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Improving the packaging efficiency and performance in Logistic Center Vaasa by using Lean

Inbounds from Italy to Vaasa

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ABSTRACT:

Logistics is one of the main pillars of supply chain management and improvement of packaging efficiency is necessary in logistics to enable the efficient operations. By meaning improving packaging efficiency, it is widely understood as only packaging of the products in general, but unpacking and unboxing of same products are sidelined or overseen. It is important to understand that packaging in logistics consists of both packing and unpacking of products. The main objective of this thesis is to improve the packaging efficiency of the materials arriving from Italy to Logistic Center Vaasa (LCV) by utilizing lean principles. The thesis endeavors the area that can be improved for obtaining the packaging efficiency and thereby, could play important role in implementing the changes for further development.

The case company chosen for this thesis is Wärtsilä Oy, Finland primarily located at Vaasa, Finland. Wärtsilä is a global leader in lifecycle solutions and innovative technologies for the energy and marine markets. The company is headed to transit 100% renewable energy future by providing efficient, reliable, safe and world- class environmental performance.

The idea for the topic of thesis cultivated from Logistic Center Vaasa, part of Wärtsilä where most of the goods are received from different parts of globes. The aim of the thesis is to understand three key major questions: (1) How to improve the handling of packages coming from Italy for both supplier and LCV end by implementing the lean principles? (2) How to create ergonomical and safe work environment for warehouse workers in LCV? (3) How to uniform EUR-pallet for all inbound deliveries coming from Italy?

The thesis uses literature review to understand the topics and all the important topics are demonstrated thoroughly. The data was collected with semi structured interviews carried out among seven workers working in “Goods Receiving Area”. The data collected from these valuable workers acts as the backbone for the analysis and implementation of the results.

The results were obtained and analysed based on the interviews. The results manifest that all the three key questions can be improved to increase the packaging efficiency and performance. The results show that lean principles can be applied for the inbound packages, ergonomical aspect can be improved and usage of EUR-pallet can be increased for many packages coming from Italy.

KEYWORDS: Lean principles, Inbound delivery, Ergonomics, Packaging

Terminology

STH	Sustainable Technology Hub- Wärtsilä's research, product development and production center located at Vaasa and is leading the journey towards decarbonizing the shipping and energy sectors
LCV	Logistic Center Vaasa- Located next to STH which is responsible for co-ordinating all the deliveries in Vaasa
SCM	Supply Chain Management- Management of flow of goods, services, information, and processes that transform the raw materials into final products
TPS	Toyota Production System- Original manufacturing philosophy developed by Toyota Motor Corporation, aiming to eliminate the waste and achieve the best possible efficiency
JIT	Just- In- Time production- An inventory management method developed by Toyota Motor Corporation to reduce the inventory holding costs and increase the inventory turnover
LM	Lean manufacturing- Methodology aimed on minimizing the waste within manufacturing systems, creating customer value and seeking continuous process improvement
VSM	Value Stream Mapping- A visual tool based on lean principles that displays all the critical steps in the service or product delivery process
TQM	Total Quality Management- The continual process of detecting and reducing the errors in manufacturing aimed at long term success through customer satisfaction
GR	Good receipt- Movement of goods or materials into the warehouse by confirming the receipt of material received from the vendor or manufacturer

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1 Introduction

This chapter gives the insight about the background of thesis, brief introduction of case company, purpose of thesis, research gap, project plan, questions and objectives, study definitions and limitations and the scope of thesis.

1.1 Background of study

To maintain the quality of anything, let it be food, raw materials, finished good, sensitive materials or anything that can be packed, the packaging itself is one of the important factors. Out of many important and critical factors, packaging of material also determines its quality in a long run. The world is shifting towards digitalization and innovation, but packaging of products remains intact and equally important as it used to be before. It is not wrong to say that packaging of product will never fade way since it is very essential for all kind of global business. So, finding the sustainable solution to the packaging which increases the efficiency of the work and quality of the product, at the same time is also ergonomic, is equally important (Heinrich, 2018).

Lean approach is based on the principle of Toyota production system regarding the elimination of wastes. There is misconception that Lean is just used in manufacturing, but it has features that can be applied in various fields such as production, packaging, and services (Brito et al., 2020).

The working environment of warehouse workers have been overseen for decades. Research have shown the negative impacts of unergonomic working environment and thanks to it, many companies are willing to invest time and effort for better work environment for their workers. Ergonomical way of working in workplace brings many benefits such as declined work- accidents, increasement in work efficiency, improvement of well-being of workers, reduced medical and production costs (Ahmadi et al., 2017).

This study aims to understand the ergonomical work environment of the warehouse workers, working in good receipt (GR) area, mainly receiving of the inbound deliveries from Italy and examines how lean principles can improve the working environment of the workers.

The basic understanding of receiving of goods from suppliers to putting the goods in designated storage bins can be seen in the Figure 1 below.

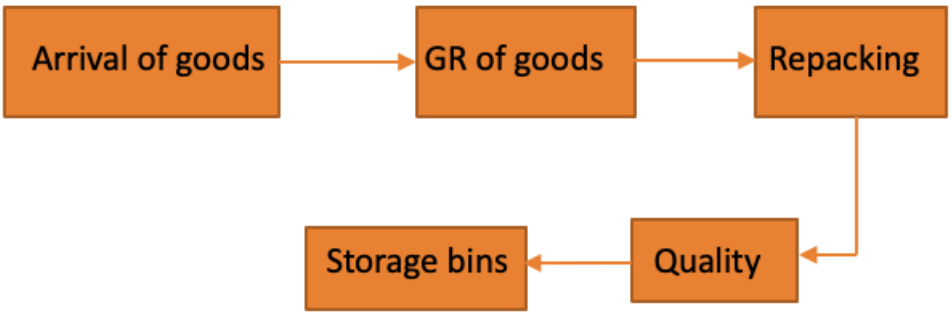


Figure 1. The process of arrival of goods to storage bins.

The materials packed in a package is arrived in the yard. Then, afterward, they are unloaded and brought inside the warehouse. The reception of goods is done via SAP system. Once the goods are received into the system, they will be repacked again if they are needed to transfer to the standard pallets used in Wärtsilä. Afterward, it will go to repacking if needed. If the goods need to be inspected, they will be transferred to quality inspection room. In many cases, the suppliers comply with Wärtsilä's standard, and they do not need any repacking done. It is pre-notified in the SAP system if the material needs to have a quality inspection. Thus, the worker can also see in the SAP system if it needs quality inspection. After all the process is completed, the final stage would be to put the materials in designated storage bins.

The aim of this thesis will be to develop better undertaking of the fourth step, i.e., to minimize the repacking process for the packages that come from Italy. It would save time

and resources of organization and improve the ergonomical working environment of the employees as well.

1.2 Brief introduction of case company

Wärtsilä is the worldwide leader in lifecycle solutions for marine and energy industries with the implementation of innovative technologies. The main objective of the company is to adapt sustainable technology and services to improve the environmental and economic performance. The sustainable approach of company is driven by economic, environmental, and social factors. The company focuses to make profit by providing environmentally friendly products and services by following the code of conduct of business (Wärstilä Annual Report, 2022).

Wärtsilä employees roughly about 17,500 employees in more than 240 locations in 79 countries. The net sales totaled to EUR 5.8 billion in 2022. The company is listed in Nasdaq Helsinki. The three main business structure of the company is Wärtsilä Energy, Wärtsilä Marine Power, and Wärtsilä Marine Systems. In addition, Wärtsilä Portfolio Business consists of business units which are managed independently to improve the performance and unlock the value through divestments and other viable strategic alternatives. The Wärtsilä Energy accounts for highest sales percentage with 47% of net sales followed by Wärtsilä Marine Power with 34% of net sales. Wärtsilä Marine System accounts for 13% of net sales and Wärtsilä Voyage accounts for 5% of the net sales of the company. The point to be noted is that Wärtsilä Voyage business was integrated into Marine Power as of January 2023 to strength the end-to-end life cycle solutions (Wärtsilä Annual Report 2022).

Wärtsilä always keeps the health and safety of its employees as a top priority. The goal of the company is to get zero lost time injuries. In 2022, the lost time injury frequency flattened out at 1.58. The company has seen continues improvement in the work environment in the last few years and encourages the erogonomical work environments for all the personnel to strengthen the safety work culture. Wärtsilä aims to provide a

healthy working environment for everyone which supports well-being, growth, and work- life balance. (Wärtsilä Annual Report 2022).

Figure 2. Wärtsilä's five pillars of well- being framework (Wärtsilä, 2022).

Wärtsilä focuses on sustainability and regards it as the core of the company's purpose and strategy. The sustainability strategy of the company is based on three interrelated pillars: economic, environmental, and social performance. The company believes in high ethical, health and safety standards (Wärtsilä, 2022).

Figure 3. Wärtsilä's sustainability approach (Wärtsilä, 2022).

1.3 Purpose of the thesis

This thesis intends to identify the application of lean principles to improve the packaging efficiency with ergonomics aspect. The ultimate objective is to find the best approach to improve the workplace by considering the packaging efficiency and safety of workers. The thesis is motivated to find sustainable solution for improving the unpackaging of inbound deliveries due the lack of substantial research done in the field of unpackaging of inbound logistics.

The Logistic Center Vaasa, shortly known as LCV is the hub for receiving packages from all around the globe. It receives few hundred packages a day. Out of all packages, packages from Italy are between 40- 50 every week depending upon the purchase order and necessity of the products. All the packages must go through a quality test and are restored to the designated locations according to the guideline of LCV standard. There are two important things that the packaging should follow: meet the quality standard of Wärtsilä packaging guidelines and, is ergonomical to unpack for the warehouse workers. Since the warehouse of LCV is only over a year old, there are different challenges related to the packaging as well.

The main aim of this thesis is to identify the challenges and improve the quality of packaging in LCV and find the best solution for the warehouse tasks. The research also aims to recognize challenges and opportunities from the implementation of EUR-pallets for all inbound deliveries coming from Italy.

1.4 Research gaps, questions, and objectives

The research gap was identified by selecting 20 different databases from my student account of University of Vaasa. The search was mainly focused on “inbound logistics” “lean principles in inbound logistics”, “ergonomics in warehouse” and at last, I combined

all titles together to get the refined and narrow result with the title “application of lean principles in inbound logistics for ergonomics”. The timeline was selected from 1980-2023 since it was bit challenging to get all relevant documents. The main objective was to compare the research from early 1980s till current time. It is clearly visible that these topics are taken with high importance in current phase and industries, scholars, researchers, and stakeholders have understood the positive impact of these topics. However, the latest and updated research papers and journals have been selected for the thesis.

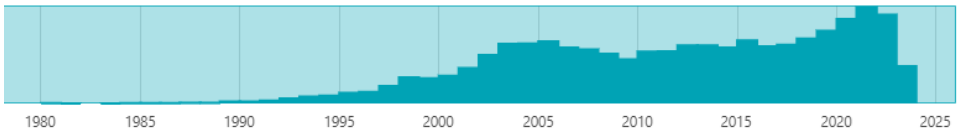


Figure 4. The search history of “inbound logistics” from year 1980-2025 (Tritonia, 2023).

There were around 23,000 results with 19,000 articles related to “inbound logistics”. It can be seen from the graph that inbound logistics is gaining its momentum. Research have been drastically elevated from the early 1990. There was relatively few research conducted also in early 1980s. On a positive note, companies have understood the value of research concerning the inbound logistics.

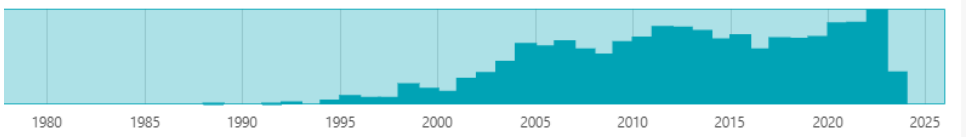


Figure 5. The search history of “lean principles in inbound logistics” from year 1980-2025 (Tritonia, 2023).

There were only round 1,300 results for the title “lean principles in inbound logistics” with around 1160 articles, which is comparatively much lesser compared to the first search. The graphical representation fell in similar pattern compared to the search

conducted for “inbound logistics”. The noticeable thing was that there was almost no research conducted in the early 1980s for this topic. Time and again, it gained its momentum from early 1990s. One of the factors for the less or no research conducted in the subject before 1980s could be due to the fact that lean principles were a new concept for the rest of the world, craving its pavement.

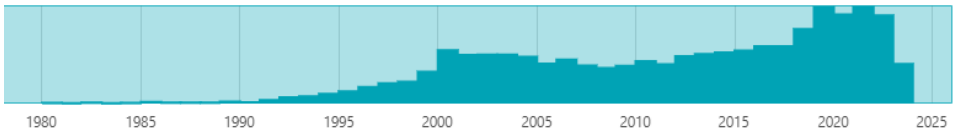


Figure 6. The search history of “ergonomics in warehouse” from year 1980-2025 (Tritonia, 2023).

