UNIVERSITY OF GOTHENBURG
SCHOOL OF BUSINESS, ECONOMICS AND LAW

How can Internet of Things (IoT) enable more time-efficient documentation handling within intermodal freight transits?

Examples from a Swedish road-rail intermodal terminal

GM0560 Master Degree Project in
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Linn Bergstrand

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Abstract

Title

How can Internet of Things (IoT) enable more time-efficient documentation handling within intermodal freight transits?

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Purpose

The purpose of this research is to identify possible improvements within intermodal freight transport transits, with a focus on documentation generated by the movement of digitalization, the emerging revolution Industry 4.0 and implementation of Internet of Things (IoT) and Internet of Logistics (IoL) in the transport industry.

Research question:

"How can Internet of Things (IoT) enable more time-efficient documentation handling within intermodal freight transits?"

Methods

Qualitative method, literature review and interviews.

Main findings

The implementation of Internet of Things (IoT) and Internet of Logistics (IoL) services have together with the fourth industrial revolution changed the environment of performing business. IoT solutions are automatizing business processes and connects the real world with the Internet. IoL solutions are changing the logistics industry and are aiming for seamless chains and transparent information flows. Within intermodal freight transport the concepts of IoT and IoL are used mostly in order to create more efficient solutions in goods handling. An exception is the intelligent video gate (IVG) that is a physical station using radio frequency identification (RFID) to identify and structure the data the goods and vehicles are generating. The technology

is currently running in Germany and the implementation results show that IVG have enabled more efficient documentation handling in intermodal freight transport transits. The technology is now implemented in a Swedish intermodal terminal (road-rail) and this research investigate the results in documentation handling within the terminal. The results are positive and a reduce in time during documentation handling identified.

Key words

Intermodal freight transport, intermodal freight transit, Internet of Things (IoT), Internet of Logistics (IoL)

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1. Introduction

In this first chapter the background of intermodal freight transport and Internet of Things (IoT) is presented together with concepts and challenges related to the research. Following, the purpose of the research is presented. This is followed by the studied question and the limitations of the project. Finally, an outline of the disposition is being presented.

1.1 Background

The amount of goods traded have grown rapidly since the beginning of the 1990s, thus a small regression during the economic crisis in 2008 (Europeiska Miljöbyrån, 2016). The world have also faced a growing globalization with extended trade- and capital flows between countries as a result (Regeringskansliet, 2008). The global trade have over a 25 years period presented a growth from a value of approximately 5 trillion US dollars in 1995 to almost 18 trillion US dollars in 2018 (United Nations Conference on Trade and Development, 2019). In 2019, the global trade faced challenges because of the United Kingdom's exit of the European Union and the contingent trade war between the world's two biggest economies, the United States and China. In 2020 the economists predicts a growth in trade volume, this however is very dependent on a solution of the tensions between the United States and China (World Trade Organization, 2019). Due to a global outbreak of a coronavirus in the beginning of 2020 the World Trade Organization (WTO) predicts effects on the global economy and trade with reduced and unstable goods flows as a potential outcome (The Economic Times, 2020).

The world trade together with an increasing globalization are creating a demand for transports and transport services all around the world. To be able to manage the growing demand for transport services, the overall transport industry have to find solutions for faster, more efficient and sustainable transports. The development of global trade have put pressure on actors in different ways, today the environmental changes and climate are one of the most important factors within the business. A part focus have therefore been put on intermodal freight transports in order to potentially reduce the environmental impact from long distance transports. The European Union and European Commission are supporting several projects with focus on modal shift and how to enable that the transports are being made fast but with a low

environmental impact. The Trans-European Transport Network (TEN-T) project is one of the projects the European Union and European Commission is supporting (European Commission, 2020).

Since projects supporting modal shifts are increasing, the research within the area is following the same pattern. Research have been made in the area of intermodal freight transport and since the usage of intermodal services are expected to enlarge during the coming decades other focus areas within the field of intermodal freight transport are now being examined, such as sustainability (Bontekoning, Macharis, & Trip, 2004). This research will be focused on one area, Internet of Things within the concept of intermodal freight transports as an emerging phenomenon.

The usage of different technology innovations in the transport industry is growing rapidly due to the fourth industrial revolution, Industry 4,0. The revolution is focusing on connecting processes to become more efficient (Erboz, 2017). Within logistics, the revolution have created opportunities for example transportation management systems and information security (Barretoa, Amarala, & Pereira, 2017). This research will therefore focus on intermodal freight transits and how digital tools created by Industry 4.0, like Internet of Things (IoT) potentially can enable faster intermodal freight transits through enabling more efficient documentation handling.

Researchers within the field of intermodal freight transport have highlighted the time-efficiency parameter of overall intermodal transports as a challenge for the concept to compete with direct transport, favorably road transport (Woxenius & Bärthel, 2004; Lowe, 2005; Bergqvist & Monios, 2017). From an intermodal freight perspective the transit inside ports, terminals or other interchanges is representing a minor part of the whole transport but due to challenges with digitalization of documentation, customs and the actual modal shift the transit is of importance and an therefore an interesting area to examine.

1.2 Purpose

The purpose of this research is to identify possible improvements within intermodal freight transport transits, with a focus on documentation generated by the movement of digitalization,

the emerging revolution Industry 4.0 and implementation of Internet of Things (IoT) and Internet of Logistics (IoL) in the transport industry.

1.3 Research question

In order to conduct the research project, the following research question have been stated, discussed and analyzed through the whole thesis. The question is focusing on the objective time-efficiency:

Research question: *"How can Internet of Things (IoT) enable more time-efficient documentation handling within intermodal freight transits?"*

1.4 Limitations

Due to a restricted timeframe to conduct the research a few limitations have been applied in order to meet different deadlines. This research therefore focus on intermodal freight transport transits within terminals and how Internet of Things (IoT) and Internet of Logistics (IoL) can be used as terminal-concepts. This research take focus on improvements that the technology can improve for a specific terminal, the results therefore may not contribute a solution for every intermodal terminal. The research should therefore be seen as a general introduction to the area. If any technical details of the solutions are needed, the details will be presented on a general level for the purpose of understanding only. This since the research is focusing on and written from a sociological perspective.

1.5 Structure of the research

The disposition of the research is conducted as following:

- **Introduction:** A general background of the research subject together with the purpose of the research, research question and limitations.
- **Literature review:** Presentation of theories pertinent to the research question.

- **Methodology:** Presentation of the chosen methodology and methods.
- **Empirical findings:** Presentation of the results generated by the literature review and interviews.
- **Analysis:** Presentation and combination of the empirical findings in order to answer the research question.
- **Discussion:** The authors analysis on the research
- **Conclusion:** Answers the research question and present future recommendations and proposals for further research.

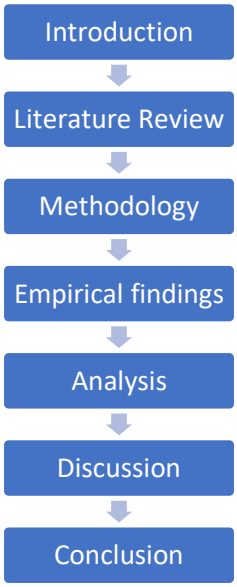

Figure 1 - Structure of the research

2. Literature review

In this chapter the theoretical perspectives related to the research are being presented. The chapter is divided into different segments. The first part focusing on Intermodal Freight Transport and different segments within that area. Following, concepts of digitalization and automatization.

2.1 Intermodal Freight Transport

The concept of intermodal freight transport has existed since the beginning of the 18th century when railways were developed and used for different types of transports. The principles of the transports are today in the 21th century, still the same – a transport unit from one transport mode to another transport mode, without breaking the goods (Lowe, 2005). There are several different definitions describing the concept of intermodal freight transport, Lowe (2005) describes the concept as following:

"Intermodal freight transport […] is the concept of utilizing two or more 'suitable' modes, in combination, to form an integrated transport chain aimed at achieving operationally efficient and cost-effective delivery of goods in an environmentally sustainable manner from their point of origin to their final destination."

