



Master's degree thesis

LOG950 Logistics

**Improving warehouse logistics for Beerenberg at
Nyhamna Expansion Project**

Daniela Gundersen

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Preface

This master thesis is the final part of the master study with specialization in supply chain management started at Molde University and constitute 30 credits. It was written in the period between January -May 2017.

As an employee at Beerenberg (the case company presented in this thesis), I had the opportunity to be involved in the process of improving warehouse operations. The demand of products stored within Beerenberg's facilities has increased and the existing staff couldn't cope with this. In order to improve the working process and achieve a better flow of the activities the company decided to implement lean ideas that fit warehousing activities. A representative from main office in Bergen travelled to Nyhamna to implement such new methods in order to respond quickly to demand from site.

In my thesis I look at the practical implications, the follow up and the result of these methods that are used to improve the operation in warehouse.

My supervisor Per Engelseth at Molde University College has provided feedback throughout the semester. I would also like to thank Kristina Kjersem, a research scientist at Møreforsking in Molde. She has given me many advices and constructive feedback. The warehouse manager Kjell Ove Falkhytten at Beerenberg has also been a major asset in the implementation of the task. It has been very instructive to get feedback from other employees at Beerenberg that I have been in contact with, which made me even more motivated to complete the task.



Daniela Gundersen

Molde 22.05.2017

Summary

Beerenberg Corp As is a company specialized in insulation of pipes, which delivers innovative solutions to oil and gas industry. Their goal is to exceed everyone's expectations and go beyond them every time.

The thesis starts with an introduction of how I chose this topic and a small presentation of Nyhamna Expansion Project and Beerenberg's role in it. The choice of theory is also mentioned here.

The next chapters present a background of Ormen Lange gas field and the proposed research questions.

The theoretical framework and the research methodology are presented. The empirical study is based on the literature described in previous chapter. The main actors of this thesis are presented, continuing with the description of warehouse processes at Nyhamna. The findings illustrate the details and challenges that the warehouse have.

The conclusions, where the research questions are answered are based on different strategies and theories. The recommendations are mentioned here, together with limitations and further research.

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Abbreviations:

AF: AF Gruppen company

AON: Activity-On-Node

CEO: Chief Executive officer

EPC: Engineering, Procurement, Construction

ETO: Engineering-To-Order

GF: General Foreman

HR: Human Resources

HSE: Health, Safety, Environment

HSEQ: Health, Safety, Environment & Quality

I54: warehouse facility on construction site

IT: Information Technology

JP: Job Pack

KCA: Kaizen Circle Activity

KST: Kværner

MIPS: Method Integrated Project System

MMO: Maintenance, Modification, Operation

MMT: Material Movement Ticket

MRD: Material Release Document

MRR: Material Receive Report

O 10: area outside construction site

PO: Purchase Order

PPE: Personal Protective Equipment

RFID: Radio Frequency Identification

ROI: Return on Investment

SCM: Supply Chain Management

VSM: Value Stream Mapping

VUP: Verktøy- and Utstyr Pool (tool and equipment pool)

XP: Cellular glass product used for pipe insulation

1.0 Introduction

The thesis is carried out as a case study and is based on a construction project that Beerenberg has on Aukra, an island outside Molde. The project is called Nyhamna Expansion Project and consist of large sub-projects, containing many companies, many subcontracts and different disciplines which demands new technology and innovation (www.shell.no).

The thesis looks at Beerenberg's warehouse on Nyhamna. While I was in search for a topic for my master thesis, I got the opportunity to work at Beerenberg warehouse. Being part of a team working within the warehouse gave me the possibility to analyze and understand their working process. Therefore, I decided to write about the topic of warehouse management and combine my practical experience with my theoretical knowledge for constructing this master thesis.

I choose to focus only on the material handling at Beerenberg warehouse and have to determine which theory they are using. If is Lean, do they use it correct, and if not, what can they improve? Therefore, I focus on Lean theory in my master thesis. I have to identify the activities within the warehouse that absorb resources but don't create additional value. I have to see what are the problems that the warehouse is facing and how can Beerenberg make the operations better.

According to Dennis Pascal, Lean is a philosophy that is doing more with less - less time, less space, less human effort, less machinery, less material - while giving customers what they want. Although lean principles are rooted in manufacturing, they apply universally (Dennis 2007).

By facing the daily issues and having to cope with them, I get a better understanding of the challenges that the warehouse is facing. I can see that the demand from the construction site is big and the existing personnel is struggling to deliver up to expectations. Once the warehouse is manned up, it is much easier to answer the demands correctly, faster, more

precisely. The lack of personnel results in incorrect and incomplete documentation of the products sent to site. This creates confusion later when the foremen asks for goods.

In the beginning, it took approx. two weeks (one rotation) for the new people to learn the new tasks they had, the procedures that the company used, the products. The learning curve went up fast. The existing workers did an amazing job teaching all the routines to the new workers.

A better implementation of Lean theory becomes possible by hiring more people. The warehouse is able to deliver “just-in-time”, manage to plan and control better the whole operation in order to meet the demand with perfect quality. For a period of time (between September 2016 and February 2017), the 15-19 operators per shift covers the needs of the project. In this time, the activities use the resources that create additional value while the warehouse tries to eliminate the waste and reduce costs.

In February 2017, towards the end of the project, Beerenberg’s warehouse personnel is reduced again to 7-10 operators per shift. Because the routines and procedures are already implemented and the operations go well, going down in the number of workers per shift doesn't affect that much the quality of the services. The remaining personnel know the tasks and the stoppages are few.

The main actors in this thesis are Beerenberg Corp AS, Benarx Solutions AS, Kværner Stord AS and Shell Norge AS.

The thesis starts with introduction and background, research questions and theoretical framework, research methodology, empirical study, presentation of the actors, findings, and conclusion.

1.1 Background

In this chapter I introduce the gas plant and try to draw a picture of the complexity of the overall project on Nyhamna. I also present Beerenberg's role in the project and describe why they have a warehouse on Aukra.

1.1.1 Nyhamna - Ormen Lange gas field

The name Ormen Lange comes from one of the most famous Viking longships which was built for the Norwegian King Olav Tryggvason. It was the largest and most powerful longship of its day (www.wikipedia.com).

Ormen Lange is Norway's second largest gas field with a reservoir situated in the Norwegian Sea, almost 3.000 meters below the surface of the sea. It covers an area approximately the same size as Molde municipality. The facility is owned by Shell Group. The well stream is processed at the land facility in Nyhamna, where the gas spend just about ten minutes before it is exported 1.200 kilometers through one of the world's longest subsea pipelines, Langeled, to Easington in England.

Ormen Lange has established Norway as the second largest exporter of gas in the world after Russia and produce also a significant amount of condensate (www.shell.no).

It became operational when the Nyhamna facility was ready in 2007.

However, Shell continues the development of the facility and they need to involve suppliers of materials and components from all over the world. Among these suppliers, Beerenberg is one that ensures the installation of land compression for improved recovery from existing fields, and is prepared to take additional gas and condensate (by-product) volumes from other fields. In order to complete their assignments, Beerenberg must create a warehouse that ensure rapid delivery of materials and components to the working place. Beerenberg Corp does not have a central warehouse. They have a clausal in their contracts with clients regarding warehouse locations. Wherever the project is, the client is ensuring warehouse facility for Beerenberg's projects. In our case, Kværner is paying for the warehouse on Nyhamna.

Beerenberg's purchasing department located in Bergen is in charge of ordering all project-specific materials and send them to each project warehouse. The company produces a part of the materials and is buying the rest.

Beerenberg has an insulation contract worth approximately 700 million NOK for Kvaerner Engineering AS in connection with Nyhamna Expansion Project. It includes all activities related to insulation, scaffolding and surface treatment, as well as procurement,

engineering, fabrication and project management. The duration of the contract is 5 years and it started in 2012. Because Beerenberg covers so many activities in their contract, they are using many different products, from insulation materials, scaffold, paint, etc. Therefore they need a large warehouse facility on Aukra, close to the construction site.

1.2 Settings, research purpose and guiding questions

The main goal of this thesis is to identify what makes the warehouse inefficient and to propose solutions to create a more efficient, Lean warehouse. We need to look at the causes, the effects and the solutions of these problems.

Beerenberg started an improvement process due to challenges on delivering goods on time. The new process helped them obtain a better flow of goods from the warehouse to the site.

The main research question is:

Question #1:

What are the problems that the warehouse is facing and how these problems reflect in the overall performance?

Preliminary observation:

- Lack of personnel;
- The demand from site is big and the warehouse have challenges to deliver goods on time;
- The lack of personnel does not make possible the correct and complete documentation of the products sent to site;
- MIPS operator is introducing the details manually in the system. This leads to errors sometimes when the writing is illegible or there is confusion over a way a number is written.

Possible problem / consequence:

- The warehouse is not as efficient as it should be;
- The existing personnel is struggling to deliver up to expectations affecting the warehouse overall performance;
- Incorrect and incomplete documentation creates confusion in the process;
- All extra work adds time to the operation;

- It is an accepted fact that increased errors lead to increased costs.

Possible solution:

- Once the warehouse is manned up, it is much easier to answer the demands correctly, faster, more precisely;
- The task is to control the logistics as well as optimize operations, to analyze the actual staff and make sure they have enough resources in relation to the workplace;
- The management need to divide clearly the tasks and the operators need to take full responsibility and complete them;
- The Warehouse Manager has to map the processes, to know who is doing what at what time and how long it takes for that operation. The management needs to find the challenges, get an overview of the situation and get control. The new staff has to be trained fast. In the mean time, processes needs to be written, the deliveries to site have to be carried out and continuous improvement is necessary. The jobs have to be processed as soon as possible, the goods have to be packed and sent rapidly.
- Consider implementing new technology in order to eliminate the manual registrations.

In order to answer the main request question, I divide it in several sub-questions:

Sub-Question #2:

How implementation of Lean concept improve the warehousing processes in project based companies?

Preliminary observation:

- The company is trying to implement the lean concept in order to improve the operations;
- The warehouse has to focus more on the processes, to create ownership and control, enforcing the rules of the company;
- The goods are not placed on shelves in a way that save time and effort in the picking process;
- There is some unnecessary work done (over processing) that can be avoided
- Poor ergonomics which creates extra motion

- Unproductive movement such as driving with empty forklift, looking for items which are out of stock.

Possible problem / consequence:

- The tasks take longer and are done according to individuals opinion;
- The warehouse has a certain capacity and is utilizing one fork lift inside. It doesn't help to have too many people on one task, because only one person can operate the truck at a time. So, in order to optimize the operation, some people have to pick goods inside and the others outside, dividing the job packs;
- Some items are running out and the construction site have to wait for replenishment;
- In order to be sure that everything is registered, some over processing of papers is taking place, creating extra work;
- Lack of synchronization at times.

Possible solution:

- Always deliver exactly what customer wants, in exact quantities, exactly when needed, and exactly where required at the lowest possible cost;
- Reduce waste in human effort, inventory, delivery time to site and storage space;
- Better performance of the staff;
- Avoid over processing;
- Elimination of waste. Waste consumes resources but does not add any value to the product;
- Involvement of staff in the operation;
- The drive for continuous improvement (kaizen).

Sub-Question #3:

Can implementing RFID system improve the information flow and reduce the waste in project based warehousing processes?

Preliminary observation:

- The warehouse on Nyhamna is not using RFID system;
- Beerenberg is printing out labels which are placed on products, but they don't have a scanning barcode system in place.

Possible problem / consequence:

- The goods are checked and labels are placed. All registration is done manually;
- This is slowing down the operation and give opportunity to human errors. Any misunderstanding or wrong registration can lead to problems in the future;
- The challenges are present also when inventory is done. The work is always ongoing and is difficult to count and pick goods in the same time.

Possible solution:

- The implementation of RFID system could improve the information flow and reduce the waste in the project based warehouse process;
- This technology offer unique identification of products, easiness of communication and real time information. It can ameliorate the traceability of products and the visibility throughout the entire supply chain, and also can make reliable and speed up operational process such as tracking, shipping, checkout and counting process, leading to advanced inventory flows and more accurate information;
- There are four common benefits in using RFID: replacement of labor through automation, cycle time reduction, enabling self-service, and loss of prevention;
- RFID can provide cost reduction, increased revenue, process improvement, service quality.

These questions address the main features of what Beerenberg wants to achieve by introducing Lean at the warehouse on Nyhamna. The purpose of the thesis is to see if implementation of such concepts can improve the operations. The thesis aims to investigate the factors that affect the performance. The implementation of Lean is associated with better performance.

2.0 Literature view

During the work on this assignment, a literature search was performed. This chapter presents the relevant theory of operation management, project management, engineering-to-order, warehouse operations, Lean, RFID and Value Stream Mapping, trying to focus on theory related to continuous improvement.

2.1 Operation Management

As Slack, Chambers and Johnston (2010) state in their book "operations management is the activity of managing the resources which produce and deliver products and services. The operations function is the part of the organization that is responsible for this activity". The authors say that every organization has this function, but not all call it by this name. The operation function is central in an organization because it produces the goods and services which are its reason for existing (Slack, Chambers, and Johnston 2010).

Operations refers to the transformation of resources from inputs into outputs within manufacturing as well as within sales, service, administrative processes, etc. In his book, Karlsson (2016) says that Operation Management put operations within the context of a business and develop the strategy for the operation (Karlsson 2016).

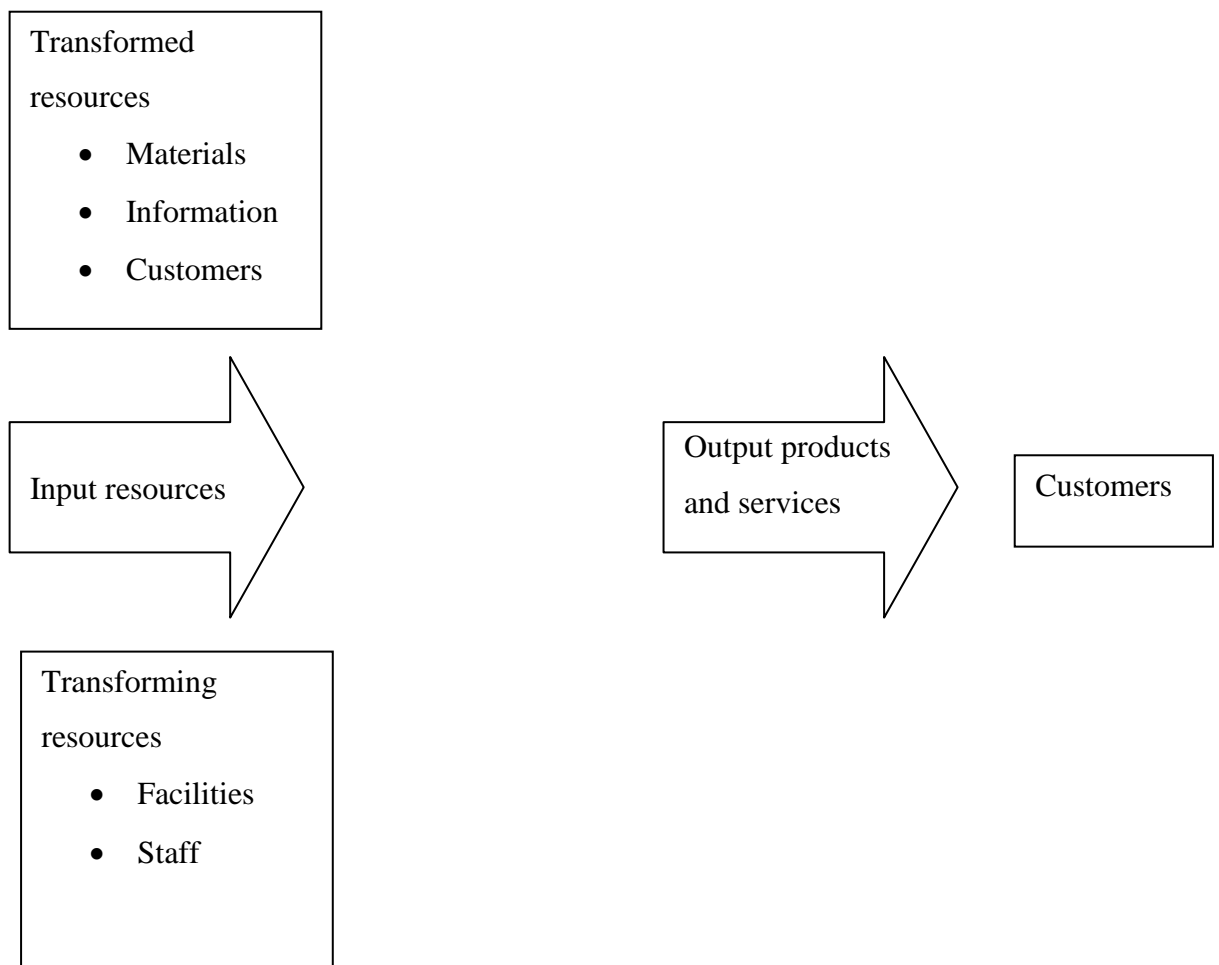


Figure 1: All operations are input-transformation-output processes (Slack, Chambers, and Johnston 2010)

There are two important aspects that needs consideration: the resource creation and the organization part. In order to build a production system where resources transform the inputs into outputs we need physical, financial and human resources. A management system controls and assesses the transformation process and work for its continuous improvement (Karlsson 2016). The author identifies three characteristics of Operation Management:

- It is an applied field with managerial character,
- It deals with problems encountered by practitioners,
- It is a cross-disciplinary field researching on economic, finance, organizational behavior, marketing, etc.

A large domain of research comes from an integrated perspective on internal and external operations within the supply chain management.

In addition of being qualitative or quantitative, the Operation Management research has several different perspectives and approaches. These fluctuates with academic or other backgrounds. Several objectives like exploration, confirmation and rejection are encountered in Operation Management research. The degree of involvement of the researcher varies both with the research project and with the research approach (Karlsson 2016).

De Mello outline in his thesis that "the main focus of OM is to contribute to the success of an organization by using its resources effectively to produce goods and services in a way that satisfies its customers" (De Mello 2015, p. 24).

2.2 Material handling

Stephens and Meyers in their book "Manufacturing facilities. Design & Material handling" define the material handling as "the function of moving the right material to the right place, at the right time, in the right amount, in sequence, and in the right position or condition to minimize production costs" (Stephens and Meyers 2013).

The material handling has five dimensions:

- 1) Movement: involves the actual transportation or transfer of material from A to B. The prime concerns here are efficiency and safety;
- 2) Quantity: dictates the type of equipment needed and the cost;
- 3) Time: determinate how quickly the material can move through the facility;
- 4) Space: is concerned with the space required for the storage of the equipment and the movement of the material
- 5) Control: some aspects of the control dimension are tracking of the material, positive identification and inventory management (Stephens and Meyers 2013).

The material handling cannot be separated from the plant layout. Any change in the material handling changes the layout, and a layout change changes the material handling system. The material can be moved by hand or by automatic methods, one at a time or in batches, it can be placed random or in fixed locations, and it can be stored on high shelves or on the floor. Only the costs can limit this variations (Stephens and Meyers 2013).

The equipment used to handle the material exists in several thousand of versions (different models, sizes, brand names, etc.). Using an equipment to handle the material has reduced the human work, the cost of production and has improved the quality of work life (Stephens and Meyers 2013).

The negative side of the equipment is that the handling of the material is attributed to more than one-half of all industrial accidents. The equipments can eliminate the manual lifting, but it also can cause injury. Therefore, safety is a very important aspect (Stephens and Meyers 2013).

Stephens and Meyers state that on average, the material handling accounts for 50% of the total operations cost. in some industries, the costs are even higher, going up to 90% of operations cost.

The authors present in their book the primary goals of material handling: to reduce unit costs of production. They identify some subordinates to this goal that can help with cost reduction, such as:

- Maintain or improve product quality, reduce damage and protect the materials;

- Put safety first and improve the working conditions;
- Promote productivity;
- Increase the use of facilities;
- Reduce dead weight;
- Control inventory (Stephens and Meyers 2013).

According to Stephens and Meyers, there are ten principles of material handling. These are adapted by the College Industry Council on Material Handling education (CICMHE):

- 1) "Planning Principle: all material handling should be the result of a deliberate plan where the needs, performance objectives and functional specification of the proposed methods are completely defined at the outset;
- 2) Standardization Principle: material handling methods, equipment, controls and software should be standardized within the limits of achieving overall performance objectives and without sacrificing needed flexibility, modularity and throughput anticipation of changing future requirements;
- 3) Work Principle: material handling work should be minimized without sacrificing productivity or the level of service required of the operation;
- 4) Ergonomic Principle: human capabilities and limitations must be recognized and respected in the design of material handling tasks and equipment to ensure safe and effective operations;
- 5) Unit Load Principle: unit load shall be appropriately sized and configured in a way which achieves the material flow and inventory objectives at each stage in the supply chain;
- 6) Space Utilization Principle: effective and efficient use must be made of all available space;
- 7) System Principle: material movement and storage activities should be fully integrated to form a coordinated, operational system which spans receiving, inspection, storage, production, assembly, packaging, unitizing, order selection, shipping, transportation and handling of returns;
- 8) Automation Principle: material handling operations should be mechanized and/or automated where feasible to improve operational efficiency, increase responsiveness, improve consistency and predictability;

- 9) Environmental Principle: environmental impact and energy consumption should be considered as criteria when designing or selecting alternative equipment and material handling systems;
- 10) Life Cycle Cost Principle: a through economic analysis should account for the entire life cycle of all material handling equipment and resulting systems" (Stephens and Meyers 2013).

These principles are guidelines for the application of sound judgment. Some are in conflicts with others, so only the situation determine what applies. The principles are a good checklist for improvement opportunities (Stephens and Meyers 2013).

2.3 Project Management

As mentioned in (Matthews and McLees 2015), project management focuses on the successful delivery of products, services, or results. Projects are a means of achieving organizational strategy and objectives.

Ryan Matthews and Jason McLees state in their article "Building Effective Projects Teams and Teamwork" that projects are a necessary means towards senior management achieving ethical business goals for a more competitive advantage within the markets they choose to compete in. Senior management must therefore support project management efforts by assuring prioritized project initiatives are properly aligned with strategic business goals and that project leaders are empowered with appropriate decision making authority to effectively execute such project plans (Matthews and McLees 2015).

The purpose of a project is to accomplish its objective and then terminate. The projects are performed by people, constrained by limited resources, and managed to meet customer satisfaction. The objective of a project is to have success, and it is characterized by its temporal nature, having an unique product and its manage teams. The customer requirements are the basis for planning and the management focus is to mitigate potential risks. The project has a high learning curve and a limited control over the resources. The main focus is on man hours and the risks are seen as not concluding the project on time, on specification or to budget. The project focus always on delivering a good quality, on time and on incurred costs (De Mello 2015).

2.4 Coordination of Engineering-to-Order (ETO) supply chain

Tsinopoulos and Bell have outlined that ETO companies are those companies that customize generic product types to meet the specific requirements of each customer and only make these to order (Tsinopoulos and Bell 2010).

De Mello states in his PhD thesis that ETO companies produce a low volume and a high variety of products on a project basis and they are specific to oil and gas industry, shipbuilding industry, etc. The author mention that the value in these ETO companies is created mainly by developing customer-specific solutions and integrating sophisticated systems. This leads to increased costs of products. In ETO companies, there is no stock of finished products. Therefore, each product needs to be engineered according to specific requirements. "More specifically, overlapping engineering and production activities is regarded as one of the main sources of uncertainty because engineering work is not finalized before production takes place" (De Mello 2015, p. 19).

De Mello has detailed some characteristics of ETO in his work, saying that ETO companies creates value in understanding customer requirements, translating them into specifications and integrating components and subsystems into products. One of the challenges that ETO supply chains have is to prevent the delivery time from being unacceptably long. Summarizing the characteristics, the ETO include: large projects with long lead times, large variety of equipment, high investment, the relationship between project partners is based on contracts, large number of engineering disciplines, complicated information flow (De Mello 2015).

ETO supply chain have two main flows: the information flow, represented by planning, design, engineering and procurement and the material flow which contains the manufacturing, the assembly, installation and commissioning (De Mello 2015).

It is more and more common for ETO companies to outsource simpler products in order to increase cost efficiency. However, they choose to produce in-house complex products and they hardly outsource design. There are some reasons for doing this, except the costs: quality, delivery and flexibility (De Mello 2015).

