THE IMPORTANCE OF PIPE TRACKING OPERATION AT WASCO COATINGS FINLAND

Ways to Improve the Efficiency during Tracking Operation

Anita Aranyász

Bachelor`s Thesis
September 2019
Degree programme in International Business
ABSTRACT

Tampereen ammattikorkeakoulu
Tampere University of Applied Sciences
Degree Programme in International Business

ARANYÁSZ, ANITA:
The Importance of Pipe Tracking Operation in Wasco Coatings Finland
Ways to Improve the Efficiency during Tracking Operation

Bachelor's thesis 57 pages, appendices 1 page
September, 2019

Tracking of items, shipments and every day commodities are getting more and more important in these days. Business environments include tracking and tracing operations to bring the competitive advantages in planning, execution and coordination of the whole business process.

The purpose of the following research was threefold: first, to find out the importance of pipe tracking in the company and understand the main theory which is to have constant link between the information system and the physical reality. Second, to investigate what kind of methods and practices could help to create more accurate and effective mapping and tracking operations and third, to propose a solution for the research problem which was the missing pipe verification.

The thesis used both primary and secondary data collection methods in order to meet the thesis objectives. Semi-structured interviews were conducted with twenty field specialists to promote the creditability of the collected data. The outcome of the research showed that tracking as operation is an essential part of Wasco’s overall business environment. Eventually, the majority of the respondents stated that Wasco has a good tracking operation in place, however, more automation and newer technologies are required in order to promote quicker, effective and more reliable tracking activities.

The findings of the research served as a strong base for the recommendation part. The implementations of GPS reach stacker tracking; automatic pipe scanning and automatic pipe positioning can achieve more solid tracking and tracing operations. Considerably, further research and investigation will be required, as the current research met with several limitations. Lack of time and physical implementation of the recommended tracking practices had not been performed during this thesis work. The objective of the further research process could investigate if the recommended tracking innovations could achieve the extra competitive advantage for the company. Moreover, it could contain the detailed documentation of the piloting process of the new tracking methods.

Key words: tracking operation, logistics, supply chain management, real-time information flow, automation
CONTENTS

1 INTRODUCTION ........................................................................................................6
  1.1 Background ...........................................................................................................7
  1.2 Research problem .................................................................................................7
  1.3 Objectives of the thesis .........................................................................................8
  1.4 Research Methodology .........................................................................................9
    1.4.1 Basic research methods verse applied research method ...............................9
    1.4.2 Qualitative research and Quantitative research .............................................10
  1.5 Thesis structure .....................................................................................................10

2 THEORETICAL FRAMEWORK ..............................................................................12
  2.1 Tracking and tracing operation ............................................................................12
    2.1.1 Need for tracking operation .........................................................................13
    2.1.2 Functionality of tracking .............................................................................16
  2.2 Logistics and supply chain management ................................................................17
  2.3 Modern tracking technology in supply chain management ....................................19
    2.3.1 Paper based tracking and human interaction .................................................20
    2.3.2 Barcode .........................................................................................................21
    2.3.3 RFID .............................................................................................................23
    2.3.4 GPS ...............................................................................................................26

3 THE CASE OF WASCO .......................................................................................27
  3.1 Background of Wasco Energy .............................................................................27
  3.2 Wasco Coatings Finland Oy .................................................................................28
  3.3 Main operations in Kotka .....................................................................................28
  3.4 Pipe tracking in the company ..............................................................................35
  3.5 Evolution of pipe tracking in the company ..........................................................39

4 THE EMPIRICAL RESEARCH ............................................................................41
  4.1 Data collection: Face-to-face interview ..................................................................41
  4.2 Interview process ...................................................................................................42
  4.3 Interview outcomes ...............................................................................................43
    4.3.1 Question number one and number two .........................................................43
    4.3.2 Question number three .................................................................................44
    4.3.3 Question number four .................................................................................45
    4.3.4 Question number five .....................................................................................46
    4.3.5 Question number six ......................................................................................47
    4.3.6 Question number seven ..................................................................................47

5 RECOMMENDATIONS ..........................................................................................49
  5.1 Automation ..........................................................................................................49
  5.2 New tracking technology ......................................................................................50
5.2.1 Practical usage of GPS ................................................................. 51
5.2.2 Automatic pipe scanning ............................................................. 52
5.2.3 Automatic pipe positioning ......................................................... 54
6 CONCLUSION ........................................................................... 56
REFERENCES ............................................................................ 58
APPENDICES ............................................................................ 60
<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>GPS</td>
<td>Global Positioning System</td>
</tr>
<tr>
<td>QC</td>
<td>Quality Control</td>
</tr>
<tr>
<td>ICT</td>
<td>Information and Communication Technology</td>
</tr>
<tr>
<td>LPS</td>
<td>Line pipe supplier</td>
</tr>
<tr>
<td>NS2</td>
<td>Nord Stream 2 Project</td>
</tr>
<tr>
<td>PCMS</td>
<td>Pipe Coating Management System</td>
</tr>
<tr>
<td>PTS</td>
<td>Pipe Tracking System</td>
</tr>
<tr>
<td>RTLS</td>
<td>Real time location system</td>
</tr>
<tr>
<td>RFID</td>
<td>Radio frequency identification</td>
</tr>
<tr>
<td>SCM</td>
<td>Supply Chain Management</td>
</tr>
<tr>
<td>XML</td>
<td>Extensible Mark-up Language</td>
</tr>
<tr>
<td>3LPE</td>
<td>Three layer Polyethylene coating</td>
</tr>
</tbody>
</table>
1 INTRODUCTION

Tracking of items, shipments and every day commodities are getting more and more important in these days. Business environments emphasize the need for tracking and tracing operations more, as it brings the competitive advantages in planning, execution and coordination of the whole business process. Thus, tracking allows optimizing cost and enabling companies to use Just-in-time concept meaning whenever possible no activity should take place in a system until there is a need for it (Christopher, 2011). Without reliable data this concept could not be utilized, so it is crucial to track the quantities, effectiveness and efficiency of the process.

The aim of this thesis is to research and present a case study in the company of Wasco where the movement and tracking of pipes are essential elements of everyday operational processes. The purpose of the following research was threefold: first, to find out the importance of pipe tracking in the company and understand the main theory which is to have constant link between the information system and the physical reality. Second, to investigate what kind of methods and practices could help to create more accurate and effective mapping and tracking operations and third, to propose a solution for the research problem which was missing pipe verification and misalignments between the yard and PCMS tracking system.

Information has always been central to the efficient management of logistics but now, enabled by technology, it is providing the driving force for competitive logistics strategy (Christopher, 2011). The case study presents the basic scope of logistics and SCM as it manages the delivery of the raw product to the yard and coordinates the whole supply until the final product is created, ensuring that the material and information flow is communicated well all the way in the process. Therefore, other important processes like storing, production and tracking of products are well utilized in the company and will be described in the upcoming chapters.
1.1 Background

The following bachelor’s thesis is commissioned by Wasco Coatings Finland Oy. As most of the companies in manufacturing and logistics sector are relying on tracking operations, without full control of these operations they could not manage an efficient logistics network. Thus, inefficient logistics network cause a massive coordination issues in the overall manufacturing and development site. The case company Wasco is responsible for providing concrete weight coating, storing and logistics services for more than 1,200 kilometers of pipes for the Nord Stream 2 project. Ns2 is building a pipeline system in the Baltic Sea with main objective to deliver natural gas from Russia via Germany to European households.

The project is facing continuous logistics challenges as time, accuracy and efficiency are basic requirements for managing successful operation in Kotka. The real-time tracking is essential to handle this demanding activates. Due to the relevance of the tracking operations in the project, helped to formulate the main idea and topic for the thesis, to provide a bigger picture about tracking operations in general and find out why is it so important in the mentioned supply chain.

In today’s changing and demanding business environment, there is a need for extra competitive advantage. In order to get this advantage, companies need to have a closer look of each element in the supply chain and make sure the link and information flow between each segments are reliable and have strong credibility towards the client. Christopher (2011, p.2) states that logistics is the process of strategically managing the procurement, movement and storage of materials, parts and finished inventory and related information flow. The previously mentioned process practiced well in the company with addition of pipe tracking, production and management of supply chain of the overall operation.

1.2 Research problem

Lee and Billington (1992) were among the first people to realize the need and relevance of tracking operations in 1992. They published the lack of capability
of informing customers on the progress of their orders as one of the most severe pitfalls of SCM. Delivering information and reliable data to customer and database can happened only if needed information is collected and communicated well among the processes.