Even if the concept of intermodal freight transport have been active since the early days of rail traffic, the growth of intermodal transports was enabled and developed with the globalization and containerization after the two world wars (Lumsden, Woxenius, & Stefansson, 2019). The containerization enabled the concept of intermodal transports to grow rapidly due to the easier handling of standardized units, the first containers were built in wood which can be compared to the steel construction used today (Lowe, 2005). In 2010, the development of intermodal services was seen as one of the most important logistical happenings since the introduction of the Roll on Roll off (RoRo)-ferry (Lowe, 2005).

A customer require reliability, flexibility and damage protection for their goods. According to Bärthel and Woxenius (2004) intermodal solutions typically perform well in the aspects of

reliability and security but face challenges with flexibility mainly because of the competition from road transport.

During an intermodal freight transport the goods remain in the same carrier during the whole transport and transits from seller to buyer (Bouchery, 2018). The concept can therefore be seen as a secure solution when transporting goods with a higher value. The security aspect is seen as one of the benefits of using intermodal freight transport instead of other transport solutions. Other benefits with intermodal freight transport are:

- A potential of lower cost per unit over longer transport distances.
- More sustainable and suitable transports for the climate and the environment over longer distances in comparison with other transport modes.

Thus the benefits for using intermodal freight transport the usage these solutions may not be suitable for all transports. High value goods and shipments with a high priority can sometimes be more suitable to transport through direct connections. This together with speed issues of intermodal transports and high infrastructure costs can be seen as drawbacks of intermodal services (Allen, 2017).

There are different views on which combination of modes that have the majority of intermodal freight services. Lowe (2005) argues that road and rail combined is the most common usage of intermodal services, Lumsden, Woxenius and Stefansson (2019) argues for a combination transport with seaways involved is the one leading within intermodal freight transport. To promote transport parties to use intermodal transports and change the behaviours of using road transports and enhance the growth of combined transports, several initiatives from the European Union (The EU) and the European Commission (The EC) connected to intermodal freight transport have been presented during the last decade (Bergqvist & Monios, Intermodal Freight Transport and Logistics, 2017). The projects are mainly focused on the sustainability perspective of transports but also to increase the percentage of freight being combined. In 2006, the combined road-rail freight transports were 5% of all transports (Debrie & Gouvernal, 2006). One of these projects is the Trans European Network (TEN-T) project which strives to connect the countries within the European Union, its infrastructure and enabling easier and more efficient transports within all transport modes, road, rail, air and sea (European Commission, 2020). Besides the Trans European Network (TEN-T) project, several project within the European Union are specific to each transport mode. Many of these projects have focus on larger shipments using rail or the seaways and waterways.

2.1.1 Intermodal Freight Terminals

To be able to perform intermodal services, interchanges are required. The interchanges are also called *terminals* and the appearance differ depending on which transport modes that are connected to the terminal. The purpose of having terminals is to coordinate and streamline a goods flow (Flodèn & Behrends, 2012). According to Lowe (2005) one of the five success factors for intermodal freight transport is to have a well-functioning terminal with the right equipment to offer efficient transits between rail, road or sea- and waterways.

Figure 2 - Stockholm Årsta Intermodal Terminal (Schrac, 2014)

There are several aspects to consider when planning and developing intermodal terminals. Bergqvist and Monios (2017) presents five factors for terminals:

- **Market potential:** When establishing a terminal there have to be a potential market to serve in order to be successful.
- **Location:** The place of the terminal is also highly relevant when developing terminals. The location have to be able to handle the different transport modes. The terminal should also have a good connection to the regional transport opportunities, for example railways in order to be as successful as possible.
- **Entrepreneurship:** A entrepreneurship is important in the creative process of the developing the terminal. The main entrepreneur is also responsible of the overall

development in the terminals which is important to focus on since terminals often have more than one stakeholder.

- **Large shippers:** The demand for large shippers to use the terminal as a part of their transport chains are one aspect to take into consideration when establishing and developing terminals.
- **Financers:** To run and operate a full intermodal freight terminal costs a lot of money and therefore financers are an important factor to take into consideration.

The factor location, Bergqvist and Tornberg (2008) is supporting the other factors and can affect the competetiveness, effectiveness and the efficiency of the intermodal services making it something that organizations needs to consider before deciding on other factors.

Depending on which transport modes the terminal is supporting different standards and factors are more important. If the intermodal terminal is connected to a rail network, the terminal should offer solutions like electrified tracks and a compatible terminal that can for example handle long trains closely connected to the other transport mode (Bergqvist & Monios, 2017). If the terminal offer rail services, connection to the regional traffic system would be optimal to reduce manual handling inside the terminal but also reduce the need of regional traffic planning from the terminals (Bergqvist & Monios, 2017).

Terminals are a part of the transportchain and many different activities are completed and put through in order to handle the goods. Lumsden, Woxenius and Stefansson (2019) presents eight different transport functions a terminal can handle:

- **Coordination:** Processes orders and oversees cycle of order fulfilment. Responsible for making sure supplies, stock, materials, packages, and/or products are processed through the delivery and/or warehouse system efficiently and safely.
- **Sorting:** Sorting and picking is a process often supported by sortation equipment that allows it to understand which direction (or client) to ship orders.
- **Transshipment:** the transshipment process can be descirbed as the process for further transportation of goods. The goods can be prepared inside terminals. Intermodal freight transport is not possible without transshipment inside terminals.
- **Kitting:** kitting is the process of pre-assembling individual items into kits. The kits can thereafter be shipped together in one loading unit.
- **Sequenceing:** a form of picking and structuring goods in order to handle the goods more easily in the last steps of the processes (the transportation).

- **Commercialisation:** the process of handling the goods and create a higher value of the goods. For example, having value-adding activities supporting the companies inside the terminal making the goods more valuable. The process also include preparation of the goods for final customers.
- **Storage:** keeping the goods inside the termials preparing it for further transportation or to be sold.

To be able to handle these different activities and the different transport modes the terminals require equitment. The eqiutment can be distinguished into different segments. For a port a part of the required equitment are quays and docks, cranes to be able to handle the on and off lifting but also vehicles handling the goods within the terminals such as reach stackers, forklifts and staddle carriers (Bergqvist & Monios, 2017). For large intermodal terminals vertical handling is paramount (Lumsden, Woxenius, & Stefansson, 2019).

An issue the different terminals handle are the handling issues together with a fluctuating demand in relation to capacity. Variations in arrivals and departures can also be discussed as an example of challenges within terminals. These problems have a strong connection to road transports and ports. The main difference between road-rail terminals and ports are that the demand for handling are for road connected to hours and in ports connected to days. This mainly because of the amount of goods being prepared for departure or arrving at the terminal. (Lumsden, Woxenius, & Stefansson, 2019)

2.1.2 Intermodal Freight Transport documents

The past years the requirements for documentation have intensified within intermodal freight transport. In the terminals the need for documentation is of great importance due to regulations, customs and handling methods that varies within the transport industry (Fredholm, 2013). Ignorance of this factor can lead to in-efficient handling and delays within the area of handling, transportation and distribution (Lumsden, Woxenius, & Stefansson, 2019). Since the intensification of the documentation started, a new focus on electronic solutions have characterized the international trade the past years (Bergqvist & Monios, 2017).

The pressure for efficient supply chains and logistical procedures have been growing over the last decades due to the growth of demand for faster transports from customers (Helmick,

Wakeman III, & Stewart, 1996). To support the development, the need of information exchange between parties have been a critical factor when handling different transport flows.

Documentation is a time consuming activity for all parties involved and can cause problems if not being handled correctly. Documentation problems can lead to delays of the goods, penalties because of wrong or sufficient information or in worst case, rejected goods in the terminal (Lowe, 2005).

In order for the freight transport and intermodal transports to decrease and use electronic sources for the documentation needed, standardizations, regulations and practice within the area needs to be settled. Fredholm (2013) states that the biggest threat for efficient information and document exchange is the complexity of coordinating programs and systems throughout the industry and between modes. The complexity with terminology within the different industries can also be a potential problem.

2.2 Digitization, Digitalization and Automatization

The way industries, organizations, societies and people use and manage data have changed rapidly over the last decades. Not only changing from analog to digital solutions through the digitization but also in the aspect of digitalization (Digitaliseringskommissionen, 2016). Digitization can be defined as the process of doing something that is analog, dialog, for example a document into an electronic file. Digitalization is about using the digitized material, for example send the electronic file to an organization (Bloomberg, 2018).