Engineering-to-order (ETO) supply chain involve multiple companies for performing a complex project. It is essential to coordinate effectively cross-business activities in order to avoid delays, cost overruns and quality problems. In practice, there is no “one-fits-all” solution for coordination. Each project represents a unique context which has specific objectives, actors and constraints. Mello, Strandhagen and Alfnes provide in their study a basis to comprehend coordination in a complex setting. The engineering and production activities involve mutual interdependences that need to be coordinated. Coordination is “the act of managing dependencies between entities and the joint effort of entities working together towards mutually defined goals”. They state that the coordination mechanisms that best fit a particular situation may change over the course of the project. The more the project progresses, the higher the need for formal coordination mechanisms (Mello, Strandhagen, and Alfnes 2015).

De Mello cites the definition of coordination given by Malone and Crowston in 1994, saying that coordination is “*the act of managing dependencies between entities and the joint effort of entities working together towards mutually defined goals*” (De Mello 2015, p. 45). He is also mentioning few coordination problems such as poor communication, leadership, inadequate cooperation and support from contractors, bad cooperation, conflicting goal priorities, etc. All these generate delays in the project.

There are four types of coordination mechanisms, as De Mello identifies in his thesis: standards (they characterize the establishment of routines and rules); plans (consist of setting predefined goals); mutual adjustments (involves communication across several units during the course of action); and teams (are formed with representatives from each unit and have the authority to develop and implement solutions). According to the author, there are possibilities to improve coordination such as use of information technology (IT) (De Mello 2015).

2.5 Warehouse operations

"A perfect order is considered to be one that has been delivered on time, in full, in perfect condition and accompanied with the correct paperwork" (Richards 2014, p. 40).

The most common operations in a warehouse are receiving, putting away, picking, packing and shipping. In Beerenberg's warehouse I can identify following:

2.5.1 Receiving and put-away (storage)

At the receiving department the new products are inspected. Damages and incorrect quantities are noted. The products are registered so that they are known to be available and payments are dispatched. Any mistake in this activity can lead to errors the following processes (Wessman and Barring 2014).

Before put-away, a storage location must be found, taking in consideration how much weight they can bear, how large they are, if they are inside or outside (depends of the nature of the goods). When it comes to storage, there are two aspects to take into account: 1) pallet storage system should be chosen with the aim to maximize volume utilisation and density in the warehouse; 2) the pallet retrieval system should be designed as beneficial as possible for the picking activities (Wessman and Barring 2014).

Richards Gwynne suggests that companies can improve accuracy and efficiency by ensuring that the correct processes are in place and operating optimally.

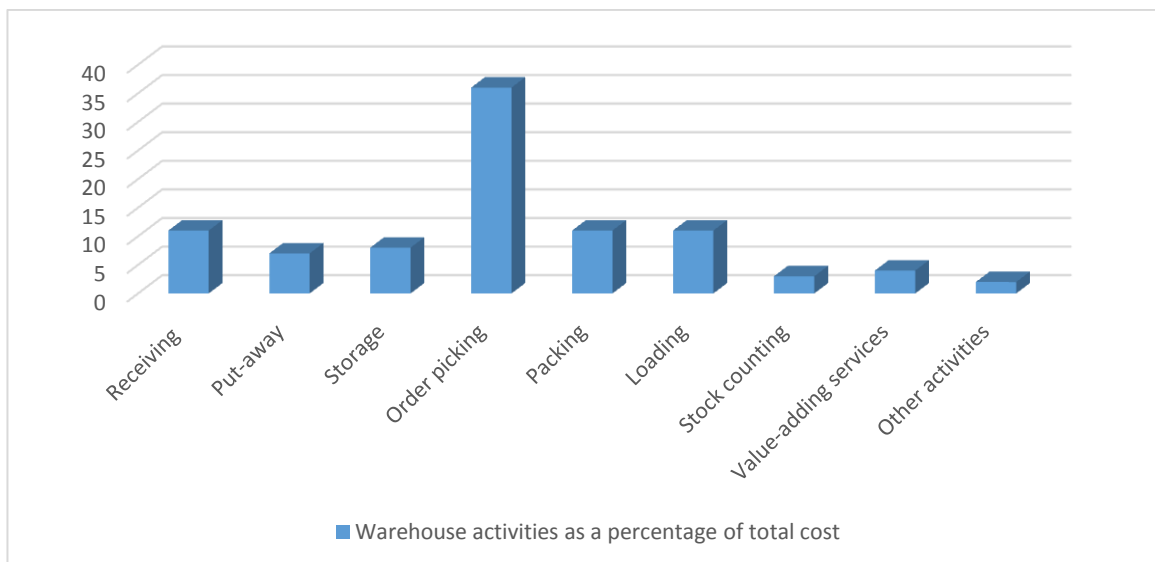


Figure 2: Warehouse activities as a percentage of total cost (Richards 2014)

The author of "Warehouse Management. A complete guide to improving efficiency and minimizing costs in the modern warehouse" is naming the process "receiving", "goods-in" or "in-handling" and says that is a crucial process within the warehouse. Ensuring that the

correct product is received in the right quantity, in the right condition, at the right time is one of the main tasks for the warehouse.

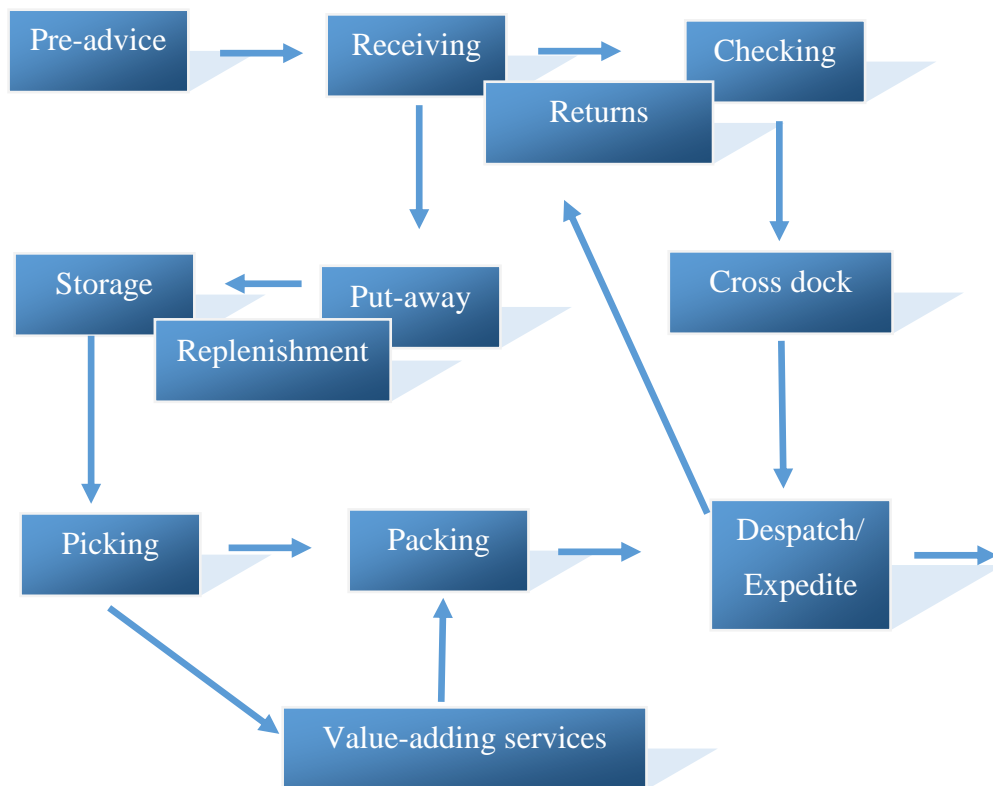


Figure 3: Warehouse processes (Richards 2014)

The costs can be reduced by handling a product the least amount of time possible because this leads to reduced labour hours. The warehouse is in control and able to match the work hours to work content by providing delivery times for each supplier. On arrival, the vehicle details need to be checked against the booking reference. The in-handling team should have appropriate labour and equipment to hand, to efficiently manage the offloading process (Richards 2014).

In the article "Supply chain management with lean production and RFID application. A case study" is mentioned that Fleisch and Tellkamp (2005) indicated that there are several significant costs and benefits of RFID implementation. Companies must decide whether to invest or not in RFID technologies by performing its own ROI analysis (Chen, Cheng, and Huang 2013).

"Cross docking is a process where products are moved directly from goods-in to the despatch bays. This replaces the need to place the product into storage and any subsequent picking operation" (Richards 2014).

2.5.2 Pick preparation

"Order picking is the most costly activity within today's warehouse. It is labour intensive, difficult to plan, is prone to error and has direct impact on customer service. Typical errors include omitting items from the order, sending the wrong item and sending the wrong number of items" (Richards 2014, p. 77).

Companies target the picking operation as the area in which productivity improvements can make a significant difference to overall costs. The trade-off in this instance is between speed, cost and accuracy. Managers are looking for quick response times, high accuracy rates and high productivity but at least cost. Satisfying these factors will determinate the types of picking systems and process chosen.

Preparation is a key element. According to Frazelle (2002), less than 15% of SKU's within a warehouse are assigned to the most efficient location, resulting in a 10-30% cost increase in travel time and underutilized locations. Prior to laying out a warehouse, deciding on the most appropriate handling equipment, installing storage systems and deciding on which form of picking system to introduce, a full ABC analysis of stock movements and stock held should take place. Understanding ABC classification begins by understanding Pareto's Law or the 80/20 rule. This states that roughly 80% of effects come from 20% of causes. The idea therefore is to concentrate time and resources on the important 20% or the "vital few". Example: 80% of profits come from 20% of products. Where small quantities of items are picked, the warehouse will also have an area of shelving where the product may be held in bins or totes to make individual-item picking easier (Richards 2014).

2.5.3 Despatch

The order cycle time is continuously shortening. The managers needs to coordinate the activities to ensure that the product is despatched on time and complete.

2.5.4 Stock counting

All warehouses are obliged to undertake some form of stock count. A full stock count usually necessitates the closure of the warehouse for a period of time when all inbound and outbound movements are suspended. The accuracy of the counts will also determine the frequency. A high error rate should result in more frequent counts until the accuracy improves.

All stock counts require organizing. You need to know what you are planning to count, when you plan to undertake the stock count, what tools and equipment you need (Richards 2014).

2.5.5 Replenishment

In order to ensure a smooth and efficient picking process we need to ensure that the right products and quantities are in the correct pick location. The result of a poor replenishment process is order shortages, increased picking times and therefore increased cost per pick and an overall reduction in service level.

2.5.6 Resourcing a warehouse: labour and equipment

These are generally acknowledged as key. Under-resourcing will usually mean failure to meet service requirements, while over-resourcing will mean failure to meet financial performance targets.

2.6 Lean warehousing

" A lean organization understands customer value and focuses its key processes to continuously increase it. The ultimate goal is to provide perfect value to the customer through a perfect value creation process that has zero waste" (Lean Enterprise Institute).

The first person to truly integrate an entire production process was Henry Ford. He lined up fabrication steps in process sequences in such a way that he managed to fabricate and assemble the components going into the vehicle within few minutes. Later on, at Toyota, they revised Ford's original thinking and invented the Toyota Production System. By using this system Toyota managed to achieve low cost, high variety, high quality and very short response times as changing customer's desires (Lean Enterprise Institute).

As mentioned on Lean Enterprise Institute, Lean is not only suited for manufacturing, but it applies in every business. It is a way of thinking and acting for an entire organization (Lean Enterprise Institute).

The warehouse management is a system that supports the daily operations in a warehouse. The flow of material and information is managed. An effective warehouse management helps the business by:

- Supporting demand for custom orders;
- Resupplying stock based on customer demand;
- Tracking inventory from the time it arrives at the warehouse to the time it reaches its final destination;
- Maintaining the facility to protect goods (Bradbury 2017).

There are some challenges that the warehouse managements is facing, such as poor layout, ineffective storage and transfer of supplies, ineffective processes and recurring slow periods in the supply chain (Bradbury 2017).

By implementing lean in the management system, the warehouse is able to meet the changing requirements of the customer and improve efficiency, reduce the errors and minimize the space available and slow periods by pulling supplies based on customer demand. Some of the tools that can be used to overcome these challenges are value stream mapping, 5S and Kanban (Bradbury 2017).

2.6.1 Lean production and Value Stream Mapping (VSM):

In the article "Supply chain management with lean production and RFID application. A case study" it is cited that Abdulmalek and Rajgopal (2007) presented that a value stream is a collection of all actions (value added as well as non-value-added) that were required to bring a product through the main flows, starting with raw material and ending with the customer. These actions considered the flow of both information and materials within the overall supply chain (Chen, Cheng, and Huang 2013).

Value stream mapping (also known as "end-to-end" system mapping) is a simple but effective approach to understanding the flow of material and information as a product or service has value added as it progresses through a process, operation, or supply chain. It visually maps a product or services production path from start to finish. It is called "value

stream" mapping because it focuses on value-adding activities and distinguishes between value-adding and non-value-adding activities. VSM uses a broader range of information than most process maps and is usually at a higher level (5-10 activities). It has often a wider scope and it can be used to identify where to focus future improvement activities.

A value stream perspective involves working on (and improving) the "big picture", rather than just optimizing individual processes. Value stream mapping is seen as a starting point to help recognize waste and identify its causes. It is a four-step techniques that identifies waste and suggests ways in which activities can be streamlined. First, it involves identifying the value stream (the process, operation or supply chain) to map. Second, it involves physically mapping a process, then above it mapping the information flow that enables the process to occur (current state map). Third, problems are diagnosed and changes suggested, making a future state map that represents the improvement process, operation or supply chain. Finally, the changes are implemented (Slack, Chambers, and Johnston 2010, Chapter 15, p. 437).

VSM requires the involvement from personnel. This can complicate it a little because without people with good understanding and knowledge of the warehouse, the VSM is not feasible and the result is not representative. On the other hand, one of the benefits is that data collected is primary data. The reason for using the VSM is to identify the muda and to find ways to improve the operation (Wessman and Barring 2014).

The value adding activities are any activities that add value to the customer and meet the three criteria for a Value Adding Activity, such as: 1) the step transforms the item toward completion; 2) the step is done right the first time (not a rework step); 3) the customer cares (or would pay) for the step to be done. The Non-Value Adding Activity refers to process steps that fail to meet one or more of these criteria. They add to the cost of doing business and usually include rework, inspection, movement and the rest of those 8 muda (Go Lean Six Sigma).

According to Kerber B and Dreckshage, J.B., by thinking lean, most of the focus is at customer (Stormyr and Hesthag 2011). There are five principles:

- Specify what creates value from the customer's perspective

The company has to look at the situation from the customer point of view and ascertain what the customer is willing to pay for the goods. Then they have to consider what they have to offer;

- Identify all steps across the whole value stream

In a company there are value adding activities and non value adding activities. The value stream is the sum of these activities. The value adding activities are the activities that make a value for the customer and non value activities are other activities. The company needs to identify all the activities;

- Make those actions that create the value flow

The goal is to reduce the number of non value adding activities. Lean is about reducing waste;

- Only make what is pulled by the customer just in time

In a Lean theory pull replaces push and the company uses a make-to-order strategy. This means that the company produces after the customer has ordered;

- Strive for perfection by continually removing successive layers of waste

When the company is following the other principles above, they are removing waste and then they get closer to obtain success (Kerber and Dreckshage 2011).

According to George (2010), there are some key success factors in reducing costs:

- Involve the people who actually do the work, teach them to see the waste in their process;
- Focus on identifying and eliminating the non-value add work so they can spend more time focusing on the customer. This increases also the capacity and the company can do more with same number of people;
- Look for and formalize best practices and turn them into repeatable processes: there are many people which are executing identical processes but based on their own interpretation. Sometimes is enough to bring people together, map their processes and determine the overall practice;
- Look for opportunities for cost reduction in the infrastructure. Often people focus on the front end processes and miss the growth of infrastructure required to deliver the service.

- Recognize interfaces with technology. It can be difficult to identify where are the bottle necks, where defects exists, where the rework creates waste and drive extra costs (George 2010).

2.6.2 The 5 S System

Bradbury, J. wrote in his article "What to know about lean management" that 5S is a lean tool that can improve warehouse efficiency by systematically organizing and cleaning the workspace, standardizing the work practices and procedures. The system includes the five guidelines:

- 1) S1 - Sort: remove unneeded items from the work place, such as tools, supplies and equipment, in order to make space for work and storage;
- 2) S2 - Set in order: arrange the work area and make it convenient and efficient in such a way that can improve the productivity, reduce movements like reaching, bending and stretching;
- 3) S3 - Shine: clear the working area after every shift. decide what to clean, how to clean, who will do the cleaning and how clean is clean;
- 4) S4 - Standardize: document successful improvements so they can be applied easier in other work areas;
- 5) S5 - Sustain: repeat the five steps on daily basis (Bradbury 2017).

According to Bradbury, "visual communication is a key element for any lean warehouse management system. Labels and signs can be used to help organize the warehouse's storage system and provide essential information, while floor marking can be used to designate where tools, equipment, and supplies should be placed. This creates a visual map that helps workers quickly find and store supplies and tools" (Bradbury 2017).

2.6.3 Kanban

In his article, Bradbury define Kanban as a "pull" system which pulls supplies to the warehouse floor based on customer's orders, by using visual cards to control the workflow within a supply chain. Kanban can improve processing time by creating a consistent material flow. The new items are ordered after the old items are picked. The packing station and shipping area does not become overloaded. the errors are reduced because it limits the work-in-progress (Bradbury 2017).

According to Pascal Dennis, there are two kinds of Kanban:

- Production Kanban: specifies the kind and quantity of product that the upstream process (supplier) must produce;
- Withdrawal Kanban: specifies the kind and quantity of product that the downstream process (customer) may withdraw (Dennis 2007).

2.6.4 Kaizen Circle Activity (KCA)

The Japanese word for continuous improvement is kaizen, and it is a key part of the lean philosophy.

In his book "Lean production simplified", Dennis Pascal writes that Kaizen circle activity is perhaps the best known involvement activity. It confers great benefits, such as: 1) strengthens team members ability to work as a team, lead as a team, think clearly and logically, solve problems; 2) builds team-member confidence; 3) attacks critical problems with "hundred of hands" (Dennis 2007).

The structure of KCA:

The manager with a problem usually triggers a kaizen circle and acts as the sponsor. The circle is formed of six-eight members who meet once a week for an hour for six-eight weeks. The members come up with a presentation to management illustrating the results achieved and future activity (Dennis 2007).

KCA training:

The team members need to be trained in: administrative skills, brainstorming, problem solving and presentation skills (Dennis 2007).

Dennis presents in his book the tasks that the control department has. This is like an KCA administration and they are in charge with creating standard forms to support circles, register new circles, record and report their results, etc. The manager has an important role by communicating daily with team members about the company's critical issues and problems in their areas. in addition, the managers must consider how to increase KCA in their areas, check the themes, estimated dates of completion, personally check with the members, support the circles that are having troubles and view the results (Dennis 2007).

2.6.5 Lean synchronization

Lean synchronization was originally called "just-in-time" (JIT). This is both a philosophy and a method of operations planning and control. Lean synchronization aims to meet demand instantaneously, with perfect quality and no waste. This involves supplying products and services in perfect synchronization with the demand for them (Slack, Chambers, and Johnston 2010, Chapter 15).

Toyota Production System (TPS), the concept of "lean" comes from the manufacturing sector, and is very much associated with Toyota. The idea behind lean is to remove any activity that uses resources but doesn't create any additional value. We have to identify the activities within the warehouse that absorb resources but don't create additional value (Richards 2014).

TPS has two themes: "just-in-time" and "jidoka". JIT is operationalized by means of heijunka (levelling and smoothing the flow of items), kanban (signalling to the preceding process that more parts are needed) and nagare (laying out processes to achieve smoother flow of parts throughout the production process). Jidoka is described as "humanizing the interface between operator and machine" (Slack, Chambers, and Johnston 2010, Chapter 15).

Synchronization means that the flow of products and services always delivers exactly what customer want (perfect quality), in exact quantities, exactly when needed, and exactly where required (not to the wrong location). Lean synchronization is to do all this at the lowest possible cost (Slack, Chambers, and Johnston 2010, Chapter 15).

JIT manufacturing aims to eliminate waste and to improve their productions by using a continuous improvement approach, including maintaining the only required inventory and reducing setup times to decrease lead times, queue lengths, and lot sizes to reach minimum cost. Lean production enables the integration of various tools in the production system and supply chain and focuses on waste elimination to reduce costs, improve quality, and decrease lead time, inventory and equipment downtime (Chen, Cheng, and Huang 2013).

Seth and Gupta (2005) presented that the goal of lean manufacturing is to reduce waste in human effort, inventory, time to market and manufacturing space to become highly responsive to customer demand. This approach focused on the elimination of waste. Waste consumes resources but does not add any value to the product (Chen, Cheng, and Huang 2013).

Gooley (2013) talks about the seven wastes or muda that lean management seeks to eliminate:

- transportation: driving an empty forklift, unproductive movement, having the warehouse operators looking for items which are out of stock;
- defects: time spent correcting errors such as miss picks, delivering wrong items to the wrong place;
- inventories: congestion at the inbound and outbound areas, keeping the unnecessary raw materials;
- motion: interrupting movement such as staging product before put-away, poor ergonomic design, unnecessary walking, poor environmental conditions;
- waiting time: bottlenecks at pick locations, waiting for forklift, for raw materials;
- overproduction: holding too much inventory;
- over processing: performing unnecessary steps such as labelling and checking when there is no reason for doing so; doing more than what the customer wants (applies mostly to engineering) (Richards 2014).

Pascal Dennis in his book "Lean Production simplified", is mentioning an 8th waste:

- knowledge disconnection: unused employee creativity which lead to frustration and missed opportunities (Dennis 2007).

There are many cost drivers in warehousing. Cost driver one is the inventory. The setting of inventory levels is an important part. Not all items that need to be controlled are critical. The labor is cost driver two and it is probably least controlled. Cost driver three is space. Lean warehousing is referring to this as slotting: put higher velocity items closer to point of use, then slower velocity items. This can save labor costs by reducing the travel time-walking or driving in the warehouse (Nasim et al. 2016).

The companies are forced to ensure that customer's demands can be satisfied as much as possible at the lowest cost.

The benefits of synchronized flow is shown in the figure below. In order to understand how lean synchronization differs from more traditional approaches to managing flow is to contrast the two simple processes. The outputs are taken from the inventory, process them, and pass them through to the next buffer inventory. These buffers are protecting each stage from the next one, making them independent. The larger the buffer inventory, the greater the degree of protection between the stages. This insulation has to be paid for in terms of inventory and slow throughput times. When a problem occurs at one stage it will not be immediately apparent elsewhere in the system (Slack, Chambers, and Johnston 2010, chapter 15).