Surprisingly, the search conducted for “ergonomics in warehouse” had less results compared to the first search and much more results compared to the second search. It had around 8,000 results with roughly 1160 articles. There was already few research done during 1980 and the trend has increased slowly.

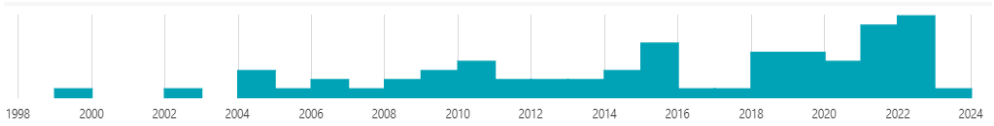


Figure 7. The search history of “application of lean principles in inbound logistics for ergonomics" (Tritonia, 2023).

The total results for the search of title “application of lean principles in inbound logistics for ergonomics” was much lesser with only 67 results with 62 articles. It proves that there has been less research conducted for this title and the numbers should be increased since it is important for the well-being of companies and workers. The one reason that motivated me to write my thesis on this topic is to add one more brick in the existing research.

The unloading of inbound deliveries directly impacts the workload balance in the eco-system of the industry. There should be a clear idea of how different kinds of inbound deliveries are to be unloaded in what way. Schonberger (2007) determined that the ideas of lean production have basically merged Just in Time (JIT) and Total Quality Control (TQC) principle which includes the inbound deliveries in the logistics process as well.

The objective of this research is to develop packaging process of LCV to more sustainable. This is made by searching answers to the following research questions:

- How to improve the handling of packages coming from Italy for both supplier and LCV end by implementing the lean principles?
- How to create ergonomical and safe work environment for warehouse workers in LCV?
- How to uniform EUR-pallet for all inbound deliveries coming from Italy?

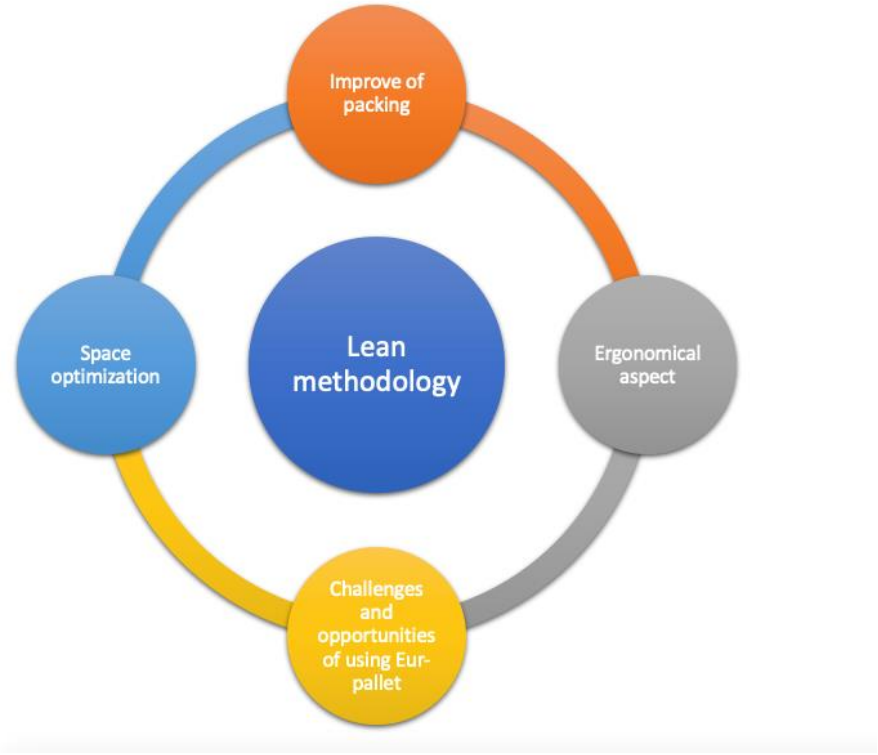


Figure 8. Cycle of research questions for the current study.

1.5 Limitation of the study

This research, however, is subject to several limitations. The study does not cover all aspects of the packaging solution. For example, the means of transportation and the cost are not included. The main challenge of this research will be to find best practice for optimizing the inbound packaging since the materials packed in the packet come with different shapes and sizes and it is really challenging to keep them uniform. Since lots of inbound deliveries come from different parts of the world, it is not possible to cover all of them. The research mainly relies on the qualitative data and thus, the evaluation of research cannot be claimed with 100% accuracy since there will be challenges in data collecting methods. This research can be addressed in future to improve. The time constraint is also one factor to consider.

1.6 Structure of the thesis

The thesis consists of five chapters with sub- chapters.

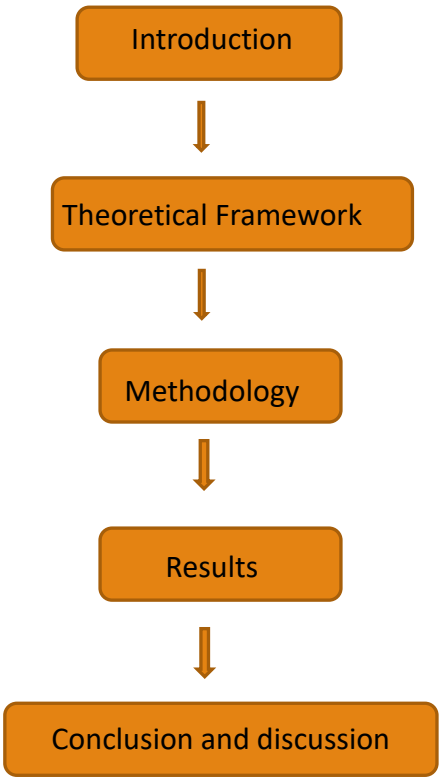


Table 1. The structure of thesis.

The breakdown for the various chapters with respective theme and sub-chapters are briefly described below.

Chapter 1: Consists of the introduction and background of the study. It mainly addresses the problems existing in the context of inbound logistics. The scope of the research, limitations, research questions are described in this chapter. The brief introduction of the case company & how the inbound logistics are managed in the case company is also

described in this chapter. How the case company practices lean principles in the inbound logistics is also described briefly in this chapter.

Chapter 2: Consists of literature review/ theoretical framework of the respective topics. The basic concepts about the topic are reflected with the latest resources available. Each topic is designed to interconnect with others. The keywords are given the most priority in this chapter.

Chapter 3: The methodology of the thesis is described. The approach to data collection and the tools used in the data collection are discussed in this chapter. The reason to choose this method for the thesis is also explained in this chapter.

Chapter 4: The results are discussed in this chapter. Consists about the empirical study of the research. It includes the various aspects such as problems and challenges in the inbound logistics, implementation of ergonomical work environment and understanding the experiences of the employees. This chapter consists of an interview process with the employees and reflection of their response with the collection of data and its analysis in detail. In this chapter, it will be discussed how lean principles can be utilized in the inbound processes of the packages arriving from Italy based on the respondents' answers which is the main theme of the thesis as well.

Chapter 5: The conclusion and discussion of the whole thesis is mentioned in this chapter. Consists Of the reflection of the whole writing process and the lesson learnt during the journey. It also presents the discussion on how to improve based on the theoretical and empirical results and analysis. The research questions are reviewed with the most important conclusions and finally, it will suggest for further development and aims to contribute for the future research.

2 Theoritical Framework

2.1 Approach to Lean

There has been a noticeable shift in how the management system has been understood in the final two decades of the 20th century. The emphasis shifted from the previous period's product- oriented approach to the one that focuses on how a company should be running to provide the customers with the highest quality product or service in a sustainable environment (Hostetler, 2010).

The history of Lean goes long way from Toyota factory in Japan which is more popular by the term Toyota Production System (TPS) or Toyota Way which was created for Toyota by Taiichi Ohno, Shingo and Eiji Toyoda. Toyota had fully applied the principles of lean production already by early 1960s, leading other Japanese firms also to adapt the lean production, although it took many years (Womack et al., 1996). The lean manufacturing (LM) has gained momentum from the researchers, scientists and scholars since James Womack popularize the Japanese manufacturing approaches in his widely recognized book "The machine that changed the world" (Danese et al., 2017). Lean focuses on three principles: consistent elimination of waste, continuous improvement, and respect for the people (Womack et al., 1996).

The journey of lean started from early 80's by identifying the popular eight wastes concept- Over production, Waiting, Unwanted transportation, Over processing, Excess inventory, Unnecessary movement, Defects and Unused employee creativity (Ojha, 2022). Lean focuses on identifying the main source of waste and uses tools like Just in Time (JIT) and Value Stream Mapping (VSM) to eliminate the waste and achieve better productivity, reduction of cycle and smooth flow of materials (Jadhav & Ekbote, 2021). The Just in Time (JIT) concept became the focus point in manufacturing areas by facilitating the value stream mapping immensely to identify the movement of goods from the raw material until finished goods and thereby reduction in wastes (Kete & Locher, 2004). There is plenty of research on lean manufacturing, including measures, strategies, frameworks,

and related insights. The impact of implementation of lean and its advantages in the manufacturing and packing industries have been researched comprehensively during this four- decade journey (Ojha, 2022). The concept of lean has become the managerial paradigm which has been applied in various sectors beyond automotive sectors with reliable results (Danese et al., 2017).

Lean production has different set of tools and techniques that matches with the company's value and operation including value stream mapping (VSM), total productive maintenance (TPM), continuous improvement, kaizen, smoothing production, heijunka, total quality management (TQM), just- in- time (JIT), communication, visualization & automation (Bhamu & Singh Sangwan, 2014; (Netland, 2013; Chen et al., 2023).

The evolution of lean principles can be seen on the figure below.

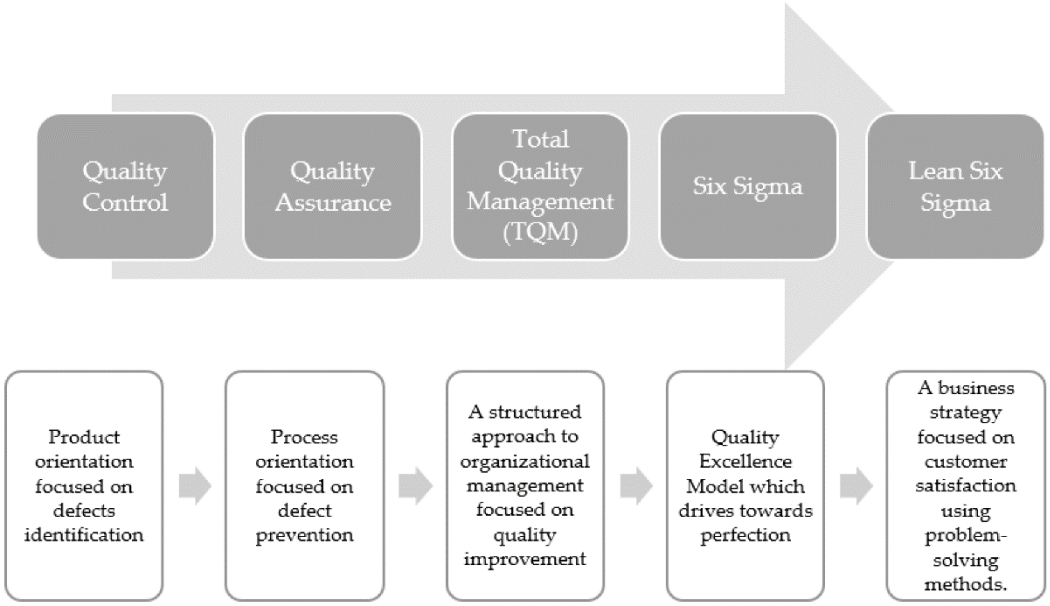


Figure 9. Evolution of Lean Six Sigma (Zaporowska & Szczepański, 2022).

Because of globalization, fierce rivalry, and demanding clients, every industry is aspired to excellence. They are dedicated to creating and deliver faultless goods, services, or solutions; endorsing first-time-right production and the zero-defects idea; training and inspiring employees; maintaining environmental protection as an integral part of all

activities; and involving people (Jasti & Kodali, 2014). Many companies are on the lane to update their traditional management method to improve the cost, quality, productivity and to optimize the performance by using tools such as Lean manufacturing (LM) (Sharma, Dixit & Qadri, 2016). The implementation of lean has been described to bring lots of benefits in both quantitative (e.g., reduction of queues and errors, increase in quality, improvement in processing cycle) and qualitative (e.g., employee satisfaction, safe working environment, commitment to work) (Danese et al., 2017).

The lean production system (LPS) is seen as a cluster of proper manufacturing techniques deployed to streamline the firm's production system fluently by eliminating the waste and complete reduction of non-value-added activities (Chavez et al., 2020). LPS is regarded as the tool to enhance the operational efficiency, reduce the environmental risks & negative impact, produce the innovative and quality products, improve the workplace safety by focusing on ergonomics and enhance the corporate competitiveness (El-Khalil, 2020).