The case company is using different kind of tracking methods to collect the required data about each pipe and deliver the collected information to the Pipe Tracking Management System (PCMS). The whole process can happen only if the place of the verification happens, meaning the required interaction between the pipe and the device need to happen in order to receive the latest position, time and quality status of each pipe.

Therefore, there was serval occasions where this verification was missed out, so certain pipes were moved without notification of the movement so the change of location had not been recorded to the system. Due to this, the pipes got lost in the yard of Kotka. The following problem gave the idea for the thesis to investigate the risk of missing verification and prove the importance of the main theory to have constant link between the information system and the physical reality.

1.3 Objectives of the thesis

The main objective of the thesis is to provide general picture about tracking and tracing operations by the means of literature and experience acquired in the company. The research will outline why pipe tracking as operation is so important elements of Wasco’s everyday operational processes. It will identify the current problems in tracking operations and propose a practical solution for the problem. The initial research questions of the thesis in this stage is to understand the importance of the tracking operations and find out what would happen if the tracking operations would not been monitored properly.

Furthermore, what methods and tracking practices could help to improve the efficiency of pipe tracking in the case of Wasco. Considering the fact that there has not been any research performed on this topic for Wasco; therefore the thesis will focus and conduct the research on existing theory and knowledge
collected during practical training and two and half years of working experience and additional information acquired from interviewing the workers in the company.

1.4 Research Methodology

There are different kinds of research methods which can be applied for the final thesis. It can be applied research or basic research; we can also talk about qualitative and quantitative research methods. Each research method has its own characteristics and can be utilized for different projects and research works. Next chapter will shortly outline the main characteristics of each method and present which research method will be utilized in the current thesis work.

1.4.1 Basic research methods verse applied research method

Every research process starts with initial problem and research question which requires to be answered. According Johnson and Christensen (2012), basic research and applied research are mainly conducted in universities, firms and corporations. The two research methods have their own characteristics so they applied for different studies.

The basic research creates the foundation of fundamental knowledge and theoretical understanding of basic human and everyday processes. However, applied research is used to solve practical issues by answering for the research question and suggesting some solution. Johnson and Christensen (2012) further explain that basic research used for contribution of social science and research action which driven by curiosity and desire for more knowledge. On the other side, the applied research is used in fields like agriculture, technology and medicine with the main purpose to answer a specific question.

In the case study of Wasco, applied research will be used aiming to solve a practical issue and find out why tracking operation is so important in the company and how Wasco could achieve a more effective tracking operation.
1.4.2 Qualitative research and Quantitative research

Qualitative research which also called exploratory research is mainly used to find out more information about a phenomenon with a subjective view. In this method, the researcher defines the exact research problem and tries to find more in-depth information about the topic without any amounts or measurements.

Quantitative research focuses for numerical measurements and aspects of the phenomenon. The researcher observes and measures the data without contaminating the research with personal involvement (Thomas et al. 2003). However, personal involvement is very important in qualitative research as one of the main data collection methods like interview and observation requires personal involvement to collect all the required information.

There are different types of interviews which can be used during research work. Structured, unstructured, semi-structured and focus group interviews which all depend on the characteristics of research questions. In the current thesis semi-structured interviews were conducted with field specialists, logistics co-workers, PTS supervisors and QC engineers in order to collect more valuable information about the operation from their prospective and suggestions for better and more effective tracking operations. The chapter four will provide the overall process of the interviews and present the main outcomes of the information acquisition.

1.5 Thesis structure

The thesis is divided into six different chapters with a common aim to understand the importance of the tracking operation in Wasco and to find some new tracking practices which could help to improve the efficiency of the pipe tracking operations in the case company.

The first chapter will provide brief background information of the thesis and serves the reader with all the basic information about logistics and tracking operations in general. It will continue to explain the research problem and formu-
late the main objectives and topics which will be applied for the thesis. It will be followed by the research methodology and description of the different research approaches and an explanation of the chosen research methodology.

The second chapter will focus on the theoretical framework; it will present the nature of tracking and tracing as main concepts by the means of literature. Moreover, it will show the main functionality of tracking as phenomenon and formulate a bigger picture about the importance and need of tracking operations globally.

The third chapter will provide an overview of the case company, it will show the company’s background, its main operational activities and outline all the currently used tracking practices. The fourth chapter will refer to the empirical research with an aim to provide all the information for the thesis objectives, supported by the interviewee from the case company. Furthermore, the interview outcome will be analyzed and summarized in a structured manner. The fifth chapter will highlight the recommendations and future improvement ideas which can help to create more efficient and solid tracking operations in Wasco. The last and the final chapter will lead up for the final conclusion to evaluate the overall research process and summarize if the objectives of the thesis have been accomplished. It will outline the main findings of the research and provide the answer for initial research questions.
2 THEORETICAL FRAMEWORK

The aim of the upcoming chapters are to provide a comprehensive picture about the body of the thesis, studying the phenomenon of tracking operation by means of literature and demonstrate all the theories and concepts which are related to the case study.

Tracking and tracing are the key concepts of the research which play a huge role of managing logistics networks efficiently. In order to understand the research in question it is crucial to define the main characteristics and need of tracking operation in general. In the case company where each component needs to be identified in each step of the supply chain, it is essential to have accurate and efficient tracking operations in place. In addition of the tracking operations, logistics and supply chain management will be described to be able to draw the overall picture of Wasco`s operation.

2.1 Tracking and tracing operation

Tracking and tracing as terms are many times mentioned together, however there is clear distinguishing between the two processes. Tracking is the process of gathering and presenting information on the location of delivery items in distribution network or supply chain (Deschner, Hofman, Reiheimer, and Bodendorf, 1998). Tracking is mainly follow a product and collect all the relevant information about the product, until tracing is mostly retrieving the already tracked information.

The case company mostly practices tracking operation to collect the data about each individual pipe and secondary they also use tracing operation to search back for information or link between the collected data. Stefansson and Tilanus (2001) indicate that tracking systems are required for co-ordination logistics as they create the connection between the information and the physical reality in the supply chain. The previously mentioned link and creation of the link is one of the main important tasks of tracking operations. The benefits of real-time location system (RTLS) attract plenty of interest from companies, who looking to
manage their inventory, assets and overall business operations in a better way. Over the next 10 years, the RTLS market is growing enormously as more innovative technologies are appearing to the market which become more affordable and portable for the companies. According to IDTechEx, the RTLS market will jump from $30 million in 2005 to $2.71 billion in 2016 (Gambon, 2006).

Tracking and tracing operations, start to play bigger and bigger role in company’s operation as their functionalities go beyond better inventory visibility and management of quality control. Nonetheless, tracking offers theft prevention, improve customer service, safer and more reliable working conditions on production facilities. The next chapter will present more facts and examples why tracking operations are required to run a profitable business and prove with several case studies that how important to include tracking as operation to achieve the company’s business objectives.

### 2.1.1 Need for tracking operation

There are several reasons why tracking operation is so important part of company’s operational processes. The ability to coordinate the flow of goods in real-time and provide information of shipment status, quality and quantity are essential requirements of a sufficient supply chain management. Tracking is needed to minimize cost, quality issues and to manage product liability risks and fulfill customer requirements. Customers in today’s world are keen for information regarding their purchased products, they would like to know where their products are and when they will be delivered.

FedEx was among of the first companies who realized the need for tracking system in early 1990s to be able to add extra value and service to the customers with capability to provide more information regarding their products. The following figure (figure 1) will show the road map of e-logistics and data management and emphasize how tracking operation is related to this process.
Wang and Pettit (2016) demonstrate that several companies have lack of confidence in their data, meaning their data are incomplete, inaccurate and having lack of timeless. In the efficacy stage, clear picture shown that for a successful management operation tracking is so important, without a proper data collection, without real-time information flow is not possible to go to the next stage which is making effective decision making. Without data, comprehensive information of product, service and process there is no sufficient information available to run an effective business operation.

Wang and Pettit (2016) further explain while efficacy deals with “getting the right data”, efficiency focus for “doing things right” and effectiveness indicates “doing the right things”. In Wasco, at the receiving (first stage of the operation) if a pipe is not scanned to the system, meaning the pipe information does not get into our database it causes several further issues. No proper planning of production can happen as the quantity of pipes on yard is inaccurate. If the production is not performing the required quantities, it causes big misalignments in the final stage which is load out operation where the company cannot provide enough pipes for the laying barge. Without tracking and proper data, there is less visibility and transparency in the process which leads to an unsuccessful business operation.
Tracking as operational practice is commonly used in so many industries especially where some sort of logistics operation is present.