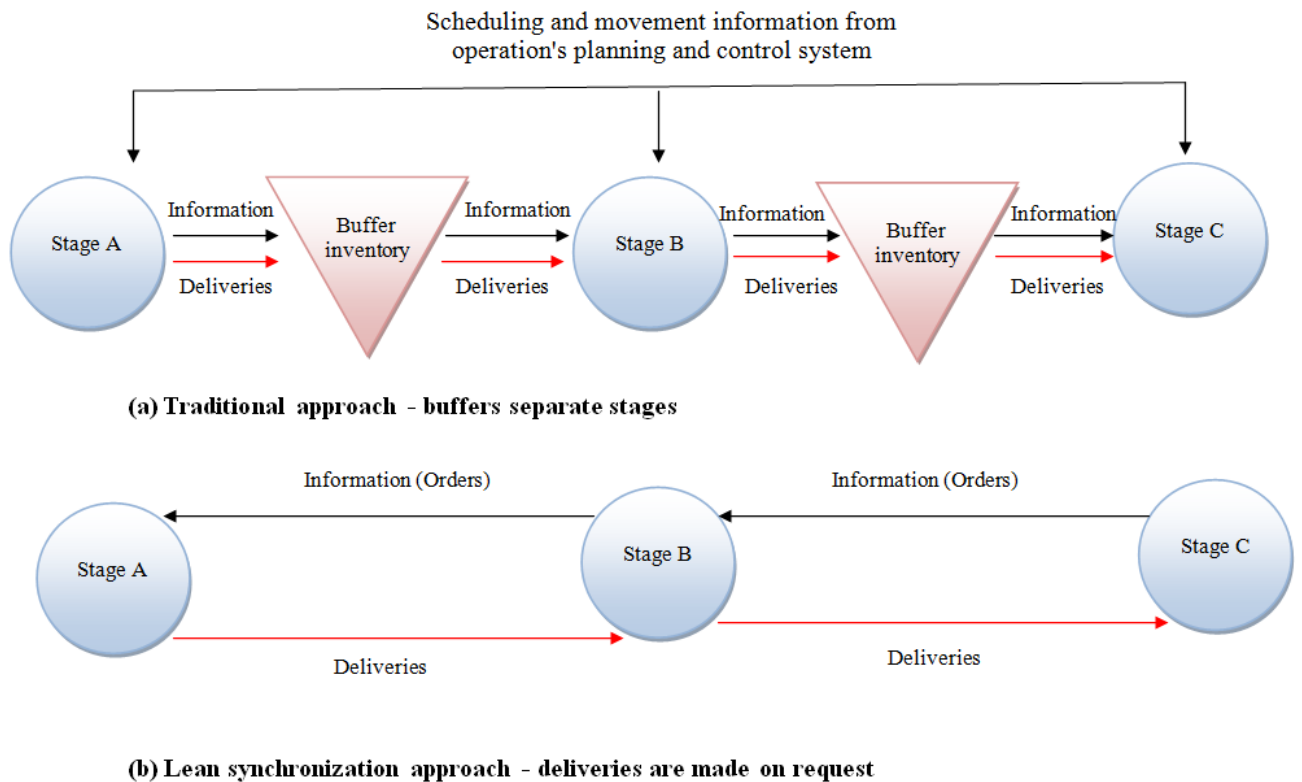


Figure 4: (a) Traditional and (b) lean synchronized flow between stages (Slack, Chambers, and Johnston 2010, chapter 15)

In the second part of the figure above (b) the items are processed and then passed directly to the next stage "just-in-time" for them to be processed further. If stage A stops processing, stage B will notice immediately and stage C very soon after. This means that

the responsibility for solving the problem is no longer confined to the staff at stage A, but it is shared by everyone. This is improving the chances of solving the problem considerably (Slack, Chambers, and Johnston 2010, Chapter 15).

When stoppages occur in the traditional system, the buffers allow each stage to continue working and thus achieve high-capacity utilization. This does not make the process necessarily to produce more. Often, extra production goes into buffer inventories. In a lean process, any stoppage will affect the whole process. This will lead to lower-capacity utilization (Slack, Chambers, and Johnston 2010, Chapter 15).

There are three key issues that define the lean philosophy: the involvement of staff in the operation, the drive for continuous improvement and the elimination of waste. The lean approach to people management has also been called the respect-for-humans system. It encourages team-based problem-solving, job enrichment, job rotation, high degree of personal responsibility, ownership of the job and multi-skilling (Slack, Chambers, and Johnston 2010, chapter 15).

2.6.6 RFID and Lean

According to Holmström, Främpling and Ala-Risku (2010), tracking can be defined as " the process of naming in a unique way, and linking to, a physical entity relevant information attributes such as handling history and instructions" (Holmström, Främpling, and Ala-Risku 2010).

The main finding of the research program started by the three authors is "to identify individual products tracking as a critical intervention that can improve efficiency and differentiation according to individual needs in the context of project delivery, industrial asset management, and industrial service delivery". Their research is recognizing tracking of individual entities to be important for improving customer input (Holmström, Främpling, and Ala-Risku 2010).

RFID application in supply chain:

This technology offer unique identification of products, easiness of communication and real time information. It can ameliorate the traceability of products and the visibility throughout the entire supply chain, and also can make reliable and speed up operational process such as tracking, shipping, checkout and counting process, leading to advanced

inventory flows and more accurate information. Companies can achieve better supply chain planning and management by integrating and storing more accurate data obtained through RFID technologies in their information technology systems (Chen, Cheng, and Huang 2013).

The article "Supply chain management with lean production and RFID application. A case study" underlines that there are four common benefits in using RFID: replacement of labor through automation, cycle time reduction, enabling self-service, and loss of prevention. RFID can provide cost reduction, increased revenue, process improvement, service quality, etc. RFID technology can enhance the responsiveness of logistics workflow. The synergy of using a combination of advanced technologies to form an integrated system can help achieve lean and agile logistics workflow.

In the next chapter, I present the methodology I used during my research for this thesis.

3.0 Research methodology

This chapter describe how the theory combined with the information collected at the work place help to solve this task. The thesis look at a field where the objective is to improve warehouse logistics in an increasingly evolving and highly risk prone industry. The thesis has a theoretical angle, and looks at a specific warehouse in a specific company. It represents a snapshot of the current situation. The thesis is limited in terms of looking at one part of the value stream - the material handling.

In order to answer the research questions, I use theoretical and empirical data. As secondary data I use text books, research reports, journal articles, master and PhD dissertations, www-information, project documentation, clips from the media press, etc. For primary data I talk to the warehouse manager, the representative from main office and other co-workers (non-formal interviews), observation of work flow, etc. Relevant theory is also used.

Normally, there is a mutual impact relationship between problem design, data collection and interpretation of these. Data collection usually takes place early in the research process and often over a limited period of time. Therefore, in practice is a tendency for different activities to follow in sequence. This means that there is little time for analysis and theoretical reflection (Pettersen and Sæter 2014).

3.1 Case studies

Eisenhardt mention in his work that case studies typically combine data collection methods such as archives, interviews, questionnaires and observations. The evidence may be qualitative, quantitative or both. Case studies can be used to accomplish various aims: to provide description, test theory or generate theory. An initial definition of the research question is important in building theory from case studies. Without a research focus it is easy to become overwhelmed by the volume of data (Eisenhardt 1989).

Field notes are also important in data collection. Eisenhardt suggests that it is important to write down whatever impressions occur, because you never know when you need them and to push thinking by asking questions such as "What am I learning?" (Eisenhardt 1989).

The author of "Building Theories From Case Study Research" underlines that the heart of building theory from case studies is analyzing data. One key step is within-case analysis. The danger here is "death by data asphyxiation" (too much data). Searching for cross-case patterns includes tactics driven by the reality that people are poor processors of information. In order to avoid this, we can select categories or dimensions, and then to look for within-group similarities coupled with intergroup differences. Dimensions can be suggested by the research problem or by existing literature. Another way of avoiding having too much data is to select pairs of cases and then to list the similarities and differences between each pair. A third strategy is to divide the data by data source (Eisenhardt 1989).

According to (Eisenhardt 1989), it is very important to compare the research questions with external literature. We should ask ourselves some questions such as: what is this similar to, what does it contradict and why. It is important to examine literature that conflicts with the emergent theory because if researchers ignore conflicting findings, then confidence in the findings is reduced. Another reason is that conflicting literature

represents an opportunity to become more creative. The author illustrates that it is also important to discuss similar findings because it ties together underlying similarities in phenomena normally not associated with each other. Often, we get as a result a theory with stronger internal validity, wider generality and higher conceptual level (Eisenhardt 1989). We can predict and control the results less when using real world data (Ellram 1996).

The objective in the research questions I choose is exploration. The questions include "how" and the appropriate methodologies for this are qualitative. It is an experiment, a case study based on participant observation. The same objective apply for "what" question, but the methodologies are quantitative, using secondary data analysis. As Ellram mentioned in her article, qualitative research is often referred to as field research, because the researcher is personally involved in. Case studies focus on holistic situations in real life settings, and tend to have set boundaries of interest, such as an organization, a particular industry, or a particular type of operation (Ellram 1996).

According to (Meredith 1998) the direct observation is very important rather than second or third observation. When you see it yourself is better than when somebody is telling/writing you about something they experienced.

There are also disadvantages of case research, such as: the requirements of direct observation in the actual contemporary situation (cost, time, access hurdles); the need for multiple methods, tools, and entities for triangulation; the lack of controls; the complication of context and temporal dynamics, and the lack of familiarity of its procedures. Qualitative research in general is commonly perceived as exhibiting a tendency for construct error, poor validation, and questionable generalizability (Meredith 1998).

In this thesis, I use observations, analyzing texts and documents from Beerenberg's and Kværner's intranet, interviews of main office representative, warehouse manager and colleagues. The cross reference is done by talking with people, having non- formal interviews with different employees where they describe the situation before September 2016, when they had only 5-6 people working there. They also describe the idea behind hiring extra people and the purpose of it. These are professionals with knowledge about the processes and the problems that warehouse has. The data is analysed after that by comparing the theory with praxis. This is done in order to map the process before

September 2016, and then see how it changed when the Lean concept was implemented. To mitigate the bias from interviews, triangulation is performed, based on additional sources of information including project documentation (procedures, reports, organization charts, information extracted from MIPS) and specialized media press (Mello, Strandhagen, and Alfnes 2015).

Since the warehouse represented my working place, I was able to do occasionally "walk-along" and to observe normal, everyday situations.

Kuula and Putkiranta (2012) cites Åhlström and Karlsson (2009) in their article and write the definition of longitudinal field study as follows: "Conducting longitudinal research implies studying the phenomena over time. Longitudinal research can be seen as a number of cross-sectional snap-shots of a phenomena taken over time". They point out also that longitudinal studies are good when alternative explanations may be found and cannot be controlled in a cross-sectional approach (Kuula and Putkiranta 2012).

Longitudinal study is a case study which studies the change process and development inside organizations. Åhlström and Karlsson mention a distinction between cross-sectional research and longitudinal research. The first one implies studying a phenomenon at a specific point in time and the second implies studying a phenomenon over time, by visiting the company often, using multiple observations. The issue of timing can be seen as a choice along a continuum with two end-points: retrospection or real-time. In retrospective studies we attempt to discern what has happened by asking respondents to recollect historical events. In real-time studies we study current events. Longitudinal field studies imply that the researcher studies change process as they unfold, in real-time. One of the key characteristics of longitudinal field studies is the fact that researcher is present in the organization. Part of the data we collect refers to past events (Åhlström and Karlsson 2009).

Longitudinal field studies in operation management are not that many because they imply significant researcher commitment and organizational access. However, Pär Åhlström and Christer Karlsson mention four studies that stands out. They use these studies in their book ("Researching Operations Management") as illustrations of good practice in conducting longitudinal field studies. Studying only one organization obviously leads to

disadvantages in terms of generalization. Another issue is misjudging the representativeness of a single event. It is important to choose an organization where the change process is transparently observable (Åhlström and Karlsson 2009).

A guiding principle for field work is that the researcher should collect information from the most knowledgeable members of that scene. Access to the management levels of the organization gives the researcher a chance to assess the impact of high-level decisions on a lower level. By talking to the main office representative and Warehouse Manager, I gain access to relevant information. On a more practical level, participating to project meetings gave me as well an insight into the details of the project. As Pär Åhlström and Christer Karlsson state, the key was to gain access that permitted me to be informed when events occurred that affected the study.

In 2009 Pär Åhlström and Christer Karlsson published the results of their own study on the implementation of lean production. This study is a two and a half year longitudinal field study of one company, adopting lean production. This is the backbone of the chapter in their book on longitudinal field studies. They were observing different types of incidents and in order to decide if an incident is critical or worthy of observation, they were asking two types of questions: 1) Does it affect the adoption of lean production? If it does, then how? 2) If something should be done, why isn't it (Åhlström and Karlsson 2009)? Beerenberg's warehouse on Aukra was quite far from being lean and this provided the opportunity to study a radical reorganization.

According to the authors of "Researching Operations Management", there are two roles that the participant observer can take: passive or active. The passive participant observer attempts not to interact with the organization's members. The active participant observer uses herself as the principal instrument of observation and interpretation. They also stated that any researcher who participates in an organization over an extended period of time will find it is difficult not to participate actively in the organization (Åhlström and Karlsson 2009).

The main risk of participant observation as a method for collecting data is the danger of "going native" and loses the perspective necessary for a researcher. Participant observation

is also associated with emotional difficulties. If you work long enough in one place, you tend to become involved with the observed emotional life (Åhlström and Karlsson 2009).

The longitudinal field researcher is also likely to use interviews as a data collection method. These interviews often tend to be informal, bordering on conversations, part of the process of observation. By engaging in conversations with organization members the researcher can gain a deeper understanding of the change process being studied (Åhlström and Karlsson 2009).

In their book "Researching Operations Management", Åhlstrom and Karlsson mention that the starting point for the analysis is a story that narrates the sequence of events in the change process. They advise to read through all the collected material several times. In this way, the researcher can then type it up as a narrative in one document, compiling field notes, documents and interview protocols. In the second stage of the analysis, the narrative exposing the studied change process needs to be divided to permit further analysis (Åhlström and Karlsson 2009).

The next chapter gives an overview of Lean theory and its application for coordinating the operations in order to improve the services that the warehouse deliver.

4.0 Empirical study

This chapter presents the actual situation at Beerenberg's warehouse on Nyhamna and the warehouse processes as they are per today. It also present the main actors of this thesis.

In below figure we can see the details of Ormen Lange under water, showing us the drills, the wellbore, the pipes, the reservoir.

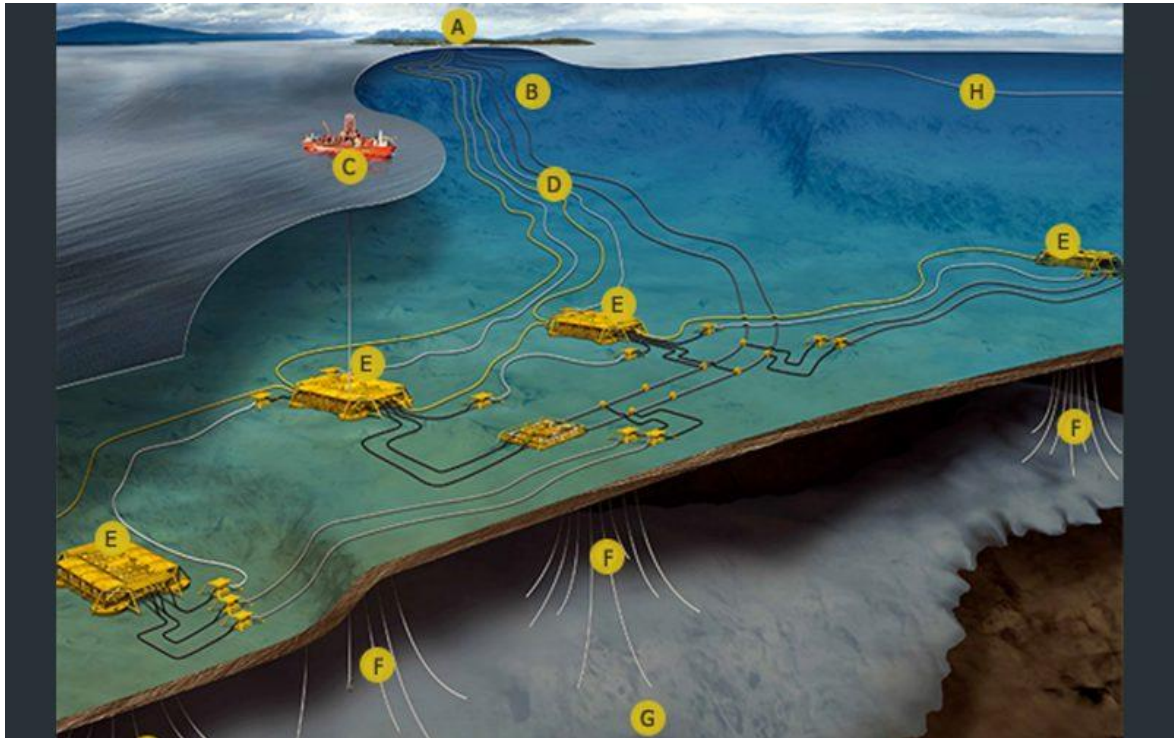


Figure 5: Ormen Lange under the water (www.shell.no)

- A) Nyhamna plant onshore
- B) Storegga: One of the major challenges of development was to lay the pipes over Storegga, which is hundreds of meters steep edge.
- C) Drillship: Drillship West Navigator drill the world's largest gas wells on Ormen Lange.
- D) Pipeline System: The gas is piped from the reservoir in the Norwegian Sea to the onshore processing plant.
- E) Wellbore frames: The wellbores drilled through the wells which stands at almost one thousand meters under water.
- F) Wellbores: Each wellbore frame can support up to eight wells.
- G) Reservoir: The reservoir covers an area of approximately 350 km² and is located about 3,000 meters below sea level.
- H) Langedled: Export pipeline Langedled consists of 100,000 tubes, and runs from Nyhamna to Easington in England. Each tube is twelve meters long and weighing up to 25 tons (www.shell.no).

Below figure shows the onshore plant.



Figure 6: Ormen Lange onshore plant (Oljedirektoratet 2017)

In an article from Petroleum Directorate dated February 2017 it is mentioned that the Directorate has granted consent for commencement of the expansion of the gas processing plant at Nyhamna in Møre and Romsdal. This allows an increase by 25 to 30 billion standard cubic meters (Sm^3) of gas (Oljedirektoratet 2017).

The upgrade - also called Nyhamna Expansion - consists of two main parts. The first is the expansion of the gas system, comprising onshore compression of gas from Ormen Lange. A new compressor maintains the gas pressure at Nyhamna as the pressure in the reservoir drops. The second part includes the export and processing facilities Polarled. This pipeline will transport gas from the upcoming Aasta Hansteen field to the Nyhamna.

Polarled compression and exports are planned to commence in autumn 2018. The gas from Dvalin field - planned to start in autumn 2020 - will also be transported through Polarled. The extension allows to increase the export capacity from Nyhamna from 70 million to 84 million Sm^3 per day. Gas is exported via the Sleipner, a platform in the North Sea, to Easington gas terminal in North East England.

Next project for increased gas production from Ormen Lange - situated at 800-1100 meters of water - is compression solutions at sea. Shell and its partners are working to examine various concepts to apply compression when the need arises - probably mid 2020's.

Ormen Lange was discovered in 1997 and production began ten years later. Field life extends to after 2035. Shell (owning 17.81%) is the operator and the other licensees are Petoro (owning 36.48%), Statoil (owning 25.35%), Dong (owning 14.02%) and ExxonMobil (owning 6.34%) (Oljedirektoratet 2017).

4.1.1 Beerenberg Corp AS

The company was established 40 years ago, in 1977 under the name of Dalseide and Fløysand. In 2005 they changed name to D&F Group, before they took the name Beerenberg in 2009. In 2013 Beerenberg had 1600 employees. The main office is in Bergen, with departments in Stavanger, Oslo and Molde.

Beerenberg offer Shell daily assistance and continuous maintenance on the part of the Nyhamna plant which is in operation (www.beerenberg.com 2015).

At Nyhamna project Beerenberg will perform activities related to purchasing, engineering and inspection, fabrication and project management, insulation, scaffolding, surface treatment, passive fire protection, cold cutting etc. (www.beerenberg.com 2015).

Beerenberg is working on Nyhamna for Kværner Stord AS on behalf of Shell Norge AS. Shell awarded Kværner a contract for the expansion of Nyhamna in 2012 (NorskPetroleumsforening 2014). The contract will last until 2017.

The Beerenberg Group has been delivering innovative service solutions to the oil and gas sector for more than 35 years (www.beerenberg.com) . Beerenberg participation to Shell's Expansion Project at Nyhamna involves various activities in Norway and internationally and in order to keep a good overview over its deliveries, the group divided its operations. The figure under depicts the organization of the group. In my research I focus mainly on Business Support.

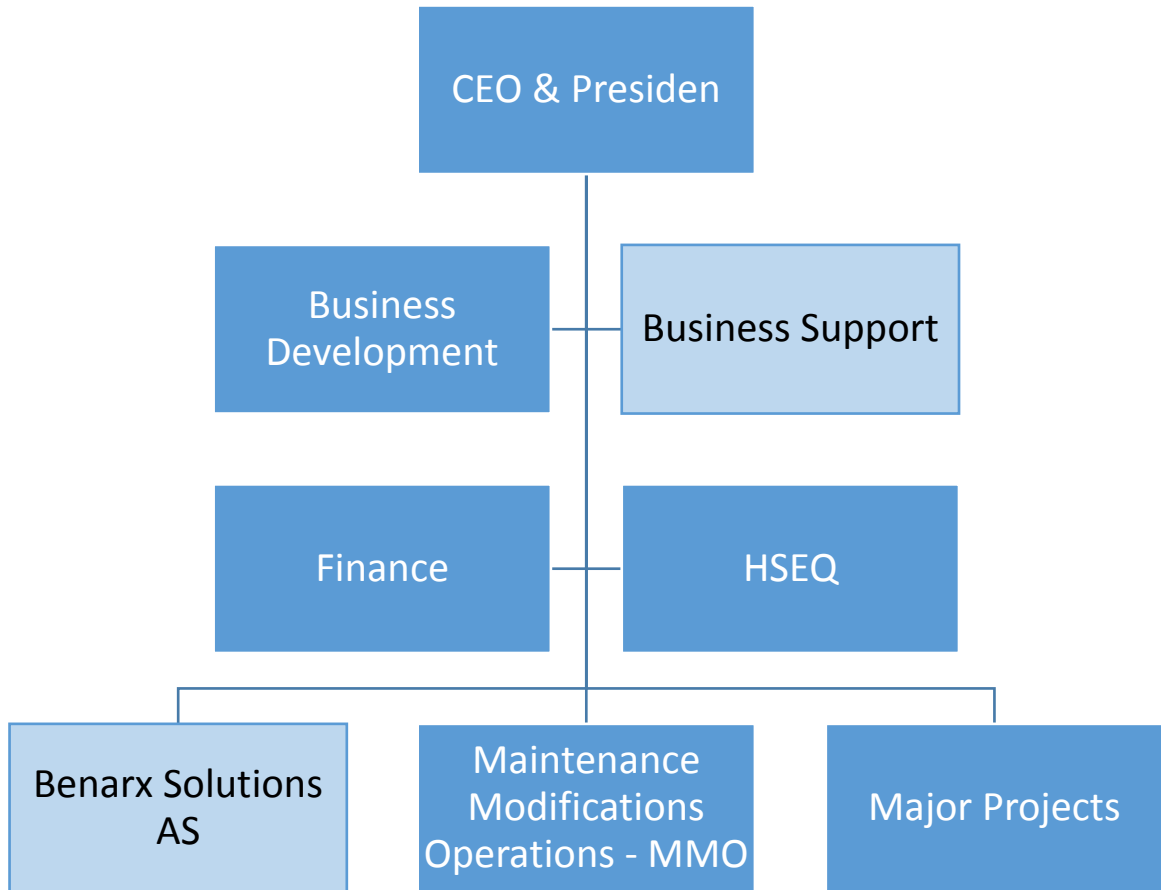


Figure 7: Organization Chart Beerenberg Corp AS

As presented above, we can see the place Benarx Solutions takes in the organisation as a subsidiary company. Further on, the warehouse on Aukra belongs under Business Support.

This department is divided in Communication, Compliance and Legal, Human Resources, Information Technology, Operational Support and Supply Chain Management.

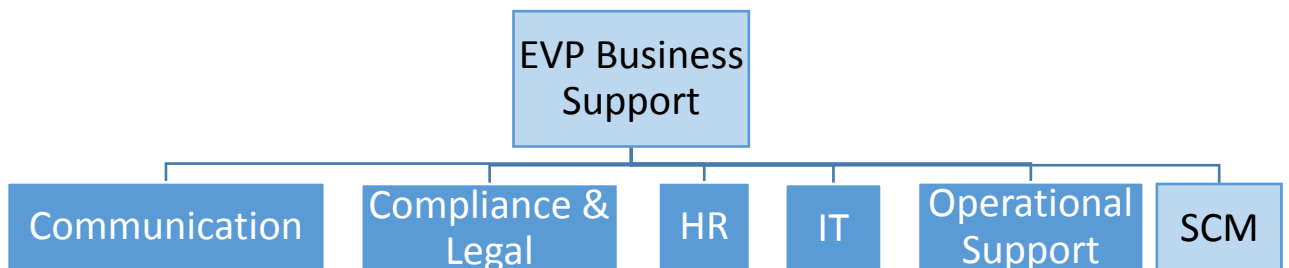


Figure 8: Business Support

Supply Chain Management department contains Material and Equipment, Personnel and Services and Procurement and Logistics. The Procurement department has office in Bergen and Stavanger. They are responsible for purchasing materials for all projects that Beerenberg has.