The supply chain is shifting towards Industry 5.0 from Industry 4.0. Nevertheless, logistics and supply chains face different challenges such as uncertainty and complexity (Paul et al., 2021). Supply chains should be flexible, agile and should implement lean thinking and technological systems which enable the information and material flow to be incorporated into supply chain operations smoothly (El Jaouhari et al., 2022).

According to Womack (1996) and Maclnees (2002), the five principles and goals of leans are combined in a singular frame as in the figure below.

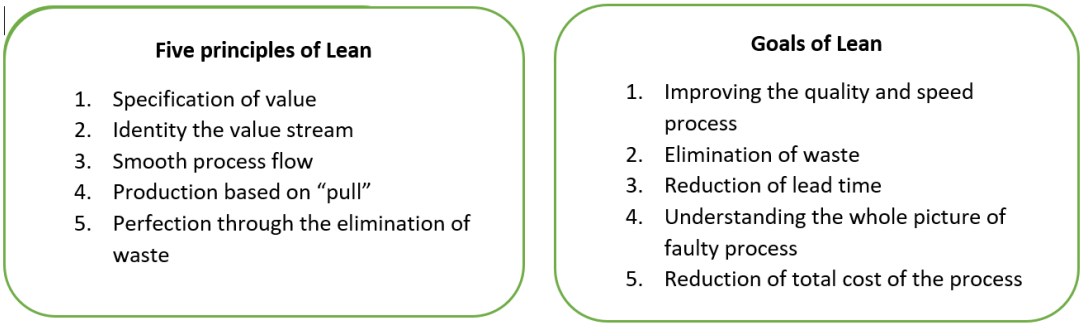


Figure 10. Five principles and goals of lean (Womack et al. (1996) for Lean principles and Maclnees (2002) for Lean Goals).

Womak and Maclnees have defined the principles and goals of lean principles in five following solid points: 1) Value is defined: The value what the customer is willing to pay for is specified. 2) Mapping the value stream: After the value is defined, the value stream is identified and mapped. The activities that do not add value to the end customer are considered as waste and they are eliminated from the process. 3) Creation of continuous workflow: The continuous workflow is created after the removal of waste to ensure that the steps' flow run smoothly without any interruption. The strategies of the workflow consist of breaking down and reconfiguring the steps, creating the cross- functional department, giving adequate trainings to the employees & levelling the workload. 4) Establishment of pull: The goal of pull- based system is to limit the inventory and ensure the required materials and information are available for the smooth workflow. The pull-based system allows the Just- in- time delivery of the products and services with the right quantities and without having to have big chunk of inventory. 5) Pursue of perfection: The process helps to pursue the perfection. It is, however, important to remember that the process is not static and isolated. Hence, new problems may occur in every steps. Therefore, it is important to brace the continuous improvement process.

The most talked about component of lean is the concept of value. The commonly used paradigms about value- added and non-value-added activities should be reconsidered in the context of manufacturing (Jones, D.T., Womack, J.P, 2016). Studies have shown that

implementation of lean improves the operational performance including quality, cycle time, delivery, cost, and productivity (Prajogo et al., 2016).

Lean production has been declared as the best manufacturing philosophy to improve the economic and operational performance of company and hence, build the resources and capabilities which support the environmental performance (Chen et al., 2023). The goals of lean principles are to create smooth and high-quality process that helps to produce finished goods and services to satisfy the customers' need without any waste (Zhou, 2012).

Lean principles ensures that the products are developed and processed with the focus to reduce the waste by adding value to the product's condition. Companies are inclined to utilize the lean principles and tools in their work process and product development process (de Toledo et al., 2023). Companies are using different tools and applications on continuous improvement of the quality of their products and services to gain the customer satisfaction and market value. Continuous improvement is one of the key concepts of Total Quality Management (Roriz et al., 2017).

2.1.1 Approach to Lean in Wärtsilä

According to the Supplier Handbook provided by Wärtsilä, it states that the company expects that the principles of lean are applied from its suppliers. Wärtsilä aims to achieve quality, delivery and cost excellence and strengthen the supply chain as well. The company's key focus is to deliver quality products and services and the company has different tools to measure and monitor the quality of product and the performance. The company aims to provide the quality products and services within optimal cost. The target is to reduce the unnecessary cost throughout the whole supply chain by implementing the lean philosophy. The company's goal is to deliver the products and services as per the agreed lead time. The company reviews and directs the actions in corrective and preventive way to improve the performance on the KPIs with periodic evaluation carried out

from time-to-time. The daily operational processes and way of working is optimized for the best performance and the company maintains the uniformity in the performance. The company seeks for continuous improvement in areas such as cost reduction projects, stock reduction, supplier agreements, employees' benefits, suppliers' performance and supporting them with the necessary resources. The company encourages the reduction of wastes, recycling of the pallets and usage of sustainable and biodegradable materials (Supplier Handbook, Wärtsilä, 2022).

Lean principles can affect the performance of the whole organization in terms of quality, delivery, and other economic requirements. The organizational culture plays vital role in implementing and continuing lean principles in the workplace. According to the Cultural Web which was developed by Gerry Johnson and Kevan Scholes in 1992, one of the major challenge to implement lean principles in the work place is to identify the cultural infrastructure of the company (Zaporowska & Szczepański, 2022). In favour of Wärtsilä, the company believes in agile performance and is vocal about implementing lean principles in the workplace. There are constant interactions between the employees and their managers, and the company seeks continuous performance improvement (Wärtsilä, 2022).

2.2 Inbound delivery

According to the Council of Supply Chain Management Professional, Inbound logistics simply involves the acquiring of goods and materials that will be processed further inbound deliveries are the part of logistics business which corresponds to the sets of operations associated with the flow of goods, materials, services, and information, which could be from the source of raw materials to the entrance in the factory (CCMP, 2018).

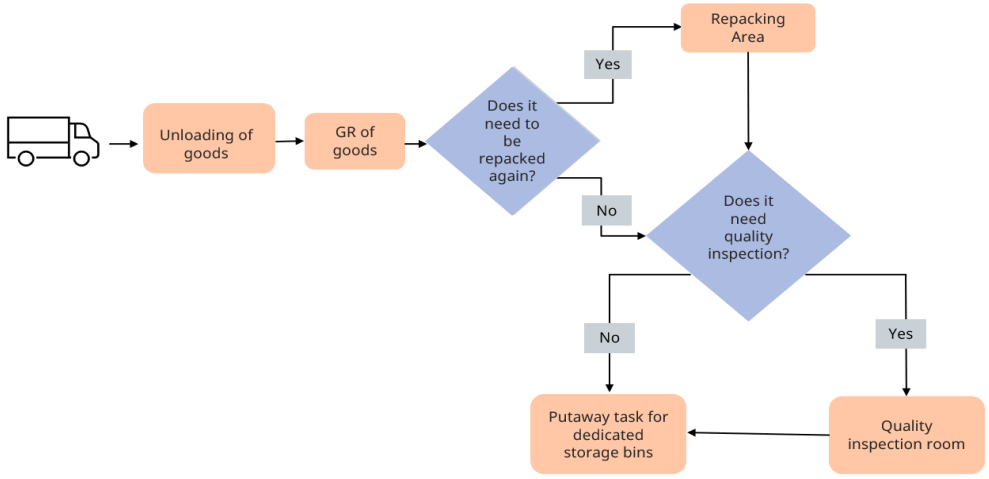


Figure 11. Basic understanding of arrival of goods until storage bins.

Inbound delivery works mainly based on the co-operation between the supplier and the receiving company. There are different stages in inbound delivery such as receiving the goods, handling the good, reporting into the system, creating handling unit and storing into the bins (Trade Financial Global, 2022).

The receiving of good involves the unloading of goods and materials physically from the carrier where the arrived goods are checked against the purchase orders and the incoming goods are recorded into the system with different stages afterwards such as repacking, quality control checking and transferring into the storage bins. Making sure that correct items has been received with correct quantity and in good condition is the foremost objective of the warehouse operation (Rushton et el. 2017).

As described in the figure 11, the goods and materials are sent by the supplier with the agreed transporter between both supplier and the company. The transporting company unloads the goods and the receiving company make the reception of good (GR) physically and record the GR into their system. Since many materials come in different shapes

and sizes in different pallets, they are sent to repacking if needed. After the repacking phase is passed, the quality of the material is evaluated and is sent to quality inspection if needed. Once the quality is passed, the material is available to store in the designated bin.

The study of inbound logistics has been done at a strategic level. The stock push strategies are applied in big companies traditionally for receiving mass inbound and mass production. This strategy has lots of advantages such as bulk transportation, reduction in travelling cost, but also lead to various problems such as high inventory cost, dead stock, unexpected shortage of components (Wang & Chen, 2019).

The logistics processes optimization has huge benefit in supply chain management. It improves cost efficiency and especially inbound logistics can alone minimize the total cost when implemented properly. Inbound logistics is the process of receiving the goods and materials that will be further processed for the warehouse task. (Audy et al., 2010).

The purchaser triggers the inbound logistics. The purchasing department gets a purchase requisition from the company. The request includes the general information regarding materials, quantity, delivery date, delivery cost, delivery address and other required information. In the next step, the purchasing department sends the quote request to the supplier aligning the requirements of costs and quality defined by the company. The supplier answers the quote made by the purchasing department by agreeing or disagreeing with the conditions. In case the supplier agrees, the purchasing department sends the purchase order to the supplier which is the most important tool of purchase. There is legal commitment between both parties to fulfill their responsibilities which includes the information such as purchase order numbers, shipping and billing, quantities and price of each quantity, delivery address and other special terms of purchase. The supplier then sends the goods to the company within the agreed specifications. Once the goods are delivered, the company makes inbound deliveries and does the good reception (Dinaryo et al., 2019).

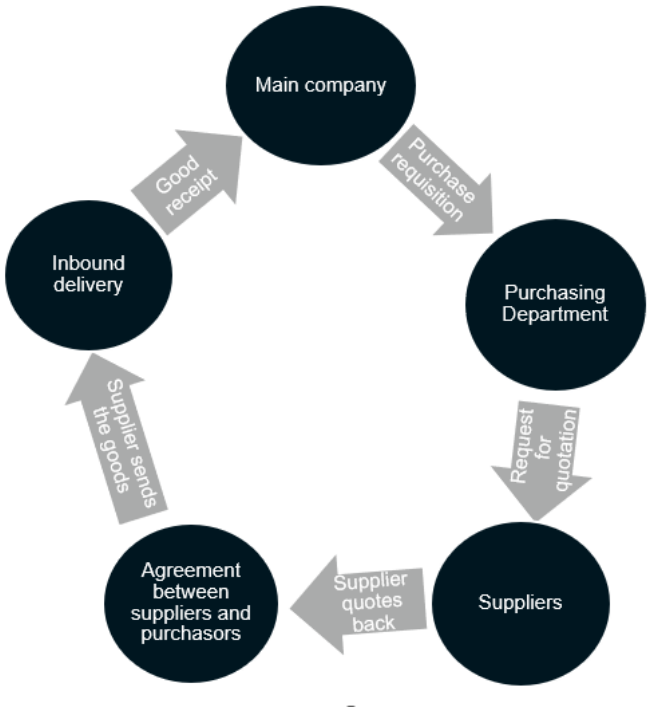


Figure 12. Inbound delivery process (Dinaryo et al., 2019).

2.3 Packaging

Even though industrial automation has been advanced, many jobs still require human workers to perform the task successfully and packaging and unpackaging of materials is one of them (Eurofound, 2019, Mital & Pennathur, 2004, Siedl & Mara, 2022).

Packaging of the materials is one of the most important pillars of logistics. On the other hand, the unpacking of materials is overlooked but it is as important as packaging since it is linked to the product from the point of filling until the point of dispatching (Molina-Besch & Pålsson, 2014). All the logistical activities in the warehouse are affected by packaging since the inventory system completely relies on how the packaging has been configured and handled. The packaging has a significant impact on the cost and productivity of a company (Molina-Besch & Pålsson, 2014).

Pallets have important roles in the distribution system of the supply chain in today's fast growing global logistics. Many packets from Italy come in plywood collapsible box. After the packet is received here in Logistic Center Vaasa, the warehouse workers will open the box and transfer it to EUR-pallet because the storage of LCV is of EUR-pallet standard. It creates more tasks for the workers and is really challenging to unbox them without any damage and transfer to the regular EUR-pallet. In addition, more time is consumed, and the ergonomics aspect of the worker is also questionable since most of these packets are heavy.

Picture 1. Plywood collapsible box (Savopack Oy, 2022).