Each operation track and trace their production and logistics segments carefully to keep the overall process together. Car production is one other example where the management of the whole supply chain is vital. To follow the flow of goods and track how the raw material transforms into the final product would be impossible without proper tracking operation in place. In order to achieve a sufficient supply chain management, companies realized they need to implement newer tracking technologies which can deliver significant reward in the company’s operation. By integrating RFID technology to the assembly line, Club Car has cut production time per golf car to 46 minutes from 88, improved its ability to customize cars and saved millions of dollars (Collins, 2004).

Club car is an American golf car producer who is manufacturing more than 100,000 golf and utility vehicles a year. The company decided to invest to RFID technology to redesign its manufacturing process to achieve faster production and overall control of the processes and logistics operations. By deploying RFID technology throughout its production line, Club Car completely redesigned the whole way how cars are produced. Introducing just-in-time material delivery and improving the ability to customize vehicles were one of the biggest outcomes of the investment. The old system required more human interaction which slowed down the overall processes, barcode labels were attached to each golf car and the workers used a handheld barcode scanner to track each vehicle. The new system provides a completely automated production line which moves the vehicles through the production process. The help of RFID tags and readers at each station support the verification of the manufacturing processes by making sure that all the work and parts are fitted to each vehicle during all the workstations (Collins, 2004).

Without tracking operation and automation car production would be hardly executed in these days. New tracking technologies provide confidence, higher production rates, capability of using just-in-time production model and major cost reduction in the whole supply chain.
2.1.2 Functionality of tracking

The previous chapter outlined the need and importance of tracking operations by showing different practical examples how companies could achieve extra competitive advantages during their operations. Meanwhile, the current section will show the main elements and functionalities of different tracking activities. Tracking as operation, has gone through several changes and improvements over the past few years, as modern technologies and automation have appeared in the working environment. First, tracking was more manual and paper oriented operation but the current tracking technologies introducing paper-less systems which helps to save our planet and reduce waste, regarding business operation it improves the accuracy of information.

The main functionality of tracking operation is to collect different kind of information of certain product, person, process in different location and in different time frame and then transfer the collected information to a management system which helps to retrieve, analyze and summarize the result of the operation. Tracking is registering the movements of certain items on different check points. When a tracked item, product appears to a checkpoint, three basic attributes required to be registered to the tracking system.

First and one of the most important elements of the tracking is the identity of the item at the checkpoint. Identity can refer to a number, letter, serial number, symbol or any kind of identification which makes the product/person unique and easily identifiable from another product/person. Mainly in the past but also nowadays, couple industries still simply print the ID to the surface of the product resulting visual inspection and paper verification. There are several other ways how the products can be identified by using barcodes, RFID tags, GPS transponders which makes the verification process much faster, accurate and more reliable.

Second attribute of the tracking operation is location. We can talk about county, city, exact street in the city, room in the company and also exact shelf in the warehouse. The definition of the location is endless in the terms of tracking. When a certain product, person or process appears to a new location the latest location has to be recorded and updated to the database. The third characteris-
tic of tracking is time. It is crucial to record the time of arrival at the checkpoint. Time is important factor in the tracking environment as the product can be tracked when it left the origin of the place and when it arrived to the final destination. Management system receive the tracked information and capable to provide different kind of statistical information like how long did it take for the product to make the required route, did it performed within the estimated time, during this rout how many checkpoints, stations it went through.

However, there are several other characteristics which can be recorded like quality, quantity, weight, temperature of the product, any defect on the product any specific requirements of the product like pressure, vibration and humidity. In the case company, next to the main three tracking elements (ID, place and time) the quality of the product are continuously tracked and recorded all the way in the production line. When the basic information is collected about an item, the next step is to register and send all the raw data to the tracking system. There are several ways how the data can be transferred to the database. However, one of the most convenient and commonly used way, what Wasco is also using is to send the collected information through automatically performed queries which configuring XML message what can interface with the tracking system.

There are handful methods and technology to register the identity, location, time of certain products. The following sections will present the most frequently used tracking technologies in supply chain and describe each method in details. However, before the clarification of the tracking methods is important to get familiarized with the basic terms of logistics and supply chain management.

2.2 Logistics and supply chain management

Logistics is essentially a planning orientation and framework that seeks to create a single plan for the flow of products and information through a business (Christopher, 2016). There are several definitions about logistics and its practices which involve information flow, material handling, production, packing, inventory, transportation and more. Giani & Laporte (2013, p 4) refer to logistics as a discipline that studies the functional activates determining the flow of materials
and the relative information in a company, from their origin at the suppliers up to delivery of the finished products to customers and to the post-sales services.

Christopher (2016, p.3) further highlights that supply chain management builds upon this framework and seeks to achieve linkage and co-ordination between the process of other entities in the pipeline, i.e. suppliers and customers, and the organization itself. Supply chain management is built around logistics management with the main purpose to coordinate all the logistics activates as well as integrating activities like marketing, operation management, finance and other important factor like information technology.

The following figure (figure 2) will present the relation between logistics and SCM. As described above logistics is relevant part of supply chain management which handles everything regarding the physical movement of goods. Logistics focus for low cost, just-in-time delivery and provide all the assurance that the product arrives to the final destination within the expected condition. Until supply chain, as a field, involve a wider strategic of everything such as shareholders, procurement, manufacturing, warehouse, sales and developments and consumers to maximize the product success and market entry.
Logistics and supply chain management can work efficiently if information is collected and distributed well within production processes and supply chains. The previous chapters already highlighted why it is so important to emphasize tracking operation in logistics service until the following chapter will provide an overview of modern information and tracking technologies which can be used efficiently to collect and distribute the needed information in different supply chains which can lead for extra competitive advantage what every business environment is aiming for.

2.3 Modern tracking technology in supply chain management

Information systems are reshaping the organization and also the nature of linkage between organizations (Christopher, 2011). In addition, from Christopher (2011, p 146), information has always been central to the efficient management of logistics but now, enabled by technology, is it providing the driving force for competitive logistics strategy. Without the support of information and communi-
cation technology (ICT) it is remaining difficult to accomplish high level of visibility, responsiveness and effectiveness as the figure 1 presents in chapter 2.1.1.

Today’s technologies like electronic data interchange (EDI), global positioning system (GPS), barcode and radio frequency identification (RFID) have a huge impact on logistics and on tracking operations. Several technologies have created the opportunity and links between products and users and users between logistics and tracking systems. These technologies include cellular networks and satellite systems, Wi-Fi, UMTS networks, 4G/LTE and WiMAX (Yingli and Stephen, 2016).

The previously mentioned technologies serve a strong base for track-and-trace capabilities, which increase the success in companies in terms of productivity, transparency and reliability. Sourcing and procurement, packing, distribution, inventory control, forecasting, transportation and logistics are all the operations which require serious integration and data transfer in different supply chains. Creating the link and information exchange between these operations is still challenging for the companies in these days.

New technologies and innovation are appearing in the field with purpose to create more efficient workflow and error-free processes. The next chapter will provide a brief review the most commonly used tracking methods and technologies starting with the old paper based tracking till the latest innovation in the today’s supply chain management.

2.3.1 Paper based tracking and human interaction

Technology and sophisticated devices were not always around and promoting logistics activates. Tracking in the past had been operated using paper, pen and visual verification with the support of human labor. In later stage, when excel arrived all the manually written data had been manually inserted to different excel sheets in order to keep, use and analyze the collected data. Speed, accuracy and reliability of the data were in question in the past and required definite improvement as manual operation always resulted error and incorrect data input
As the need was bigger and bigger for faster and more accurate operation, technologies like barcode, RFID, GPS started to appear and take over the data collection and tracking operations over human labor. Current innovation doesn’t necessary means that no human interaction needed it only emphasizes that human and technology require to work in relation to maximize the outcome of tracking operation. Humans always required for coordinating the process and overall flow of goods. Next chapter will show the first innovation in tracking technology, barcode as data collection method which are still widely used practice in these days.

2.3.2 Barcode

There are several ways how the data can be collected and transferred to the tracking systems. Stefansson and Tilanus (2001) state that barcoding is the most used identification technology in tracking. Barcode system exists in logistics sector long time ago to identify products and locations in the supply chain. There are two different barcode technologies which can be applied in logistics operation. Mainly depending on how much information is required to be shared about a product.