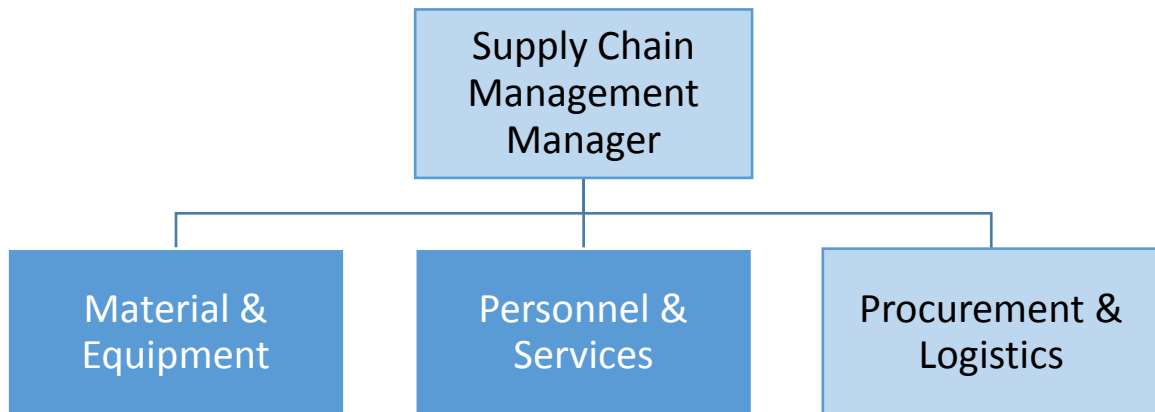


Figure 9: Supply Chain in Beerenberg

The Procurement team is divided according to different contracts that Beerenberg has around the country. Nyhamna is one of them. Logistics in Beerenberg are part of Business Support Project planning.

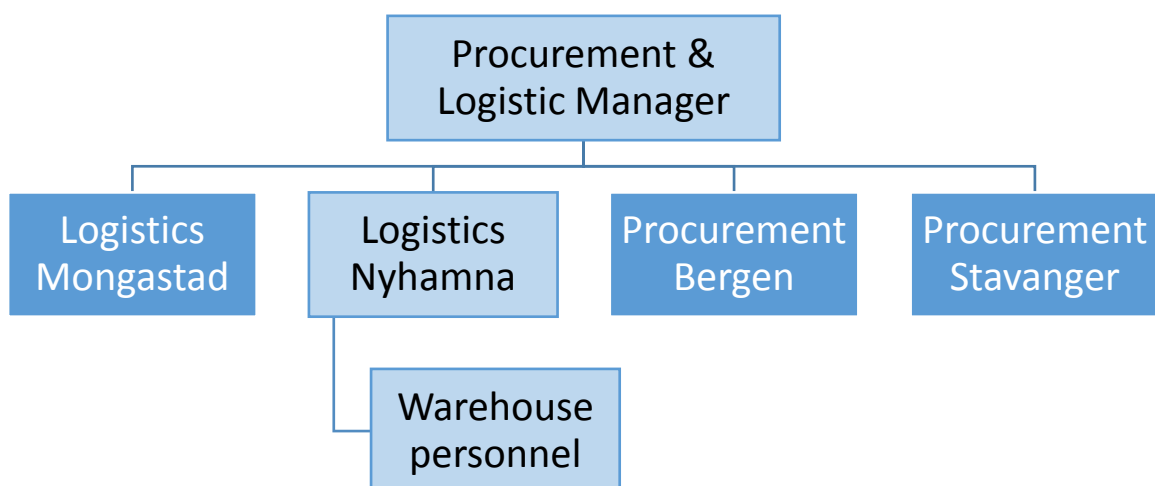


Figure 10: Procurement and Logistics

4.1.2 Benarx Solutions AS

Benarx Solutions AS was established in 2015 and has 108 employees. Is a fully owned subsidiary of Beerenberg Corp AS. The revenue for 2015 was 542 237 mil NOK (www.proff.no). They design, produce and deliver high-tech insulation products and advanced subsea insulation for the global Oil& Gas Industry (BenarxSolutions). Benarx is one of the many suppliers that Beerenberg has.

The first Benarx products to hit the market in the early 2000s were manufactured in Norway. Moving the production to Poland (in year 2015) and more suitable premises has helped improve the quality of the products. Benarx has now a factory in Gościcino, near Gdansk. The factory's three main departments – prefab, epoxy and insulation – manufacture the company's advanced fire, thermal and acoustic insulation products. Benarx factory in Poland is using a Scandinavian management style with focus on quality and HSE. They have introduced lean manufacturing – a philosophy for creating an efficient production process (www.beerenberg.com 2017).

Benarx has a department on Nyhamna and is helping Beerenberg with modifications of products and fabrication of new ones. This allows for shorter delivery time to site. The foremen are taking contact with Benarx if they need modifications on the boxes they are mounting. Benarx is sending then a person to check the problem on site. The products (mostly boxes) are taken to Prefab (Benarx work shop) and the necessary modifications are made. Benarx is also fabricating new goods (aluminium boxes, cladding, etc.). The raw materials for these are either bought in by Benarx purchasing department, or taken out of warehouse with purchase order. Kværner approval is mandatory in all this process. After the products are modified / repaired by Benarx, the goods are placed in a specific location on warehouse (VH2 Prefab) and registered by MIPS coordinator. The foremen can pick up the goods again from storage.

Kværner and Norske Shell are the main clients that Beerenberg has on this project.

4.1.3 Kvaerner Stord AS

Kvaerner is a leading provider of engineering, procurement and construction (EPC) services, and delivers offshore installations and onshore plants for upstream oil and gas production around the world (NorskPetroleumsforening 2015).

The headquarters are in Oslo, but the company has offices and fabrication facilities in several of the world's main oil and gas regions. Kvaerner delivers complete oil and gas offshore platforms and onshore process plants to operators and other customers.

The company has an organization of 2 700 employees with expertise and experience covering all phases of a project's life cycle, and an annual revenue for 2015 of 12 billion NOK. They also have the ability to call on a workforce of skilled personnel from strategic partners, subcontractors and suppliers, with whom they have well established relationships (www.kvaerner.no).

The companies brought together to create Kvaerner were established in the first half of the 19th century, during the Industrial Revolution: Aker established in 1841 and Kvaerner established in 1853 in Oslo (www.kvaerner.no). These companies delivered products such as steam engines for rail and marine use and a range of industrial ironworks.

Over the next hundred years, the businesses grew significantly. In the mid 1900s, both Kvaerner and Aker were international corporations with activities in shipbuilding, hydropower, wood processing and other process operations, mechanical workshops and other industries. Through the 1970s, 80s and 90s, they developed their capabilities and experience as suppliers of complete solutions to offshore and onshore oil and gas and processing projects. They each grew – organically and through international acquisitions – to be leaders in their markets.

In March 2002, the former Kvaerner Group and the Aker Maritime Group (comprising the oil and gas activities of the wider Aker Group) were merged, and started to operate as one company under the name Kvaerner.

In December 2010, Aker Solutions announced a decision to cultivate its core businesses. Kvaerner was established, through a demerger, as a specialized EPC (engineering, procurement and construction) company addressing the global market.

On 6th of May 2011, the shareholders' annual general meeting approved the establishing of Kvaerner as a separate company (www.kvaerner.no). They have delivered offshore platforms, substructures and onshore facilities for upstream oil and gas projects for nearly fifty years.

The company is the key contractor on the ongoing major expansion project at Nyhamna plant (www.kvaerner.no). Kvaerner is specialized in executing engineering, procurement and construction (EPC) projects (www.kvaerner.no). The Nyhamna Expansion is such a project, where Kvaerner designed the engineering according to Shell's order. Beerenberg is also offering engineering services to Kvaerner in this project.



Figure 11: Kvaerner at Nyhamna (www.kvaerner.no)

4.1.4 Shell Norge AS

Shell was active in Norway for more than hundred years. The company was established in 1912. The main activity is looking for oil and gas and production of oil and gas. The main office in Norway is nearby Stavanger (www.shell.no).

Royal Dutch Shell was established in 1907, but their history go back to 1800, to a little store in London where Samuel family sold oriental seashells. Today, Shell is a global group consisting of energy and petrochemicals companies with an average of 94,000 employees spread across more than seventy countries (www.shell.no).

Shell is known as an oil and gas company, but they also generate energy from wind and produce sustainable biofuel from Brazilian sugar cane. They also operate demonstration filling stations where drivers can refuel with hydrogen (www.shell.no 2016).

The word "Shell" was first used in 1891 as the trademark for petroleum Marcus Samuel and Company transported to the Far East. This little store in London traded originally in antiques and oriental seashells. The shells were so popular - the Victorians used them specifically to decorate jewelry box - that soon they formed the basis for the company's profitable import and export trade with the Far East.

Word got company status in 1897, when Samuel formed company Shell Transport and Trading Company. The first logo in 1901 was a mussel, but in 1904 was a shell of scallop, or a scallop emblem, has been introduced to give a visual representation of corporate and brand name.

When Royal Dutch Petroleum Company and Shell Transport and Trading merged in 1907, the latter company's brand name and symbol (Shell and scallop) became the emblem of the new company Royal Dutch Shell Group. The form of the Shell emblem has changed gradually over the years in line with trends in graphic design. The current emblem was introduced in 1971. Thirty years later still used and is now one of the world's most popular symbols (www.shell.no).

The main activities Shell has in Norway are related to use of their expertise, technology and innovation to deliver more cleaner energy to help meet the growing needs of the world, and find more efficient ways of using energy. They also work with partners, local communities and management forces to do this in an environmentally friendly manner and socially responsible ways. Shell is involved in several projects for safe capture and storage of CO₂ in order to reduce the use of hydrocarbon. They have a decade of experience in wind power and are involved in nine projects in North America and Europe.

Transport is essential for modern life. Shell is innovative in transporting people and goods in a cleaner and more efficient manner by developing more efficient lubricants and fuels

including low carbon biofuels and hydrogen, and creating training programs that help drivers to increase their own fuel economy (www.shell.no).

4.1.5 Beerenberg as part of the Expansion Project

In the end of year 2012, Beerenberg signed an agreement with Kværner for the implementation of insulation work at Nyhamna. The agreement has a five years duration, with options for extra two years. The estimated contract value is 700 million NOK.

Beerenberg had good experience with working at Nyhamna during the original development in 2003-2007. In the Expansion Project, they built on their experience. The company is familiar with the facility, the area and the suppliers in Central Norway (offshore.no 2012).

Beerenberg was hired to work on this project, making a temporary effort to create a unique product, service and result, satisfying the client's needs. The Expansion Project has a defined life span with a beginning and an end, usually involving several departments and professionals (Larson and Gray 2013).

The project life cycle includes four stages. Beerenberg starts with the defining stage where the specifications of the project are defined, the objectives are established, the teams are formed and the major responsibilities are assigned.

The next stage is planning. The company develops plans which determinate what the project entails, when it is scheduled, what quality level should be maintained, and what is the budget.

The next major part of the project work takes place in the executing stage. The actual work starts, the insulation is mounted on pipes. Beerenberg is using time, cost and specifications measures for control to see if the project is on schedule and on budget (Larson and Gray 2013). At a certain point in the project, they realized that they need more resources in the warehouse, so they hired more people.

We are heading now towards the final stage of the project, the closing stage. This includes three activities: delivering the project product to the customer, redeploying project resources, and post-project review (Larson and Gray 2013).

4.1.6 The warehouse department at Beerenberg on Nyhamna

Up to this point in my thesis I described Beerenberg in general. Now is time to look at the warehouse department in details, to specify how things are done.

The physical warehouse is placed ca. two km outside the construction site. The facilities are big, having enough place for storage of goods. The large space is divided in halls, tents and outside areas. In the beginning they used the main hall (Hall 1 – Golan), Hall 2, Hall 6, Veidekke Tent, parking place on Golan, I 54 tent on site, AF tent outside the site area.

They have one truck inside Hall 1 at Golan, two trucks outside and three pallet jacks. The plastic wrapping machine is the newest addition to the warehouse equipment.

Further in this chapter I present the situation before September 2016 when the department has low staff, and illustrate the work tasks that the operators have. I then present how the warehouse functioned in the period between September 2016 and February 2017 when the staff is sufficient and the warehouse services are effective. In the end, I mention the challenges that warehouse is facing after cutting personnel towards the end of the project.

If I have to divide the warehouse operations by the amount of personnel that worked there in different periods of time, I can identify three stages:

Time period	1) The period before September 2016	2) The period between September 2016 - February 2017	3) The period after February 2017
Number of employees	5-6 persons / shift	15-19 persons / shift	9-10 persons / shift (even less afterwards)

1) Before September 2016

As described before, the warehouse department is part of Business Support. In the beginning they started with few people. When the project activity expanded, the resources increased in order to face the project requirements. It is normal to have a lower activity in the beginning of the project. As the project goes on, the activities increase, the demand is higher, and the tasks become more challenging.

In the period before manning up the warehouse, only few people are working there. The warehouse has only 5-6 people per shift before September 2016. There are busy times with many requests from site, increasing demand all the time. The personnel cannot cope with the amount of work anymore. The efficiency is not very high and the project group is complaining about the performance, for not being able to deliver on time. Therefore measurements are taken and more people are hired.

2) September 2016 - February 2017

In September 2016 the warehouse personnel increases with more than 10 persons per shift. This make possible a better performance of the warehouse and the project group is visibly satisfied with the performance. The workers are divided on two shifts. Some of them are working from Monday to Friday (5-2), others are working two weeks and have two weeks free (14-14) and some are working two weeks and have three weeks free (14-21). Like all projects, it is important to understand the project flow, the planning and executing of tasks.

The roles started to be defined:

- Two persons are responsible with receiving of goods;
- the Logistic Leader and MIPS operator are handling the e-mails and paper work, delegating tasks to warehouse operators;
- two persons are responsible of VUP (verktøy- og utstyr pool = tools and equipment pool);
- one person is driving the “bulk car”, delivering what is necessary to foremen directly on construction site;
- the Warehouse Manager together with two others are handling managerial tasks;
- three people are on packing;
- two persons are responsible with I54 storage;

As the project gets closer to end, the locations are reduced and the goods are collected. In order to cut the costs and the inefficient travel time, they moved the goods out of AF tent and Veidekke tent.

Some of the goods are packed by job pack number and stored. This makes it easier and faster to deliver the order when required. These jobs are stored either closer to site, on I 54 or on Golan. The facility on I54 is staffed with two persons that helps avoiding overloading at Golan.

The surroundings are very important. The warehouse has a certain capacity and is utilizing one forklift inside. This implies that it doesn't help to have too many people on one task, because only one person can operate the truck at a time. Therefore, in order to optimize the operation, some people are picking goods inside and the others outside, dividing the job packs. Therefore, the warehouse personnel have to use the facilities at maximum, take what they have and work with it, make it better.

Once the warehouse hired more people and became a larger team, the five-stage team development model can be identified. The initial stage is forming, where the members get acquainted with each other and understand the scope of the project. They begin to establish ground rules by trying to find out what behaviours are acceptable. This first stage is completed once members begin to think of themselves as part of the group.

The storming stage is marked by a high degree of internal conflict. There is conflict over who will control the group and how decisions will be made (Larson and Gray 2013). This is clearly seen after the new members join the team in September. Suddenly, the warehouse has so many people and the job descriptions are not defined yet completely. After one-two rotations, it is clear that the Logistic Leader is an intermediary between MIPS coordinator and warehouse operators, answering to warehouse manager.

Next stage is norming, in which close relationships develop. Feelings of camaraderie and shared responsibility for the project are heightened. The group structure solidifies and the group establishes a common set of expectations about how members should work together.

In the following stage, the performing stage, the team's operating structure is fully functional and accepted. They work together now to accomplish the project goals (Larson and Gray 2013).

From September 2016 until February 2017, the warehouse team is going through all these stages, getting to the fifth, which is adjourning stage. For project teams there is a completion phase. The team prepare for its own disbandment. High performance is no longer a top priority. Instead attention is devoted to wrapping up the project (Larson and Gray 2013).

Scheduling resources and costs

If resources are not adequate to meet peak demands, the late start of some activities must be delayed, and the duration of the project may be increased. This process is called resource-constrained scheduling. A deficit of resources can significantly alter project dependency relationships, completion dates, and project costs (Larson and Gray 2013).

The project manager can classify the project as either time constrained or resource constrained by answering to the question: "if the critical path is delayed, will resources be added to get back on schedule?" If the answer is yes, assume the project is time constrained; if no, assume the project is resource constrained (Larson and Gray 2013).

By hiring approx. 14 people in the middle of September 2016, we can see that Beerenberg was running a time-constrained project which must be completed by an imposed date. Therefore, resources were added to ensure that the project is completed by a specific date. The time is fixed and the resources are flexible.

Adding resources is a common method for shortening project time. However, doubling the size of the workforce will not necessarily reduce completion time by half. Additional workers increase the communication requirements to coordinate their efforts. There is the additional delay of training the new people and getting them up to speed on the project (Larson and Gray 2013).

Everybody is quite flexible and solve all the required tasks, moving from their main attributions. Having this extra staff, the warehouse is able to deliver better service and the project management is happy with the improvements. The actions are documented better and the traceability of goods is secured. The challenges are overcome and the warehouse operations are optimized.

The Logistic Operators learned the routines and are familiar with the facilities and the products. The tasks are split in such manner that are easier to be accomplished. By having enough people to work, the rules are respected at all the time, the focus is kept on HMS, the waste is eliminated, the products are delivered in the right quality and quantity on time to site.

The synchronization is good and the team deliver as requested. The overall project register progress. Beerenberg is satisfied with warehouse department, the other departments are happy with the cooperation. The client is also satisfied with the overall performance.

3) After February 2017

The overall project is getting close to an end, the tasks are closing, the pipes are insulated and the amount of project work is decreasing considerably. The management is trying to find a balance between speed of delivery, cost and accuracy. This is well shown in the decision that Shell together with Kværner and Beerenberg made to reduce the number of warehouse operators in March 2017, going down to approx. 10 persons per shift (and even lower after April 2017). Almost all of those hired in September 2016 were demobilized, except two positions. The number of warehouse personnel decreased to approx. ten persons per shift.

The roles are split as follows:

- Warehouse manager (1)
- MIPS operator (1)
- Logistic Coordinator (1)
- VUP (2)
- Bulk car (1)
- Warehouse operators (4)

The amount of work is fluctuating a lot lately. Some days are very busy and some are going slow. In the busy days, I noticed that it is quite challenging for warehouse personnel to cope with the demand from site. There are considerably fewer people than previous period. The goods are still arriving at warehouse (new purchases). Many returns are

coming from site due to cleaning and closing areas. These goods need to be placed back on shelves in the same time while people are packing and sending products to site. Some of the positions disappeared from warehouse organization chart and the responsibilities are combined and assigned to fewer persons. This puts a certain pressure on warehouse operators, making it again difficult to respect all procedures, rules and Lean theories that were implemented in previous time period.

The amount of workers going down it is noticeable overall in the project. The other departments are cutting down staff. The client and the management is focusing on cutting the costs. Even though the project is going to an end, it is not finished yet. The work load is big for the few remaining people. The amount of e-mails, the requests in the GF list, the radio requests are still demanding that the warehouse personnel delivers. It is challenging to pick, pack, send and follow all that paperwork in order to register accordingly and to maintain control. Now is the moment when bottle necks are creating in warehouse operations.

An incident as the damage of the truck inside Hall 1 is almost taking the warehouse out of operation. It takes few days for the truck to be fixed. In all this time, the operators are not able to reach and deliver products from the upper shelves in Hall 1. The production is affected and slowed down by this. Once the truck is fixed, the management decides to limit the persons that are allowed to use the truck to one or two per shift. This is slowing down the picking, packing and delivering of goods. One of the persons allowed to drive is not working on week-ends and after 16 o'clock. The other one is also responsible of I 54 storage facility on site and is running from one location to another. People on Golan are forced to wait for him in order to pick the goods from higher shelves.

4.2 Warehouse processes at Beerenberg

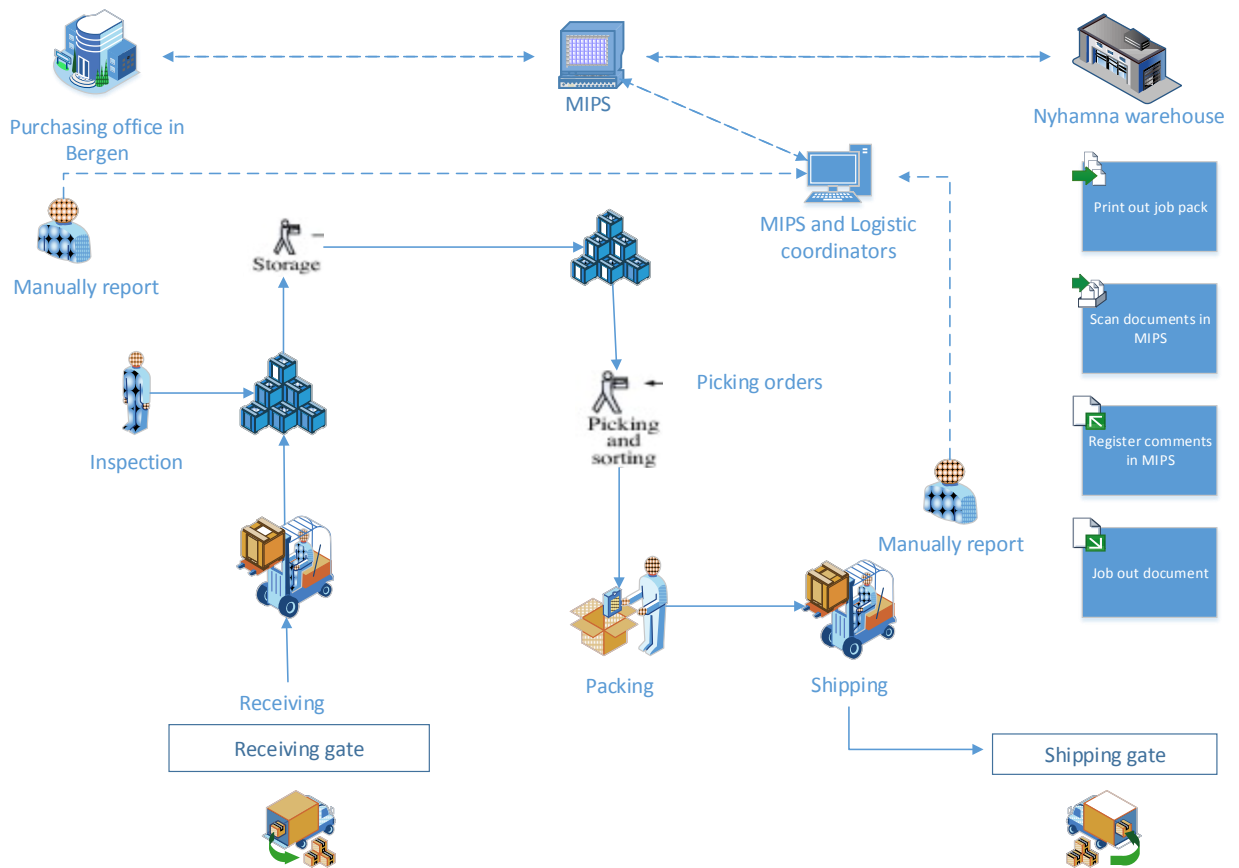


Figure 12: Current warehouse operations

4.2.1 Receiving of goods

On Nyhamna Expansion Project Beerenberg is using a program called Method Integrated Project System (MIPS). This is developed by Kværner and is used by the entire project.

The system is divided in 3 main parts:

1. Material: this is used by purchasing department and warehouse. It contains requisition, package and inquiry, purchasing, procurement status, warehousing, etc.
2. Construction: used by engineering department. It contains technical information, weld documentation, document control, cost control, etc.
3. Completion: used in the end of the project for completion and preservation.