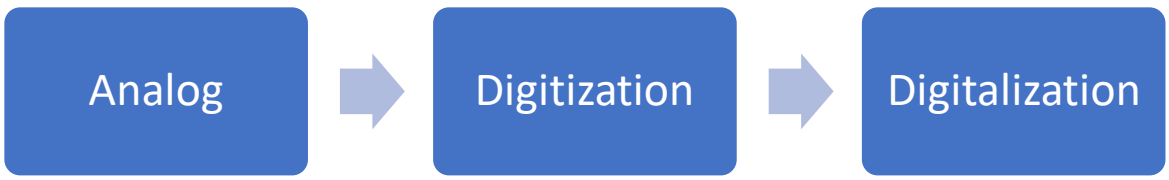

Figure 3 - From analog to digitalization

The movement from analog to digital have and will continue to affect the future of business. The technique enable and create new conditions for businesses like digitalizing and

automatizing the manpower in industries which can lead to more efficient allocation of resources (Bylund, 2016). Automatization together with digitalization were introduced as a part of the third industrial revolution taking place in the 1960s. Some research even call it “the digital revolution” (European Commission, no date).

As a result of a more digital world during the 1960s and 1970s the automatization of businesses grew rapidly. Automatization can be defined as a step in a process that create opportunities for the process to run on its own without any assistance (Nationalencyklopedin, 2020a). Automatization in industries are common, were machines handle and process different activities without any assistance. Within the field of transport the focus of automatization have been on autonomous cars but researchers can also see an increase in the automation of the shipping industry and airports (Holmberg, 2016). The purpose of automatization is to release manpower and in that way create high quality and efficient processes (Nationalencyklopedin, 2020a). Digitization, digitalization and automatization and the third revolution have set the way for a fourth revolution that organizations, societies and people are experiencing today, *Industry 4.0*.

2.3 Industry 4,0

Industry 4,0 or the fourth industrial revolution is changing the environment of industries once again. Since the third industrial revolution the innovations has changed focus are now challenging the standards with innovations in artificial intelligence (AI), machine learning, big data, cloud computing and Internet of Things (IoT). The general goal of Industry 4,0 is to reduce lead times, reduce errors and create opportunities for more flexible solutions within different processes, Internet of Things (IoT) are an important component in these processes (Nationalencyklopedin, 2020b). The definition of Industry 4,0 is used as a collective definition for all the improvements within the focusing fields.

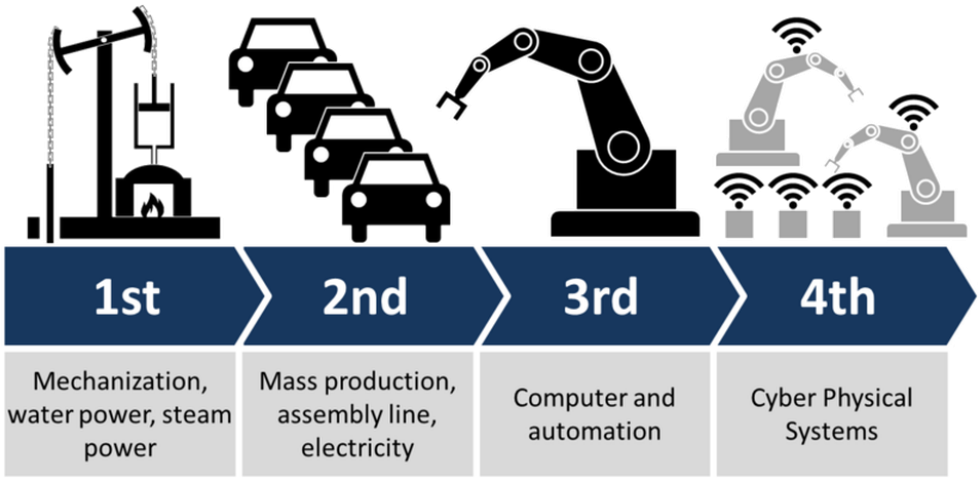

Figure 4 - Industry 4,0 (All about Lean, 2015)

As more sectors, businesses and industries are implementing innovations connected to the movement of Industry 4,0 the competition within different field are growing. To stay competitive and create legitimacy on the market, it is of importance to be up to date and take an active part of the progress (Iveroth, Lindvall, & Magnusson, 2018). Industry 4,0 takes focus mostly on production processes but the same technologies are used in the field of logistics and transportation in order to create and develop processes in the field of logistics (Alpman, 2014).

2.3.1 Artificial Intelligence (AI)

The term artificial intelligence (AI) is a definition that is used to describe many different concepts within the usage of data collection and analysis in different organizations and companies. The computers are taught to understand different patterns in data in order to create valuable information in different processes (Flodén, 2018). The concept of AI in logistics where introduced around 2000 but the overall concept was introduced to the world in the end of the 1950s (Danielsson, 2020). Today, AI can be expressed in robots, processes and systems that can handle a large quantity of data, turn it into information and do something with the transferred information (Tecuci, 2012). The term AI can also be used in order to describe more specific concepts within the collection, for example machine learning.

2.3.2 Machine Learning

Machine learning are in many cases used under the same definition as AI. The concept of machine learning is based on the theory behind AI and therefore the two concepts can be seen

in some cases as daughter definitions. Machine learning is as the name tells machines that learn different patterns or movements based on data, creating algorithms that improve a specific task or concept. The pattern recognition can be based on given datasets or randomized sets, the learning can also be divided into supervised or unsupervised learning where the supervised learning have a right answer and the computers are taught to recognize a pattern, the unsupervised learning is challenging the computers to find hidden patterns in data sets. (Flodén, 2018)

2.3.3 Big Data

Many of the activities being made in the society today generates some form of data. The data can be in many different forms and create different patterns and generate information necessary for people in different meanings. The concept of Big Data helps and allow companies, businesses and people to analyze data through computers and algorithms in real time (World Economic Forum, 2016).

To describe Big Data and its impact McAfee & Brynjolfsson (2012) identified the three V's to distinguish from analytics.

Volume: Every second a large amount of data is created. During 2020, Desjardins (2019) predict a digital universe of 44 zettabytes. Much of the data generated today is collected through the Internet but other forms of data collection is also implemented. For example, the grocery stores can analyze data from every transaction and use for their forecasts or other business related areas (McAfee & Brynjolfsson, 2012). Lewis (2019) have presented what happened during one minute on the Internet in 2019, all of these activities are creating data that needs to be analyzed. A increase in volume of data is estimated to grow as the 5G is being introduced, together with 5G-connection appromimatly 50 million people and things will be connected to the Internet and therefore also generate data (Lindvall & Osowski, 2019).

Figure 5 - Internet Minute (Desjardins, 2019)

Velocity: The speed of the data can sometimes be more important than the volume of it. The speed of the data create opportunities for businesses to study coming trends and use it as a competitive advantage against their competitors (McAfee & Brynjolfsson, 2012).

Variety: Data can be presented in many different formats such as numbers, text and pictures. The data generated can be either structured or unstructured where the last mentioned is the most common way and the hardest to handle and analyze (Flodén, 2018).

Atzori, Iera, and Morabito (2010) explains how logistics and transportation generates data. Cars, trains, airplane and ships are all connected to programs and systems and generate data every second. The data can for example be used as information to different control centers for route planning and different permissions which are commonly used within the air and shipping industry.

2.3.4 Internet of Things (IoT)

A wending machine controlling its own storage and through connection to the internet managing its own orders when the storage was decreasing can be seen as the first device defined and connected to the theme of Internet of Things (IoT). The theme was introduced into the channels of interest in 2014 together with a strong implementation of devices connected to this

type of service during this time (Wortmann & Flüchter, 2015). In 2020 researchers within the field are predicting that devices connected and defined as IoT will reach 30 million and together with the implementation of 5G up to 50 million (Lindvall & Osowski, 2019). The globalization of IoT and the broader usage have been enabled because of the decreasing production and overall product costs. The production and implementation of IoT does not seem to slow down (Flodén, 2018).

As the objects and people connected to IoT are constantly growing the need for regulations and guidelines within the area is required. One aspect to consider in the theme of IoT is the security, privacy and ethics when handling, analyzing and processing different data generated by the different devices and services. This issue is one of the most discussed within the field, all services and devices connected to the internet can be used for different attacks to harm or damage organizations or businesses over a longer period of time, but also harm people and spread personal information (Padaki & Seemanapalli, 2016). According to Flodén (2018) computer crime can be by computers using for example the Internet to harm or target the computers using for example Internet, like devices connected to IoT.