Barcode system is half way in automating the data capture as it cannot be fully automatized due some reading requirements of the barcodes. The barcodes cannot be covered during reading process and scanning also has to happen on line-of-sight. Scanner and the product have to be close to each other which are typically measured in inches in order to get the barcode scanned. Most popular barcode type is the linear or one-dimensional barcode which the case company uses as well (picture 1). One-dimensional barcode is capable to contain only limited amount of information up to 30 characters.
Barcode is commonly used tracking practice however it result multiply problems due to weather conditions (picture 2). When the weather is too extreme, it is difficult to scan the barcodes as too strong sun can cause fading in the ink of the barcode which make the barcode hard or even incapable to read. Snow and rain can cause similar complications if the product has to stay and stored outside.
The second version of barcode system is the two-dimensional (2-D) barcodes. This type of barcode used when more information and details of a product needed to be stored. This barcode type has data capacity up to 3,000 characters. Generally between those data there is a QR code which can refer to an URL address to provide a link to a website to get more information and tracking details about the product.

Barcode system appears many areas in the logistics sector, good examples are airports. Shipments and luggage are still labelled with standardized barcodes and scanned all the way in the airfreight supply chain. There had been several trials to use the newer tracking methods like RFID system but they have faced with multiply issues as there is still no any universally adopted RFID tag which could be used over several airline so currently this system can be utilized only at individual airlines and airports. There are plenty of examples where companies receive more benefits from RFID system over the barcode technology. The next chapter will describe the main functionality of RFID system and show what competitive advantages RFID technology has over the barcodes.

2.3.3 RFID

RFID technology has a long history to look back with roots of 1879 when normal radio had been invented. Bhuptani and Moradpour (2005) explains that RFID applies the same principles of physics as those used in radio broadcasting, where radio waves, a form of electromagnetic energy, transmit and receive various types of data. For electronic data collection in RFID technology three basic components are required. The transponder or commonly called RFID tag, the receiver or the reader and the antennae.

RFID technology is commonly used in supply chain and in logistics activates to track items and processes, improve visibility and transparency in the operation. However, it also implemented in many other sectors like healthcare, safety, education and many other industries. In healthcare there is a big tracking operation towards commonly lost items like wheelchairs and machinery and also in better hospitals after child birth the mother and the baby get an identical RFID bracelet including the same tag to make sure not loose each other or swap ba-
by to different mother like happened in the past. Also RFID technology is used to monitor and track the location of elderly or disabled people in hospitals and in healthcare centers.

Other example where RFID technology is successfully utilized is sport events. RFID tags on competitors, on runners enable to record an accurate time in each different running, cycling and motor events. Also in wildlife, scientist use RFID tags to track and follow endangered species, RFID technology helps to collect useful information where and when the animal is situating in specific time of the year and collect as much information as needed for different studies. RFID is used to help many practical issues or avoid any issue to happen but of course biggest use is still in logistics and supply chain environment. RFID technology is an ideal enabler, to help to track the movement of products through the link in the supply chain, inspect and analyze the data collected from RFID tags, act upon the data, and potentially add or associate more useful data to the tags that can be used at the next link in the chain (Bhuptani and Moradpour, 2005).

In terms of RFID system we can talk about active and passive tags. Active tags are used when the information about a product or a person is required in real-time. This system depends on a power source which receives the signals continuously. Passive tags do not require any power source as the readers send a radio signal to activate the tag when it is needed and after the same reader receives back the signal and the information from the tag.

The following table (table 1) will present and describe the main functionality of RFID system and show what competitive advantage RFID has over the bar-codes.
TABLE 1: Differences between RFID and Barcode technology

<table>
<thead>
<tr>
<th>RFID technology</th>
<th>Barcode technology</th>
</tr>
</thead>
<tbody>
<tr>
<td>RFID require no line of sight during scanning</td>
<td>Barcode reading require line of sight during scanning</td>
</tr>
<tr>
<td>RFID can scan many item at the same time</td>
<td>Barcode can scan only one item at the time</td>
</tr>
<tr>
<td>RFID is capable to scan item when it is moving</td>
<td>Barcode can scan item which is stable and not moving</td>
</tr>
<tr>
<td>RFID handle environmental issue like rain, sun, coldness</td>
<td>Barcode cannot handle hard environmental issues</td>
</tr>
<tr>
<td>RFID have reading range up to several meters</td>
<td>Barcode has reading range up to couple of inches</td>
</tr>
<tr>
<td>RFID is capable to add new information to an existing tag; it has read and write mode</td>
<td>Barcode cannot be updated with new information, new barcode has to be applied, it has only read mode</td>
</tr>
<tr>
<td>RFID tags are reusable as many times</td>
<td>Barcode cannot be reused</td>
</tr>
<tr>
<td>RFID tags can be applied more easily to any surface</td>
<td>Barcode can be applied on straight / flat surface</td>
</tr>
</tbody>
</table>

Source: Bhuptani and Moradpour (2005)

The table presented many aspects where RFID can be better choose in terms of tracking as it is capable to capture information more efficiently with better circumstances. However, it does not mean that barcode system is not functioning well. There are several companies, where barcode still appear as the number one tracking method with successful outcome. At Wasco, the combination of barcode and RFID system works in pair to maximize the efficiency of data collection and transparency at yard during production operation. To find the perfect tracking method is important to understand what the need is and how important the speed, accuracy, cost and automation.
2.3.4 GPS

Global positioning system is a satellite-based radio navigation system which is a frequently used tracking method. First it was mainly used for high-value, temperature-sensitive products but nowadays GPS used universally in different industries. GPS not only track a position of a certain item it also monitor temperature, vibration, barometric pressure, light exposure and humidity (Wang and Pettit, 2016). GPS works independently so no human interaction is required when sufficient internet is provided as it transmits the geolocation and time information to a GPS receiver anywhere in real-time.

Queensland Rail in Australia provides the MyTransLink app for commuters to maximize real-time tracking of consignments with improved tracking information which provided by 2,670 track check points across the network, up from the previous 447 (Probert, 2019). With the help of GPS passengers can see continuously their train on an interactive map and help to plan and execute their journey better.

Many industries realized the importance of tracking operation for custom satisfaction and capability to provide real-time information of a certain items. GPS is definitely one of the most sufficient modes of tracking if the information required anytime and anywhere in order to have control over a product or person by instant information exchange.
3 THE CASE OF WASCO

3.1 Background of Wasco Energy

The following chapter will introduce the case company in details. It will present the size, the nature of business and all the main operational structure of Wasco.

Wasco Energy is a leading integrated services group primarily serving the oil and gas industries. Wasco is operating with its headquarter and central office in Malaysia. However, the main business operations are supported by a huge operational network in 18 international locations including Canada, United States, Finland, Norway, Greece, Germany, Arab Emirates and several other countries who are committed to provide effective and efficient pipe coating and other engineering solutions (Wasco energy, 2019).

Wasco is operating with its main mission of providing reliable and competitive products, services and solutions to the markets, while continuously creating value for their customers, employees, shareholders and other stakeholders with positive impact on profit, people and planet (Wasco energy, 2019).

Wasco energy group provides the following business operations:

- Pipe Coating
- Asset integrity
- Pipe manufacturing
- Engineering solutions
- Modules for Offshores & Onshore installations
- E-house & Modular Building
- Compression & PowerGen
Aftermarket services

Leasing and Rental

3.2 Wasco Coatings Finland Oy

Wasco Coatings Finland Oy started its operation in 2016 in Kotka to supply concrete weight coating, storing and logistics services for more than 1,240 km of pipes for Nord Stream 2 Project. In port of Kotka, Wasco employed over 400 people to be able to utilize all the requirement and coating operations for the Ns2 project.

Nord Stream 2 is a planned pipeline through the Baltic Sea which is planning to transport natural gas over 2400 km from the world largest gas provider Russia though the most efficient route to European consumers. The pipe line will start from south-west of St Petersburg and ending in the German coast of Greifswald. Ns2 project will help to transport 55 billion cubic meter of gas per year which will helps to serve over 26million European households. Ns2 and Wasco are big part of the Europe’s objective to have a more climate-friendly energy mix as the built pipeline will transport natural gas which will be low of CO2 emission (Wasco energy, 2019).

3.3 Main operations in Kotka

The previous chapter described briefly the nature of Wasco and the purpose of Nord Stream 2 project until the current chapter will go into details of Wasco`s main logistics operations and workflow to understand the need and importance of tracking operation while incorporating practical examples where pipe tracking was not practiced well and caused further issues.