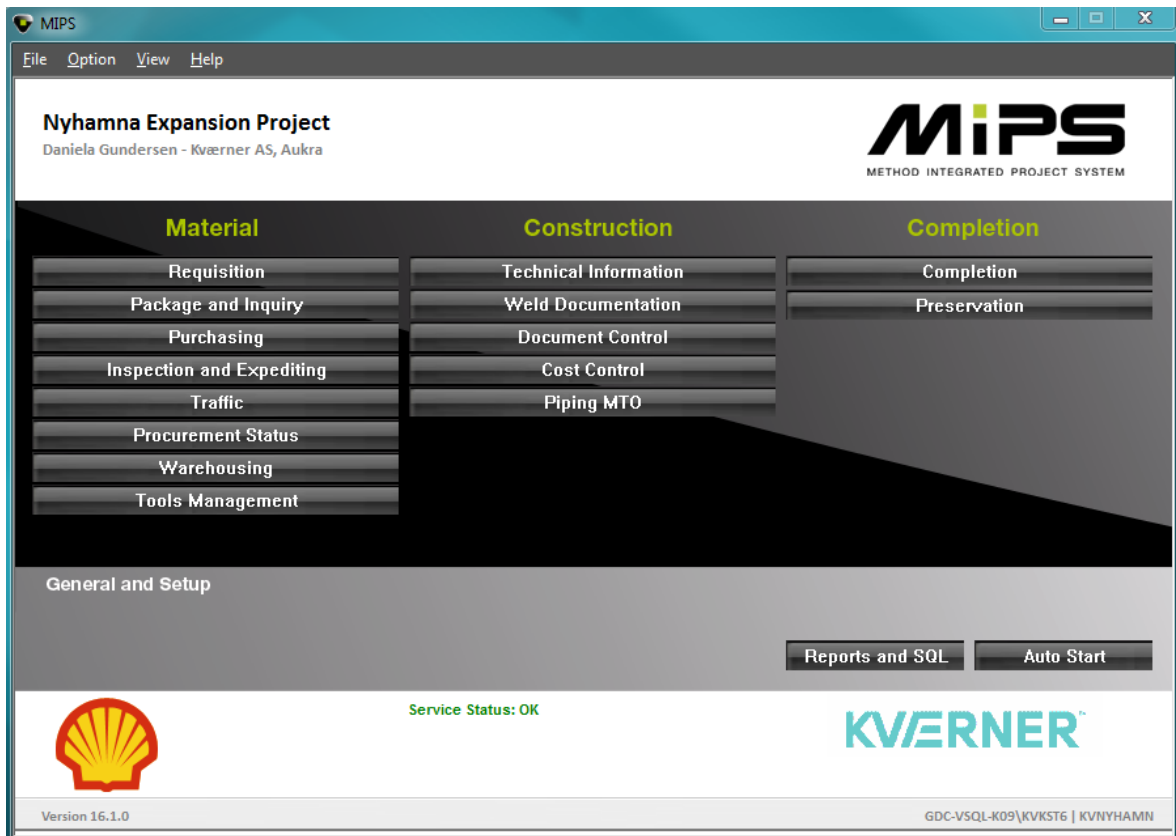


Figure 13: MIPS

The necessary of goods and approximate amount is known from the beginning of the contract. However, when we try to break down the process it looks like this:

The person that is measuring needed material on site (measurement engineer) is checking the dimensions of the pipes and evaluates the necessary material for insulating the pipes. He is informing Engineering Department. Engineers are connecting the material to job packs. In the same time they send the purchase order (PO) to Kværner (KST). After PO is approved by KST goods are ordered. The job packs represent the basis for invoicing.

The PO is registered in Kværner's system. PO becomes then a MRD (Material Release Document) → MMT (Material Movement Ticket) → MRR (Material Receive Report).

MRR is then printed out and given to the Logistic Operators for handling. The operators are checking the goods for visible damages, checking the quality and the labels. They are then placing them on shelves (or different warehouse locations) and are making a note of that. This information is going to MIPS operator which is registering it in the system.

When the information is punched in MRR again, the signal is given back to the system and the PO is registered as confirmed (received).

There are many items used by Beerenberg on this contract, but the most common goods used for insulation of pipes (that we store on warehouse) are: AES fibre, adhesives, bolts, boxes (aluminium and chartek), cladding, cellular glass (XP), cryogel, drain plugs, flange belts, flange boxes, mineral wool, pyrogel, bands, sound stop, etc.

The most important product in insulation is cellular glass (XP). The Benarx Cellular Glass XP pipe insulation is ideally suited for passive fire protection of pipes. The light weight construction of cellular glass combined with intumescent epoxy coating is designed to withstand the toughest hydrocarbon and jet fire scenarios. The prefabricated insulation elements are available as pipe shells, bends, tees, reducers and conic ends, and can be further modified on site to fit pipe lines from ½ " to 40 " in diameter. The modular design saves valuable installation time on site and also allows for fast and easy removal and re-use of the insulation material for inspection of the insulated pipe (www.benarx.com). This is fabricated in Poland by Benarx. The goods are transported to Aukra and receiving of goods are done according to procedures implemented by Kværner.

Beerenberg warehouse on Nyhamna has two forklift trucks, which they can use. The goods are placed in Hall 2 or outside the warehouse (depending on what kind of product it is). Once the goods are offloaded, they are checked before put-away. It is already decided which products will be checked. The main ones are the XP and boxes.

The utilization of barcode scanners could speed up the process significantly and improve accuracy. Beerenberg is printing out labels which are placed on products, but they don't have a scanning barcode system in place. The goods are checked and labels are placed. Then, they are placed on shelves. The location is written on paper and handed over to MIPS coordinator for further registration in the system. The registration is done manually. The literature is mentioning another system that could reduce the checking time at the receiving bay: RFID (radio frequency identification). This was not implemented at Nyhamna either.

Cross docking process is used at Beerenberg when the products are coming from modification. Once Benarx Prefab is done with them, they deliver to warehouse in Hall 2. The goods are sent directly to site, without being placed on shelves. However, they are registered in MIPS with new location (VH 2 Prefab). There are cases when the foreman

want the box before we have the chance to register it in MIPS and issue it again. In this situation, the Logistic Coordinator is filling out the Job Out paper, the foreman is signing and takes the product. The scanning and registration in MIPS is done on the old issue, as a proof that the product was delivered again. In this case, the implementation of RFID system could improve the information flow and reduce the waste in the project based warehouse process. Any misunderstanding or wrong registration can lead to problems in the future.

4.2.2 Storage of goods

Beerenberg has many locations to store the goods on Nyhamna. The main warehouse is called Golan and is situated at approx. two km from the plant (construction site). Benarx work shop is also located here, in the opposite end of the building.

Outside the main hall, are few other halls and tents where the goods are stored. Each location has a code in MIPS. The halls are divided into rows and shelves.





Figure 14: Golan Hall



Figure 15: Hall 6



Figure 16: Hall 1 – outside; Storage of chartek boxes



Figure 17: Storage area for goods that are packed on job packs (H1Fxx)



Figure 18: Hall 6 – outside; Storage of cladding



Figure 19: Hall 6 – outside; Storage of pyrogel and monarflex (bulk material)

The goods that cannot withstand rain are stored inside. The others are stored outside. All goods are placed on pallets, some of them are secured by pallet collars.

4.2.3 Picking and packing of goods

First I describe shortly how the warehouse operators are getting the information they need to start picking the orders.

The workflow for outgoing shipments look like in the figure below:

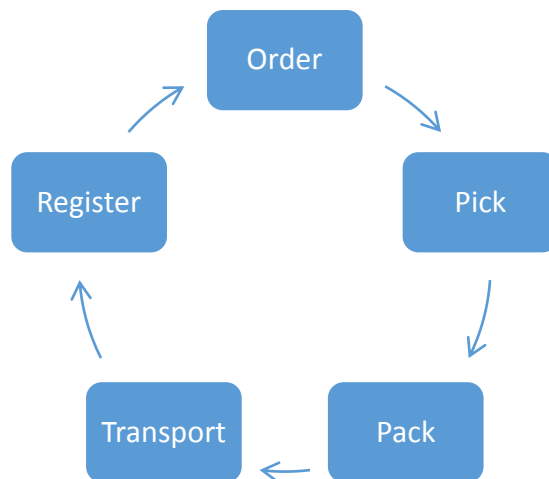


Figure 20: Workflow outgoing shipment

The processes from above figure are described in the following text.

In order to cope faster with the request of goods from site, the warehouse is receiving orders to pack goods connected to different job pack numbers.

The General Foreman is sending requests either by e-mail or by registering the need in the common Excel file that Insulation department is sharing with Warehouse department.

The Logistic Leader together with MIPS operator is handling these requests (orders). The job pack is issued and given to Logistic Operators to pick up and pack the goods. The job pack is usually printed by MIPS operator. He/she is also printing the labels that will be marked on pallets. Every pallet will contain the transport card and the packing list. These will be partially filled up by warehouse operators according to the information they receive from their leader (where the pallets need to be sent and to which team, the content of each pallet, etc.).

KVERNER Kværner Stord AS
TRANSPORTKORT FOR NYHAMNA EPCm

TIL R 45

V/ Team A (Nerijus)

Jobb nr.: **LX22501P010NYH.S01-001**

Tlf. nr.: Minor-M Rute: 1/xx paller

Figure 21: Transport card

Object

Unit

Date:

Pall

Figure 22: Packing list

If the goods will be packed for storage, the details will be filled up later on.


		Nyhamna Expansion Project			KVERNER			
		NYH MAJOR						
		Warehouse Issue Requisition Picking List						
Issue Requisition No Process No / Description		Description		Issued Date	Requested	Issued By Job Issued by		
LX21603P510NYH.02-001		LX21603P510NYH.02		23.01.2017		271853		
		LX21603P510NYH.02 Final installation of boxes after N2/ HE test, Piping Test 1603-P510, Boxes for test 1603-P510 (N489V40) & 1604-P501 (N467V01) (NYX)						
Delivery Info								
RequestedBy		Requested Date/Time		Deliver To LocationNo/Description/WarehouseOwner				
Note: Pack and store								
Article No		Description		Unit	Requested	Issued	Remain.	
13952		Flangebelt, T, M10, SS316, ASME B16.47 Series A #600 - 28"		EA	1,00	0,00	1,000	
Location No		Name		Location Owner		On Stock Quantity		
H1410FG		Pallereol LagerHall 01 Golan		NYH MAJOR		6,00		
Article No		Description		Unit	Requested	Issued	Remain.	
13992		Pipe, 2xM10 nipple, 200 mm		EA	1,00	0,00	1,000	
Location No		Name		Location Owner		On Stock Quantity		
H1408GG		Pallereol LagerHall 01 Golan		NYH MAJOR		98,00		
Article No		Description		Unit	Requested	Issued	Remain.	
LX2-1603-P510-06479		FLG:04310-1601: LR0684903-E-JFRB-25-DN700-1603-P510		EA	1,00	0,00	1,000	
Location No		Name		Location Owner		On Stock Quantity		
H1-UTE-9		Hall 1 uteområde Golan		NYH MAJOR		1,00		
Date	23.01.17						Page	1 of 1
Time	11:26:38							
Ref	pl_jreq1							

Figure 23: Warehouse Issue Requisition Picking List (Job pack)

At Nyhamna we use small order quantities and frequent deliveries. This type of picking is referred to as item, eaches, broken-case or split-case picking (Richards 2014, 77).

Pick preparation is labour intensive and difficult to plan at Beerenberg warehouse on Nyhamna. It is easy to make mistakes and it affects customer service directly. There are cases when items were missing from the order, wrong items or wrong quantity was sent to construction site.

The material that is weather resistant is stored outside. Here is easy to access, prepare and pick the goods (either by hand or using the forklift truck). Additionally, Beerenberg has a truck inside Hall 1.

The warehouse pick area layout is very basic and is based on minimizing the amount of travel through the warehouse when picking an order.

The route followed by the picker when assembling the order needs to take into account the following:

- The most effective route beginning at the front of the racking nearest the dispatch bays
- Heaviest items are picked first
- The picker should be able to pick from both sides when moving up and down the isle (Richards 2014, 90).

These rules are respected in Hall 1, because the layout permits it. In Hall 6 however, not all these rules are in place. The goods are stored on ground floor, one pallet on top of the other. The warehouse operators need to move the items in front to get to those in the back. They also need to remove the pallets on top if they only need what is in the bottom. The goods are then moved to Hall 1 where the packing activities are done. This is not cost and time effective.

There are a number of dimensions to the picking process. These includes how and when the orders are presented, how the actual items are picked and the equipment required. There are many interrelationships and many options. Beerenberg uses following:

Picker	Orders	Handling equipment	Storage methods	Picking operations	Hardware and software
<ul style="list-style-type: none"> •Picker to goods 	<ul style="list-style-type: none"> •Pick by order 	<ul style="list-style-type: none"> •Pallet jacks •Powered pallet trucks •Forklift trucks •Ergonomic work station 	<ul style="list-style-type: none"> •Bulk/floor storage •Conventional racking •Shelving 	<ul style="list-style-type: none"> •Paper pick •Pick by label 	<ul style="list-style-type: none"> •MIPS

Figure 24: Picking strategies and equipment at Beerenberg on Nyhamna warehouse

There are multiple benefits when we pick by individual order: single stage operation, flexible, quick implementation, ability to isolate urgent orders, picker is able to decide pick path, utilize manual or technology systems. The disadvantages are low pick rate, very labour intensive, can result in bottlenecks at the pick faze, training can take some time depending on the tools used (Richards 2014).

Beerenberg is using a paper pick list which includes the order number, location, product code, description and quantity to be picked. When the pick list is returned to Logistic Coordinator, the discrepancies are checked immediately and alternative locations are provided if there are shortages. MIPS operator then introduces the details of the pick manually in the system. This leads to errors sometimes, if the writing is illegible or there is confusion over a way a number is written. This all adds time to the operation. Paper picking requires little investment; however, it can have low accuracy and may require order validation. Once an order has been picked, the operator has to return to the office for further pick lists or instructions. It is not a real-time system (Richards 2014).

It is an accepted fact that increased errors lead to increased costs. The elements involved in an incorrect pick include:

- Cost of recovering the item
- Labour cost of in-handling and checking the item on return
- Cost of picking the replacement item

- Cost of re-packing
- Cost of re-delivery
- Administration costs of registering paperwork
- Possible stock write-off if the returned product has been damaged in transit (Richards 2014, 160).

Time and experience taught us to better document our activities. Therefore, the Logistic Leader is registering all job packs in a log (book) before giving it to the warehouse personnel for packing. In this way we secure traceability of job packs and make sure that all are handled, that nothing is lost in the process. The warehouse personal is picking the goods according to the locations mentioned in job pack.

Beerenberg has a storage location on site, called I54. There we have two warehouse operators which are picking and packing goods, delivering to foremen and holding a close contact between main warehouse and construction site. We store both individual goods and finished packed goods on I54. We have a separate log for the job packs that are going to be handled from there.

After the goods are picked, the operators are packing them accordingly in pallets with collars in order to protect them during storage and / or transport. The items are very well secured inside the pallets with plastic bubbles and cartoons. The pallet is covered, strapped and wrapped in plastic foil.





Figure 25: Packing of goods in plastic foil

The warehouse operator is making remarks on the job pack, mentioning the location he/she used to take the goods from and the amount. He is also writing his initials, date and the location he placed the pallet on (in this case, the pallet was stored at Golan on location H1F10).

As mentioned in the material handling theory, the equipment used is very important. It make the work easier for people, improve the working conditions and reduces the costs of productions. In this case, the wrapping machine protects also the goods and reduce damages.

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		Nyhamna Expansion Project NYH MAJOR Warehouse Issue Requisition Picking List			<i>Conf.</i> 		
Issue Requisition No Process No / Description		Description	Issued Date	Requested IssueDate	IssuedBy Job Issued by		
LX22501P002NYH.FA01-001 LX22501P002NYH.FA01 Final installation of boxes after N2/ HE test, pipe test 2501-P002, (FAV: P45V12) (NYX)		LX22501P002NYH.FA01	10.01.2017		271853		
Delivery Info							
RequestedBy		Requested Date/Time	Deliver To LocationNo/Description/WarehouseOwner				
Note: Pack and store MS17							
Article No		Description	Unit	Requested	Issued	Remain.	SND
LX2-2501-P002-09916		FLG-4000-2501: LS070431-E-JFRB-57-DN80-2501-P002	EA	1,00	0,00	1.000	OK
Location No		Name	Location Owner		On Stock Quantity		
H1106HG		Pallereol LagerHall 01 Golan	NYH MAJOR		1,00		
Article No		Description	Unit	Requested	Issued	Remain.	SND
LX2-2501-P002-09917		FLG-4000-2501: LS070431-E-JFRB-57-DN80-2501-P002	EA	1,00	0,00	1.000	OK
Location No		Name	Location Owner		On Stock Quantity		
H1106HG		Pallereol LagerHall 01 Golan	NYH MAJOR		1,00		
Date	10. 01. 17					Page	1 of 1
Time	13 : 40 :30						
Ref	pl.irepl						

Figure 26: Confirmed job pack

Pareto's Law is widely used in logistics and is an excellent method for categorizing items. One of the measurements taken to decrease costs and use less time from the warehouse operators, was to place the bulk items in Hall 1 on Golan on the ground floor, easy accessible to the workers that needs them. The foremen can come to Golan, pick up the goods they need after filling out a form. The warehouse operators don't use their time to pick and deliver these. The filled out form is placed next to the shelves. MIPS coordinator is collecting them and update the system. Additional to this, the person driving the bulk car is delivering small size bulk items directly to site.

Third-party shared-user warehousing is a typical example where a number of clients share the building but the picking activities are typically segregated. Shell is using Hall 1 for storing some of their own items (Richards 2014, 92). The Shell warehouse operators come to Golan from time to time, use the truck and pick their own goods, not interfering with Beerenberg workers.

4.2.4 Delivery of goods to site / foremen

The handling of material has to be done to the right place, at the right time, in the right amount, in sequence and in the right condition in order to minimize the costs.

On Nyhamna, once the product has been picked, the operator is packing the goods immediately on pallets, attach shipping labels and job out documentation paper.

Every order should be checked before it leaves the warehouse, especially the high value products (XP, boxes). A quality check routine was recently implemented. A form needs to be filled out by the warehouse operator. This adds extra time and paperwork to the process, making the picker less effective. We couldn't see the benefits of using this document, because it was not implemented 100%. The form consists in checking the cracks and damages of the items, the paint, etc. It was noticed that the warehouse personnel gave up quickly on using the form. The management was not following up on this either.

The Logistic Leader is coordinating transport of requested goods to site. For a better efficiency, more than one order is collected and the pallets are placed on a specific area, called sending zone. Then, he/she is contacting Kværner transport in order to move the pallets from Golan to site. Loading needs to be efficient. The space on the truck needs to

be used properly and the number of transports need to be plan in such a way to avoid waste. Logistic Leader is preparing the document that will be sent together with the goods (Job Out). Despatch documentation and labelling needs to be completed to ensure compliance with customer requirements.

JOBS OUT

STORAGE LOCATION: _____

JOB NUMBER: LX22501P010NYH.S01-001

NAME: Team A (Nerijus)

LOCATION: R45

PALLETS: 1

BOX 07170

EA 1

SIGNATURE:

DATE:

Figure 27: Job Out

This is given to the driver (Kværner Transport) which is handing it over to the foreman on site. The foreman is checking the goods and sign the Job Out paper which is then returned to the Logistic Leader on warehouse.

For small items, Beerenberg is using the bulk car to send goods on site. In some cases, the foremen come to the warehouse and pick up needed products. This decreases the time used to transfer goods from warehouse to production site.

Logistic Leader is keeping an Excel file where he/she register all finished job packs stored. The storage locations registered there are: Golan, AF Tent, I 54, O10. Once the goods are sent to site, the job pack number is removed from this list.

After the goods are sent, the Logistic Leader is registering the activity by making a comment in MIPS.

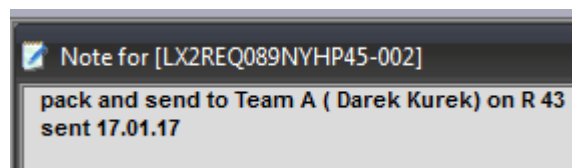


Figure 28: Comments in MIPS

When the signed Job Out paper is received, it is scanned by the Logistic Leader and attached in MIPS on the specific job pack, as a proof that the goods were delivered and received by foreman. Here is place for error because the Logistic Leader has no official proof of sending the goods from the moment the job out paper is given to the driver and until he / she receive it back.

As mentioned in the material handling theory, control is one of the five dimensions of material handling. The rest are movement, quantity, time and space. In this case, the tracking of the material, the positive identification cannot be done for a short period of time, until the warehouse receives the signed job out paper.

In many cases, the foremen are coming by the warehouse to ask the status for different materials. The requests from General Foreman (GF) don't get fast enough to warehouse personnel, or the foremen prioritize differently. The Logistic Leader is helping the foremen finding the goods they need and the communication is very good between the parts. If the goods are small, the foremen are taking them in their cars. If the goods are placed on pallets, then the Logistic Leader is organizing transport from warehouse to site. The goods that come from Benarx Prefab from modification are also delivered back to foremen and the Job Out paper is signed.

4.2.5 Inventory of goods

The warehouse personnel is checking the inventory of goods regularly. They are using specific forms which are handed over to MIPS operator after that. He/she is updating the system manually. The challenges are that the work is always ongoing and the warehouse is not closed completely. It can happen that the daily activities increase fast. Then the picking is coming in conflict with counting, making it difficult to count and pick goods in the same time. Some errors are registered and we need to count again.

Therefore, the counting is done on a location at the time, in periods when is not so busy (week-ends for example). The amount of items is very large. It is almost impossible to have 100% control of all goods at all the time. However, by increasing the warehouse personnel, Beerenberg's system is working much better and the system is more accurate.

4.2.6 Return of goods from site

After the goods are issued on job package and sent to site it can happen that the product don't fit or they have some extra material. This is returned to warehouse. The team responsible for return is unpacking and inspecting the goods and placing them back on shelves, informing MIPS operator about locations. These are registered back in the system. The return can be registered on the job pack or only as individual item.

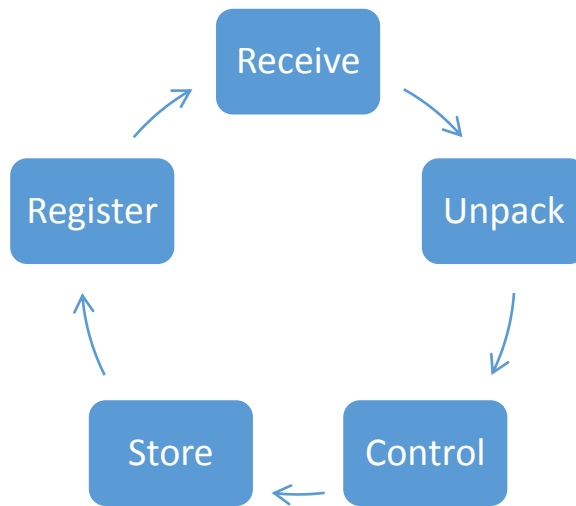


Figure 29: Workflow incoming shipment

If the product was wrong delivered and returned to warehouse, correct product is then sent to site following the picking-packing-sending procedure described above.

4.2.7 VUP (verktøy- og utstyr pool = tool and equipment pool)

The warehouse is divided in two parts: one part is handling the materials used by the workers to fulfil the contract that Beerenberg has with Kværner (products used in the scope of work). The other part of the storage is handling working clothes, equipment, tools necessary for the workers to do their job.