The possibility of having devices connected against each other through the concept of IoT over a distance can enable efficient handling with different intermodal loading units (ILUs) and send required information to actors involved in the process. IoT solutions can also help to reduce human errors that can be made within documentation. (Ozkoca, 2017)

Witkowski (2017) presents three features of IoT that can be used to describe the usage of IoT solutions within logistics, the features are context, omnipresence and optimtization. The context of IoT can be described as a interaction between a environment with a direct response with a possibility for change. The objects can provide information about location and different conditions. Omnipresence describes the development of connections, devices today are not only able to communicate with networks but also with other devices connected to the Internet. The connection between and through the different devices can create a functionality which can be described as optimization of a certain thing or process.

Examples of IoT solutions in the logistics sector are fleet management systems, drone deliveries and self driving vehicles. All these examples are based on the technology behind IoT and can are both cloud services and physical products (Maltseva, 2019).

Internet of Logistics (IoL)

The development of IoT have created opportunities for further development within the segment. The term Internet of Things have created sub-groups with connection to other fields within the usage of the same technology, Internet of People (IoP), Internet of Services (IoS), Internet of Data (IoD) (Maslarić, Nikoličić, & Mirčetić, 2016) and Internet of Logistics (IoL) (Diotallevi, Aronsson, Bergstrand, Kordnejad, & Åkerfeldt, 2020) have been identified as subgroups.

The approach of Internet of Logistics (IoL) have been focused on the creating of a common interoperable exchange of data within certain infrastructure. The main purpose with the concept is to achieve a steeped visibility through whole logistics chains. The usage of Internet of IoL devices and services are according to Diotallevi et. al (2020) more relevant when handling international trade involving more than one transport mode that require both physical handling in form of transfers and handling in form of different documents inside the terminals.

IoL have a wide range of usage areas since the definition enable for several different approaches and projects. In Europe, a trend of development in the physical infrastructure connected to IoT with connection to IoL can be identified (Witkowski, 2017). One IoL product is the intelligent video gate (IVG) that is growing as a concept after an implementation of Deutsche Bahn in Cologne (Deutsche Bahn Netze, 2019). The gate register data from trucks or wagons through radio frequency identification technology (RFID) tags on both the vehicle and a station. The data can via AI create faster transits (Deutsche Bahn Netze, 2019).

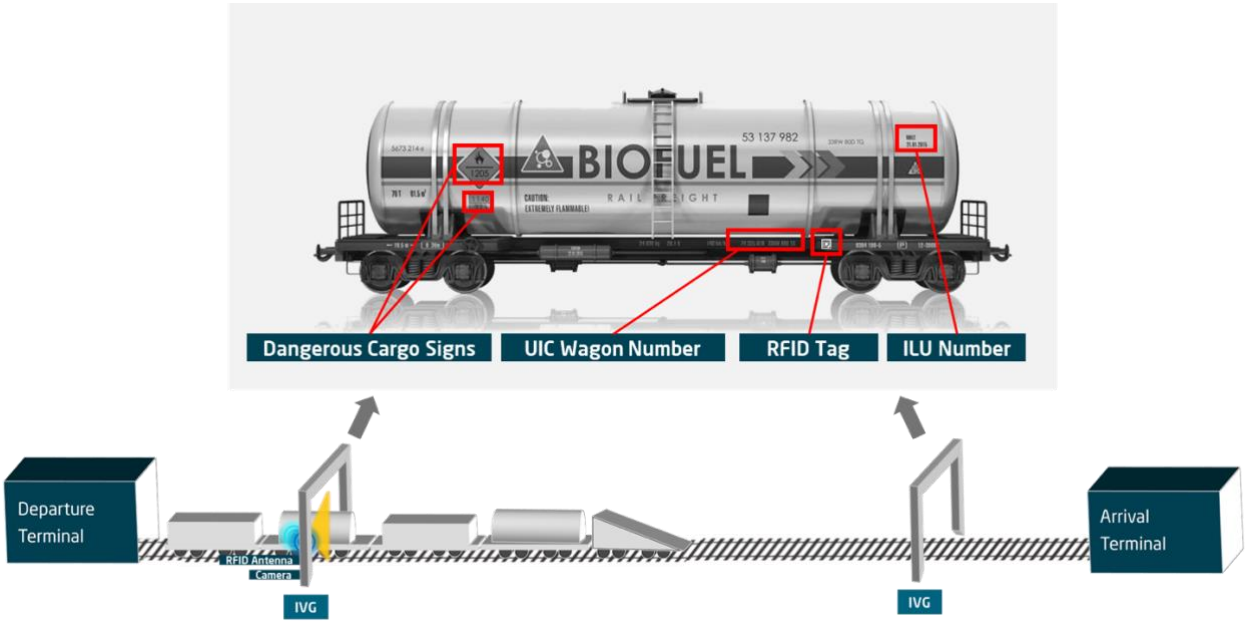

Figure 6 - Intelligent video gate (Deutsche Bahn Netze, 2019)

The introduction of IoT and IoL both depends on the technology behind RFID. The concept is described more in detailed in the following piece of text.

Radio Frequency Identification (RFID)

In 1999 the definition of IoT was introduced to the world by the brit, Kevin Ashton. Ashton presented an introduction for connecting radio frequency identification technology (RFID) with the Internet. RFID is an automatic identification technology with non-contact transmission. The technology have been adapted in many different sectors and fields within many different industries since the beginning of the 2000s. The main reason for the growth in adaption is the lowering costs of usage and implementation for the technology. (Rajaraman, 2017)

The transmission of the data from the tags is connected through antennas where the data is transformed into through the readers into computer databases. The data can thereafter be transferred into computers that can make information out of the incoming data. This concept is used widely in the logistics sector and have also grown into a segment within the IoT.

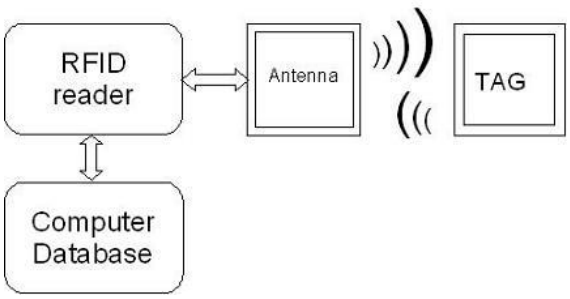

Figure 7 - The technology behind RFID

3. Methodology

In this chapter the methodology of the research is presented and discussed. The chapter presents four subchapters: research approach, research design, data collection and quality of the research. This chapter is presented to the reader to create an understanding of how the process of the research has been, factors are also taken into consideration while conducting the research and presented in this chapter.

3.1 Research approach

This research project wants to investigate how intermodal freight transport transits can be more time-efficient with a directed focus on the documentation handling. Therefore, this study is formulated and analyzed from a qualitative perspective. A qualitative research perspective is focusing more on words than numbers which is focus in the quantitative research perspective (Bryman & Bell, 2011). When using a qualitative research approach there are some important steps to take into consideration and follow to conduct a pleasant and well-structured research. Patel and Davidsson (2019) explains the model in six steps, all explaining the process of how a qualitative research can conducted. The steps are presented below:

- **Collect knowledge about a problem/situation.**
- **Choice of research places/people/objects.**
- **Collection of data.**
- **Interpretation of data.**
- **Theoretical analysis.**
- **Presentation of results and conclusion.**

For this research the following conduction of research have been made:

- **Collect knowledge about a problem/situation:** Intermodal freight transport and the challenges the business are facing.

- **Choice of research places/people/objects:** Intermodal freight transport, intermodal freight terminals, Industry 4.0, IoT and IoL.
- **Collection of data:** Literature review and interviews.
- **Interpretation of data:** Connection of the data from literature review and interviews.
- **Theoretical analysis:** Analysis of the empirical findings.
- **Presentation of results and conclusion:** The researchers own thoughts of the problem and possible solutions.