As seen in the picture 1, plywood collapsible boxes are one of the popular packages. They are light in weight and are mainly used to transport in the freight. They are easy to tailor according to the product's shape and size. The corner of the box has hot- dip galvanized metal profiles and tongue at the top and bottom edge, which acts as handy quick release lock (Savopack Oy, 2022).

Pallets are one of the essential parts of the logistics world. They look simple in structure and can be found in different shapes and sizes, made from different materials. Among several types of pallets, EUR-pallet is a widely used pallet with a standard size of 1200 mm x 800 mm and is mostly available in plastic or wooden frames. There are more than

650 million EUR-pallets circulating worldwide currently. 109 million new EUR-pallets were produced in 2022 with the growth of 7.55% or 7.65 million pallets compared to previous year. (EUR-pallet, 2023).

Research shows that implementation of uniform pallets in the warehouse from receiving the inbound until storing the goods can improve the efficiency of work and increase the ergonomics of the work environment (Neumann & Medbo, 2010).

Picture 2. Standard 1,200mm x 800mm x 144mm EUR-pallet (EPAL Euro Pallet, 2021).

The EUR-pallet with standard size of 1,200 mm *800 mm * 144 mm is the most used pallet in logistics industry in Europe. The safe working load is maximum 1,500 kg with maximum additional load of 4, 000 kg when stacking. Different layers of collars can be used to increase height to increase the safety of the product (Euro Pallet, 2021).

EUR-pallet is one of the standard unit load carriers and acts as the fundamental tool in packaging and logistics systems. EUR-pallet is used worldwide and has played a central

role in shaping the logistics systems by providing the suppliers and companies with transport efficiency and easy handling (Hellström & Nilsson, 2011). Better utilization of pallets overall would improve transportation efficiency, optimize the space, and makes efficient handling of materials in the warehouses and stores. It helps in the reduction of usage of packing material which makes it easier to develop efficient logistics systems and saves the packaging and unpackaging costs respectively (Hellström & Nilsson, 2011).

According to (Hanson & Finnsgård, 2014), usage of EUR-pallet can result in efficient in-plant material supplies with fewer moves required in repacking in different pallet and thus, saves time and money. However, there is a lack of proper knowledge about managing the in-plant material configuration which is even more challenging to support the efficiency of packaging itself.

It is important to consider that some of the products do not fit in standard EUR-pallet due to the dimension and weight. In these cases, companies need to use single use pallets with their own customization. The pallets that are not standard are normally called as single use pallets. They are customized with different dimensions and are tailored according to the customers' specification. The Logistic Center Vaasa has a separate storage place to store these kinds of massive products that do not fit in EUR-pallet. Since they do not fit in the normal storage bins, they are stored in the separate storage bins which can fit big and weighty products.

Picture 3. Wooden Fin pallet of size 1000 mm*1200 mm (Etra, 2023).

The wooden fin pallet as seen in picture 3 is common loading pallet used in Europe. The approx. load capacity is 1000 kg (Etra, 2023).

Packaging companies seek innovative approaches to gain successful green, digital, and sustainable transitions by adopting lean production n as the main alternative. However, further investigation is required to implement the strategy with pragmatic inputs and identify the right technologies that could be applied with the lean principles for the mutual benefits of all (Chen et al., 2023).

The most common types of packaging used in Wärtsilä coming from Italy are plywood case, crate, container, pallet, and carton. Among all these materials, pallet, specifically EUR-pallet is most common type of packaging. Plywood case, crate and containers are many used for sea freight whereas pallets and cartons are used for transportation in domestic market and with the authorization of buyer, also in Europe.

2.4 Importance of ergonomics in workplace

Ergonomics in a simple language can be defined as a design of a system, and peoples' interaction with it which allows the human to work in a comfortable environment with less physical burden and high efficiency. The system can be an artefact, facility, building, network, organization, or society (Wilson, 2014).

The world is shifting toward fifth industrial revolution, human still have the central role. The industries must take care of human sustainability to ensure the workers' health and well- being. Several studies have evinced the importance of ergonomics in the workplace and its benefits (Ciccarelli et al., 2022).

The manufacturing industries have moved from mass production to mass customization aiming to offer a high quality of goods with massive quantity as well and are different from each other and are customized for a single consumer. This new paradigm requires to be more agile and responsive to human behaviour. The industries should focus on giving more flexibility to the workers by giving them the central roles (Chryssolouris et al., 2008).

Since the efficiency, productivity and product quality is directly dependent on human performance, it is extremely important to take care of the workers' health and well- being. Guaranteed health, safety and well- being to the workers has a positive effect on the overall industries. It is a fact that whole industry gains benefits from the satisfied and motivated employees (Peruzzini et al., 2017).

Lean principles and workplace ergonomics are deeply interconnected. It is important to integrate ergonomics way of working in workplaces, because ergonomics risks can lead to lean wastes and vice- versa (Brito et al., 2020).

2.5 Relationship between lean, inbound and ergonomics

Activities related to lean manufacturing and ergonomic evaluation should start simultaneously. There is a high chance of new ergonomics problems if the lean improvement team focuses on improving only the processes without considering the ergonomic aspects. These ergonomic risks can lead to work-related musculoskeletal disorders (WMSDs), including repetitive motion injuries, cumulative trauma disorders, carpal tunnel syndrome, tension neck syndrome, low back pain, and soft tissue disorders of the workers. Ergonomics can support smooth lean transformation and lean can support ergonomics risk reduction and vice-versa. Poorly managed workplaces result to substantial wastages of resources, whereas safe workplaces identify and utilize the talents of employees without letting it waste (Aqlan et al., 2013).

The framework mentioned below in Figure 13 to implement lean and ergonomics is based on five steps with implementation of ergonomics aspects. The first step is to identify the value. After the value is identified, the ergonomics requirements are collected. In the second step, the value stream mapping is then plunged with ergonomics value stream. Following that, in the third step, the process flow is identified, and the ergonomics risks are assessed and analyzed. In the fourth step, the “pull” rather than “push” way is established with actions taken to minimize ergonomics risks to achieve fifth step, i.e., perfection (Aqlan et al., 2013).

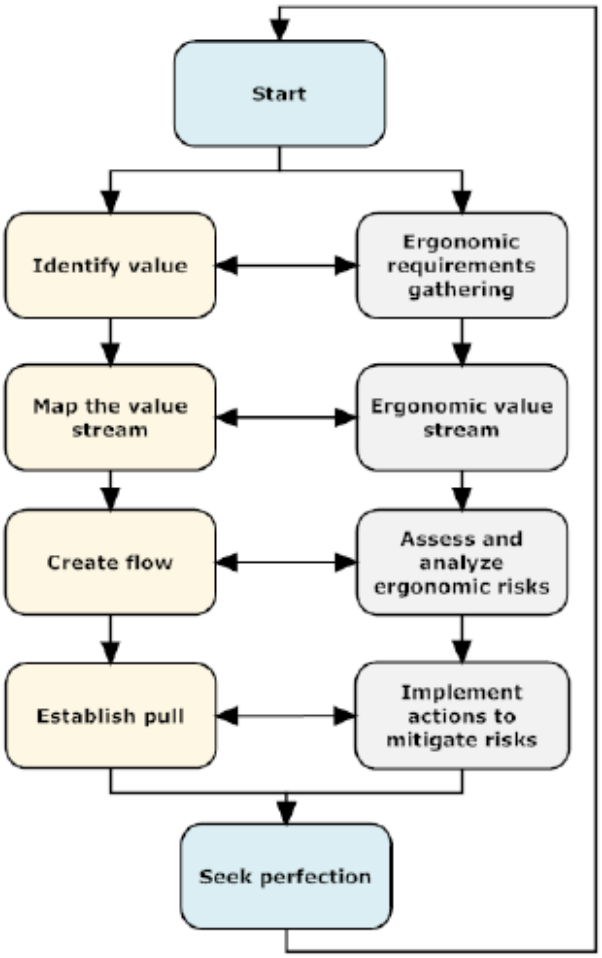


Figure 13. A framework to integrate Lean and Ergonomics (Aqlan et al., 2013).

3 Methodology

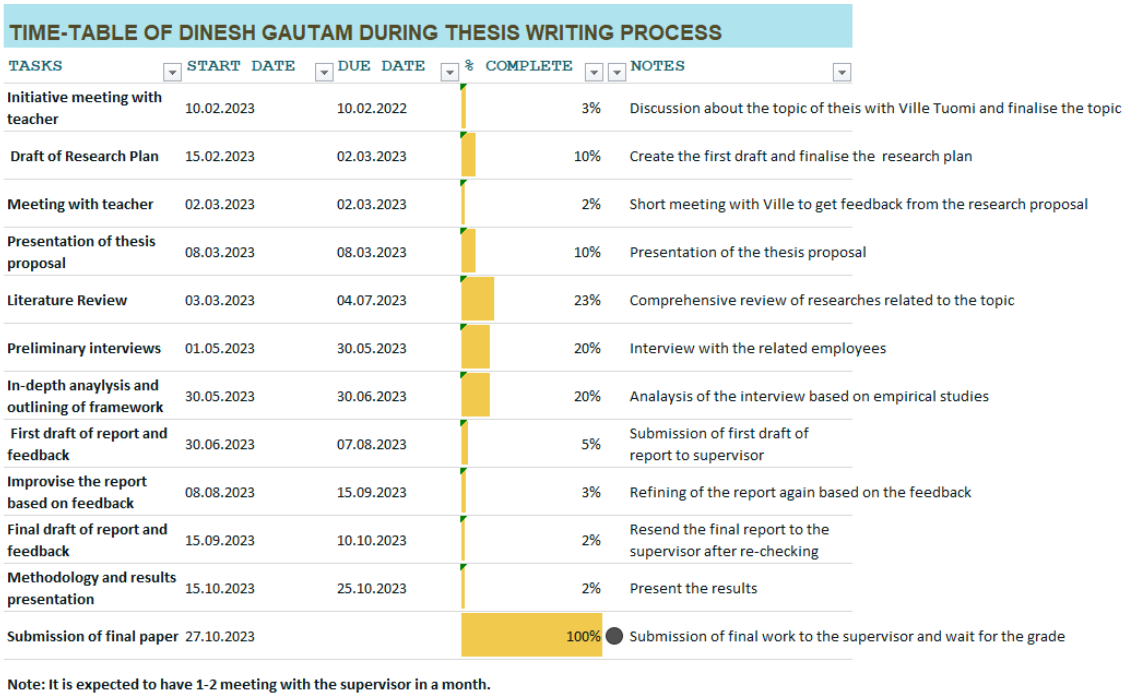
The main objective of writing this thesis was to find the best way to implement sustainable packaging and ergonomics of the workplace. The literature review results were first complemented with the primary research conducted. The primary research was carried out as in- dept interviews among the warehouse workers. The key requirements, expectations and problems were identified, and the solution was implemented according to the interviewees' opinion. The protocol of interview was designed and developed as per the advice of Castillo- Montoya (2016). Montoya suggests that the interview should contain four- phrase processes: (1) make sure that the interview questions align with the research problems/ questions, (2) build an inquiry- based conversation, (3) receive the feedback on the interview protocols, and (4) pilot the interview protocol. By following these steps, the reliability of interview will be accurate and strong, therefore contribute to the improving of quality of data gathered from the interview (Castillo-Montoya, 2016).

3.1 Research process and research data

The study and research were carried out in a busy timetable and thanks to everyone involved, it went smoothly as planned. There were lots of hiccups during the writing process. The co-operation from supervisors and the interviewees was exceptional. The thesis started from the beginning of April and was completed at the end of August, taking around 5 months for the final completion. The collection of data was done by interviewing the workers face to face by using the recorder of smart phone. It was simple and easy since the interview was done in a peaceful meeting room.

Seven participants from different work backgrounds were chosen for the interview process. All the participants agreed to take part in the interview. The time slot was booked for each participant. Since the interview was taken in relaxed and flexible timetable, it took around 1 week to complete interviewing all the participants. On average, it took about 12 minutes of time to complete each interview.

The aim is to finish the thesis within proposed timeframe. The clear and comprehensive overview of the timeframe is provided via Gantt chart in the Figure 9 below. The whole project plan and activities are illustrated in the Gantt chart. All the significant phases starting from the beginning until the end can be viewed in the Gantt chart. Gantt chart is helpful tool to illustrate the project schedule. The chart lists the tasks to be performed on the vertical axis, whereas the time intervals are presented on the horizontal axis. It took approximately 8 months to finish the thesis which was expected time period.