Main operations in chronological order:

- Load in operation of raw pipes
➢ Pipe storing in the yard

➢ Pipe coating operation

➢ Pipe mapping in the yard

➢ Transshipment to the ready product to Koverhar

➢ Load out the ready product to laying barge

In November 2016, Wasco has received the first shipment of 3LPE pipes via rail which contained 295 joints of pipes. The load in operation of the raw pipes continued until mid-2018. During this period Wasco had received over 101,000 joints of 3LPE pipes. The load in operation was one of the first operations where Wasco faced with challenges as continuous pipe movements, quality inspections of the raw pipes and stock piling, mapping and tracking of the pipes required professionally skills in logistics, PTS and quality department. Accuracy, efficiency and time were huge requirement of load in operation.

During load in operation the first identification of the pipes had been performed including an extensive quality inspection to make sure that each raw pipe was in acceptable condition and ready for the concrete weight coating operation. There had been several mistakes, missing verification, wrong barcode scanning in that stage, which created huge effect for later planning and coating operation. This phase already emphasized how important the tracking operation in Wasco. Each pipe is unique in the project meaning all of them have its own pipe number/ pipe ID to ensure the whole planning and resource management for the pipe line is accurate and secured. Pipes in that stage were placed with barcodes inside on the flow coat of the pipes (picture 3).
In the first inspection PTS inspectors scanned the barcode with a zebra scanner to make sure the pipe ID for each pipe and the result of the inspection are recorded to the database. If the pipe is not scanned in that stage to the database the further production station will not be aligned with the reality. There had been several cases where pipe missed the scanning of the first inspection so when the pipe arrived to the second operational phase which was pipe stacking and stock piling the system was showing system alarm that “pipe missing previous inspection status”. The first verification of the pipes were vital as without that scanning operation the pipes could not appear to our database which blocked the whole further operational and logistics operations. As mentioned previously this missing verification had happened several times due lack of attention and too much human involvement in the process.

After pipes had passed the load in inspection, pipes started to head towards the yard for the next operation which was pipe storing and stock piling. Specifically modified trucks are used to transport the 3LPE pipes and the offloading of the pipes at the stacking area carried out by using of reach stacker which capable to carry and lift heavy items. The following picture shows the yard of Kotka, detailing each storage area of the yard where the pipes had been transferred. Different fields (A, B, C, D) had been identified for easier yard verification and for sufficient pipe tracking purposes.
Each field contains several stacks where certain amount of 3LPE and CWC pipes had been delivered. The numbers of the stack in the yard depend on the size and type of the area. The following picture (picture 5) shows the detailed map of the A field where over 20,000 jts of 3LPE/raw pipes were stored. At the moment we can find 14,000 CWC pipes as the production operation was already completed by 2019 April. Currently on the yard of Kotka mainly concrete weight coated pipes can be found.
PICTURE 5. Map of field “A”

Source: Wasco 2019

Stock piling of the pipes depends on what production status the pipe is. Before the production of concrete weigh coating, all the pipes were raw/ 3LPE pipes which gave the possibility to stack them up till five layers. However, after production line, the concrete weight coated pipes could be stacked up only to four layers due to the higher weight and tension to each other so in the end, less CWC pipes could be fitted to certain stacks.

When a stack got full, the mapping crew went to map the exact layers and positions of each stack in order to identify what is the exact position of each pipes. As pipe’s tracking team job is to know each pipe location all the time, including the capability to provide all the locations and quantity statuses of the final products on the yard. However, in the mapping process there had been several occasions that pipes were missed to scan as this operation was completely manual operation. Missing pipe scanning and position identification caused misalignment between the pipe tracking system and the physical reality.

The importance of the tracking operation had been outlined by all departments in the company, as all operation connects together and the link between these operations are promoted and supported by the tracking team. Without proper pipe details, locations and quality circumstances of the pipes would have a huge influence on production, logistics, quality department, purchase department and custom department.

The following picture (picture 6) will help to understand how the stacking operation is being performed at Wasco, how the stack, layer and position is defined in the company.
By March, 2017 Wasco received sufficient amount of 3LPE pipes enabling the concrete weight coating operation to start. Pipes had been transferred from the yard to the coating plant for the production process. When the raw pipes entered to the factory and the ready pipes left the production area, each pipes was recorded and scanned to PCMS for tracking team to know how many of the were unmapped in the yard which promoted a new mapping operation to identify the final location of the ready products.

During the production process, the pipes were required to go through on different production phrases, all together seven production stations were mandatory for each pipe. The tracking operation had to continue inside the factory as well. The PTS team needed to know on which production status a certain pipe was and needed to make sure that each pipe passes all the station in a good quality condition. Tracking operation was responsible for double confirmation that there was no any pipe which skipped the required production steps. This confirmation and verification could not happen without tracking technologies. There had been several cases, where operator missed to perform the scanning and the inspection of a pipe, but when the pipe arrived to the next station, the PCMS was alarming that previous station of the pipe had been missed, so the process could not continue. These occasions, highlighted the fact, if there would not be any tracking operation inside the factory it would cause several misalignments.
The operator in each production panel was required to scan the barcode, in the later stages the RFID tag to the database for tracking and quality purposes as in each station the final status of the pipes had to be given to evaluate if the pipe got accepted, hold or rejected quality status for that production stage.

After the second station, the pipes had been placed with end caps to protect the pipes internal cleanliness and quality conditions. Due to this operation the barcode was not fully visible any more so new tracking technology had been implemented. Passive RFID tags had been placed to the surface of the endcaps which were used until the last phrase of the project which is the final load out operation to the laying barge.

After pipes had been coated and delivered to the yard, the PTS team performed the last mapping operation. After one year of production, Wasco reached a big portion of the CWC pipes which allowed the transshipment operation to start. The pipes required to be transshipped to Hanko to an interim storage area to fulfil the laying barge in better and more sufficient way at later stage. During the transshipment operation it was crucial to have proper tracking operation in place, in order to know which pipes had left the yard of Kotka and to present how many pipes had been totally sent and located in Hanko to plan the further load out operations. After transshipment completed, Kotka had started the final load out operation which is currently on ongoing operation when the thesis is written.

Load out operation is the last and final operation in Kotka. Ready products are required to be sent to the laying barge for construction of the pipeline for the Ns2 project. Load out operation requires the biggest coordination and focus from logistics and PTS team as in this stage a small problem, delay can cause huge financial issues. In the final stage the importance of tracking operation emphasize even more. The exact location of each coated item is crucial, not to mention that there is no more time for mapping and searching for pipes when the vessel is in the port as Wasco is in title to provide the pipes for the vessel on time and without any delay. The whole logistics and production operation goes hand in hand with the tracking operation. If tracking and tracing are not done properly it has a massive consequence of the other operations to a negative
way. The next chapter will continue to explain how the tracking as operation is performed in Wasco.

3.4 Pipe tracking in the company

The previous section defined the main operations in Kotka, with the current chapter, the reader will get clear picture how the whole mapping, tracking operation is happening. What kind of tools and management systems had been implemented in order to coordinate the big amount data and information about each pipe.

The movement of pipes from one operation to the other happens continuously and simultaneously. Any time, when a pipe is moved from one station to the other and from once stack to another, the location of the pipe is required to be updated. In Wasco, the whole mapping and tracking operation is happening in manual way operated by humans. In first operation which was the load in operation, pipes were scanned and identified by 1-D barcode scanners. In the inspection platform the scanning of the barcode to the database did not cause any issue, however the mapping of pipes in the stack by using barcode scanner was not the most efficient operation.

The section 2.3.2 already outlined the difficulties of barcode technology like reading complication, the line-of-sight scanning method which caused several issues in the higher layers. It was extremely difficult to scan if a pipe was moved to a different angle so the barcode was not located at 6 o’clock position. The mapping operation of 3LPE pipes required ladders, forklifts to reach the higher layers for scanning and verification of the barcodes which made the whole operation very slow with several manpower and extra machinery resources and not to mention when the weather was too sunny or rainy it increased the complication of the scanning process.

Eventually, when the pipes entered to the coating factory the barcode tracking method was used until the first two stations. First station of the production line was an intense washing operation of the pipe’s internal, to make sure the pipes are cleaned and ready for the further stations. However, this washing operation
was using a brushing system that washed away the printed barcodes several times when the barcodes were not applied correctly in the LPS factory (picture 2).

The second station in the production line started to use a more trusted system which was the RFID system. Pipes were placed with passive RFID tags which gave the freedom of scanning as the pipes could be scanned from further distances, no line-of-sight scanning was required which made the whole operation much faster and more reliable.

When the pipes arrived to the final station, pipes were scanned to an “Out-bound” location so the tracking team always knew how many pipes arrived to the yard and require mapping operation. However, to find out the right stacks where the pipes had been stacked up was not always the easiest task. Logistics coordinator and supervisor were responsible for the entire stack planning and decision making for stack utilization for each day. After each production day, logistics supervisor informed PTS supervisor that today those stacks had been used so the mentioned stacks could be mapped. Sometimes when communication was not practiced well, stack details were forgotten to be informed to the tracking team, so they were searching for full stack sometimes without any success, resulting stacks which missed mapping operation.