Bryman and Burgess (1999) explains difficulites in understanding how qualitative research is conducted as a general problem within business research. The approach differ from the other research perspective, the quantitative research. A qualitative approach to a problem is often used to examine experiences or different happenings of places, people or objects. To collect data a fundamental knowledge about the area of interest needs to be developed and keen through the whole research in order to be able to conduct a trustworthy and reliable research (Collis & Hussey, 2014). A strong connection to the research place, people or objects are also identified to be one thing that characterizes when qualitative research is advantageous. Changing research questions during the time of the research is also characteristic for qualitative research since the process often change during the research period (Patel & Davidsson, 2019).

When conducting a qualitative research, literature reviews and interviews are methods often used in order to see how the reality from another perspective (Bryman & Bell, 2013). For this research a literature review has been put through in order to gather data about the research subject. The process of the literature review have been structured and organized and collected data have been structured in Microsoft One Note for easy access and organization of the different subjects and aspects. The chosen subjects are intermodal freight transport, intermodal freight terminals, Internet of Things (IoT) and sub-categories to the earlier mentioned subjects.

Throughout the start of the research both internal and external supervision from supervisors have been completed. The internal supervision focusing more on the academic perspective and the approach of the research. The external supervisor focusing more on finding relevant material and respondents for the interviews. Since the research is not being made for a company or organization, the external supervisor have been a support to brainstorm and exchange ideas with since the research is conducted by one author. The feedback from both the internal and external supervisors have been constructive and detailed and helped to create a good structure of the research.

According to Rahman (2017) a disadvantage when conducing a qualitative research is the time aspect. When conducing a qualitative research a lot of work and time is consumed to analyze and interpret different data, both separately and commonly. To be able to conduct larger research projects, a well-structured timetable of the work have to be set in order to be able to manage the data and information on time. Another potential problem related to qualitative research, discussed by Bryman and Bell (2011) can be the lack of subjectivity. Since a qualitative research does not include any statistics, the results and generalizations can be too subjective and the research unusable.

3.2 Research design

Eisenhardt and Graeber (2007) presents a theory explaning that case studies are applicable in methods where "how" and "why" are expressed in the research question. For this research the design is approached by a case study. Using case study as a research design is often established when the resarcher or researchers want to investigate a specific subject. The subject can be an organization, a place, a specific person or a specific event (Bryman & Bell, 2013). In this research the implementation of IoT and IoL is seen as a case study based on a event (the implementation) and the researcher is investigating opportunites with the implementation. When perfoming a case study, studies from severeal methods and perspectives is common (Collis & Hussey, 2014). For this case study, both a literature review and six qualitative interviews have been conducted. The choice of research design is therefore supported by the theory.

Ryan, Scapens and Theobald (2002) explains four types of case studies:

- **Descpriptive:** a case study where focus lays on the current practice of an organization or other objective.
- **Illustrative:** a case study where focus is directed at one organization and new processes inside the organization.
- **Explanatory:** a case study where the research is based on the existing theory within the subject.
- **Experimental:** a case study where focus is on implementation and new development in organizations and thereefter be able to evalute potential advantages and disadvantages.

This research have a mixture of several types of research designs which according to Collis and Hussey (2014) is common in a large amount of research. The research have points in the descriptive design since the studied practice of IoT is investigated into already running operations. The research can also be partly discribed as illustrative and experimental since IoT and its subcategory, IoL is focused on the usage of the technology in a Swedish intermodal terminal. The same contentions can be used in order to descibe the research as a experimental design, where a new concept of IoL is implemented and evaluated from a different perspective.

3.3 Data collection

The research material consists of primary- and secondary data. Patel and Davidsson (2019) describe the primary data as collection of data that is collected through surveys or interviews. Secondary data is the data that is collected from already existing sources collected by someone else, example of secondary data can be different types of literature (Collis & Hussey, 2014). For this research the primary data is collected through interviews with experts and project leaders within the area. The secondary data is collected through books, scientific reports and conference papers to get a concreate picture of the material within the subject. The material collected through the secondary sources have helped to set the aim for the conducted interviews.

3.3.1 Literature review

To gather valuable data for the research, a literature review has been put through. During the review earlier studies and problem areas were identified. Potential research slots have also been detected during the review. To conduct the literature review and collect data for the research, data bases have been used. Examples of data bases used for the review is the Gothenburg University Library “Supersearch”, Google Scholar and ScienceDirect. In searches, keywords such as “Internet of Things”, ”Intermodal Freight Transport”, “Logistics”, “Industry 4,0”, “Big data” and “Radio Frequency Identification” have been used.

3.3.2 Interviews

Interviews are a common way in the field of research for collecting primary data in qualitative studies. The concept is well-used thanks to the high flexibility of collection the method allows (Collis & Hussey, 2014). For this research a total of four interviews have been performed in order to fullfill the reqiurements of the research and be able to answer the research question.

Patel and Davidsson (2019) have identified three types of interviews:

- **Structured interviews:** where the interview questions are set from the beginning with no space for additional questions.
- **Unstructured interviews:** an interview form where the question or questions are open and tend to resemble a standard conversation.
- **Semi-structured interviews:** the semi-structured interviews often have one or more themes of areas that the researcher wants to discuss. The form allows additional questions and an open but structured conversation.

For this research semi-structured interviews have been performed. The method was chosen because of the flexibility it offers during the interviews if additional questions were necessary for understanding. The concept of semi-structured interview also fit the group of respondents well. The respondents have different backgrounds and work with different things within the research area and therefore having the opportunity of being able to formulate different questions to different respondents have been used. The interview form also gives the respondents the opportunity of adding information that the researcher may not be aware of.

To conduct the interviews an interview guide was set up to collect the necessary information from the respondents. The guide was a support during the interviews to keep the time schedule but also to secure that all the questions was answered. The four interviews and the interview guides all had the same design with small differences depending on which respondent that was getting interviewed. Neutrality in the questions was important for the researcher in order to not lead the respondents in some course. The interview guides are attached in appendix 1.

Performance of the interviews

Due to the coronavirus outbreak the interviews were conducted through telephone and videocalls. All interviews were recorded for the purpose of the researcher collecting the information and using transcreation to be able to listen to the material again and also use the material in the empirical and analytical parts of the research. The ethical perspective when

recording interviews or other material is important to take into consideration. Collis and Hussey (2014) discuss the problems related to this types of recordings. The voluntariness of the respondents are one important aspect to discuss before conducting or put through interviews. If the respondents are positive about recordings it could be valuable to sign some form of contract to secure that the information from the respondents are usable within the research.

The transcribation of the interviews help the later on in the research process since the information and data collected from the interviews was structured and coordinated in a document.

The collected data have been approached by thematic anaysis approach where the collected data from the interviews were structured in different themes in order to ease the empirical and analysis processes. The thematic approach have been of deductive character and the themes for anaylsis had been set on beforehand where focus was put on the existing theories and earlier research. According to Bryman and Bell (2013) the thematic analysis approach is one of the most common ways of analyzing qualitative data.

Respondents

The respondents for this research have been carefully selected within the logistics sector in order to get sufficient answers and information about intermodal freight transports, intermodal terminals, Internet of Things (IoT), Internet of Logistics (IoL) and the connection between all concepts. Due to privacy requests from some respondents the researcher decided to anonymize the respondents names and instead use their title of profession to identify their competence within the area. The respondents have gotten a specific code, RX which identifies their title, the date the interview was conducted and the total interview time.

The respondents are Swedish and European men and women representing companies and organizations within both the public and the private sector. The interviews have been held in Swedish with the Swedish speaking respondents and in English with the European respondents. The interview's overall questions have been produced in English and translated to Swedish in order to secure that all respondents, either Swedish or European answer the same questions.

Two of the respondents (R1 and R3) are closely connected to the Swedish intermodal terminal being examined in this research. The other respondents (R2, R4, R5, R6) are experts within their area and work the knowledge all of the respondents possesses have been valuable for the research.

Below a summary of respondents and conducted interviews is presented:

Respondents	Title	Date of interview	Time	Language
R1	RFID Consultant within logistics	2020-03-20	57 minutes	Swedish
R2	Intrapreneur	2020-03-27	72 minutes	Swedish
R3	Workpackage Manager Intelligent Video Gate	2020-04-06	47 minutes	Swedish
R4	Researcher within transport planning	2020-04-06	47 minutes	English
R5	Researcher within transport planning	2020-04-07	54 minutes	Swedish
R6	PHD in logistics	2020-04-07	65 minutes	English

Table 1 - Respondents

3.4 Quality of research

In order to secure that the research have been performed in a trustworthy way, there are many different aspects to take into consideration. The following pieces are evaluating the research from different perspectives in order to legitimize and review the performance. When evaluating a research there are several approaches to apply. Bryman and Bell (2013) explains one their evaluating methods in the perspective of validity and reliability.