TIME-TABLE OF DINESH GAUTAM DURING THESIS WRITING PROCESS

TASKS	START DATE	DUE DATE	% COMPLETE	NOTES
Initiative meeting with teacher	10.02.2023	10.02.2022	3%	Discussion about the topic of theis with Ville Tuomi and finalise the topic
Draft of Research Plan	15.02.2023	02.03.2023	10%	Create the first draft and finalise the research plan
Meeting with teacher	02.03.2023	02.03.2023	2%	Short meeting with Ville to get feedback from the research proposal
Presentation of thesis proposal	08.03.2023	08.03.2023	10%	Presentation of the thesis proposal
Literature Review	03.03.2023	04.07.2023	23%	Comprehensive review of researches related to the topic
Preliminary interviews	01.05.2023	30.05.2023	20%	Interview with the related employees
In-depth anaylysis and outlining of framework	30.05.2023	30.06.2023	20%	Analaysis of the interview based on empirical studies
First draft of report and feedback	30.06.2023	07.08.2023	5%	Submission of first draft of report to supervisor
Improvise the report based on feedback	08.08.2023	15.09.2023	3%	Refining of the report again based on the feedback
Final draft of report and feedback	15.09.2023	10.10.2023	2%	Resend the final report to the supervisor after re-checking
Methodology and results presentation	15.10.2023	25.10.2023	2%	Present the results
Submission of final paper	27.10.2023		100%	Submission of final work to the supervisor and wait for the grade

Note: It is expected to have 1-2 meeting with the supervisor in a month.

Figure 14. Project plan for the thesis.

3.2 Semi structured interview

The thesis employs qualitative research methodology primarily based on the data collected from the empirical research from the interview conducted with the warehouse workers responsible for receiving goods mainly from Italy.

Qualitative research is a method for comprehending and evaluating the significance that different people or groups assign to social or human problems (Ishtiaq, 2019). It is appropriate to do research on new and emerging issues due to the exploratory capacity of qualitative research, allowing the researchers to get in- depth understanding of the research problem under investigation (DeVaney, 2016).

A semi- structured interview is mostly used in qualitative research with the interviews characterized by increasing the level of flexibility to answer with open end discussion. It lacks proper structure and are based on emotion (Edwards & Holland, 2013).
In- depth interviews are qualitative discussion with the participants to get the further knowledge in the respected field (Wetzel, 2020).

Initially, pilot interview was made ready and was distributed among random friends who are completely not aware of the topic and its goal so that genuine and critical response would be generated. Few changes were made in the questions after the pilot test. An email was sent to the supervisor of the employees regarding the interest to interview them so that they can be prepared and allocate their time. The final draft of interview was then distributed among the employees. The interview was carried out face to face by recording it with the help of mobile phone. The interviews were further developed and adjusted to be more relaxed and more understandable by using the daily used language of the interviewees. Each of the participants were given approximately 30 minutes of time for the whole process. The interview was conducted in different time and different day as per the availability of interviewees and schedule of my own timetable.

The table below demonstrates the basic outline of how to get the interview in more reliable and accurate form.

Who would be the best person to conduct the interview?	Seven employees from the external company with whom I have occasionally work

	and have good understanding of the inbound process
How to conduct the interview?	Face to face with the warehouse workers since they are physically in the location, making the interview smoother
Language used in the interview?	The main working language for the interview will be in English. Finnish language will be used in some cases
What to expect from the interview?	Honest and reliable answers so that the answers can be implemented for development process

Table 2. Outline of the interview.

3.2.1 Designing and implementing the interviews

For the interviewing part, seven different workers were chosen. Since the type of interview was semi- structured, complete freedom was given to the respondents so that they can answer with flexibility. The main purpose of the interview was to discuss and understand the challenges existing in good receiving area (GR) while dealing with the materials coming from Italy. The respondents comprised from different nationality, different age-group, male and female both to get the valid and genuine answers. The respondents represented from different age group varying from 20 years to 60 years. It was an interesting observation to get different answer on same question. The answers didn't completely deviate but it was not same either. The name of respondents is kept anonymous, and they were also informed that their name is not going to be published in the final thesis. It was beneficial in terms of receiving more open and unbiased answers.

The interview process was divided into three logical categories: before, during and after the interview (Burke & Miller, 2001). Below in the Figure 16, it can be seen the summary of highlights of each three phases of the data collection.

Before the interview	During the interview	After the interview
• Pre-testing the interview protocol • Communicating with potential participants • Determining audio-taping techniques • Pre-determining data analysis needs and logistics of gathering data • Scheduling each of the interviews • Introducing yourself in the call • Informing participants of confidentiality • Identifying necessary form of note-taking • Communicating whether and/or how the results will be shared	• Identifying appropriate interviewer style • Getting the participant to talk freely • Creating different types of questions • Giving useful feedback to participants, without distorting potential data • Considering interview length concerns	• Revisiting the collected data for accuracy • Preparing the data for analysis • Allotting ample time for data analysis

Figure 15. Recording the phone as a mean of data collection (Burke & Miller, 2001).

The pre- interview phase was concerned with the things such as planning, pre- testing and organizational skills before the interview. In this phase, the interview protocol was pre-tested by making the lists of questions and piloting those questions with demographically similar profile or at least who have basic understanding about the so-called sample questions. The interview questions were communicated ahead of time to the respondents, along with the general information and objective of the study so that the

respondents can prepare their mind mentally and can schedule their time from the busy working life.

During the interview phase, there were numerous lessons learnt. The interview was done in a friendly, conversational, unbiased, and courteous manner. Each and all respondents were given separate time. The respondents were given complete freedom to answer the questions. Any signs of surprise or disapproval with the respondents' response was not shown during the interview period. The respondents were given to talk as much as possible.

The post- interview phase was also a lesson learning phase since it consisted of incredible amount of descriptive and rich data. Each interview was checked and verified that they are in correct format and in good quality. Immediately after the interview, the interview conversation was re- checked to make sure that they are accurate and complete. The average time taken for each respondent was approximately 12 minutes excluding the introduction and warm up session Afterwards, the preparation for analysis of data collection was started. The thematic analysis was used for the analysis of data.

None of the transcribing software were used to prevent the distribution of sensitive data into the internet. The recorded interviews were transcribed by listening each of them and writing the same answers given by the respondents into Microsoft Word. The unnecessary parts such as pauses, tones, emotional reactions, repeated words were left away to optimize the transcribing work. It gave lots of insights about the warehouse workers' tasks and challenges when transcribing which was beneficial to understand the concept even better.

The analysis process cycle was created to have clear framework during the interview phase. The first phase of the interview was to brainstorm the interview questions. The first draft of interview questions was created. All the irrelevant questions were filtered

and removed to keep the questions within framework. The pilot interview was distributed among few friends to get their feedback. After the feedback, few changes were made, and final interview questions were created. The workers were requested to participate in the interview few days ahead by providing the brief agenda of the interview. The interview date was agreed as per the availability of the workers. The interview was conducted and then it was transcribed. After all the process, the result was prepared. The analysis process of the thesis can be seen in Figure.15 below.

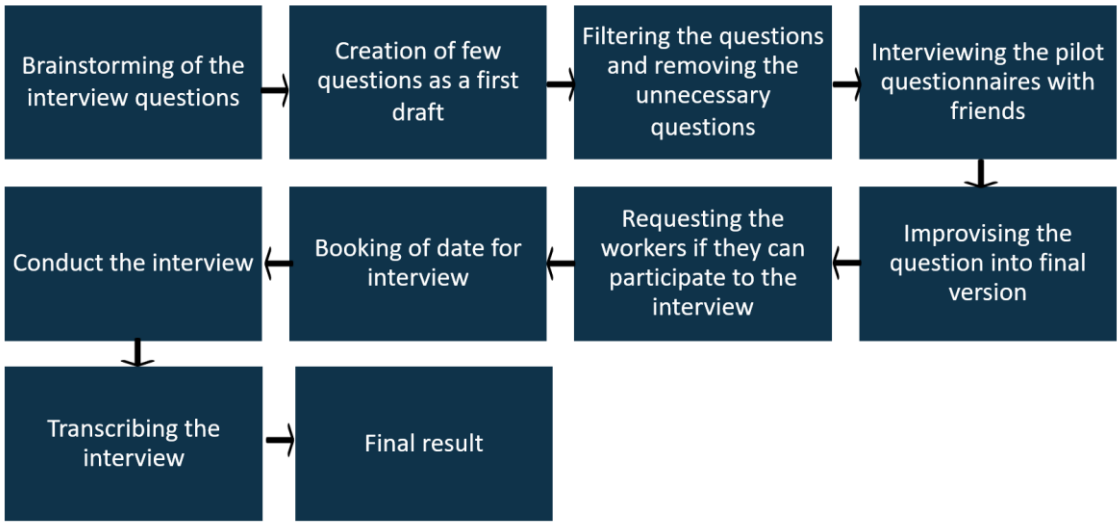


Figure 16. Analysis process cycle.

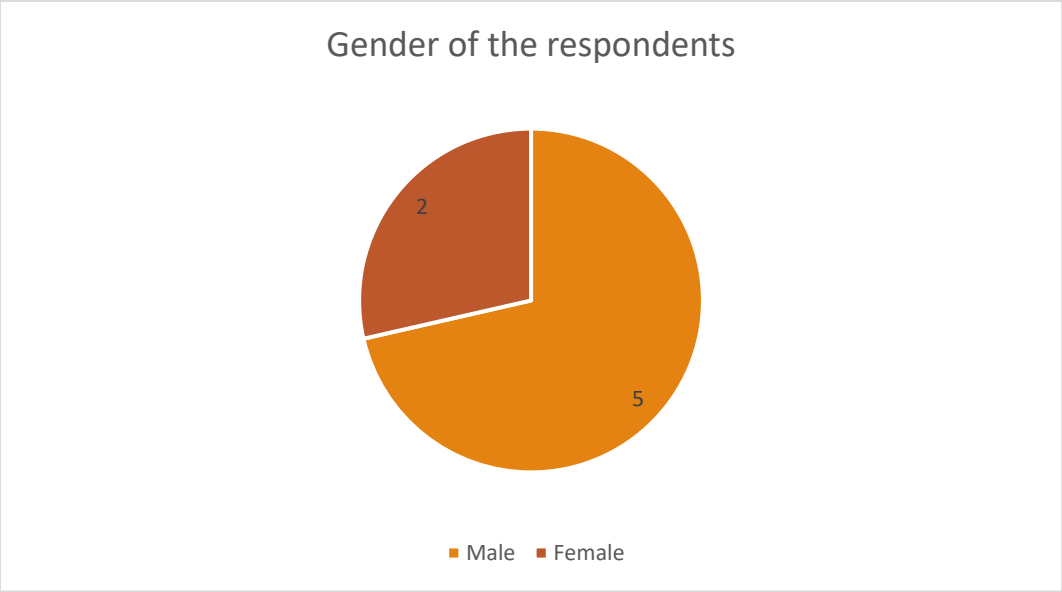


Figure 17. Gender of respondents.

According to Research Council of Norway, integration of gender in the research increases the quality of research, knowledge production and improves the acceptance of innovation in the market. Gender perspectives in research and innovation gives birth to new ideas and better result (Grønnesby, 2014). The interview was conducted with 2 females and 5 males respectively (see the Figure 17).

Figure 18. Ethnicity of respondents.

The objective was to make more inclusive and diversified by collecting the data from respondents from different background. According to Research Council of Norway, inclusion of diversity in research provides with broad understanding about the cultural norms and helps to bridge the gap between the workers (Grønnesby, 2014). Since people from different social background have different opinion and have different priorities over same question, the study tries to find the balance between the response. There were people from different countries where 4 participants were from Finland and 3 participants were from other country than Finland with completely different work culture (see the Figure 18).

4 Results

4.1 Packaging in Wärtsilä

According to Wärtsilä's packaging guideline, the goods should be packed in such a way that it is designed to be stackable to allow forklift handling and sling handling when loading the goods. The packing instructions are mentioned in purchase order if it is necessary. All the suppliers are responsible for the proper packaging of products and ensure the secure journey from their premises to Wärtislä. Suppliers should always inform the transporter if the handling units are stackable (Wärtsilä, 2023).

All the packages must contain all the required information and should be properly marked and labelled according to the instructions provided by Wärtsilä. The following points such as durability of product, duration of transport, means of storing, mechanical stress on package, climate precautions, security and potential chemical hazards should be considered.

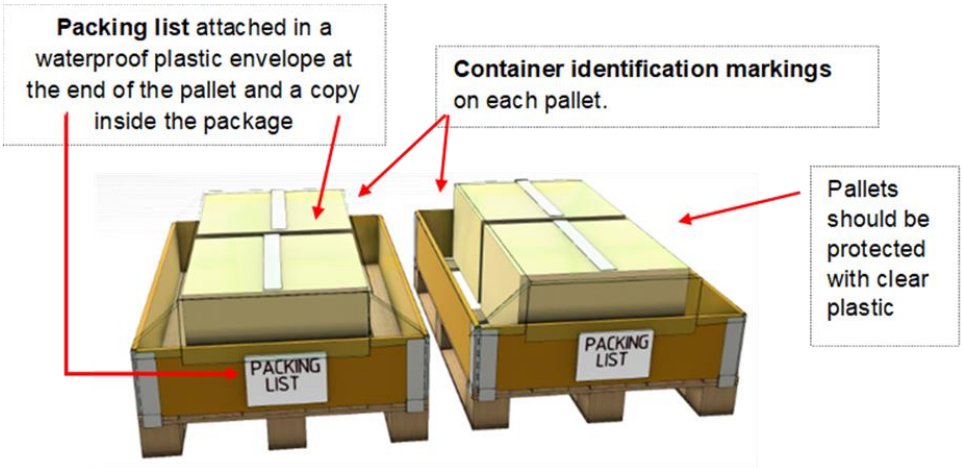


Figure 19. Packing list requirements (Wärtsilä, 2022).