When the information arrived correctly, tracking team arrived to the stack and they started to scan each layer one by one using the RFID scanner, which made the whole operation faster and more reliable. Each pipe has RFID tag on both sides for double conformation, so each time tracking team scanned both end of the pipe to make sure each pipe has the correct RFID tags on place. Generally, to a normal stack around 280-300 joint of CWC pipes can be stacked and the mappings of that example stack took around 20-25 minutes.

When the stack had been mapped, the team provides the tablet which was connected to the RFID reader to the supervisor who uploads all the mapping details to the PCMS. Pipe coating management system is the main system for tracking, coating and overall controlling of Wasco’s operation. They system been programmed by Wasco programmer to customize for each operation to achieve maximum outcome and operational support. Before the mapping file
could be imported to the PCMS, PTS supervisor is required to modify the excel documents and customize the content for the system.

When the mapping file is uploaded by the supervisor, PCMS collects and organizes all the information received from each individual pipe. The picture (figure 3) shows an example where the movements of the pipe VP200443 can be seen. PCMS records the above mentioned three basic attributes of tracking (2.1.2 section) like VP200443 arrived to D26 stack in 17.1.2018 then couple months after the pipe had been moved to D17 in 15.5.2018.

FIGURE 3. Screenshot of PCMS showing pipe location

![Screenshot of PCMS showing pipe location](image)

Source: Pipe Coating Management System of Wasco 2019

The next example, where PCMS clearly states that VP200443 were at Incoming Rack at 2017, 28th of March and the inspection result of that stage was accepted. Later, when the pipe arrive to the concrete coating station it got rejected status as the quality of the coating did not meet the project quality requirements(figure 4).
Without PCMS, the tracking and tracing of the 100,000 pipes would be impossible or at least would require more time and manual input. PCMS can work efficiently if the correct data is imported and continuously updated. There had been several cases where a certain stack required destacking operation due safety reasons so logistics team moved 20 pipes out from that stack and moved to another stack. Most of these small movements were not communicated to the tracking teams so the system showed in that stack there were still 100 joints but in the reality there were only 80 joints.

These kinds of operations caused several misalignments between the PCMS and the physical reality which gave the main objective to this thesis, to find out how the mapping operation could be improved to be more efficient and how the differences between the system and the reality could be reduced to achieve better control over the yard and the pipe movements.
3.5 Evolution of pipe tracking in the company

The following chart (figure 5) will help to demonstrate the main purpose of the thesis with a timeline by showing how the pipe tracking had been developing in the company during the years and what could be the next step and development in the means of technology and practical methodology.

FIGURE 5: Timeline of pipe tracking at Wasco

In the beginning of the project when the first pipes arrived to the yard there was no any mapping operation on place. With time, it was obvious that there was a need for some sort of mapping and tracking operation in order to have good knowledge over the yard, to know exactly how many pipes were on the yard in each day.

First, paper-orientated mapping was used which caused incorrect, unreliable and slow data collection and data input. In later stage, the barcode scanning was utilized by connecting to a laptop which required to be carried all the way to the field. This method was more reliable and easier on the first layers of stacks, however, the higher layers caused some difficulties due to holding the laptop and finding the perfect angle for the barcode scanning. The next stop in the mapping improvement was to use small tablets which were connected to the barcode scanners via Bluetooth to simplify the overall operations. When the pipes arrived from the factory as ready products, new tracking technology had
been used. Passive RFID tags were placed on each pipe’s end which helped the tracking team to use RFID scanner which had much better, reliable and convenient scanning result.

The final tracking and mapping method what Wasco is practicing at the moment is RFID technology with a coordination of tablet and google drive. Each tablet is logged in to a google drive and during the mapping operation a google sheet is used to collect the scanned pipe details. The google drive gives capability to the office people to see the mapping operation in real-time and get more information which stacks are mapped, and which data can be downloaded then uploaded to the PCMS. There is no need for the mapping crew to come to the office and return the mapping tablet for data collection, it can happen on much faster and much easier way and of course on real time.

Mapping and tracking as operations have improved lot during the two and half year. However, there are still rooms for improvements to shorter downtimes, communication issues and reduces the effect of human errors. The next chapter will highlight the data collection and the interview process and present the finding of the interview to see how the workers see the importance of the tracking and what kind of future improvements they might have to increase the efficiency of the tracking operation in Wasco. Upon the outcome of the interviews the chapter 5 will provide some recommendations and improvement ideas on how Wasco could achieve better and more solid tracking and mapping operation.
4 THE EMPIRICAL RESEARCH

The topic chosen for the current thesis required extensive research in order to gather comprehensive data and statistical information for thesis objectives. The thesis used both primary and secondary data collection methods to gather as much information as possible about the pipe tracking operation in Wasco and to find out why the tracking operation is so important in the case company and what kind of tracking methods could help to improve the efficiency of the operation.

The working experience in the company provided a huge advantage and analytical knowledge to start the thesis process, however, for the wider perspective, more information was required to be collected through face-to-face depth interviews. Therefore, the following chapter will describe the flow of data collection, interview process and the main outcomes of the research.

4.1 Data collection: Face-to-face interview

In order to secure some deeper insight into the tracking operation and to create an extensive overview of the process, extra data needed to be collected and interpreted through face-to-face interviews, based on 7 open ended questions. The interview questioner can be found in Appendix 1. The aim of the interview process was to find out how people who have knowledge about the field and currently working in the company see the importance of tracking operation and what kind of future recommendations they might have to improve the effectiveness of the pipe tracking at Wasco.

Based on the strategic sampling criteria, the target sample included workers from different departments and from different positions to ensure the variety of respondents and view regarding the topic. All the questions had been asked from each department from Wasco and from the client side as well, who have also been influenced to some extent, to achieve better understanding of the topic. The interviewee’s background information are demonstrated in the table 2 below:
### TABLE 2: Background information of the interviewee’s

<table>
<thead>
<tr>
<th>Department</th>
<th>Company</th>
<th>Position</th>
<th>Number of interviewee</th>
</tr>
</thead>
<tbody>
<tr>
<td>PTS</td>
<td>PTS Wasco</td>
<td>PTS Supervisor</td>
<td>3</td>
</tr>
<tr>
<td>PTS</td>
<td>PTS Wasco</td>
<td>PTS Inspector/Mapper</td>
<td>5</td>
</tr>
<tr>
<td>Logistics</td>
<td>PTS Wasco</td>
<td>Logistics Coordinator</td>
<td>2</td>
</tr>
<tr>
<td>Quality</td>
<td>PTS Wasco</td>
<td>Quality Engineer</td>
<td>2</td>
</tr>
<tr>
<td>Quality</td>
<td>Nord Stream 2</td>
<td>Senior Inspector</td>
<td>2</td>
</tr>
<tr>
<td>Project Management</td>
<td>PTS Wasco</td>
<td>Project engineer</td>
<td>3</td>
</tr>
<tr>
<td>Project Management</td>
<td>PTS Wasco</td>
<td>Material planner</td>
<td>2</td>
</tr>
<tr>
<td>Custom</td>
<td>PTS Wasco</td>
<td>Custom specialist</td>
<td>1</td>
</tr>
</tbody>
</table>

### 4.2 Interview process

All twenty interviews were conducted within one month, from 04.06.2019-05.07.2019. After a short introduction, all the questions had been asked one by one with incorporated flexibility to achieve better atmosphere, openness and new aspects about the topic.

Altogether, there were seven open ended questions with common aim to find out what the person in the interview process thinks about the tracking operation in the company. To find out which department finds that the tracking has the biggest influence on its operation and how do they feel if tracking would no support their department at all, would it still operate efficiently. It was interesting to see how people are satisfied with the current tracking methods and how do they feel about future developments and more automation in the tracking operation. The outcome of each interview was different due to different background and position in the company. Furthermore, the main approach of the research relied on of the outcome of the interview responses, which included the human involvement and the lack of objective perspective and ethical viewpoints.

During the secondary data collection, all the information collected during the working experience, thus, access to database and pipe tracking management
system helped to collect all the relevant information and values for the theoretical framework and for the overall thesis and the interview process.

Known as facts, to analyze and interpret the information collected through open ended questions are more challenging and harder to summarize, however, it can provide the extra advantage for the researcher to gain a broader view of the thesis topic. The next chapter will summarize the main outcome of the interview process and present the conclusion of the research operation and the phenomenon of tracking operation in Wasco.