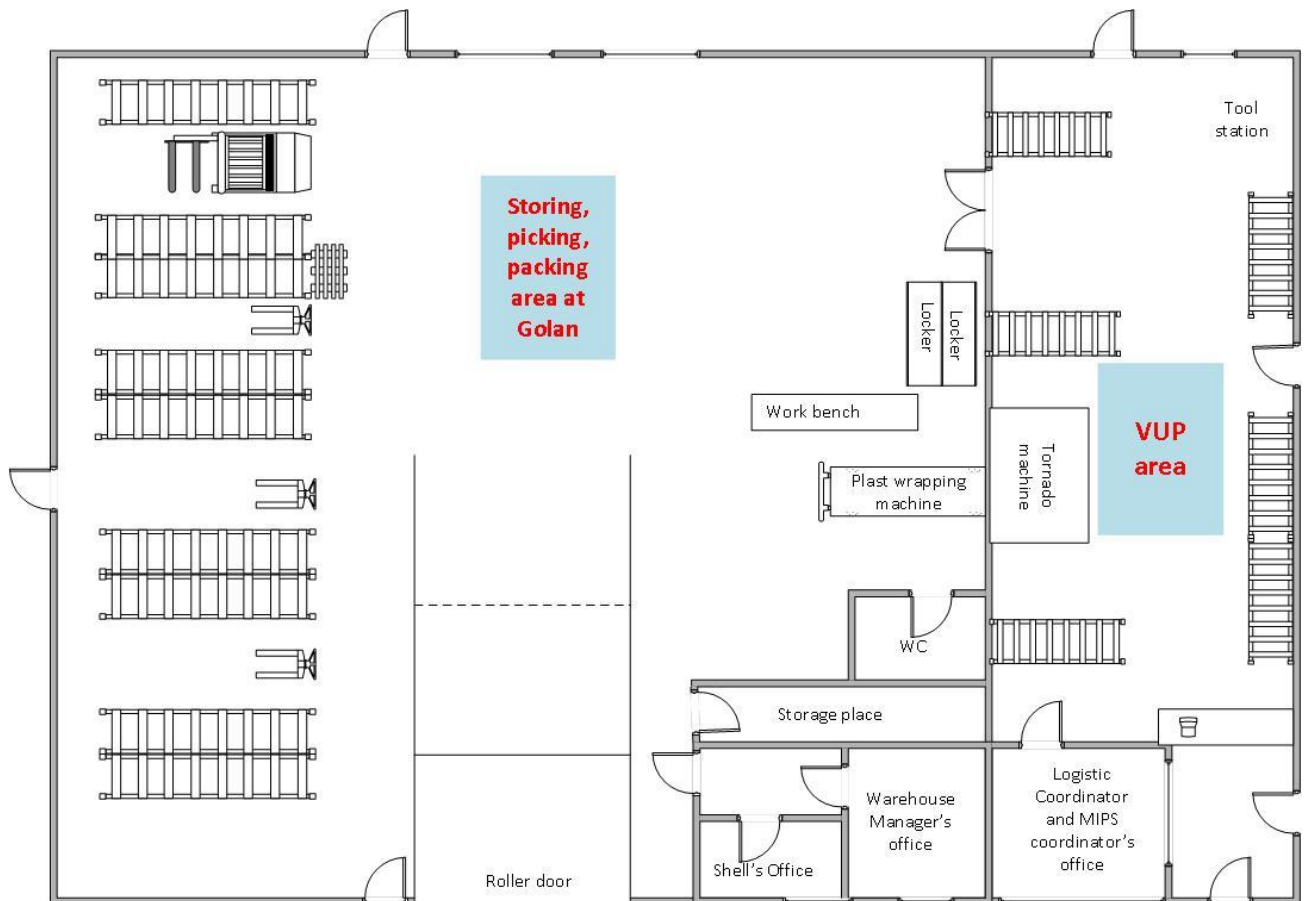


Figure 30: Golan Hall 1

In VUP the operators maintain the tools, check them and fill up the tool boxes. The majority of workers in Beerenberg are working shifts. They are usually changing on Wednesdays. They all come to VUP on Golan to pick up their clothes and tools, personal protective equipment (PPE), shoes, etc. Increase of warehouse personnel improved the service in VUP as well.

4.2.8 Health and safety (HSE)

In Beerenberg on Nyhamna is a big focus on health and safety. There are weekly inspections where the management from all three companies (Shell, Kværner and Beerenberg) walk around warehouse facilities, inspect and take notes. Every Wednesday is a project meeting held by the Project Manager. All employees that arrived on site that week are meeting mandatory for an update on HMS in the project. Additional, every Thursday is a HMS meeting mandatory for all new employees held by the HMS Manager. Issues from the last four weeks are brought up here, lessons learned and concerns are

addressed. "Goal Zero" is the motto that the companies on Nyhamna have. HMS information is always rolling on the canteen screens, the day rooms and other facilities in Camp. All warehouse personnel is fully equipped during working hours, including office workers. Signs are posted on walls and PPE is clearly indicated for each area of activity.

4.3 Findings

This chapter presents the comparison of collected data against the theory, combined with own assessments of the solution.

The warehouse has to focus more on the processes, to create ownership and control. The workers have to perform their tasks in an efficient way, taking full responsibility, documenting and having proof for their actions.

The time in the project and the deadlines have a big role. Everything is different from project to project and Beerenberg needs to adapt to client's specifications. The task is to control the logistics as well as optimize operations, to analyze the actual staff and make sure there are enough resources in relation to the workplace. The Warehouse Manager needs to map the processes, to know who is doing what at what time and how long it takes for that operation. They need to find the challenges, get an overview of the situation and get control. The new staff need to be trained fast. In the mean time, processes have to be written, the deliveries to site have to be carried out and continuous improvement is necessary. The jobs have to be processed as soon as possible, the goods have to be packed and sent rapidly.

The contract has many milestones and an end date which need to be respected. This creates a certain pressure on the project team to perform better, faster, more efficient.

The analysis of warehouse on Nyhamna led to the identification of several factors that affects the performance. By trying to adapt the factors described by (Mello, Strandhagen, and Alfnes 2015), I can identify following:

- One of the factors is the integration of engineering, production and warehouse departments. All three belong to Beerenberg and are located at the same site. Such a level of integration demonstrates an important factor in facilitating coordination. They have direct communication, but sometimes is challenging because there are

too many people involved (workers worked in shifts, changing often without perfect handover notes);

- This takes us to the next factor: the size of the project. Per total, the expansion project is big and Beerenberg has a vast role in the project. More than 160 workers are present on site, divided on different departments, disciplines and locations. The amount of work is large, the products used are many, the activities are complex. Due to the size, the need for communication and interaction is high and complicated to coordinate;
- The third factor is the overlapping project activities between engineering, production and warehouse department. Some of the tasks are not clearly defined from the beginning. This creates extra work and waste of time and resources.
- Another factor is maturity of design/technology: some of the products doesn't fit the gas pipes. The boxes or the XP are sent to Benarx for modifications. This demands more coordination, since a number of adjustments are necessary. Prior making the adjustments, the production staff has to interact with Prefab (Benarx) personnel. After the products are modified, Benarx is contacting the warehouse. All three departments are in close dialog. Such interactions tend to be very time consuming. The situation can generate delays during the project execution;
- Collaboration between project partners is representing another factor that contribute to the improvement of the services that warehouse delivers. The communication with Kværner transport improved after the warehouse personnel increased and the tasks are better distributed. Kværner is in charge of transporting the goods from Golan to site. Same thing happened with other suppliers that handled the transport of new purchased goods. The good collaboration is a factor that helps coordination and better flow of the project. On the other hand, the poor collaboration affects the project negative. Collaboration assumes that companies can commit few resources, in order to obtain indirect benefits;
- Customer changes is another factor that affects the warehouse improvement. Changes from the amount of workers in warehouse, to the amount of goods allowed to handle, to the postponement of mile stones and the amount of existing work are affecting the performance. The occurrence of changes demands more coordination to assure a smooth transition from one situation to another.

- **Production capability:** the scope of production capability covers not only the skill and experience necessary to get the job done and install those insulation products on pipes, but also the knowledge necessary to understand the procedures and rules that the company and the project have. Additionally, the workers need to be able to read and understand drawings and specifications, be familiar with the products and the technical details. These apply for all workers in the warehouse department, the production department and the engineering department. The interaction between these three and the good communication help the improvement process of the warehouse (Mello, Strandhagen, and Alfnes 2015).

In order for Beerenberg warehouse to be more effective, I suggest to look into developing a project network by using activity-on-node (AON) approach. The activity is represented by a node (box). The dependencies among activities are depicted by arrows between the boxes on the AON network. The arrows indicate how the activities are related and the sequence in which things must be accomplished.

There are three basic relationships that must be established for activities included in a project network. We have to think which activities must be completed immediately before this activity (predecessor activities); which activities must immediately follow this activity (successor activities); and which activities can occur while this activity is taking place (concurrent / parallel relationship) (Larson and Gray 2013).

The activity A must be completed before the activity B can begin, and the activity B must be completed before activity C can begin. In this case, the goods must arrive at Nyhamna warehouse before they can be unpacked and placed on shelves. Then the MIPS operator is registering location for each item. The demand from site must come in before MIPS operator print the job pack. The paper need to be printed and delivered to warehouse operators before they can start picking and packing goods. The documentation must be created (job out paper, comments in MIPS) before Kværner transport coordinator is contacted and transport is ordered. The goods are then loaded on trucks and transported to site, where the foreman is receiving them and signing the job out paper. This returns to Logistic Coordinator at warehouse, which is scanning it and attaching it in MIPS.

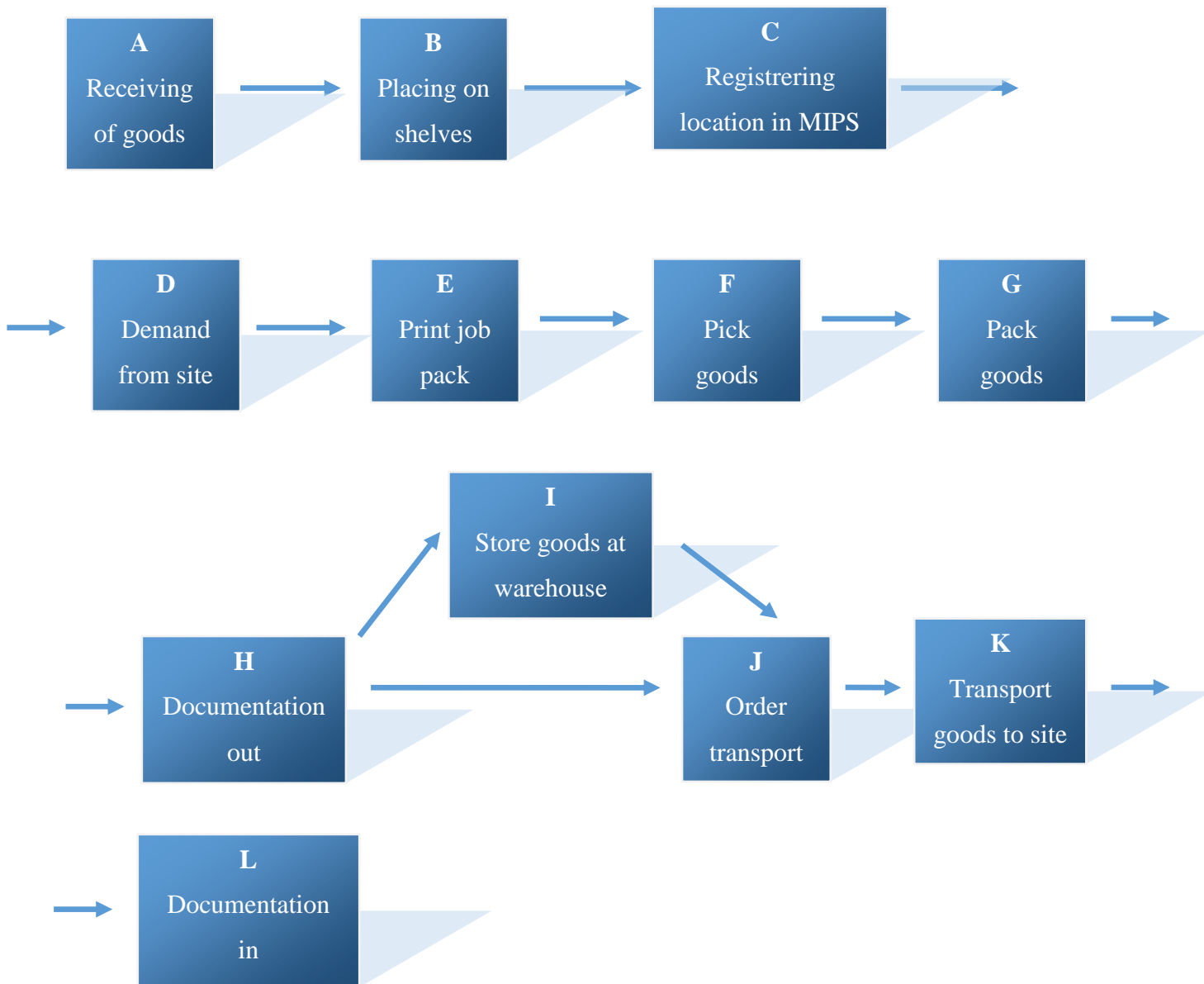


Figure 31: AON Network for packing and sending the goods from warehouse to site

Value Stream Mapping

Additional to the theory presented in the literature chapter, I am identifying here some of the wastes that Beerenberg's warehouse has on Nyhamna together with possible solutions for improving the operations.

The information is collected by me, personally, at circumstances relevant for the present situation. The mapping starts at the supplier. The material flow is viewed in actuality and

the fact that every day looks different is ignored. I am using different symbols to mark the process (Wessman and Barring 2014).

Based on the area of improvement that I identified, I recommend for Beerenberg's warehouse to consider a solution where received materials are directly stored on locations, avoiding the temporary storage.

All packing before confirmation from production should be eliminated. There are cases when the warehouse is packing an order, store it, and later on the production asks only for parts of the order. This create extra work for operators, since they have to unpack, select only parts of order, and then pack and store the remaining items. This is a waste, called over production. In order to eliminate this waste, I suggest an improvement in the information flow between warehouse and production.

Regarding the material flow, there are unnecessary transports of pallets from one storage location to another. Specially in the end of the project, when the amount of job packs packed are not so big, it is not useful to move pallets from Golan to I54. The staff on I54 storage does not have a forklift there to handle the goods. They are wasting time to move a forklift from Golan to site storage. Later on, when the goods are delivered to production, the staff is using again unnecessary time and effort to deliver. In this situation, the goods could be delivered directly from Golan to plant and the transport between the two storage locations can be eliminated.

Poor packing quality of goods stored at warehouse create extra work because they need repacking.

A better information flow lead to better material flow. If the production department is collecting their requests (orders), instead of sending them one by one, the warehouse department can collect the pallets and send all at once. In this way, there is a continuous flow where starts and stops can be eliminated (Wessman and Barring 2014).

The inspections of goods packed (specially cellular glass XP of big dimensions) is an activity that cause problems for the warehouse. This muda is called defects. The operators need to go to Benarx Prefab, located in the other end of the building, and ask a worker to

come and inspect the goods. This happens because the warehouse personnel does not have sufficient knowledge of the product and how the pieces are mounted on pipes. In order to avoid shipping wrong parts to plant, Benarx is helping by approving the correct quality. The solution here would be either to train better the warehouse operators or to assign permanently a Benarx specialist to the warehouse.

Another activity that creates waste is placing same type of items in many different locations. In this case, the warehouse should collect similar products in one location in order to eliminate the time used by the operator between locations.

Another recommendation that I have, is to negotiate with the cellular glass supplier to label better the items. This will eliminate the waste of taking out of the box each item and try to assemble them in order to identify how many pieces make a whole. This can reduce picking errors and simplify the manual handling of picking for the warehouse personnel (Wessman and Barring 2014). A better negotiation with the rest of the suppliers can make the work easier for warehouse operators and eliminate unnecessary steps in the process.

I identified another waste in the warehouse. This is connected to the coffee breaks that the employees have (9 o'clock and 15 o'clock). In some cases, the operators are extending the breaks and the efficiency goes down. The management and supervisors need to be more strict and enforce the working schedule.

The outside area where the pallets are stored (H1Fxx area at Golan) need to be arranged in such a way that the forklift have access from both sides. In this way the time to move the pallets from the front in order to pick the ones in the back can be eliminated.

As mentioned in the theory chapter, one of the wastes is motion caused by poor ergonomics. This is underlined by the fact that the MIPS coordinator and Logistic leader didn't share same office at first, making it challenging for them to communicate verbally. Another aspect is the location of the color printers. A lot of time is wasted on going back and forth to pick up the papers necessary for operators to do their job.

Over processing is a very time consuming task. There are too many steps registered in MIPS in order to document the shipment or storage of goods. Registration of same

information in more than one file is also wasting time and efforts. Printing a lot of papers which end up in the garbage afterwards is another waste (time and raw material).

In addition to above mentioned wastes, I describe below some findings from the project. It is highly important that these will be handled as soon as possible in order to improve the warehouse operation and obtain a better work flow.

- MIPS: after we confirm the JP, the system is not good enough to follow up what happen with the goods. The items are packed, but not delivered. Because they are confirmed, they are out the system. The goods are stored still at warehouse (on H1Fxx location). The only way we register details are by using the comments in MIPS;
- Pick up bulk material: the workers need to fill up a form whenever they pick up bulk material. The information on this form is not always complete with item no., location, amount. This makes it difficult for MIPS operator to register correct the transaction. This leads to wrong information in the system;
- This issue apply to other items as well. If the remark is wrong on job pack, the MIPS operator will not know from which location the goods were taken. Then the inventory on a specific location is wrong (reality vs. system);
- Poor communication between foremen, team leader, General Foremen (GF) and Discipline Leader in production department. As an example, the GF ask warehouse to send goods, but the foremen is not informed about the ownership of that job pack. Another situation occurs when both Team Leader and GF send same request to warehouse, by making double registration in GF list;
- Foremen don't use their time to check status on goods. Instead, they prefer to send many e-mails to the warehouse asking for information they could find on their own;
- Sometimes the foremen forget that they signed and received goods, asking for it again. The attachments in MIPS with signature help the warehouse personnel to prove that goods were sent and received;
- Poor handover notes from one shift to another;
- Due to the stress and pressure they are faced to, the departments are pointing fingers at each other trying to avoid taking responsibilities for their acts;
- The production workers don't use enough time to look for goods on site. They prefer that warehouse uses the resources instead.

These are only few challenges that the warehouse is facing. Improving these will definitely improve the warehouse performance. Even if Lean refers mostly to manufacturing, it can apply to service businesses as well. At Nyhamna, it will be the responsibility of Warehouse Manager to carry out the implementation of this concept.

All the suggestions above are meant to create an ideal future state. Some findings are considered more important than others. Goals such as in-time delivery to the customer should be set so they are achievable for the organization. The goals should be broken down in order for the warehouse to adapt them to their department and introduce them in their every day work (Wessman and Barring 2014).

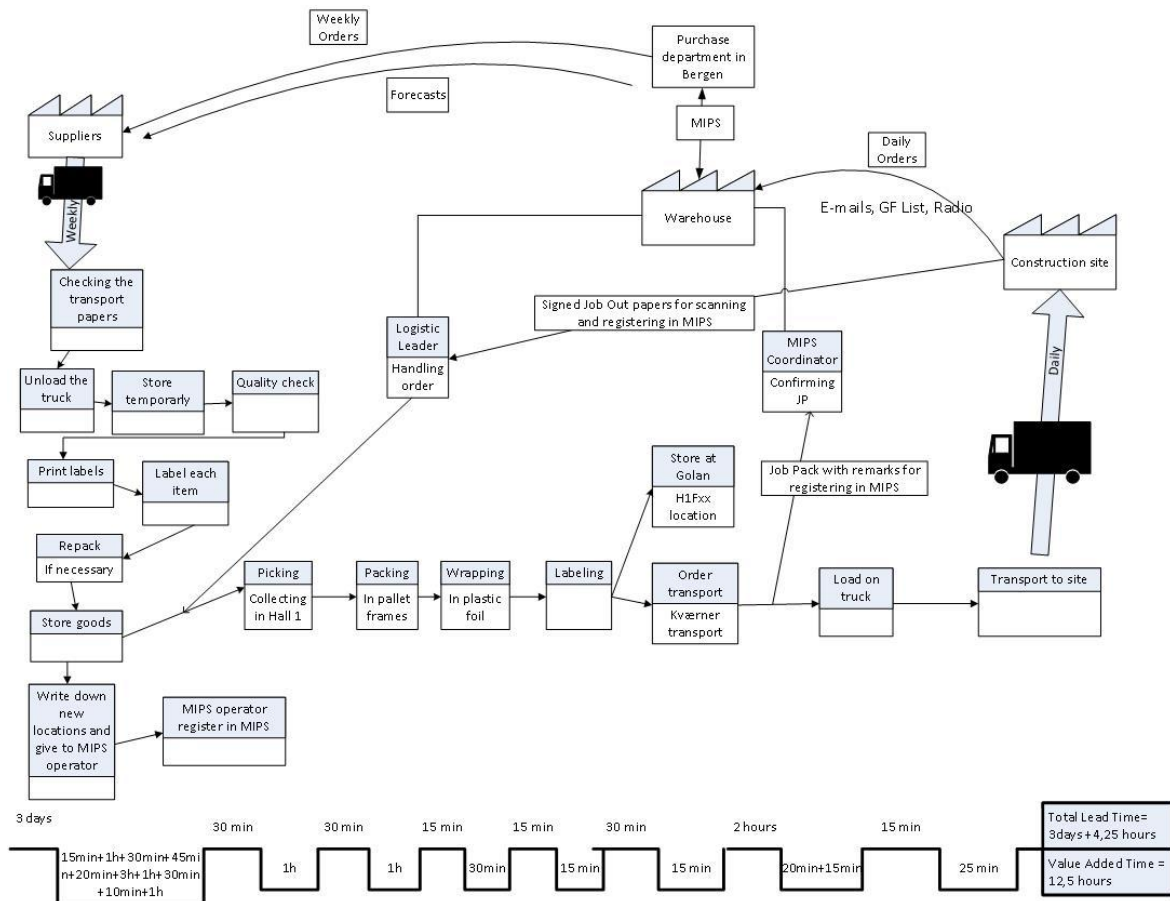


Figure 32: Current-State Value Stream Map

The current state identifies how material moves, from arriving to departure, from the warehouse to the construction site. This map is essential in discussing areas of improvement. It involves the waiting time, the storage areas, the personnel participating in

different activities, the equipment needed and the time required for each activity. One important part is to identify the wastes along the flow, since these are not adding any value to the customer (Wessman and Barring 2014).

The figure above shows the warehouse operations, from receiving of goods, putting away (storage), picking, packing and shipment activities.

The goods arrive from suppliers. The truck driver is presenting the papers to the warehouse operators in charge with following the new purchases. The other operators begin then to unload the truck and place the goods temporary close by. The quality check of the pallets is done. According to transport papers, the labels are printed. The goods are checked and labels are placed individually in each item. Depending on what kind of product it is, the goods are placed on storage while the operators make a note of the new location. These notes are sent to MIPS operator in the end and introduced in the system. All these activities are done manually.

In the current-state VSM is also presented the material flow that take place when the production sends an order to the warehouse. By mapping the processes, I can illustrate the lack of coordination and communication between departments. The orders come on more than one channel (e-mails, GF List, Radio, direct dialog), making it difficult to follow up and giving place for errors and extra work for both departments. The Logistic Leader and/or MIPS coordinator are printing out the job pack and the labels. The papers are handed over to the operators which starts to pick, pack, wrap and label the pallets. When the goods are prepared, the Logistic Leader is calling Kværner Transport and waits for the truck. The MIPS operator receives back the job pack and manually register and adjust down the inventory. Once the truck arrives and load at Golan, the foremen are informed on site to wait for the goods. The pallets are then transported to site locations, the foremen sign the job out papers that the truck drivers hold, sending it back to the warehouse. The Logistic Leader is scanning and making comments in MIPS when the signed paper is received.

"Information flow is the movement of information on customer desires backward from the customer to the points where the information is needed to direct each operation" (Wessman and Barring 2014). I have marked the information flow with blue in figure 32.

As examples of information flow in the warehouse I have: forecasts from main office to suppliers, schedules from management to employees, orders from production department, shipping orders from warehouse to Kværner transport, etc. The difference between the current-state and the future-state is that the information flow is simplified, more clear and precise.

The material flow is represented by the shipping of physical items. The improvements made from the current-state to the future-state are represented by the elimination of unnecessary steps in the flow, such as: temporary storage of goods after unloading, the printing of labels, labeling process, repacking, writing locations manually, adjusting the inventory manually, etc. The material flow is marked in red in figure 33.