Wärtsilä's packing guideline states clearly following rules to be applied for each inbound package:

1) During the shipment of the packages, the durability of products should be considered, and adequate protection should be applied to the materials against stress during the transportation.

2) The materials should be delivered in standard EUR-pallet (1200 mm * 800 mm * 144 mm). The pallet should have necessary collars on the top of it and the material should not go beyond or exceed the collar. This helps a lot during the good reception process since the worker does not have to change the pallet and the material does not need any re- packing in case, if the packing is done according to the Wärtsilä LCV standard. It will also increase the ergonomics and safety of work since the worker does not need to deal with the package so much. The extra use of pallets, plastics and papers will be saved which increases the sustainability (Wärtsilä, 2022).

3) Each pallet should contain a packing lists attached to the pallet with all the required information such as sender's name and address, shipping date, purchase order number and item, delivery address, delivery date, material number and the total amount shipped, dimension and weight of material (Wärtsilä, 2022).

Packing list for handling unit 100

Forwarding instruction , Priority Normal

Loading address	Shipping address
Company	Name
Name 2	Name 2
Street address	Street address
Supplier ID	

Handling unit 100

Packing	Pallet with collars 80cms * 120cms	Dimension	80x60x40 cm
Gross weight	35.00 kg	Volume	0.19 m3
Net weight	35.00 kg		

Order number	Item	Qty	Unit	Material description	Pickup date	Material no.	Barcode
45054	00010	400	PCE		09.06.2023	981	4505 .00010.400.20230609

Figure 20. Packing list (Wärtsilä, 2023).

4.2 Results of the interview

The results of interview included the open-end semi structured questions. The questions comprised lots of qualitative variables. They were not confined to just “yes” or “no”, rather, utilized the opportunity to include the opinion and understanding of the workers. There were total of 12 questions. The questions were divided into two sections; 1. background questions and 2. content questions. There were four background questions and eight content questions. The background questions consisted of responsibility areas, work history and task description of the employee whereas the content questions consisted of the main questions related to the thesis i.e., questions related to the packages coming from Italy.

The first question was to describe the responsibility area and daily task. Since all the seven respondents are primarily working in the goods receiving area, their task was also

of same nature. Their primary task was to receive goods, take the packages from pallets, check if the material matches with the purchase order and receive the goods in SAP system. One respondent answered that he/she is mainly working with the small packages daily. According to one respondent, the response was: *"My main task is fluctuating right now. I am usually working in different areas like repacking area, special receiving area, and good receiving area. I know about inbound processes, and I try to solve the problems raised from our inbound personnels, the purchasing departments and the vendors."*

When asked how long the respondents have been working in the good receiving area, two respondents said that they have been working for around 5 months here in Finland, but they have been doing same task for around 8 years back in their home country. Two respondents answered that they have been working for around 9 months and two respondents answered that they have been working for 4 months. One respondent answered that he/she has been working for more than 10 years.

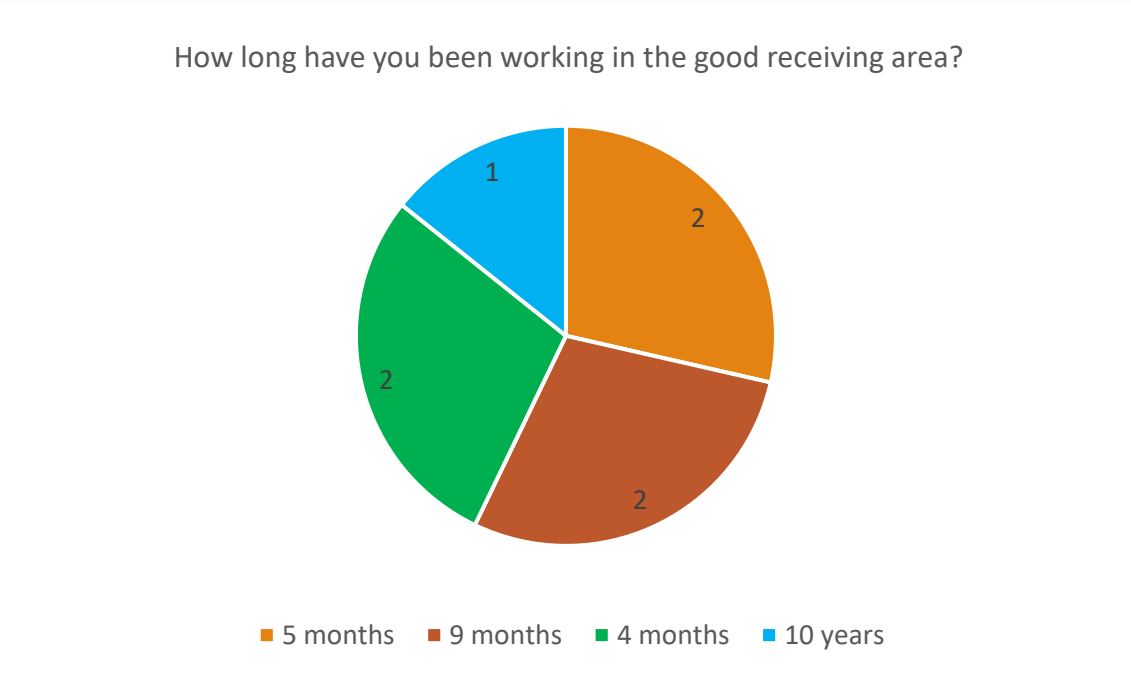


Figure 21. How long have you been working in the good receiving area?

When asked about how well do the workers understand their task, all the respondents said that they understand their task well enough. Three respondents answered that they are confused sometimes even though they know their task due to different factors. One worker focused that he/she wants to understand the whole picture on how the supply chain works. He/she was concerned that some workers are working like a robot, and he wants to avoid it. One respondent had different and unique answer. The response was: *"I understand my task well enough. I was very interested in the good receiving area from the beginning, and I wanted to understand the whole picture on how the supply chain works. I noticed some of the people working here worked just mechanically like an algorithm. I thought it was cool when you know what's happening instead of just how to it. It resulted in me to understand my task well, better than average workers since I am also responsible for teaching new workers here in GR area."*

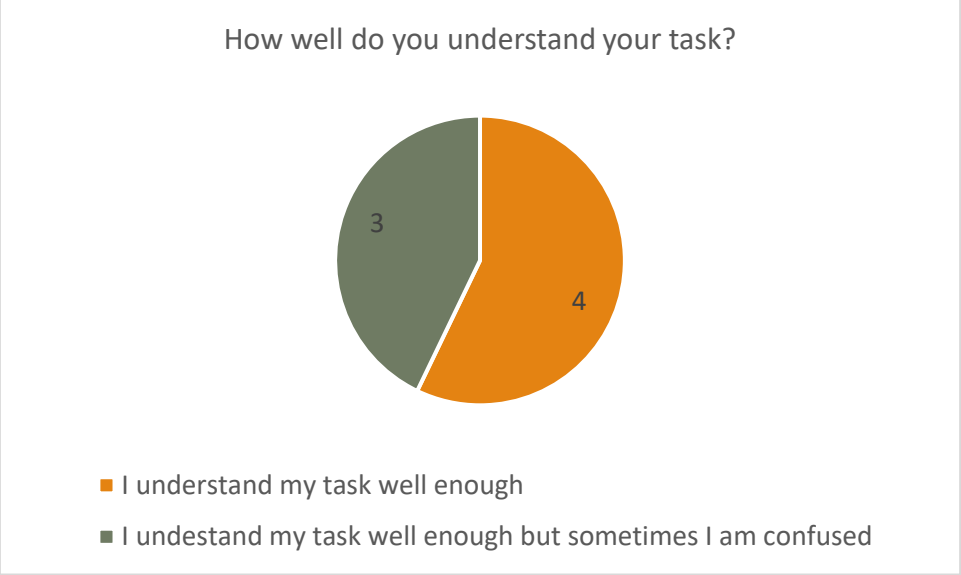


Figure 22. How well do you understand your task?

The next question was related to if they get additional instructions and support from their colleagues and supervisors. 4 respondents replied that they get full support and instructions from their supervisors and colleagues. 3 respondents said that they get the supports and instructions, but it could be much better. They responded that it would be easy if they could find the right person to contact when there is a problem so that they

do not have to spend their time searching for them. According to one respondent, he/she had to say something like this: *"It could be a lot better. There are lots of areas the workers need support. I learnt most of the things myself. If I encounter some problem, I must find the right person myself and then I have to explain them which is really hard since sometimes it is not so easy to explain."*

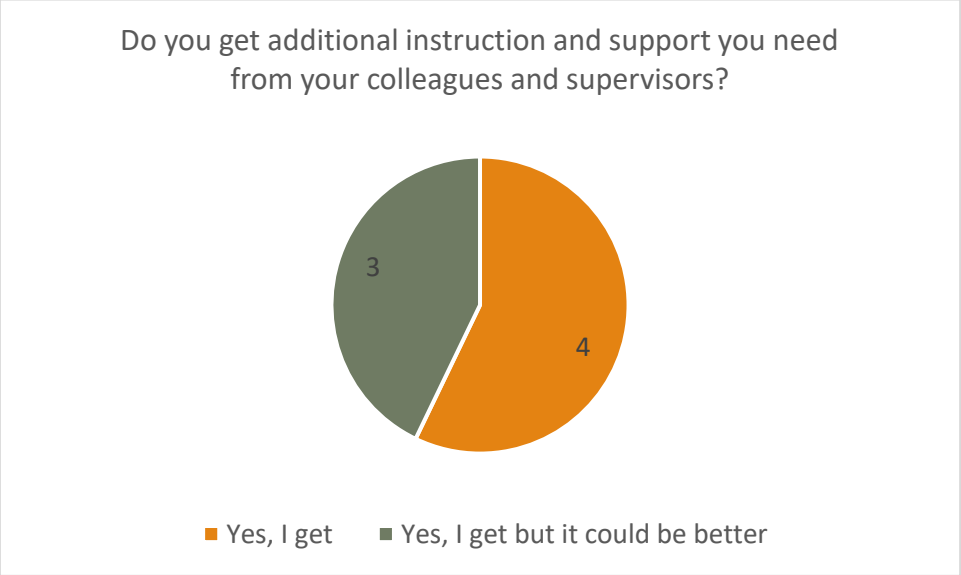


Figure 23. Do you get additional instruction and support you need from your colleagues and supervisors?

The next part was content questions, meaning the questions related to the packaging coming from Italy. When asked how often they do receive the goods from Italy, four respondents said 2-3 time a week, two said at least once a week and one respondent said 3-4 daily in an average. It was difficult for the workers to give precise answer since there were lots of factors affecting their answer.

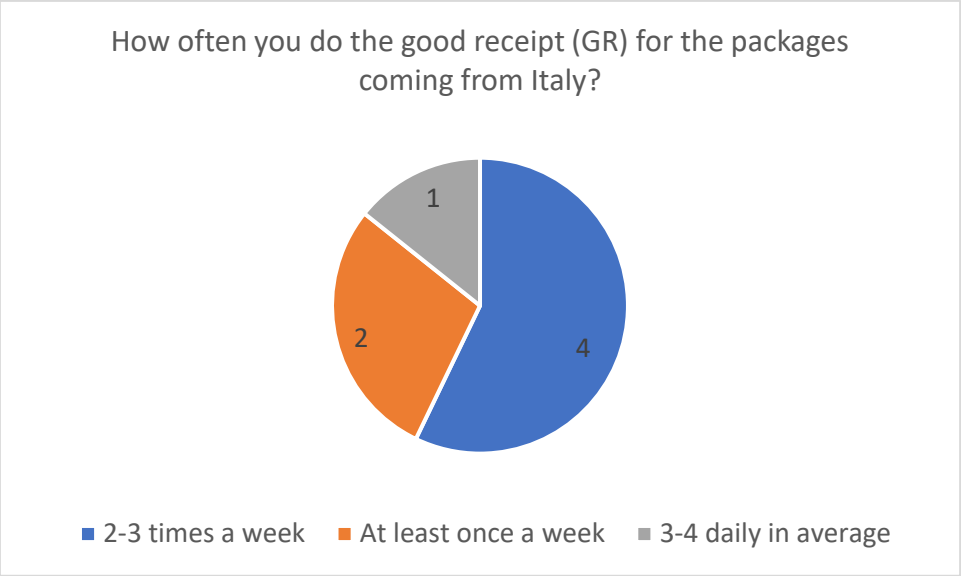


Figure 24. How often you do the good receipt (GR) for the packages coming from Italy?