4.3 Interview outcomes

The previous chapter highlighted the flow of the data collection, interview process meanwhile the current chapter will present the main outcome of the interviews and data acquisition and demonstrate the main conclusion of the respondents.

Arguably, it was challenging to analyze the outcome of the open ended questions as they were more qualitative responses than quantitative ones. However, theme coding was helping to categories the responses into identical groups which allowed the interpretation into statistical data. The open-ended question responses were summarized in quantifiable graphs, based on the majority of the answers, to better illustrate the key insights of the empirical evidence.

4.3.1 Question number one and number two

“Do you feel that pipe tracking is important for Wasco` s operations? If yes why?”
The first chart represents the answer for the first question where all respondents answered yes. Each interviewee started to explain how important do they feel the pipe tracking operation in Wasco. Several respondent from PTS and logistics team stated “If we would not know a pipe’s exact location there would be a totally mess and chaos in the yard.” Answering the first and the second question the outcome was definitely proving that each department in the company is relying on tracking operation and it’s required for their every day’s operation in order to perform their job well.

### 4.3.2 Question number three

“What would happen if there would be no tracking operation?”

The outcome of the third question highlighted further the importance of tracking operation as the respondents were explaining what would happened if there would not be any tracking operation in the case company. Several answers had been received, each interviewee highlighting what issues and problems would occur without proper tracking and tracing operation on the yard. Each feedback had been interpreted into identical categories in order to analyze and create the following chart (figure 7).
4.3.3 Question number four

“For which department do you think pipe tracking is important and relevant?”

In the next question, the interviewees were asked, what they think, for which department the tracking as operation is the most important and has the biggest influence.

FIGURE 8. Outcome of interview question number four
People form each department reacted to this question differently as each of them feel the importance differently but still in end, the main outcome of this question was repeated by everybody that tracking operation is important globally, as Wasco is operating a big supply chain, meaning one operation cannot work without the other operation. If there are some issues in logistics department and the truck driver doesn’t know which pipes to pick up from the yard it has big influence on the production as there are not enough pipes inside the factory for coating operation. If there are not enough coated pipe on the yard it will continue the influence on the material planning, transshipment, load out operation and on other small operation.

4.3.4 Question number five

“Do you feel Wasco have sufficient tracking operation?”

The following question, question number five was asking the interviewees how they feel does Wasco have sufficient tracking operation currently.

FIGURE 9. Outcome of interview question number five

The interviewees provided interesting feedbacks. Most of the department outside of the pipe tracking team found the tracking operation pretty much well organized and efficient operation. However, from the PTS team eight people had been interviewed who are working on pipe location, pipe history and coordina-
tion of pipe mapping and movements on daily basis. Most of the outcome was good but definitely not efficient enough. People working in the tracking team know exactly, how many times pipes were lost in different fields, how many times PCMS and physical reality was not aligned at all. Several times it required massive team, manual effort and time to find each coated item on the yard. Different methods had been put into place to be able to scan the barcode of the 3LPE pipes, however it still caused multiply issues for the tracking team, to keep the yard status and picture up-to-date on daily basis. On the other hand, it was positive feedback from other departments, according to their opinion, PTS team always provided sufficient tracking information available for each department to support their operation which highlighted the fact that even it was hard work for the tracking team to keep the yard information up to date, the hard work definitely promoted good result.

### 4.3.5 Question number six

“*If not, do you have any recommendation how we could provide a better tracking data, more automation? Less human involvement?”*

Question number six relates to the previous question, it asked the interviewees to suggest some solution to improve the tracking operation in Wasco. Couple good recommendation had been given which will be used in the next chapter (chapter 5) where all the recommendation for more efficiently tracking operation will be explained in more details.

### 4.3.6 Question number seven

“*In you previous work (related to pipe coating) did you used similar tracking systems like barcode, RFID or any different tracking method which had better outcome? “*

For the last question, only six people could answer as previous pipe coating experience was required to answer the question. The question wanted to find out that in previous work place was there better tracking operation provided by the coating company. The outcome of the question was commonly given with
same result that people who worked on similar coating projects before, have not experienced as good pipe tracking operation as Wasco is providing. Many of them claimed, some project still use manual tracking operation which causes lot of misalignments and issues in the overall operation. Some of them highlighted that in previous projects there was not much technology involved into the pipe tracking operation which resulted inefficient operation.

The last answers supported even more the fact that Wasco has a good tracking operation on place. However; there is still room for improvements in order to reduce time, manual effort for the tracking team, to keep the yard of Kotka updated on daily basis. These days where technologies are around us, companies need to start implement technologies more, to increase their operational processes, increase efficiency, decrease cost and manual involvement. Wasco implemented new technologies inside the factory. However, on the yard where the movements of trucks and the pipes are more active and free it would require even more technologies to control the pipe movements, pipe stacking and overall pipe mapping operation.

The next chapter will demonstrate all the recommendations which can promote more automation and accurate mapping operation by decreasing time, misalignments and manual involvements.
5 RECOMMENDATIONS

The previous chapter provided all the knowledge and information collected from primary and secondary data collection. Extensive data had been acknowledged during the data collection process in order to provide the reliability and credibility of the outcome of the research. People, who work at Wasco, promoted the fact that tracking operation is extremely important and required to coordinate each supply chain and operation efficiently. Wasco has a good tracking operation on place, as each department gave positive feedback about the current tracking practices. However to minimize manual errors, increase the speed to improve the information exchange and reliability of the data, couple of changes are recommended for implementation which will be described in the following sections.

5.1 Automation

In today’s world, technology is around us and helping our everyday life. However, modern technology and automation appears more and more in different industries and operational sectors to reduce time, cost and human intervention.

Automation and automatic control is gaining the competitive advantage if it is implemented well in company’s operation. In logistics sector it has been recognized long time ago that any information gathered from hand-written documents and entered into an IT system via a keyboard is by definition delayed, possibly incomplete and almost certainly contains errors (Wang and Pettit, 2016).

Automation and machines first appeared to remove the hard and dangerous works from humans as there are several production operations which could not be utilized by humans. Then automation started to focus to make things faster, more accurate and in more secure way. However, it is important to realize that human is still important factor of company’s operation as Jonatan Gal the regional director of Amazon emphasizes that the robots work in collaboration with humans, taking on tedious roles and handling more complex operations like
crunching numbers and assessing databases but people are still at the center of the operation (Logistics Manager, 2018).

In Logistics and supply chain, the real-time information flow is essential to reach the demand and provide the needed product on time. Automation in logistics and in transportation management system surely helps drive efficiency, eliminate waste, and most importantly helps to save money in the transportation department (Robinson, 2018).

As mentioned previously, the relevance to change from paper based operation to electronic operation is essential in tracking environment. In Wasco, figure 5 represented, the company started with manual tracking operation which caused several misalignments in the database due wrong data input and several not existing pipes ID. With years, the tracking operation involved more technology and new tracking methods but still significant human interventions are appearing in terms of tracking.

During the interview process, people were asked what future development and improvements they would recommend for the company to increase the efficiency of the tracking operation. Globally, the outcome of this question was automation, more technology and less human mapping and tracking. Automation had been between the recommendations when the thesis had started, when more information had been collected it started to prove it even more, to coordinate the huge amount data about the pipe movements and pipes locations on real time, more technology and innovations are required to be used.

### 5.2 New tracking technology

The biggest change towards newer tracking technology is required to put in action on the yard where the real pipe movements and tracking operations are happening. The section 1.2 already highlighted the main research problem which is the missing pipe verification. There had been serval occasions where the movements of the pipes had not been informed, meaning certain pipes had been moved without the notification of the movement so the change of location had not been recorded to the system. Due to this fact the pipes got lost. This
issue happened, due missing communication and no tracking operation of the reach stacker. The new tracking solution proposes to track the movements of the reach stacker, so any time when the reach stacker would move in or out from a certain stack, the system would get a notification that reach stacker number one entered or left the D23. The next two improvements which are closely connected to the reach stacker tracking are to place the RFID reader to the end of the reach stacker finger resulting continuous pipe scanning and automatic mapping operation which operated by a specific algorithm of the stacking sequence. The three innovations would make sure if a pipe is moved by the reach stacker, the system would receive automatically, the stack and the pipe location. The following sub chapter will explain in detail how these actions could be implemented and how these innovations would achieve more solid tracking operation.