3.4.1 Validity

The validity of a study can be described as the level of trustworthiness the research instill. The process of using validity as an evaluation measurement is often used in qualitative studies when focusing specifically on a subject or a phenomenon. In this parameter, the opinions from eventual respondents should also be included. Malterud (1998) explains four perspectives to consider when evaluating a qualitative research from a validity perspective:

- **Knowledge of the area**: the authors pre-knowledge and knowledge within the area.
- **Collection of data**: how the data for the research have been collected and over which period of time
- **Selection of respondents**: detailed information about eventual participants and respondents.
- **Explaining the analysis process**: how the process went and which decision that where taken. The structure of own interpretations and facts should be explained.

The authors pre-knowledge about the area have been on a good level where the fundamental knowledge have been extended more and more over the period of the research. The data have been collected through interviews with respondents. The answers from the participants have been presented in a correct way with permission. For this study, the respondents from the interviews have given their approval to be quoted and published, the respondents have also had the opportunity of having their parts reviewed before any form of publication. Participation in any form of the study have been fully voluntary. The research process have been completed between January 2020 – May 2020 which is a limited amount of time. The analysis process was conducted and introduced in a separate chapter. Own intrepretations are stated and facts secured with references.

3.4.2 Reliability

The reliability is according to Bryman and Bell (2013) a possible way to measure how secure the results of the study is. The reliability also measures the possibility of having the same results if the same study is accomplished once again. When measuring reliability, Malterud (1998) presents three areas of evalutation, focusing on the author:

- **The authors ability to make good observations or interviews**
- **The authors ability to interpret data**
- **The quaility of supervision**

The author have through earlier studies on both bachelor- and advanced level gained a good knowledge about both of the processes of performing and handle interviews and interpretation of data. The supervision of the research have been of high quality, the supervisor have knowledge within the area and have a wide experience of supervising research on advanced level.

Malterud (1998) also include aspects about the technology used for the research, for example recording eqiutment. For this research, during the coronavirus situation the degree of using technology have been higher than previously estimated. The quality of the results from the technology usage have overall been satisfactory.

4. Empirical findings

In this chapter the empirical findings are presented. The findings are a result of the conducted interviews. This chapter is structured in three main categories. Firstly, the aspects of intermodal freight transport, terminals and documentation handling is being presented. Thereafter, the findings regarding Industry 4,0, Internet of Things (IoT) and Internet of Logistics (IoL) is presented. In the finishing section, the results regarding the combination of intermodal freight transport, terminals, documentation and Internet of Things (IoT) and Internet of Logistics (IoL) is presented.

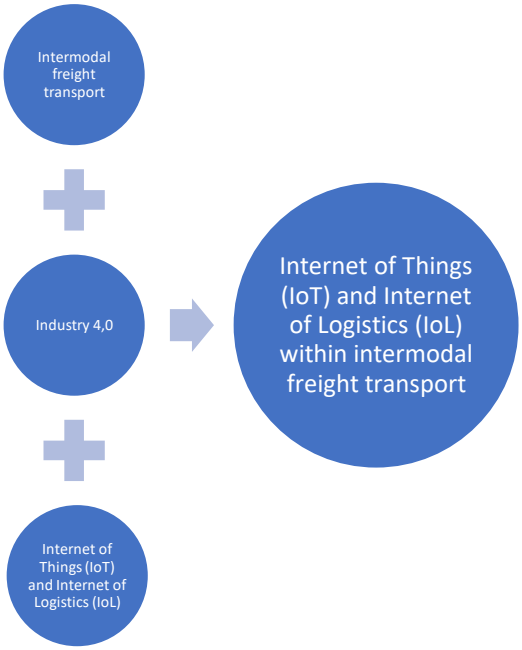

Figure 8 - Structure of chapter 4

4.1 Intermodal freight transport, terminals and documentation

The importance on intermodal solutions for freight transport are growing due to a change in the demand for more sustainable transports over longer distances. Respondent 4 (R4) explains the development of demand in intermodal freight transport as quite low in relationship to direct

point to point transport, this because of the longer lead-times. R4 also take the behavioral factor into consideration while discussing intermodal freight transport demand. The change in demand is according to R4 a results of an increase in interest in sustainability and environmental questions, from both companies and end-customers.

Repondent 2 (R2) descibe the physical infrastructure as one of the bottlenecks when dealing with intermodal freight transports and its demand challenges. The transports are depending on the physical infrastucture to be completed and since all intermodal transport modes require some infrastruture the subject is constantly discussed within the business. The most common intermodal transport combinated modes, road and rail are heavly dependent on not only the movable infrastructure like example wagons and trailers but also the permanent infrastructure in railways and roads. R2 also take the physical infrastructure, for example forklifts, reachstakers and cranes [note. lifting equitment] inside the terminals as one potential bottleneck when dealing with intermodal freight transport since the equitment is a part of other logistics chains than the intermodal transport.

According to respondent 5 (R5) there are many projects within the European Union that is promoting intermodal freight transport, both in supporting the physical infrastructure development but there is also projects supporting a change in the behavior in the transport industry. R5 explains the current situation and developments as good and points out that according to R5 the most important factor is the behavior movements. R5 also states that it can be hard to promote a behavior change if the physical infrastructure is not in place.

The physical infrastructure is brought up by four of the total six respondents. All four bringing up the infrastructure as a potential disadvantage with the intermodal freight transports where the majority explains the costs as the main disadvantage. The containerization have helped the development with the movable infrastructure but there are still improvements in that area to be done according to R3. R3 describes the Swedish terminals as sufficient for the amount of goods they handle each year. The examined terminal X is described as of good standard. The larger Swedish intermodal terminals is according to R3 well positioned for the stakeholders that are operating the terminals but also for customers using the intermodal terminals for their goods.

R3 also descibes the importance of the processes within the terminals as important and describes the terminals as *"the heart of the whole service".* The business inside the terminals is explanied as neccesary for the transport companies in order to secure companies transportchains.

Respondent 1 (R1) considers the location of the terminal as one important factor. The connection to other transport opportunities and a large catchment-area is discussed and seen as valuable. The examined terminal is described as a terminal with opportunities to expand in the upcoming years.

Respondent 5 (R5) and respondent 6 (R6) discuss the documemtation in intermodal freight transport. The need for documentation during transport have been a emerging phenomenon due to new standards within the business. R5 also points out that the scale of documentation can flucturate depeding on which transport mode that is used and what kind of goods that is transported. R6 explain a situation where the information today is carried together with the goods and is being handled in every transit. Sometimes the documentation is still being printed on paper and carried with the goods. R6 also explains that the logistics chains have been lagging and in the case of the digitization and digitalization.

R1 confirms the statement from R6 and explains that over the past years a change in focus have swiched in the logistics sector. The focus is now on digitalization in the logistics sector and in the logistics infrastructure according to R1.

4.2 Industry 4,0, Internet of Things (IoT) and Internet of Logistics (IoL)

The development of Industry 4.0 and IoT have according to respondent 1 (R1) been focusing on the intelligence of services connected to the logistics sector and not on the actual logistics. The focus within the logistics sector, both in services and in the actual logistics can therefore be identified as IoL services and concepts.

According to R5, the development of the industrial technologies within the logistics sector will keep a steady growth over the coming years. The sector is still adapting to changes with digitization and digitalization and more radical changes will appear on the market in the upcoming two till five years. This movement within logistics takes time since the industry is constantly experiencing changes in some parts of the business. A global change within a specific area takes time to implement. A change in a specific area can according to R1 take 10-15 years.

IoL can according to R6 be presented as a further development of the concept of IoT. IoL can be used to describe how logistics processes with technology and services connected to the Internet can create more efficient logistics and supply chains. R6 explains the outgrowth of IoT into IoL as following:

"IoL is so much more than just an outgrowth from IoT. In a couple of years, I think specific services and units with connection to the Internet will be defined as "typical" IoL products. Today we have a few projects running that could be defined as "real" IoL projects."