The next question was if the packages come in different shapes and sizes. All the respondents gave marginal "yes" to this question. It was clear that the packages come in different shapes and sizes.

The next question was related to how easy or difficult it is to unpack/ unbox the packages coming from Italy. The response for this question was mixed. The first respondent said that few boxes coming from Italy, especially the red box is challenging to unpack. They are time consuming as well and there can be series of these boxes in one batch.
According to second respondent, the packages are well packed most of the time and there is not any trouble in the unpacking process. The third and fourth respondent answered that it is not the most efficient packaging and could be much better. They have lots of screws which demand the screwdrivers, and it takes too much time. According to them, it is not too complicated or difficult, it is just time consuming. The fifth respondent responded that the packages are well packed, but it is difficult sometimes to unpack since some of the packages have metal locking system at the edge which leads to the usage of physical strength and a hammer which is not the safest measure to unbox the packaging. In addition, it consumes the time as well.

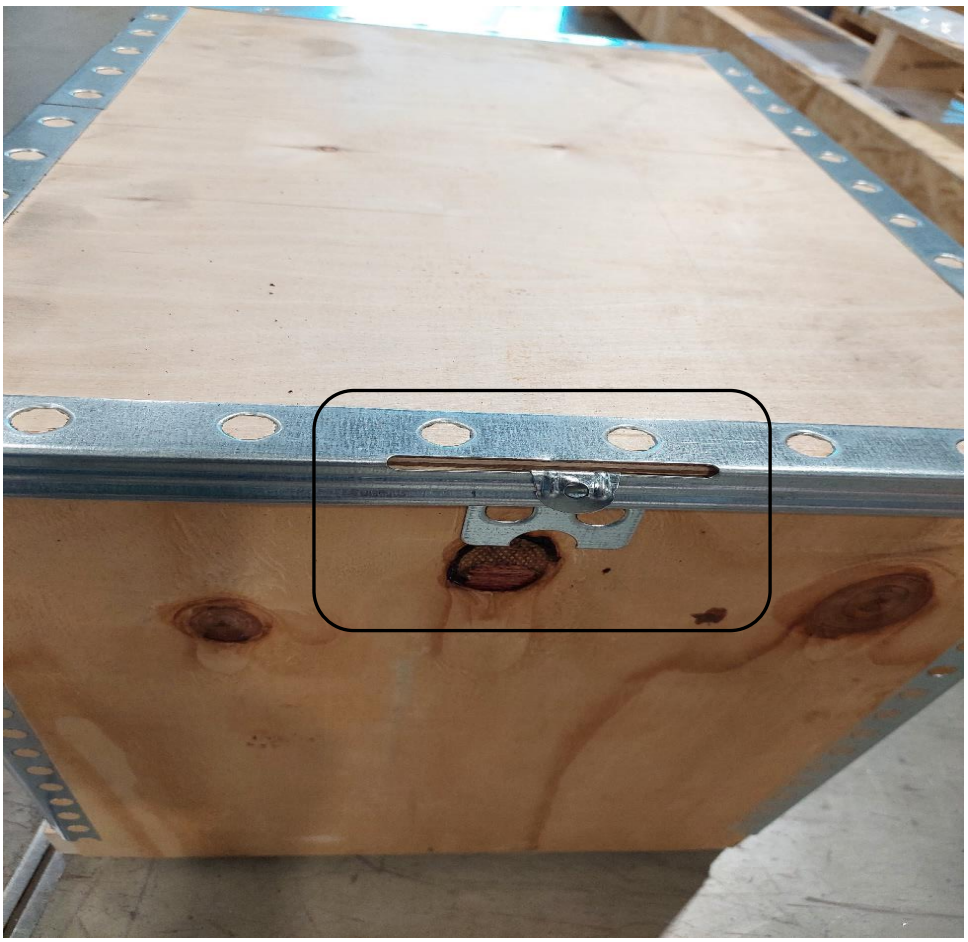
The sixth respondent only worked with the smaller packages, so it's easy for him/her to unbox them. The last respondent also responded that it is sometimes easy and sometimes difficult to unpack the packages coming from Italy.

The third respondent said which is quoted: *"It is not the most efficient packaging. They have lots of screws, so you need a screwdriver almost always and it takes too much time, but it is not too complicated, just time consuming. "*

Picture 4. The example case according to third and fourth respondents.

The fifth respondent said- *"Talking about the packaging, they are well- packed. But it's bit difficult sometimes to unpack since they have metal locking system, and the box is*

often locked with this bent metal, and you need to use your physical strength and a hammer which is not the safest way of unboxing. In addition, it consumes more time as well. Otherwise, most of them are easy to open. "



Picture 5. The example case according to fifth respondent (plywood collapsible box).

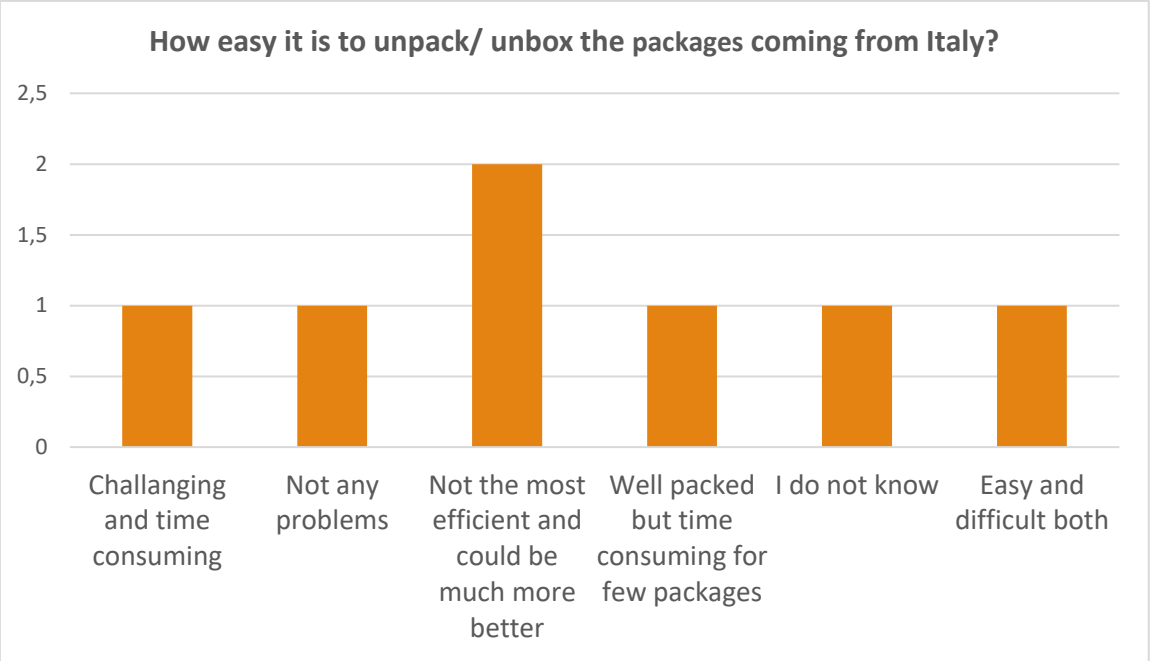


Figure 25. How easy it is to unpack/ unbox the packages coming from Italy?

When asked what could be done in a better way, all the respondents had constructive suggestions. Out of seven respondents, two respondents suggested if the materials could be sent in EUR-pallets with proper collars instead of boxes. It makes them easier to deal with packages. According to them, if the materials come in EUR-pallets already, they do not need to do repacking in most of the cases, which saves the resources, time, and energy of the workers.

Two respondents implied that the documentation could be done better. According to them, in some cases, the documents are mixed and are not matching with the products which creates problems in the work. They must fix that problem before receiving them, again consuming more time and effort which could be fixed easily. The packaging is done quite well but sometimes the documents are lacklustre. They should start working on proper documentation so that it will be easy for the worker working in good receiving area here. They proposed that there should be separate documents for separate purchase orders.

Three respondents responded that the screws can be replaced with plastic strapping. It saves lots of time of workers. There are durable and strong plastic straps available. If they really need to use nails, the least thing that can be done is to use standard nails which fits in the screwdriver so that the workers do not need to use physical force but can open by using only screwdriver. Not all the workers have screwdrivers with them. Metal straps can be replaced by plastic straps since they are not the safest option. The metal strap could fly to the workers' face while cutting it off. Same suggestion for the boxes having metal locks, they could be replaced with plastic straps. They also mentioned that the different materials could be sorted in a different pallet. If there are lots of different small components, they can use same pallet to save resource, but in that case, there should be clear marking of the documents for the products so that they will not get mixed up.

Only one respondent responded that the products could be organized well. Sometimes they are scattered in different places, and they could easily get lost. He/she recommended one separate space dedicated for only smaller packets so that it will be easy to find them. The last respondent also suggested to replace the nail and screws by plastic straps. According to him/her, *"The smaller packets are scattered here and there, and they can easily get lost. It takes so much time and effort to search one small packet just the time when somebody needs. The smaller packets can have one space dedicated for only smaller packets so that it will be easy to find them."*

Picture 6. Three respondents suggested that standard screws could be used in case if they really need to use the screws.

Table 3. 8. Do you think that things could be done in a better way? If yes, what it could it be?

Usage of EUR-pallets with proper collar	1	1	
Proper documentation of the packing list	1	1	
Replacement of screws and nails with plastic strapping	1	1	1
Replacement of metal strapping with plastic strapping	1	1	
Usage of separate pallets for different materials	1		
Organized and dedicated space for small packages	1		

The next question was asked if it would be easy if all the materials that come from Italy fit in EUR-pallet. All the respondents answered that it would be much easier if they could fit in EUR-pallet. Every respondent had almost same view that it will save the time & resources and will be more ergonomical. One respondent had different opinion due to

the nature of work. He/she mostly works with the smaller packets and EUR-pallets are not necessary for the packages she is dealing with. Direct quotation from one respondent which was clear and had responded- *"It would much more be easier if all the materials that could fit in EUR-pallet are delivered in EUR-pallet. There are lots of materials that could have fit in EUR-pallet, but they mix different materials in one big box. Then we must sort them out and divide them in EUR-pallet which is again time consuming and not the best practice of ergonomics."*

Table 4. 9. Do you think it will be easy if all the materials that come from Italy could fit in EUR-pallet?

It will be much easier, and the package does not need to be sent to repacking anymore which saves lot of time and resources
It will save time and resources and eliminates the possible wastes
It would reduce the lead time
For small packages, EUR-pallets are not necessary

Then next question was related to ergonomics aspect of the work environment. The word 'ergonomics' was not used in favour of the respondents to avoid any misunderstanding or confusion. Instead of 'ergonomics', the words 'safe', 'comfortable' and 'efficient' were used since everyone is familiar with these terms and these words represent the value of ergonomics quite effectively. In this way, the essence of the ergonomics was kept lively. All the respondents said that they feel relatively safe when working on the packages from Italy. Few respondents had alternative suggestion for the improvement of the safety. Second respondent felt that it would be more ergonomical and safer if they do not need to deal with screws and metal straps by replacing with the plastic straps. According to one respondent, he/she quoted like this: *"I feel relatively safe, but they are not like the same quality of boxes as we have in LCV. Their boxes have risk of getting small piece of wooden splinter into the hand. But the workers should wear safety gloves all the time."* According to him, the workers should be also prepared well and use their common

sense to avoid any small accidents such as risk of getting the wooden splinter which can be significantly reduced by using proper gloves.

Moving on, the second last question of the interview, was about what could be done to improve the safety of the work environment. All the respondents had suggestions based on their experience. The first respondent focused that the packaging should be changed to EUR-pallet and usage of straps instead of screws should be initiated. The second and sixth respondent said that there should be more space in the working area. According to them, sometimes there is narrow space in the working area making it difficult to move the materials from one place to another. The second respondent also emphasised that there should be one moveable crane in the good receiving area so that the workers do not need to carry any heavy materials physically and they can shift the materials to other pallet without any physical demand. This will save the time and resources as well. The third respondent suggested that there should be more signs and pamphlets in the good receiving area so that the workers can get familiar with the basic terms of safety. He/she said- "*There are not enough signs and pamphlets around the GR area. The forklift drivers should slow down and be more careful. I feel like they are rushing most of the time*." The fourth and fifth respondents answered that there should be more proper working tools in the good receiving area. They also mentioned that the metal straps should be replaced by plastic straps. They said that the comfortable and safe work gloves should be made accessible easily. The seventh respondent did not have anything to say regarding this matter.

Picture 7. The metal strap (left) could be replaced by using plastic strap (right) according to the respondents.

Picture 8. Lifting tool as suggested by one worker to reduce the physical stress (Konecranes, 2023).