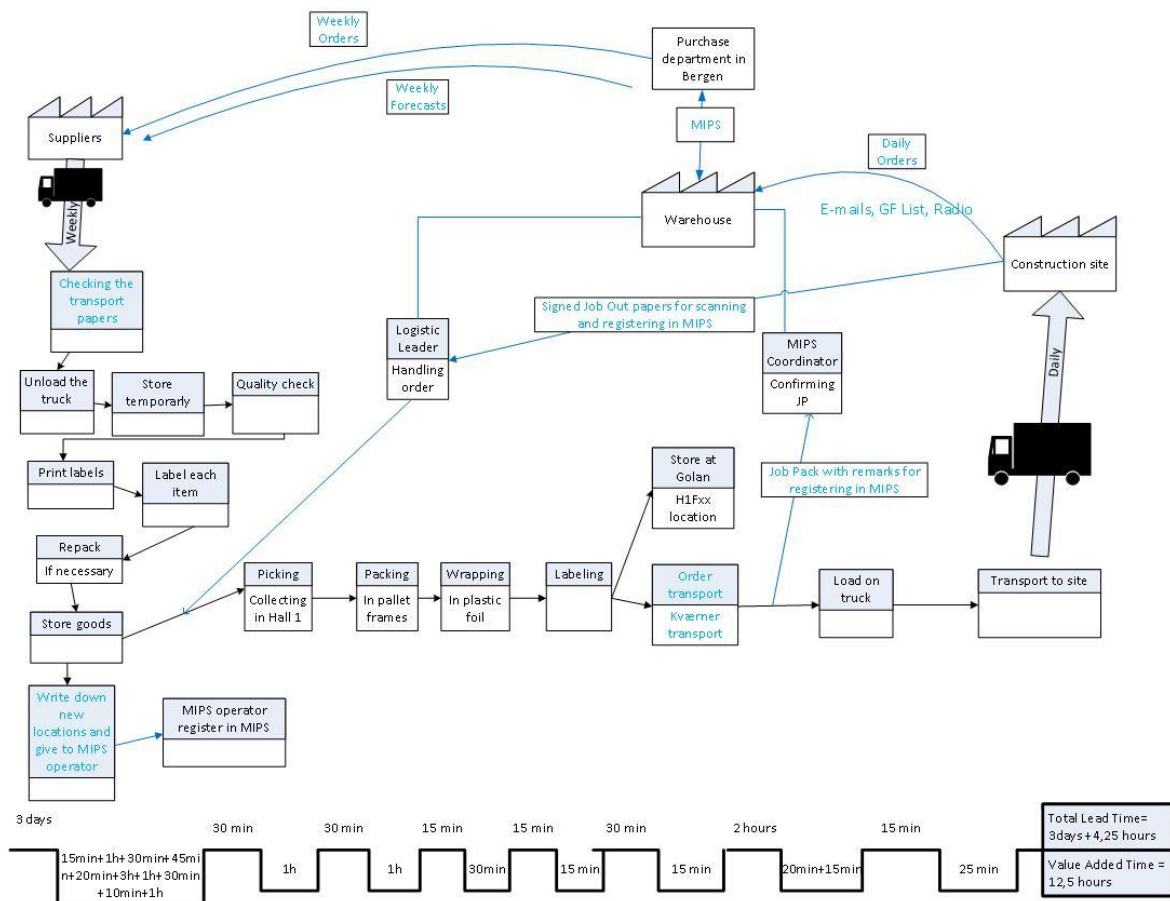


Figure 33: Current-State Information Flow in Beerenberg's Warehouse

Some of the value adding activities are the quality check of the products, picking, packing, shipping etc. The non-value adding activities include all wastes, such as retrieve and replace, the unnecessary walking from office to printer, the telephone talk, rework, small talks, breaks outside the scheduled ones, different odd jobs, etc. These activities absorb resources and don't create value for the customer.

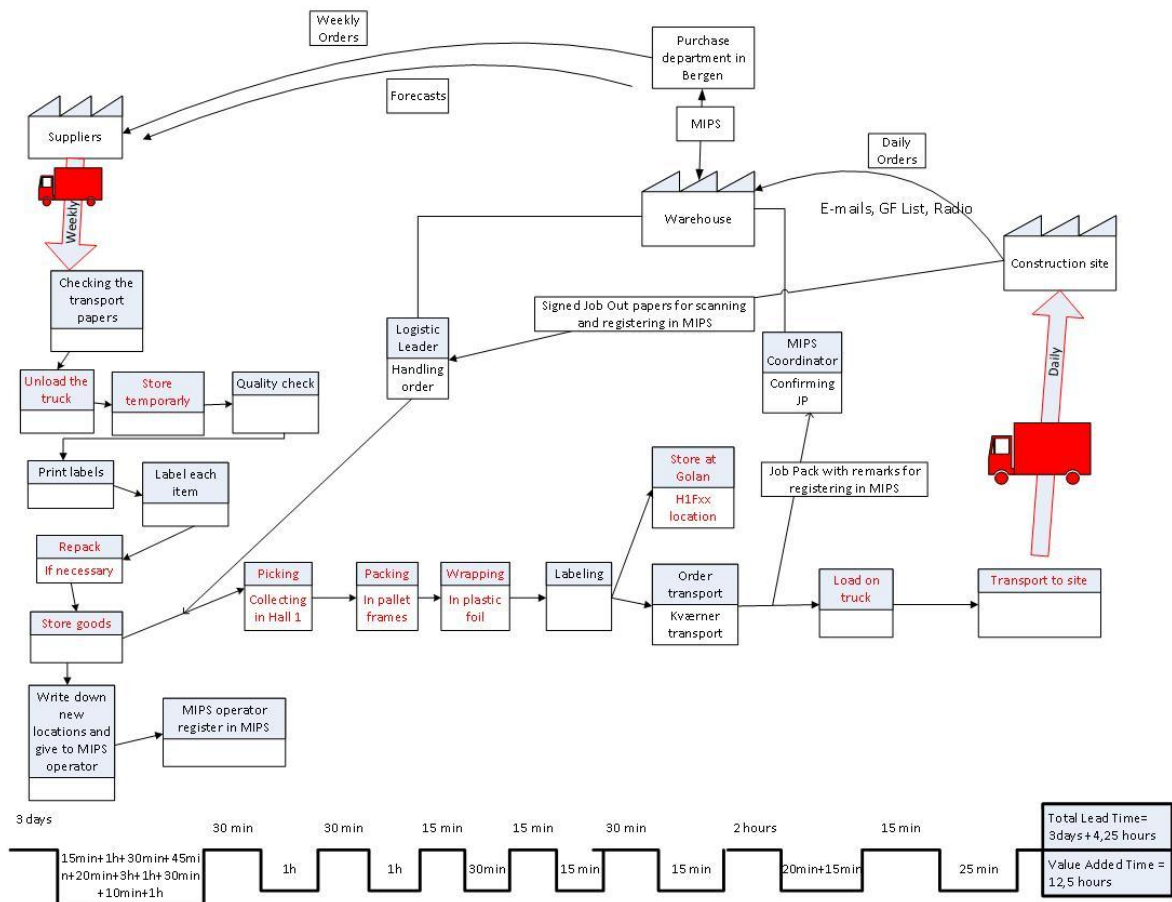


Figure 34: Current-State Material Flow in Beerenberg's Warehouse

By identifying the challenges through Current-State Value Stream Map, an ideal future state can be created. The recommendations which are presented here can be used later by the company in order to improve the warehouse operations. First, there is a need to eliminate the unnecessary work, over processing, to improve the material and the information flow. Second, I suggest to merge the stored goods in fewer locations in order to use fewer resources to handle the orders and to avoid the transportations back and forth between the warehouse locations. All starts and stops of activities, material waiting and over production can be eliminated. The amount of people working on one activity can be

reduced. Implementing RFID system can help to eliminate few steps from receiving of goods activity and reduce the manual work for registering in MIPS. The picking is also improved by using an electronic solution. A better collaboration with the suppliers can save time when it comes to re-packing of goods and labeling (Wessman and Barring 2014).

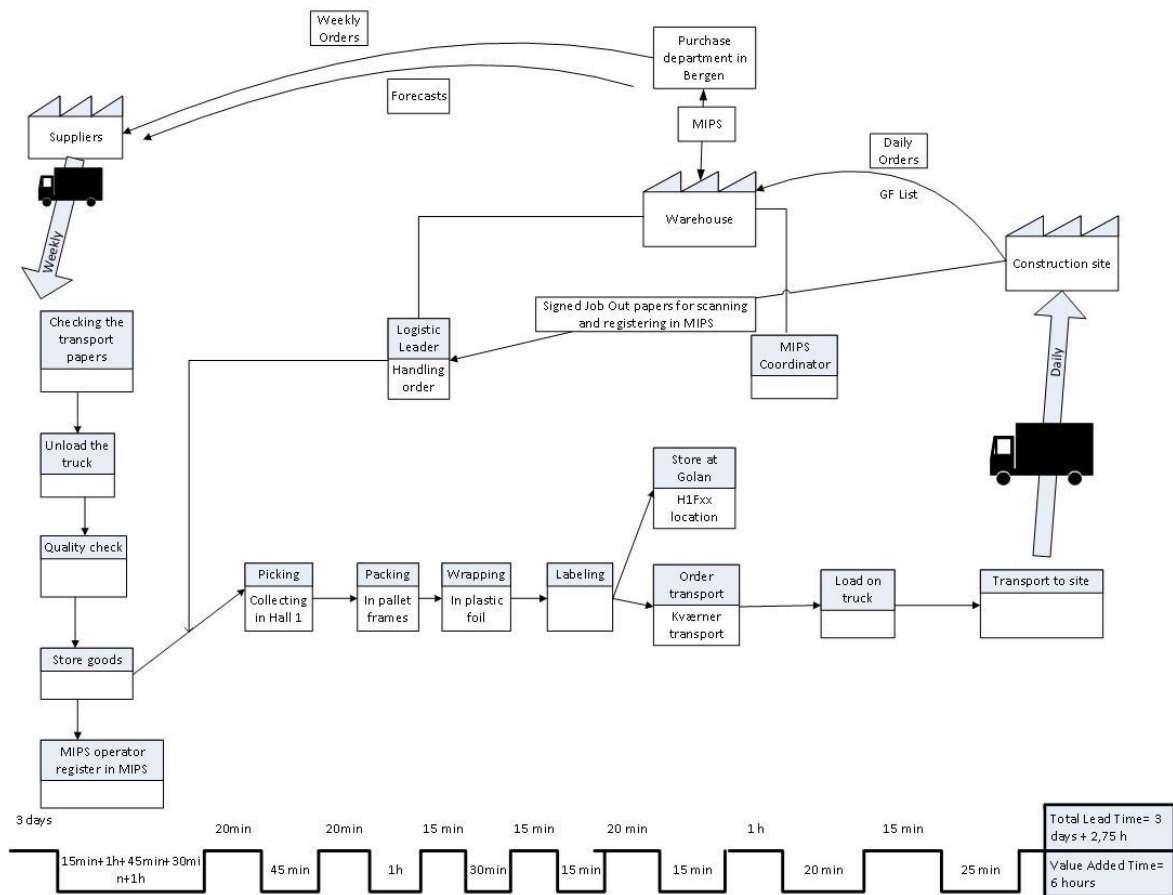


Figure 35: Future-State Value Stream Map

The figure above present fewer activities than the current-state VSM. The wastes are eliminated and the total time is lower than the previous state. The warehouse is more efficient.

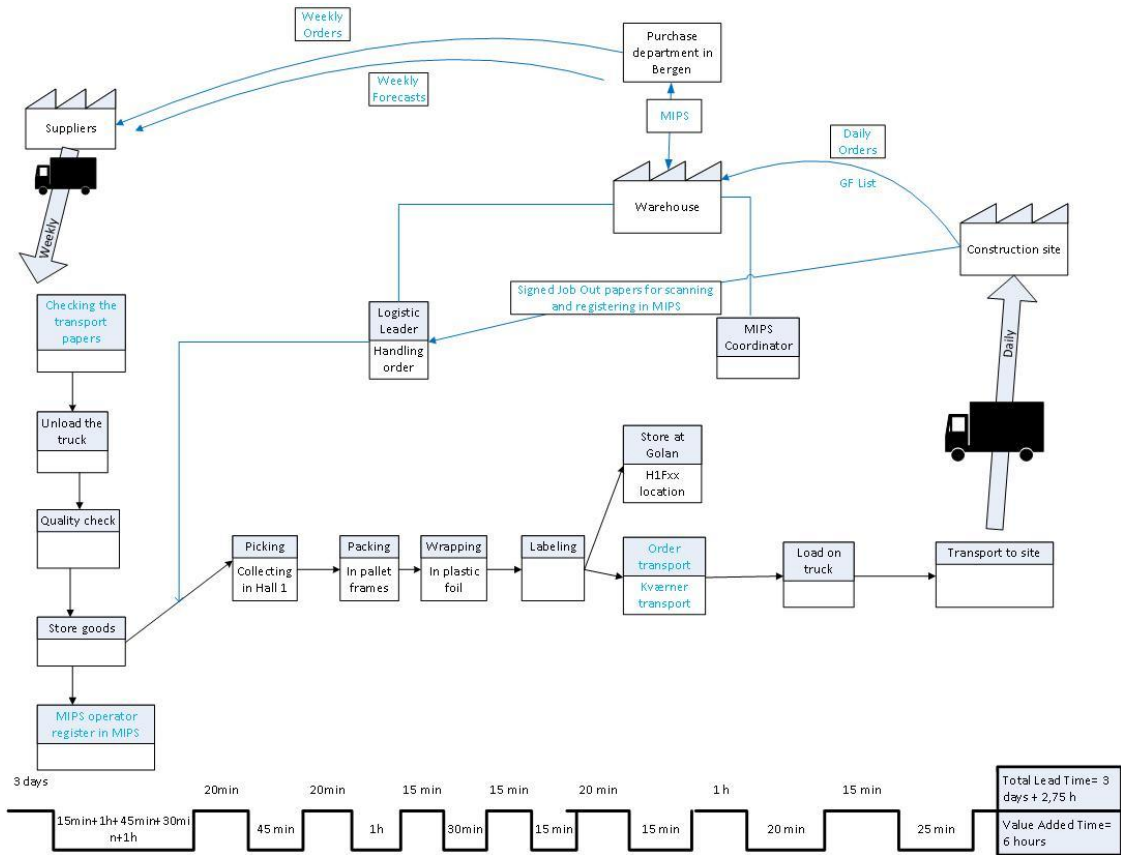


Figure 36: Future-State Information Flow in Beerenberg's Warehouse

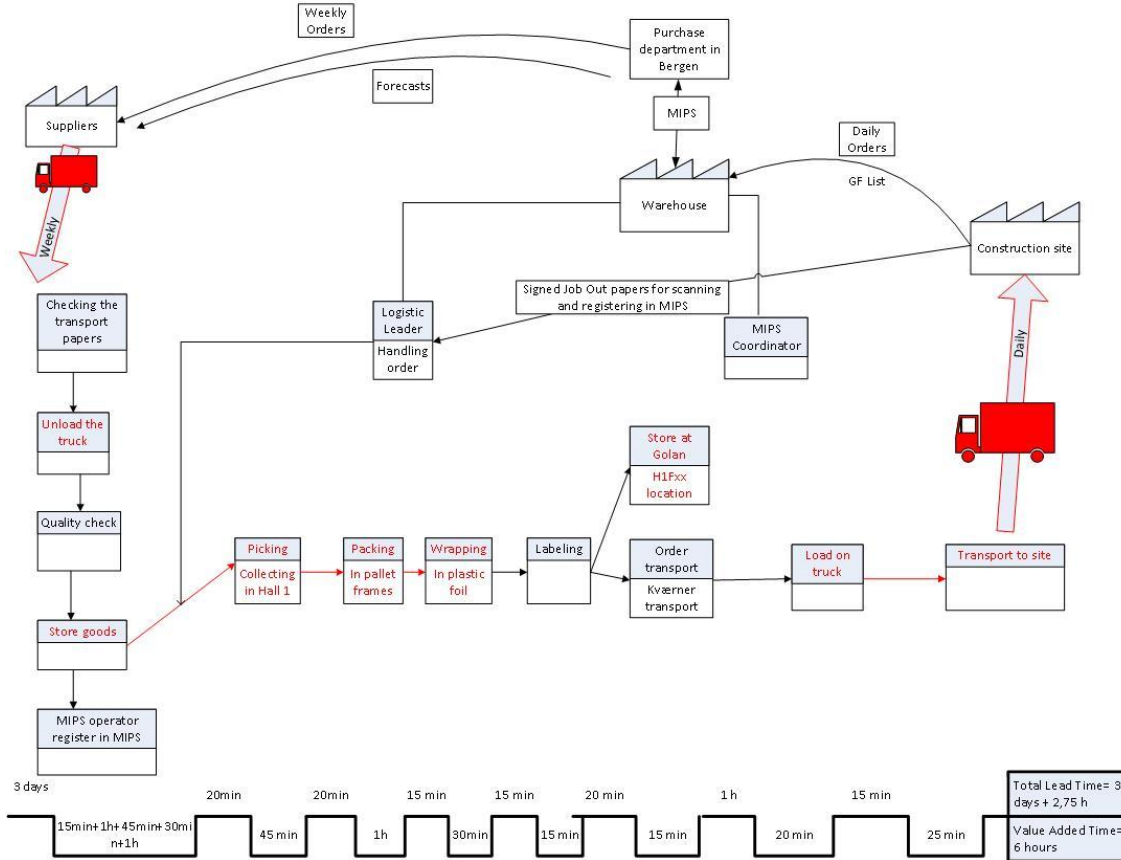


Figure 37: Future-State Material Flow in Beerenberg's Warehouse

The warehouse is playing an important part in the project. The time in the project is very important; the milestones need to be achieved, the deadlines need to be met. The pressure is reflected on all departments. Everybody needs to take full responsibility of their job, of the tasks they have. Everything needs to be well documented.

The challenge is to handle the logistics and to optimize operations at warehouse.

5.0 Conclusions

In this chapter the research questions are answered based on the literature review and the findings from previous chapter. Limitations and proposals for future research are also presented.

5.1 Answering the research Questions

The analysis of literature suggested that the main solutions in implementing lean in the warehouse are: use less time to pick, pack and send goods to construction site, keep less inventory and use less space, avoid over processing, use less human effort, less machinery and perform better. Just-in-time needs to be used actively together with lean synchronization in order to meet the demand instantaneously. The warehouse personnel needs to eliminate waste, to improve continuously and to remove the activities that don't create additional value. All these activities need to be done at the lowest possible cost.

As well as in shipbuilding industry, the oil and gas companies have shifted to a new form of organization, fragmented, where they outsource many activities and focus only on few in order to remain innovative and to adapt to new markets (De Mello 2015).

Coordination has become increasingly more important as companies augment their focus on providing a short and reliable lead time. This is particularly true for larger projects. Multiple companies are involved in performing diverse activities during a project, such as: design, engineering, procurement, manufacturing, assembling and commissioning (Mello, Strandhagen, and Alfnes 2015). Beerenberg had to cope with diverse customer requirements and deliver the highest quality of product in a highly uncertain environment.

The occurrence of delays is a major problem. More specifically, the poor coordination among project participants in dealing with specific requirements and product changes is one of the main reasons for delays which increase the lead time (Mello, Strandhagen, and Alfnes 2015).

Question #1:

What are the problems that the warehouse is facing and how these problems reflect in the overall performance?

Looking back at the initial research questions and trying to answer them, I can say that issues mentioned in Chapter 4: "Findings" are few of the problems that warehouse is facing. It is clear that they affect the overall performance.

Some of the observations I made are connected to the lack of personnel, to the fact that the demand from construction site is big and the warehouse don't manage to deliver the goods on time. I also illustrate that incorrect and incomplete documentation creates confusion in the process, that the increased errors lead to increased costs.

The management has a solution for these challenges. Extra personnel is hired, the tasks are divided better, the operators take full responsibility of the tasks and the warehouse manage to deliver the goods on time, in the right quantity and quality to the right location. The project group and the client are visible satisfied with warehouse performance.

There are still some things that can be better, but because the project is getting close to the final stage, it seems that is no more time to implement them.

Sub-Question #2:

How implementation of Lean concept improve the warehousing processes in project based companies?

The period between September 2016 and February 2017 is the peak period for Beerenberg's warehouse on Nyhamna. By having enough personnel, they manage to implement the Lean concept and to improve the warehouse process.

By using the value stream mapping I identify some of the activities that create waste in the department. It identifies the unnecessary waiting times and where the over processing occurs. It shows clearly the value-adding activities vs. non-value-adding. The VSM was done by taking notes of how much time it is spend on each activity, on the products, the frequency of the transport, the distance, the equipment used, etc.

Few of the observations are connected to the focus that the warehouse have on the processes, the ownership and control required of the operators and their involvement in daily operations. By improving the communication and coordination between and within the departments, Beerenberg can improve the quality of services delivered to the customer.

The company should take in consideration the suggestions and change the layout in order to be more effective in work, eliminate the unnecessary transport between the warehouse, reduce the errors. They have to involve more the people who actually do the work in finding new solutions and improve continuously.

By looking for opportunities for cost reduction and eliminate wastes such as over production, unnecessary transports, extra work, over processing, Beerenebgr can improve the warehouse processes. The personnel needs to be trained better and challenged to contribute with ideas in order to make a better working place for all.

Sub-Question #3:

Can implementing RFID system improve the information flow and reduce the waste in project based warehousing processes?

I can say that implementing a RFID system would improve the information flow and reduce visibly the waste in the warehouse. The accuracy of picking would be improved and it would reduce the time used to search for materials, being able to locate products faster.

A better communication and negotiation with the suppliers can make the job easier for the operators. Labels with correct information can come straight from suppliers. It is ideal to use same system as the suppliers. In this way, the labels can be scanned and sent directly to Beerenberg system.

An RFID system can help the operators locate the goods faster and eliminate the errors in inventory holding. The over processing can also be eliminated in this way. It creates less manual registrations and the resources can be used in other tasks.

The operational process such as tracking and shipping can be more reliable. The products can be traced and visible in the whole supply chain. The information flow become better. Using RFID systems can replace man power through automation, enable self-service, can provide cost reduction and increase revenue.

Since the project is getting close to the end, I don't think that such a system will be taken in consideration on Aukra project.

5.2 Limitations and future research

In this paper the findings are limited to the material handling in the warehouse. The review of the literature and the case study have mainly focused on the needs of implementing Lean concept while the case study focused on Beerenberg's warehouse on Nyhamna. Since each industry has its specific characteristics, the study is limited to project-oriented industries dedicated to producing capital goods (De Mello 2015). However, many other project-oriented companies may find similarities in oil and gas industry, having same challenges.

During the time period when the thesis was written, I encountered few challenges and limitations:

- **Time:** The due date for master thesis is May, but Beerenberg is still continuing work on Nyhamna. Due to various delays, they are postponing the delivery date towards Kværner. The time pressure forced me to stop researching the subject here. The warehouse has now low work flow and few people;
- **Information:** I only joined the company at the end of the project and didn't get complete first hand information and facts regarding the beginning of the project. The information I collected was from the people working there and it can be subjective and difficult to see if this is the real situation in the company;

- Project related: Nyhamna Expansion Project is one of the many projects that Beerenberg has. Since the company operates in different parts of the country, with different teams, I am not able to know their routines, ways of doing things, rules and regulations. I cannot say if Beerenberg is applying Lean concept in other projects, if they have an RFID system or other warehouse operations.

One interesting topic for a future research is whether the Lean concept and the RFID system are implemented at other warehouse that Beerenberg has in different projects. I would also be interested in looking at the supply chain to see how such a big company with many projects manage to coordinate the whole chain.

Working directly in Beerenberg's warehouse on Nyhamna had benefits. I was able to be part of implementing Lean theory and improve the operations. It gave me the opportunity to contribute to an important project, made me feel part of the team. On the other hand, it was challenging to write the master thesis and be objective, keeping all the frustrations of a daily work away. Possible weaknesses of the assignment consists in the fact that the project on Nyhamna is getting to an end, Beerenberg is closing up and moving to the next contract. We didn't have more time to be even better, to fully implement Lean in warehouse, to continue seeing the benefits of the theory. Was no more time for suggestions, considerations of implementing RFID or other good methods that could improve the operations.

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7.0 Appendix

Appendix 1: Procedure Nyhamna Site - Material Handling at Nyhamna Site

The material handling procedure attached here is a document made by the client (Kværner). All sub-suppliers, including Beerenberg must comply with it during the period of this contract.