One of the most common questions discussed by the respondents are the questions discussing the security aspects. The security aspects are brought up by R1, R2 and R3 as possible challenges or disadvantages of the implementation of IoT and IoL in today's logistics. R1 states that cyber-attacks might be a future problem. R2 have a similar way of discussing the possible challenges. The challenges according to R2 is legal-, security-, organizational- and technical questions that needs to be managed together with the increasing implementation of IoT and IoL. R3 states that the secret of business is a specific challenge to consider in situations with implementation of this type of services.

Respondent 4 (R4) mention IT-secutiry as a potential challenge when discussing implementation of IoT services in any sector.

Respondent 5 (R5) discuss the implementation phase of any new technology or service as important in the aspect of *"geting all parties on board"*. If one company implement one new service and the introduction and implementation does not expand to other parts of the business or into other companies. There is a risk of being inefficient from both a time- and cost perspective.

4.3 Internet of Things (IoT) and Internet of Logistics (IoL) within intermodal freight transport and intermodal freight terminals

The implementation of IoT and IoL services within intermodal freight transport have according to all respondents a positive contributing factor within the transport concept. The respondents have different perspectives when discussing introduction of IoT and IoL.

R1 and R3 descibes the implementation of IoT and IoL connected to efficiency and discuss solutions that is implemented in intermodal freight transport. R1 presents a theory about a enlarged automatization in terminals, shunting yards and ports, that will gain more effective handling by the reducement in human errors. A reduce in paper work and manual work also be seen according to R1.

R3 focus on the sharing of information as a consequence of the implementation. The sharing of information can increase efficiency due to correct information in early steps of the transportation. Sharing data amongst stakeholders can potentially according to R3 result in better operational efficiency with higher filling rates as an example.

The possible increase in time-efficiency with IoT and IoL in intermodal freight transport in matter of time seperate the respondents from each other. R1 estimates a possible reducion in time of 70% if the concepts are implemented globally. The reduction would be dependent on the shift from manual work and abbreviated waiting time. R2 reasons from the mode perspective. The possible reduce will depend on which mode that is performing the transport. A pure full truck load on road would accoring to R2 reduce more time than an international intermodal freight transport. R3 take all possible modes in consideration and explains a possible reduce of 20%.

The way of handling documents and operating terminals is changing because of the implementation of IoT and IoL within intermodal freight transport according to R1. The handling of information will be faster, more efficient and more automated. The aftermath of automatisation is less misstakes and less manpower that will be needed in terminals. R4 also state a need of automatization because of the increased demand from throughput. R6 takes the terminals perspective and explains how IoT and IoL can help terminal operators with planning activities and resources.

The respondents also comments on the advantages of implementing IoT and IoL solutions for intermodal freight transport:

R1: *“Time and cost! This will gain less human work and by that less misstakes.”*

R5: *“Early information and possibility to optimize operations. Better and faster info to customers and other parties involved in the process”*

R6: “*There will be better control of the flows of goods, better control of the goods itself (e.g. temperature, shock and sudden acceleration (such as "bumps" and sudden impacts), quality*

measurements of various kinds. IoL is about the logistic flow, if it is going as planned or not, awareness along the transport chain to all parties, lessen the impact of "information bullwhip effect", for example parties overreacting on small deviations from plan."

Possible disadvantages of IoT and IoL within intermodal freight transport vary from the respondents. R1 finds the implementation overall positive. The implementation can cause reduction in workers and needed backup for technology fails which could be tricky according to R1.

R3 explains the different implementation phases as a disadvantage:

"It will take time before it is applicable to all freight so there will be a mix of new ways and old ways which is always difficult to manage in a volume operations."

The respondents were asked about the most important concept, services and/or devices for intermodal operations and the respondents described both parts of infrastructure and services.

R1 explains: *"I think that IVG, Intelligent Video Gates will play an important part in this scenario. In 2018 a prototype was build and implemented in Germany with good results and now we are implementing one here in Sweden which is exciting for me as a consultant in the area"*

According to R2 there is no specific concept that will be outstanding. It will be a plethora of services depending on what the intermodal terminal see as its competitive advantage, examples of competitive location, speed, security, dangerous goods, cold chain. R4 see the documentation handling services as the most important one.

The usage of IoT and IoL services within intermodal freight transport services in twenty years will according to R3 will be out most important and the respondent do not see any major upcoming solutions that will change the industry during the time. R4 and R6 have the same opinion in the question. The respondents are positive that the technology will operate but express a uncertainty in the timeframe.

5. Analysis

In this chapter the theory and the empirical findings will be compared and build up as an analysis. The analysis will follow the same structure as the previous chapter.

The purposes of Internet of Things (IoT) and Internet of Logistics (IoL) are to enable transmission of data through the Internet with different services and devices. Of the two concepts, Internet of Things (IoT) is by far the most known concept comparing the two concept IoT and IoL. The concept IoL have not been established in larger extent in either in the field of research, the logistics sector or other close sectors that could have use of the services offered by the technology yet. The generalizations of these concepts connects well to the theories that Diotallevi et.al (2020) and Maslarić et.al (2016) presents of the development of the different sub-categories in relation to the fundamental development of IoT solutions. The overall results from the three parts examined in chapter 4 follow the same pattern both from the material studied in the literature review and results from the six interviews.

5.1 Overall - Intermodal freight transport

From the literature review and the interviews a trend in intermodal freight transport can be detected. The trend is showing results on the total usage of the services connected to the subject. A low willingness of usage can be detected as in Woxenius and Bärthel (2004) due to the low flexibility of the transportation services. The same trend can be be confirmed by R4 since customers instead chose other transport modes with a more direct and faster service in order to get the things delivered in a shorter period of time.

The overall willingness of using intermodal services can also be characterised by the heavy pressure and need for large infrastructure investments. The need for large investments for operating intermodal services can be one of the potential bottlenecks in the development of services and infrastructual progress. This is identified as a problem by R2 which characterise the physical infrastructure as potential risk for underuse and as Bergqvist and Monios (2017) presents in financers are important in order to be able to operate a terminal with full equitment. There are several projects running in the European Union with the intentions of having a more

standardized infrastructure, the TEN-T project have this question as headliner in many of their projects (European Commission, 2020). R3 presents the Swedish intermodal terminals as sufficient standard with good connections which can be seen as the opposite of what the R2 explains, focusing on the risks of having lacking quality in infrastructure.

It is in the terminals where the most staff crucial acitivities are being made which also puts pressure on the operators to deliver high services and fast transfers. Lowe (2005) identified the transfer from one transport mode to another as one of the key success factors in order to succeed with intermodal freight services and operations. The same point is R3 discribing and point out the utilization as a factor for success in the operations of a terminal.

R4 is descibing a change in demand of intermodal freight services due to the sustainability perspecive. The customers are nowadays asking for more sustainable transports with a focus on the environmental impact. The research behind intermodal freight transport from the sustainability perspective is supporting the statement and projects with intermodal freight transport operating from a environmental friendly perspective are running today in order to develop the business and industry from the sustainability perspective.

The location of the terminals are of importance when planning for a new terminal or operating a current terminal. For a successful business there have to be a demand for the services. Bergqvist and Tornberg (2008) states the location as the primary factor since it can affect the competitiveness and efficiency. R1 considers the terminal as important in the area of catchment. There have to be a demand for the services in order to operate a full business.

The physical infrastructure have been discussed as a potential bottleneck and disadvantage in terminals from both earlier research and the respondents.

5.2 Industry 4.0, IoT and IoL

Industry 4.0 have introduced several new concepts into the world of business. Together with IoT and IoL, AI, machine learning, big data have been introduced. The implementation of new services connected to the Industry 4.0 have changed many business way of working and have enabled more digital and automatized solutions. In the logistics sector the innovations of IoT and IoL previously been focused on the services connected to the Internet according to R1. A

possible change from this movement can be identified in the IVG implementation at the examined terminal where it is a physical device that is being installed.

The IVG is connected to the trucks and train wagons through RFID and according to Ozcoca (2017) connectivity between things or concepts can enable more efficiency in different operations.