5.2.1 Practical usage of GPS

In order to track the exact position and continuous location of each reach stacker on the yard, GPS tracking method has to be implemented. First, GPS tracking requires the programming of the yard of Kotka in the sense of coordinates. Each stack positions need to be specified with GPS coordinates in order to know when the reach stacker arrives to certain coordinates it means D20 in the yard of Kotka. GPS tracking would allow the full visibility of the pipe movements on a real-time concept.

GPS works independently so no human interaction is required when sufficient internet is provided as internet helps to transmits the geolocation information to a GPS receiver anywhere in real-time. Each reach stacker needs to have a small computer or commonly used Raspberry Pi 4 tiny desktop computer which use 4G-connectivity to connect to GPS and to PCMS. This technology allows the continuous information exchange about the position and the time of the reach stacker in real time. Furthermore, the next chapter will demonstrate how PCMS can receive the information about which pipe is moved by certain reach stackers.
5.2.2 Automatic pipe scanning

The previous chapter explained how the reach stacker tracking could be utilized on the yard of Kotka by the usage of GPS. The current chapter will further demonstrate how the automatic pipe scanning would be addressed as it is not enough if we know where the reach stacker is moving we need to know when it’s moving which pipes it is carrying.

The technology behind the automatic pipe scanning would be to build a small RFID scanner to the end of the reach stacker finger in order to scan the pipe on live system. When the reach stacker moving the fingers inside the pipes, the reader would activate the passive tags placed inside the pipes resulting automatic pipe scanning. The reading power of the reader would be limited so it would only read the RFID tag which is closest to the finger. There are two types of reach stacker. Some can lift only one pipe at the time but most of them have two fingers meaning two pipes can be lifter at the same time, to increase the efficiency of the pipe movements. Each finger needs to be placed with the built in system of the RFID scanner to be able to track both pipes during each lift. The following picture (picture 7) will illustrate where the RFID scanner could be placed and how it would look in action (picture 8 and picture 9).

PICTURE 7. RFID scanner placed inside the finger of the reach stacker

Source: Wasco 2019, modified
PICTURE 8. Loading of 3LPE pipes from the truck to the stacking area

The picture above (picture 8) presents automatic scanning in action. First, the pipes arrive to the stacking area by specifically modified trucks. Then reach stacker starts to lift the pipes from the truck and start to head towards the stacking area.

PICTURE 9. Process of automatic pipe scanning and movement to the stack

Source: Wasco 2019, modified
When the reach stacker places the finger inside the pipe, the scanner automatically scan the RFID tags found inside the pipes. The reach stacker sends the information to PCMS that reach stacker number one lifted VP200456 and VP234567. The reach stacker continues its way towards the stack, when it passes the entrance of the stack, the GPS coordinates identify the location of the stack and an automatic information exchange happens with PCMS that reach stacker number one arrived to D22 with the two pipes. The reach stacker places the two pipes to the sand berm according the stacking instruction which will be describe in the following section to understand how the automatic mapping operation could start by implementing the previous two technologies.

5.2.3 Automatic pipe positioning

Stacking of the 3LPE and coated pipes happen by following an automatic sequence planned and defined by safety and logistics department to ensure the stack itself remains stable all the way through the stacking operation. There is only one way how the pipes can be stacked and de stacked to ensure the safety and stability of the stacks as each pipe weight over 12.000 tons when they are 3LPE pipes, after the production the pipes weights are over 22.000 tons. The stacking sequence of the pipes is followed by a specific instruction and in accordance of the stacking diagram which can be found below.

PICTURE 10. Stacking Sequence of the 3LPE pipes

Source: Wasco 2019
When the reach stacker arrives to a certain stack for the first time, PCMS will know the only place and the position where the pipes can be stacked will be on the first layer, position one and position two. When the next lift arrives to the stack and PCMS receives the two pipe numbers, system will already know, there had been previously two pipes loaded to the stack so the next two pipes can be stacked only to the first layer, position three and four. PCMS will always know where the next two pipes can be lifted all the way till the stack is completed as the stacking sequence will be programmed to PCMS in order to follow the proper and safe stacking sequence.

This method would make sure if any pipe arrives to the stacking area, the pipe will receive stack, layer and position information. Of course to be able to trust 100% of pipe’s exact location, it will be recommended to rescan the whole stack when is full to be able to perform a double confirmation of each stacks and positions but this new implementations will ensure if any pipe moved from one stack to the other the system will follow the physical reality which was the biggest purpose of the following thesis work.

The three new implementations would help to create more accurate mapping and tracking operation allowing shorter downtimes, communication issues and reduce the effect of human errors. Stefansson and Tilanus (2001) indicate that tracking systems are required for co-ordination logistics as they create the connection between the information and the physical reality in the supply chain. The new recommendation and tracking innovation would promote stronger link and connection between the PCMS and the physical reality. The concept of the new system would introduce more automation and real-time information exchange in order to execute each supply chain better in Wasco’s overall operation as time, speed and accuracy means everything for the company.

As the current study is a bachelor thesis, there was limited time and research possibility to implement and test of the improvement ideas in details but the concept had been discussed with Wasco’s current programmer who gave strong creditability and the success of the new innovation which provide the fact that in the pipe coating environment the need for tracking operation and for an exact and trustable tracking operation is really high with a lot of potentials.
6 CONCLUSION

The aim of the thesis research was to find out why tracking operation is so important in the case company and explore if the company has proper tracking operation on place. Furthermore, to recommend newer tracking technologies and innovations to achieve more efficient and effective tracking operation in Wasco’s business environment.

The theoretical framework indicated all the information related to tracking and tracing operation in general in order to understand the main functionalities and need of tracking operation. Several literatures helped to create a deeper insight and final conclusion for the case company and for the thesis objectives.

The topic chosen for the current thesis required extensive research in order to gather comprehensive data and statistical information for thesis objectives. The thesis used both primary and secondary data collection methods to gather as much information as possible about the pipe tracking operation in Wasco and find the answer for the initial research questions.

Working experience in the company, the comprehensive face-to-face interview and the data gathered from secondary data collection provided and proved the fact, that field specialists, logistics and production workers who work in the case company emphasized the need and relevance towards the tracking operation. Furthermore, they claimed, tracking operation is such a huge part of the company’s overall operation and without proper tracking on place each supply chain and yard operation would be completely chaotic. Thus, inefficient tracking operation would cause huge delays, coordination and financial issues.

The research highlighted that tracking operation in the case has improved a lot in the past couple years, more technology and newer tracking practices has appeared to the operation itself. However, the interviewees indicated the fact, that the company has a good tracking operation in place but still there is room for improvements as less human intervention and manual operation can help to achieve more accurate mapping and tracking operation allowing shorter down-times, communication issues and reduce the effect of human errors.
The outcome of the interview process supported the main concept for the recommendation to use more automation and automatic scanning in the tracking activity. The implementation of the automatic pipe scanning and pipe positioning system on yard would avoid the missing verification of the pipe movements which happened several times in the case company where pipes were moved without the notification of the movement meaning, the change of pipe location had not been recorded to the system resulting, inaccurate data and misalignments between PCMS and the physical reality.

The current research performed for Wasco, defined the importance of the tracking operation in the company and also found practical solutions for the research problem which was the missing pipes location and missing verification of the pipe movements. The research met with some limitation as time and the physical implementation of the recommended tracking practices could not be utilized. This limitation provides the base for further research studies. The objective of further thesis and research process could be to investigate if the recommended tracking innovations could achieve extra competitive advantage for the company. The further research could also contain the detailed documentation of the piloting process of the new tracking practices to see if the implementation would face with any issue. In case of any issue the research could also find out how those issues could be fix in order to meet the thesis objectives.

The thesis process provided a positive learning experience, an opportunity to learn more about the company’s supply chain management and wider information about different logistics practices. The research helped to gather useful information not only for the thesis but for personal growth as well. It gave opportunity to acquire wider theoretical knowledge about logistics, supply chain management, project coordination and mostly about tracking operation. The thesis provided several occasions to meet with filed specialists who have extensive knowledge about the pipe coating business which granted different benefits and perceptive for this business environment and for future opportunities.
REFERENCES


Online sources


APPENDICES

Appendix 1. Interview questions

Name:
Position:
Department:

1. Do you feel that pipe tracking is important for Wasco’s operations?

2. If yes why?

3. What would happen if there would be no tracking operation?

4. For which department do you think pipe tracking is important and relevant?

5. Do you feel Wasco have sufficient tracking operation?

6. If not, do you have any recommendation how we could provide a better tracking data, more automation? Less human involvement?

7. In you previous work (related to pipe coating) did you used similar tracking system like barcode RFID or any different tracking method which had better outcome?