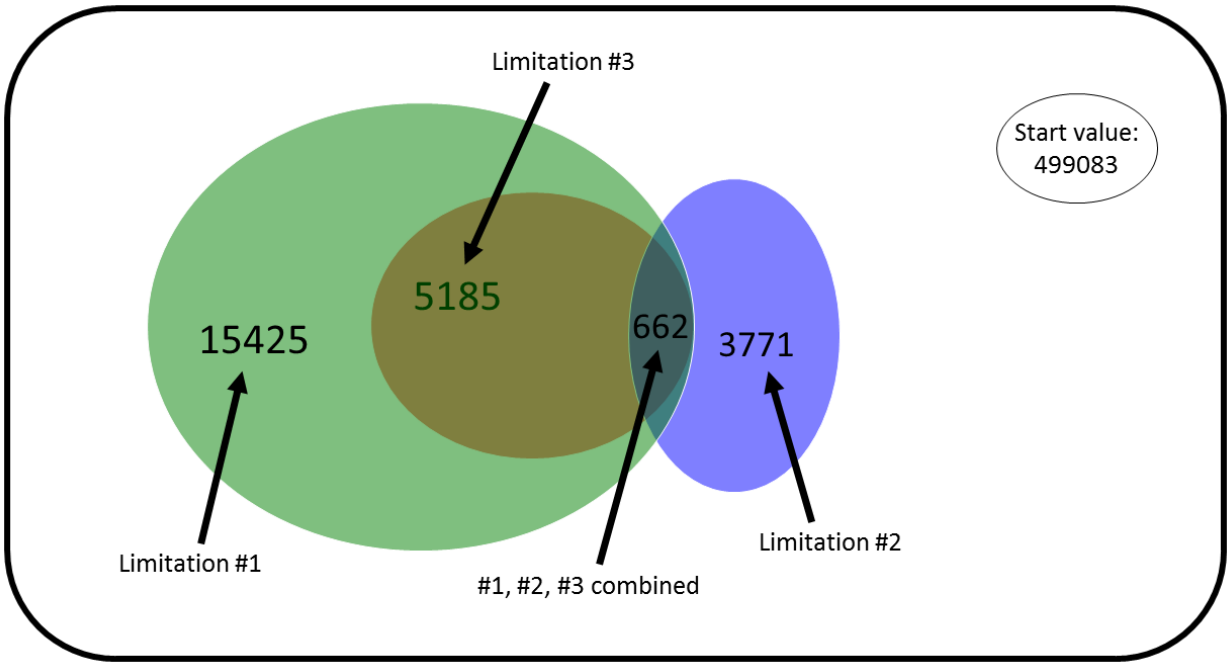

Figure 45. The first selection criteria limits the prospective amount of clients to 15425. The second limitation limits the prospective amount of clients to 697. These 697 clients are reduced to 662 by the third limitation. The third limitation builds on the first limitation.