Devices and services connected to IoT and the Internet have grown rapidly during the past twenty years and does not seem to slow down, instead the services and devices are estimated to increase over the coming years. After the implementation of the 5G network, 50 million devices are estimated to be connected through IoT (Lindvall & Osowski, 2019). The same pattern can be identified within the logistics sector. R5 describes a business where the technologies follow the general trend with a steady growth and an estimated growth in the coming 5-10 years. The respondents also discuss the future insights of the technology and a future with IoT and IoL solutions, R3 is very positive and think that the concept of IoT and IoL will expand together with the general improvements of technologies.

The time aspects of IoT and IoL valuable when discussing potential investments in infrastructure in different logistics processes and potentially terminals. Since the implementations of IoT and IoL is estimated by the research and respondents to grow over the coming years (Flodén, 2018), the concept does not seem to be a temporary trend but instead solutions that can enable better and more efficient businesses. To implement in IoT and IoL services can therefore be seen as a relatively secure investment that will be running and developing even over the next decades.

Together with the increased development of the concept of IoT and IoL, the lack of standardizations and regulations is clear. The potential risk of different attacks against the systems are identified as one of the major disadvantages of implementation of IoT and IoL solutions. If wrong information gets in the wrong hands it can possibly harm organizations over a longer period of time Padaki & Seemanapalli (2016). R1, R2 and R3 all strongly agree that the security aspectsaround IoT and IoL are in strong need of development and progression. As the IoT and IoL solutions require regulations, the technology behind some of the innovations, RFID technology can require extended regulations and standards in the future.

5.3 IoT, IoL and intermodal freight transport

The implementation of IoT and IoL services within the logistics sector and the intermodal freight transport sector have according to the respondents been positive and created better opportunities for the business to grow over the next couple of years and decades. The respondents have been focused on many different perspectives within the implementation of IoT and IoL within intermodal freight transport. The main themes that both the research and respondents have touched is the reduce of mistakes, data sharing, time-efficiency, documentation handling and future aspects and usage of IoT and IoL solutions within intermodal freight transport.

As discussed in the earlier analysis piece, the costs of infrastructure in terminals can be very high in order to have the right equipment with the right quality for the work it is going to perform. R1 and R3 describes the implementation within intermodal freight transport as constant development within the business, that now has focus on IoT and IoL.

According to R1 the most valuable innovation classified as an IoL service is the IVG. The IVG have according to Deutsche Bahn Netze (2019) reduced the handling time with both goods and documents with up to 50% depending on the size of the goods loads. This results is in line with R3's estimation of a 20% reduce in time when handling goods in the Swedish intermodal terminal. R1 estimates the put through in matter of time in the Swedish intermodal terminal to be reduced by 70%. The other respondents have a more optimistic approach to the reductions and would like to see the operations running over a period of time before making any assumptions in order to secure that everything within the chain is connected and is operating properly.

The implementation of IoT and IoL within intermodal freight transport follows the same pattern as the implementation in general- and logistics field. The main advantages can be identified into three pillars, time, cost and control. The time will be an intresting factor since the intermodal freight transport business due to its inflexibility looses customers, if more efficient solutions are offered a possible change in demand may happen. The cost factor is based on the assumptions on reduced mistakes and human errors from R1 and R2. Ozkoca (2017) means that the human errors within documentation can be minimized if IoL services are used in the process within terminals. The usage of IoT and IoL will also lead to better control of the goods and documents according to R6. Since everything is connected to the Internet it is easy to track the

goods and the documents during the time of the transport and that can possibly help organizations when dealing with both the physical goods but also the documents that comes along with the actual goods.

Implementing new devices and services takes time and need to be introduced in stages in order to work properly. Digitalization and automatizarion within the logistics have according to R6 been very slow and is still not optimized. The *general* digitalization that was introduced during the 1960s and Holmberg (2016) mean that in the field of logistics the focus previously have been on the processes in the car industry. The implementation of IoT and IoL within intermodal freight transport will according to R3 take time. The different terminals and operators will use different techniques and technologies and there will be an overlap with older solutions. It is therefore neccesary to consider the implementation phase as a a disadvantage initially because of the potentially mixed phases of implementation on a local, regional and global level.

6. Conclusion

In this chapter the contribution to the research is presented, together with an answer on the examined research question. Finally, a recommendation of further research is presented.

6.1 Contribution to the research

The concepts of IoT, IoL and services and devices connected to these growing phenomenons have changed the way of living and operating businesses over the last couple of years. Everything today is data and can through technologies like IoL give us the information we need, exactly when we need it. The development from handling physical papers in intermodal freight terminals to not even move a finger have been and still get the same information have gone extremly fast that organizations have not had the time to readjust their businesses.

The purpose of this research project have been to investigate if the usage of IoT solutions could reduce transit times within intermodal freight transport with focus on the documentation handling. The following research have not been presented before and since the usage of IoT is constantly growing and the pressure on more flexible intermodal freight transports continues the two objectives create a unique contribution to the research within both of the fields. This research is contributing to the current literature within both areas with an investigation within a new common area that have not been focused on in a broader perspective or to a larger extent before.

6.2 Answer on the research question

"How can Internet of Things (IoT) enable more time-efficient documentation handling within intermodal freight transits?"

The logistics sector is constantly changing with innovations in many different fields. IoT have been introduced to the industry and is now an established way of working for many organizations and companies within the sector.

IoT and IoL can enable more time-efficient documentation handling within intermodal freight transits due to the transparent data sharing that IoT and IoL services offer today. The implementation of the IVG is seen as one big step into the *real* IoL with a possible reduce of time between 70-20% according to the experts within the field. The reduce is based on many factors but the main time saving activities include reduced errors and better flows of the goods and documents due to the shared information in the IoT and IoL services.

The question is not if IoT and IoL services can reduce the documentation handling time within intermodal freight transport transits but how much in the aspect of time.

6.3 Recommendations for further research

During the research process, the sustainability perspective have been excluded due to the limitations of time. For further research the sustainability perspective of both intermodal freight transport and Internet of Things can be included to add another objective. The sustainability perspective is always relevant when studying logistics but not particularly in the perspective of IoT. The growing demand of Internet due to IoT solutions and 5G networks affects the environment in many different ways and those aspects can be interesting to examine to get a full picture of the development. For this research, the sustainable perspective of IoT was excluded under the same circumstances as in the case of intermodal freight transport.

Further research within the area could also be more technical with focus on how the actual processes work. This perspective was excluded due to a lack of knowledge within the area from the author.

Another perspective further research could take is to examine details in reduced time in a quantitative study where actual data of transits could be used. This was excluded within this research due to lack of data.

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Appendix

Appendix A - Interview guides

Interview questions	
Question 1	What is your current work title?
Question 2	What is s your thoughts on the implementation on IoT and IoL in regards to enabling time efficient transits? Do you think it will have an impact on time and efficiency?
Question 3	Do you see any challenges in regards to the actual implementation of IoT and IoL?
Question 4	Do you think IoT and its related solutions will change the way intermodal terminals will operate?
Question 5	What advantages and disadvantages do you see whit implementing IoT and IoL in intermodal terminals?
Question 6	What advantages and disadvantages do you see whit implementing IoT and IoL in intermodal terminals?
Question 7	Do you see IoT and IoL services operation in the next 20 years or do you see another future development?
Question 8	In regards to intermodal terminals who are the main stakeholders when it comes to implementation of IoL & IoT solutions?
Question 9	Comparing IoT and IoL services against each other what are your thoughts on what services are more important for intermodal terminals?
Question 10	Do you have any other interesting input on the subject that has not been talked about up to this point in the interview?

Appendix B – Introduction to interviews

Dear Sirs/Madams,

My name is Linn Bergstrand and I'm currently writing my master thesis at Handelshögskolan vid Göteborgs Universitet. The main focuses of the thesis are intermodal freight transport combined with Internet of Things and Internet of Logistics.

The research question for the thesis is: "How can Internet of Things (IoT) enable more time-efficient documentation handling within intermodal freight transits?".

The participation is 100% optional.

I estimate the interviews to take 1h and can be conducted over phone, Skype or in person. No compensation is available since it is an academic study.

If you would like to participate in this research I would appreciate it very much!

Feel free to ask me if you have any questions or concerns, I'm available on email and/or telephone +46 708 80 99 58.

Best regards,

Linn Bergstrand

Student – Master of Science in Logistics and Transport Management at Handelshögskolan vid Göteborgs Universitet