The final question was if the respondents had anything to say which was not mentioned in the questions above and three respondents had nothing to say. Three respondents suggested that they should work on proper documentation. Out of three respondents, one respondent said- *"They could use proper packing list. Sometimes the whole packing list is missing. Each item should be easy to recognize in the packing lists".* According to the sixth respondent, sometimes there are wrong quantities delivered which should be

fixed and they should be more careful with these kinds of issues in future.

4.3 Improvement of packaging efficiency and performance

The current status and action required to improve the packaging performance and efficiency is presented in table 5 below. The table demonstrates the status of the packaging and the actions required to improve them. The table consists of seven 'subjects' that must be supervised. Each subject is described with the current status and if the action is required, it is also described shortly. It is illustrated that some actions are required to improve the packaging efficiency and the performance of Logistic Center Vaasa. The action is needed in some parts of documentation, in usage of EUR-pallet, one material with high volume which is not possible to fit in same pallet/box, same pallet with different layers used for different materials, screws/straps, metal straps, and space for smaller packets. It is clearly visible that the action is required for most of the status. Among all the subjects, usage of EUR-pallet is most important subject that requires further attention. The objective of Logistic Center Vaasa is to optimize the usage of EUR-pallet for all possible materials. It is believed that the space will be also utilized better if the pallets are uniform, the waste will be reduced, resources will be saved, and the packages do not need to be repacked again in most of the cases.

Subject	Current status	Is any action required?
Documentation	Two copies of packing list: one inside the pallet and other outside the pallet.	**No**
	Purchase order number with correct item number	**Yes:** Clear indication of purchase order number with corresponding item number
		Yes: Separate pallets/ boxes for the different purchase

	If the components are small with high volumes, the suppliers stack different material numbers from different purchase orders in same pallet/ box to save the space.	orders shall be used. If there are high volume of smaller components and same box/ pallet is about to be used, the purchase order and material number should be marked clearly so that the materials do not get mixed up. Clear documentation should be used.
Usage of EUR-pallet	Usage of wooden crate for the bigger materials to utilize the space of the box	**Yes:** Usage of EUR-pallet whenever it is possible with four frames as the maximum height. Wooden crates can be used for bigger components.
One material with high volume which is not possible to fit in same pallet/box	One label placed in one pallet and rest of the pallet might have/ might not have any information	**Yes:** If there are too many pallets/ boxes with same material under same purchase order, the pallets should be marked clearly. For example: 1/3, 2/3, 3/3. All the pallets should contain same document as in the first pallet.
Same pallet with different layers used for different materials	Suppliers use same pallet with different layers for different materials to optimize the space	**Yes:** Each layer of the pallet should contain same material. It is recommended not to use too many layers for different materials to avoid risk of mixing the materials
Screws/ Straps	Some pallets/ boxes are screwed with the nail making it difficult for the workers to open the box	**Yes:** Usage of plastic straps instead of screws

Metal straps	Some pallets are tied with metal straps which are also challenging to cut and have risk of flying over worker's fae	**Yes:** Usage of plastic straps to avoid the risk of the metallic strap flying over the worker's face
Space for smaller packets	The smaller packets are delivered around the same area where the bigger packets are delivered	**Yes:** Separate area for smaller packets could be built so that it will be easy to track them whenever the material is needed

Table 5. Current status and action required to improve packaging performance and efficiency (Wärtsilä, 2023).

4.4 Validity and Reliability of the study

The validity and reliability of the study is discussed in this chapter. Validity and reliability are key aspects of all studies and meticulous attention to these two factors can make big difference between a good research and bad research. It is very common in qualitative research, that the researcher's interpretation of data and findings are often questioned or viewed with doubt by the scientific community. To avoid scepticism, one need to have strong validity and reliability of the study (Brink, 1993).

Qualitative research does not provide the statistical calculation of validity and reliability. It rather works on the theme which suits better to the human subject matter. Validity in the research paper is mainly concerned with the truthfulness and accuracy of the findings solely depending and trusting on the answers given by the respondents (LeCompte & Goetz, 1982). Reliability is concerned with the consistency, repeatability, and stability of the respondent's answers as well as the interviewer's ability to collect and record the information accurately. It should yield same and consistent results over repeated testing. (Engelhart, 1976).

There are different kinds of validity in research such as internal validity, construct validity and external validity. Reliability on the other hand, increases the consistency and repeatability of the research process (Hollweck, 2015).

The construct validity determines the ability to identify the appropriate operational evaluations for the concepts. Construct validity can be improved by using a range of research resources, creating a chain of evidence, having the key informants to evaluate the report and by using the comparable metrics with similar studies (Hollweck, 2015).

Both validity and reliability were anticipated to be higher and reliable since the interview was conducted with the workers who had fare experience with the topic. The time and effort were also invested significantly making the data collection process smooth. The workers were informed very well about the motive of the thesis, and they were given sufficient time to be prepared. The relaxed environment was created so that the validity and reliability of the study will be increased. The study attempted to increase the validity and reliability even more by (1) providing the clear motive of the thesis, what I am studying, how the data will be collected and what to do with the collected data, (2) building the trust relationship with the respondents by providing them comfortable environment, (3) comparing the results obtained from one respondent with other respondents and other evidence, (4) keeping the detailed fieldnotes to the variation in response over the course of time and (5) showing the fieldnote to the supervisor to get the approval of the interview.

5 Conclusion and discussion

5.1 Conclusion

The objective of thesis was to find the implementation of lean principles in the inbound logistics, especially the materials coming from Italy. Based on all the empirical studies and interviews, lean principles play vital roles in improving the packaging efficiency and the ergonomics of the workplace. The objective of this research is to develop packaging process of LCV more sustainable. This is made by searching answers to the following research questions:

- How to improve the handling of packages coming from Italy for both supplier and LCV end by implementing lean principles?
- How to create ergonomical and safe work environment for warehouse workers in LCV?
- How to uniform EUR-pallet for all inbound deliveries coming from Italy?

The thesis tries to find the answers for these questions, keeping in mind that there were limited numbers of respondents. The conclusion is thus, based on the on the answers provided by the limited number of respondents.

The result shows that the implementation of the lean principles increases the packaging & unpackaging efficiency and performance of the work. The unnecessary cost reduction is feasible by applying the lean principles. The company itself is successful in achieving the quality, delivery, and cost effectiveness by encouraging the suppliers and workers to reduce the wastes, recycling of pallets and usage of sustainable and biodegradable materials.

There are different methods and tools that can be utilized for the safe and ergonomical work environment. The screws and metallic straps could be replaced by durable plastic straps. It makes the workers' task easier as well as, it is also sustainable choice from the environmental point of view. One common lifting tool could be assembled in the good

receiving area so that the workers could utilize it if they need to shift heavy materials which does not need to go to repack. The materials could be organized in a better way so that it is easy for the workers to find right material which saves the time and effort.

All the materials that could fit in EUR-pallet could be delivered in EUR-pallet. The materials that are delivered in plywood collapsible boxes could be replaced by using EUR-pallet in the possible cases. The speed process of the workflow will be fast, the unnecessary waste will be drastically eliminated, the lead time and total cost will be reduced which saves lots of resources of the company. It will also make the workers' workload easier and increases the productivity of the whole warehouse.

The interview was conducted with participants from different backgrounds to get the broader and reliable answers. Based on the answers from the respondents, following aspects could be improved for the inbounds coming from Italy:

i) Usage of EUR-pallet for all materials if possible
ii) Providing proper training and additional support to the workers
iii) Proper documentation with clear purchase order and items from the suppliers. Usage of separate purchase orders for separate pallets with clear indication of the items
iv) Usage of plastic straps instead of screws or metal straps
v) At least one moveable crane in good receiving area to reduce physical stress of the workers
vi) Organized and designated places for the small materials so that they are easy to track

5.2 Discussion

The thesis work had practical implications and the results could be used in the case company to improve the packaging efficiency and performance. The results could be also used in other departments of the company for the research & development process.

The lean principles have been discussed widely. However, the practical utilization and implementation of lean principles in the companies are not explored adequately. Even though there has been numerous research done in the application of lean principles in the packaging industry, the same principle has not been explored widely for the unpackaging industry. Further research should focus on the importance of lean principles for unpackaging the materials.

The results can be only partly generalized since the research was a case- study with limited respondents. The data collection for this study was limited to qualitative method by interviewing to small group of people. For the future research, multiple sources could be used to gather the data and information to strengthen the validity and reliability of the study and to acquire more thorough knowledge.

The study was based on the case company Wärtsilä and the results are trustworthy and can be implemented in Wärtsilä. Having said that, different companies have different working environment and further studies should be made to implement the same result outside Wärtsilä.

This study hopes to lay the foundation for future research in the field of improving unpackaging of materials by applying lean principles. The whole process was a learning milestone.

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Appendices

Appendix 1. Name of appendix

The interview was mainly carried out in English and partly in Finnish. The interviewees were requested to participate in interview prior few weeks ago so that they could be prepared. The objective of the interview was described clearly to the respondents.

Hello,

I am Dinesh Gautam, a final year master's student in University of Vaasa. I am currently working on my master's thesis and the subject is "Improving the packaging efficiency and performance in LCV by using Lean principles".

The main objective of this thesis is to find out the convenient solutions for inbound packages that come from Italy and your anonymous answers will remain valuable. Your response will be used for the further development of inbound process and will play important role in upgrading the work environment.

Please, answer as per your experience and knowledge since there is not any right or wrong answers for these questions.

Please, respond to these questions by latest 30.06.2023. If you are interested to have face to face meeting, that can be organized as well. Please let me know your timetable so that I can book a brief meeting.

Thank you for your time.

Contact Information:

Dinesh Gautam

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Background questions

1. Can you briefly describe your responsibility area and your daily task?
2. How long have you been working in the good receipt area?
3. Do you understand your task well enough?
4. Do you get additional instruction and support you need from your colleagues and supervisors?

Content questions

5. How often you do the good receipt (GR) for the packages coming from Italy?
6. Do the packages come in different shapes and sizes?
7. How easy it is to unpack/ unbox the packages coming from Italy?
8. Do you think it will be easy if all the materials that come from Italy could fit in EUR-pallet?
9. Do you think that things could be done in a better way? If yes, what it could be?
10. How safe and comfortable you feel while working on the packages from Italy?
11. What could be done to improve the safety of your work environment?
12. Do you have anything to say related to the inbound deliveries coming from Italy which is not mentioned in the questions above?

Thank you so much for your time and effort!

Appendix 2

Hei, minä olen Dinesh Gautam, viimeisen vuoden maisteriopiskelija Vaasan yliopistosta. Tällä hetkellä työskentelen diplomityöni parissa ja aiheena on "Pakkaustehokkuuden ja suorituskyvyn parantaminen LCV:ssä Lean-periaatteen avulla".

Tämän opinnäytetyön päätavoitteena on selvittää Italiasta tulevien saapuvien pakettien kätevät ratkaisut ja anonyymit vastauksesi pysyvät arvossa. Vastauksesi käytetään saapuvan prosessin jatkokehitykseen ja sillä on tärkeä rooli työympäristön parantamisessa.

Ole hyvä ja vastaa kokemuksesi ja tietosi mukaan, sillä näihin kysymyksiin ei ole oikeita tai vääriä vastauksia.
Vastaa näihin kysymyksiin viimeistään 30.06.2023. Jos olet kiinnostunut kasvokkain tapaamisesta, sekin voidaan järjestää. Ilmoittakaa aikataulunne, jotta voin varata lyhyen tapaamisen.
Kiitos ajastanne.

Yhteystiedot: Dinesh Gautam
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Taustakysymykset

1. Voitko lyhyesti kuvata vastuualueesi ja päivittäisen tehtäväsi?
2. Kuinka kauan olet työskennellyt vastaanottoalueella?
3. Ymmärrätkö tehtäväsi riittävän hyvin?
4. Saatko työtovereiltasi ja esimiehiltäsi lisä-opetusta ja -tukea?

Sisältökysymykset

5. Kuinka usein teet vastaanoton (GR) Italiasta tulevista paketeista?

6. Ovatko paketit eri muotoisia ja kokoisia?

7. Kuinka helppoa on purkaa Italiasta tulevat paketit?

8. Luuletko, että olisi helppoa, jos kaikki Italiasta tulevat materiaalit mahtuisivat Euro-lavalle?

9. Luuletko, että asiat voitaisiin tehdä paremmin? Jos kyllä, miten se voisi tapahtua?

10. Kuinka turvalliseksi ja mukavaksi tunnet olosi työskennellessäsi Italiasta tulevien pakettien parissa?

11. Mitä voidaan tehdä työympäristön turvallisuuden parantamiseksi?

12. Onko teillä mitään sanottavaa Italiasta tulevista saapuvista toimituksista, joita ei ole mainittu yllä olevissa kysymyksissä?

Paljon kiitoksia ajastanne ja vaivannäöstänne!