OL document No.: 37-1A-KST- X03-00036			Rev.: 06M		Page: 1 of 23	
KST document No.: P0154ENYX						
Originator: KST		Tag No. : N/A	System No. : N/A		Area Code: N/A	
Document Title:						
PROSEDURE NYHAMNA SITE - MATERIAL HANDLING AT NYHAMNA SITE						
Project name:						
NYHAMNA Onshore EPCm Project						
06M	21.05.2014	Approved (independent of project phases)	HÅ	LLØ	BC	JT
05	02.05.2014	Re Issued for Review	HÅ	LLØ	BC	JT
04M	17.03.2014	Approved (independent on project phases)	HÅ	LLØ	BC	JT
03M	26.11.2013	Approved (independent on project phases)	HÅ	LLØ	BC	JT
02	06.11.2013	Re-issued for review	HÅ	LLØ	BC	JT
01	22.10.2013	Issued for review	HÅ	JSE	BC	JT
Rev.	Issue date	Description	Org'd by	Chk'd by	Disc. Appr.	Proj. Appr.
SHELL network code.: EWR-NYX-100			Contract No.: 4610036236			
			Contractor:			
			KVÆRNER™			

1. HISTORY

Revision	Modifications
01	First issue
02	Re-issued for review. Comments from NS on rev 01 added.
03M	Approved (independent on project phases)
04M	Attachment 4 updated – Chapter 3 and 4. (P0154ENYX-4)
05	Attachment 11 updated- Chapter 1.11 – text updated
06M	Approved

2. PROJECT SPECIFIC REFERENCE DOCUMENTS

Document title	Requirement ID
Exh. A, Scope of Work	90.03.X
PG 17c Construction Management	52.31.6
Exh. J, Procurement & Subcontracting, section 7.	90.13.X
Exh E Quality Management, Attachment 1- Quality Plan Content, Content 3. Quality of Procured Items and Services	
DEP 31.10.00.10-Gen, Positive Material Identification	
DEP 82.00.10.10-Gen. Project Quality Assurance section 3.4.1 & 3.4.2	60.01.Y

Procedure title:	Material handling in <i>KST</i> warehouse at NYHAMNA Site	No.: P0154ENYX
Applies to:	Kvaerner Stord AS, NYHAMNA Site.	
Purpose:	The purpose of this procedure is to describe material handling in KST warehouse at NYHAMNA Expansion project: Incoming control, material identification, storage, distribution during project execution and scrap identification / removal.	
Scope: (Start/end of process)	The scope of the procedure is to describe control of materials purchased by Contractor and Company according to legislation, Contract and standards.	
Definitions/ abbreviations:	MIPS: Kvaerner's Method Integrated Project System KST: Kvaerner Stord AS PDA: Personal Digital Assistant MDS: Material Data Sheet MMT: Material Movement Ticket MRR: Material Receiving Report OS&D: Over, Short & Damage Report PO: Purchase Order PRB: Purchase responsible buyer DRR: Daily receiving Report CE : Conformity European marking HOLD: Quarantine HSE: Healthy Safety and Environment MSDS: Material Safety Data Sheet	
Attachment:	P0154ENYX-01 MMT P0154ENYX-02 DRR (link to form in Excel) P0154ENYX-03 Return sheet (link to form in Word) P0154ENYX-04 Traceability system for steel materials (link to form in Word) P0154ENYX-05 Flowchart Material receipt and traceability control P0154ENYX-06 Flowchart Storage of materials P0154ENYX-07 Flowchart Issuing of materials P0154ENYX-08-OS&D report P0154ENYX-09-Preservation damage report. P0154ENYX-10-Preservation Weekly report "Example" P0154ENYX-11 Colour Coding	
Legislation-/group-/ standard requirements	ISO 9001 chapter. 4.2 and chapter 7.1 and 7.5.3, 7.5.4, 7.5.5 NS-EN ISO-3834-2 chapter 11, 12 and 17 EN ISO-1090-2 chapter 5.2, 6.2, 6,3 PED 97/23/EC (Pressure equipment directive) LOVDATA Forskrift om utførelse av arbeid § 2-1 Stoffkartotek	
Revised by:	Name: Harald Årvik Warehouse Lead	Date: 02.05.2014
Procedure owner:	Berk Celik Logistics & Infrastructure Lead.	Approval date: 02.05.2014 Valid to: 31.12.2015
Revision comments:	<i>Changes indicated with Italic letters / words</i>	Rev.no: 02


Action by Whom	Act. no.	Activity/description (Use key-words starting with a verb) What	Additional info in: How	Result Deliverable
	1	MATERIAL RECEIPT AND TRACEABILITY CONTROL		
Warehouse operator	1.1	Material received on Site, will be transported to designated area for material receipt.		
Warehouse operator	1.2	Incoming inspection of materials arriving at Site shall be carried out immediately: <ul style="list-style-type: none"> • Bill of loading/consignment note (number of packages.) • Visual check for damages. • Presence of documentation package. • Check that HSE data sheet's for chemical requirements are present /available. • All documentation to be handed over to Material Controller. Notify damage and shortage in Bill of loading. 	MIPS P0154ENYX-01 P0154ENYX-02	Updated "Receiving log"/DRR for every delivery (enclosure P0154E-02)
Material Controller	1.3	Perform material receipt control documentation and MRR. Issue daily preliminary MRR, based on packing list/MMT <ul style="list-style-type: none"> • Check material certificate against material documentation • Packing list • Purchase order/MMT • Report damage and shortage in shipment to responsible PRB & transport company • Submit OS&D report in case of non conformity situation to project Procurement dept. Logistic within 5 working days. • MSDS • Chemicals; additional control <ul style="list-style-type: none"> • Control of storage and transport requirements according to MSDS • Control of CHESS to assure that chemical allowed on site. MRR acceptance check during storage.	MIPS P0154ENYX-01 P0154ENYX-04 E-mail / OS&D P0154ENYX-08 P0026E	MRR Release material for receipt control. OS&D report Release material for construction CHESS MRR
Warehouse operator	1.4	Perform material receipt control Content: <ul style="list-style-type: none"> • Visual inspection • Dimensional/technical control where relevant with support from technical specialist. • Check of traceability marking between materials and certificates/certificate lists. • Check that preservation is performed. • Check that material certificate meets the specified requirements. • Check to CE marking. 	Technical requirements	Identified storage location in MIPS. Status material released for construction
Warehouse operator	1.5	Perform receipt control of prefabricated item: <ul style="list-style-type: none"> • Visual inspection • Check the label marking • Check that preservation is performed. • Record of prefabricated item by PDA. 	MMT/ Packing list MIPS	Identified storage location in MIPS. Status material released for construction
Warehouse operator	1.6	Perform receipt control of Company provided items. <ul style="list-style-type: none"> • Notify Company representative • Visual inspection • Check the label marking • Check that preservation is performed. • Assure storage according to Company requirement 	According to documentation from Company	Identified storage location in MIPS.
Material Controller	1.7	Records of transfer ownership of material from Company to Contractor or vice versa are available	MIPS	Updated MIPS

Action by Whom	Act. no.	Activity/description (Use key-words starting with a verb) What	Additional info in: How	Result Deliverable
Warehouse operator	1.8	Handling of non-conforming materials (damage, unidentified materials, loss of traceability etc.). Materials shall be stored in "Hold areas" and marked with "Hold" labels. Release of non-conforming materials shall be based on closing of OS&D report.	MIPS P0154ENYX-08	OS&D report Letter of complaint Updated status in MIPS with hold
Warehouse operator	1.9	Maintain full traceability on piping materials <ul style="list-style-type: none"> • Pipe fittings and valves will retain the manufactory identification. • Pipes will be marked with a unique identification code, linked to certificate and charge number. /test number. The identification code consists of MDS, a project related letter and a sequential number. This identification marking will be in both ends of the pipe, see enclosure P0154E-04 	MIPS P0154ENYX-04	Traceability Cert. file
Warehouse operator	1.10	Maintain full traceability on all structural steel when required: <ul style="list-style-type: none"> • All structural steel that require full traceability, will be marked with a unique identification code, linked to certificate and charge number. /test number. The identification code consists of MDS, a project related letter and a sequential no. See enclosure P0154E-04. 	MIPS P0154ENYX-04	Traceability Cert. file
Warehouse operator	1.11	Maintain full traceability of electrical/instrument material : <ul style="list-style-type: none"> • <i>Instrument fittings and tube will retain the manufactory identification.</i> • Electrical Cable will retain the manufactory drum number. 	MIPS	Cert. file Traceability
Warehouse operator / production	1.12	For piping material: Make use of a colour coding system to segregate material qualities. See procedure P0073E, enclosure 04.	P0154ENYX-11	Traceability
Cutting operator	1.13	Is responsible for transferring the <i>heat number</i> , identification code and colour coding for piping material on to the pre-cut material.	P0083E	Traceability on surplus materials
Cutting operator	1.14	PLATE REMNANTS Note remnant number on remnant plates together with the identification code if the cutting sketch notifies that surplus plates shall have an own remnant number.	MIPS	Traceability on surplus materials
Material controller	1.15	Register all material certificates for piping materials and steel in MIPS with reference to: <ul style="list-style-type: none"> • Po. No. • Item • Article • Charge no. • Test no. • Manufacturer • Contractor identification no. <p>The certificates will be filed on increasing Contractor certificate number.</p>	MIPS	Cert. file
	2	STORAGE OF MATERIALS		

Action by Whom	Act. no.	Activity/description (Use key-words starting with a verb) What	Additional info in: How	Result Deliverable
Warehouse operator	2.1	Store the materials according to supplier's and Company's requirements Indoor/outdoor storage. Sensitive Material like instrument and other Equipment, specified from suppliers to be stored in an air conditioned environment. Materials, except cable drums, not requiring concrete or asphalt flooring shall be placed on the ground on dunnage such that material is elevated from the ground.	MIPS/PDA	Updated MIPS
Warehouse operator	2.2	Store and label chemicals according to HSE safety data sheet, hard copy of data sheet to follow the product.	P0026E	Updated MIPS
Warehouse operator	2.3	Segregate materials according to technical and preservation requirements on location	MIPS/PDA	Updated MIPS
Warehouse operator/ Material controller	2.4	Company category 1, 2, 3 materials, Company provided Items, capital insurance spares and Special tools shall be recorded separately. Contractor or Subcontractors supplied material shall be stored separately from project material.	MIPS/PDA	Updated MIPS
Warehouse operator	2.5	Store the shop prefabricated item in storage area on dunnage such that item are elevated from the ground.	MIPS/PDA	Updated MIPS
Preservation Coordinator	2.6	Maintain preservation of tagged equipment according to procedure: P0146E Maintenance and preservation of tagged equipment.	P0146E P0154ENYX -10	Preservation list
Warehouse operator/ Material controller	2.7	Report damages revealed during storage by the use of damage report form in procedure P0146E	P0146E P0154ENYX -09	Damage Report
Warehouse operator	2.8	Carry out inventory control.	Stock report	Updated MIPS
Warehouse Lead	2.9	Report, identify and list those surplus materials or equipment that have laid idle for six(6) months or more	MIPS	MIPS
	3	ISSUING OF MATERIALS		
Work preparation responsible	3.1	Issue materials list per job pack to store according to installation plan.	MIPS/PDA	Updated MIPS
Warehouse operator	3.2	Prepare material according to bag & tag principles. All preserved and marked with requested name, work order and installation/site address.	MIPS/PDA	Updated MIPS
Warehouse operator	3.3	Update MIPS with issued materials and transfer materials to pre-agreed installation storage delivery area.	MIPS/PDA	Updated MIPS
Foreman Production	3.4	Return of materials from installation shall be logged on return sheet; P0154ENYX-03. <ul style="list-style-type: none"> • Materials shall be traced to original job pack • Materials shall be preserved and not damaged, or corroded/rusted 	P0154ENYX -03	Updated MIPS
Logistic/procurement	3.5	Reconciliation	02-C- MAB036NYX	Updated MIPS
	4	SCRAP		

Action by Whom	Act. no.	Activity/description (Use key-words starting with a verb) What	Additional info in: How	Result Deliverable
Warehouse lead.	4.1	<p>Dispose of scrap from Company provided materials according to agreement with Company prior approval.</p> <p><u>DEFINITION OF SCRAP:</u></p> <p>Structural steel</p> <ul style="list-style-type: none"> • Plates that are less than 1 m² or that are less than 500 mm wide and 4000 mm long. If the plates have a special shape, the limit of 1 m² may be increased. • All profiles and pipes less than 1000 mm. <p>Process pipes</p> <ul style="list-style-type: none"> • Carbon pipes ≤ 6" sch ≤ 80 s less than 1,0 m • Carbon pipes ≤ 6" sch > 80 - " - 0,5 m • Carbon pipes ≥ 8" all sch - " - 0,5 m • Fine pipes ≤ 3" sch ≤ 40s - " - 0,8 m • Fine pipes > 4" sch > 40s - " - 0,5 m • Fine pipes ≤ 10" sch ≤ 40s - " - 0,6 m • Fine pipes ≥ 10" sch > 40s - " - 0,3 m <p>Cable</p> <ul style="list-style-type: none"> • Cable lengths less than 10 m. 	Agreement no. 4610025417	Sales note

Procedure name:	MMT	No.:	P0154ENYX-01
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 <p>PRIMARY MMT MMT No NEP-NYH-0001</p>		<p>Nyhamna Expansion Project Address Kværner Stord AS, Nyhamna Nyhamna Expansion Project Area O10 6480 AUKRA Norway Telephone +47 67595535 Telefax</p>	
<p>To Agent Company Bring Cargo AS Avd Bergen EDG Project/Prosjektavdelingen 5836 BERGEN Norway</p>		<p>Contact Gerdts, Peter E-mail Peter.gerdts@bringlogistics.no Phone Fax</p>	
CC	Phone	Attn	E-mail
Future Pipe Industries	31523280518	Faber, Gerard	G.Faber@FuturePipe.NL
Bring Cargo AS Avd Bergen		Hordnes, Vegard	Vegard.hordnes@bringlogistics.no
<p>MMT NEP-NYH-0001 Title 40610 GRE Pipes, Fittings, Flanges Issue dat 15 Oct 2013 Revision / 0 / Thorsen, Karl karl.thorsen@akersolutions.com</p>			
<p>Please arrange for transport as listed below.</p>			
<p>Collection Future Pipe Industries - 7770 AG Hardenberg Netherlands</p>		<p>Contact Stoit, Henk E-mail G.Faber@futurepipe.nl Phone 31523280552 Cellphone 31643363267 Fax 32523280700</p>	
<p>Terms of Delivery FCA</p>		<p>Free Carrier Incoterms 2010</p>	
<p>Destination Kværner Stord AS, Nyhamna Nyhamna Expansion Project Area O10 6480 AUKRA Norway</p>		<p>Contact Lodden, Anund E-mail anund.lodden@kvaerner.com Phone Cellphone 4790768091 Fax</p>	
<p>Mode of Transport: Means of transport MMT Dates : ETC ETA:</p>			

Procedure name:	Traceability system for steel and pipes materials	No.:	P0154ENYX- 04
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1. Coding system for structural steel and piping

For all structural steel and piping with requirement to full traceability, the steel plates, profiles and pipes will be given a unique identification code, linked to certificate, charge no., test no. and plate no. given on the material. The established Material coding list (M.C.L.) shall be used.

The code no. shall be marked on the plate/ pipe by using Paint stick / soft nose stamp.

Profiles delivered by *Steel suppliers* will not be given a unique identification code due to that each profile is marked with project name, article no and charge no.

2. Code system for plates

The code no for plate consists of 11 digits. The tree first digits describe the steel quality (MDS).The third is project related letter. The 3 next digits describe plate thickness. The 4 remaining digits are a sequence no.

YYY W XXX ZZZZ

YYY - Steel quality (MDS) *
W - Letter "N", project related.
XXX - Plate thickness.
ZZZZ - Sequence no.

Example:

Plate Y30 and 50 mm thickness: Y30N050001.

NB: The sequence no. for plate starts at 001 for each plate thickness.

3. Code system for profiles and pipes

The code no. for profiles and pipes consist of 8 digits.

The tree first digits describe the steel quality (MDS).

The fourth is project related letter.

The three last digits are a sequence no.

YY Y X ZZZZ

YYY - Steel quality (MDS) *
X - Letter "N" project related.
ZZZ - Sequence no.

Example:

Pipe, Steel quality (MDS) D22: D22N001

NB: The sequence no starts at 001 for each steel grade (MDS).

* When MDS is not present, use:

355 as code for Carbon steel materials

AL as code for Aluminium materials

SS as code for Stainless steel materials

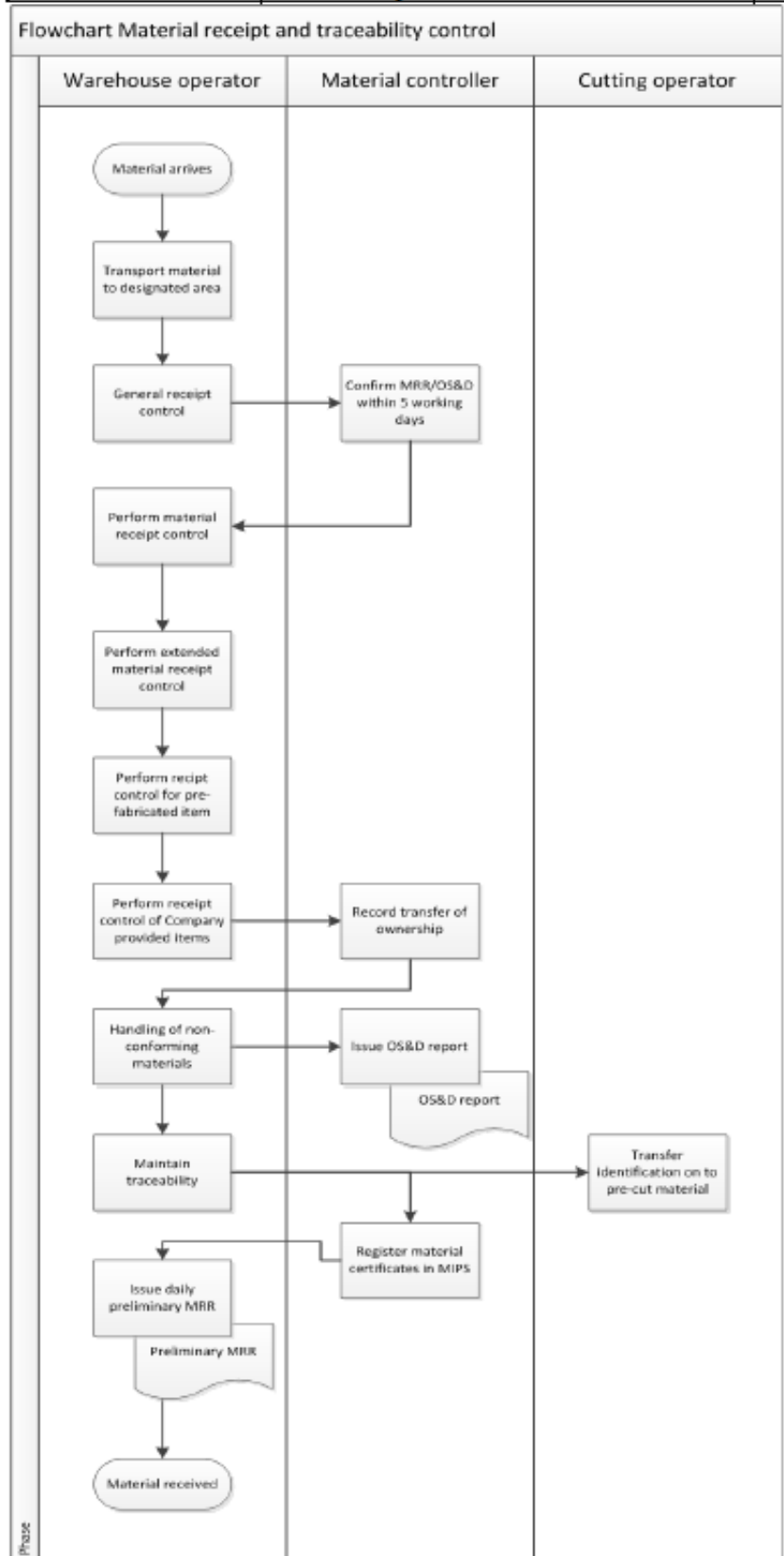
Procedure name:	Traceability system for steel and pipes materials	No.:	P0154ENYX- 04
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4. Sequence for each site

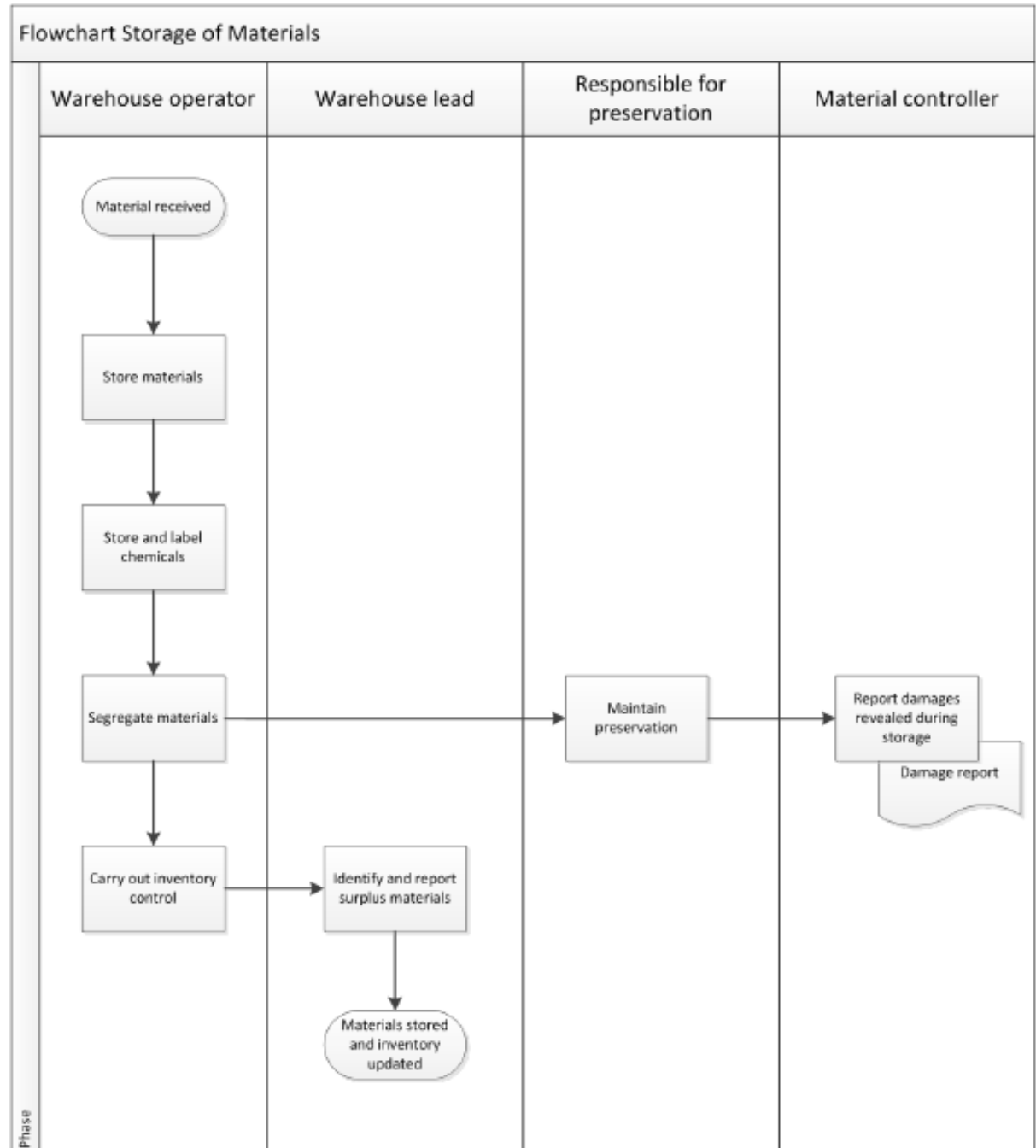
SITE NAME	SITE CODE	FROM No.	TO No.
KVÆRNER VERDAL	KVE	0001	0499
COOEC	COOE	0500	0999
OFFSHORE GROUP	OGN	1000	1499
KVÆRNER STORD NYHAMNA	NYH	1500	1999
KVÆRNER STORD	KST	2000	2999
MOSTOSTAL POMORZE	MPG	3000	3499
ENERGOP SOCHACZEW	EMS	3500	3999

Each Site uses the Sequence number given in this table in order to ensure that the same number is not used on different site.

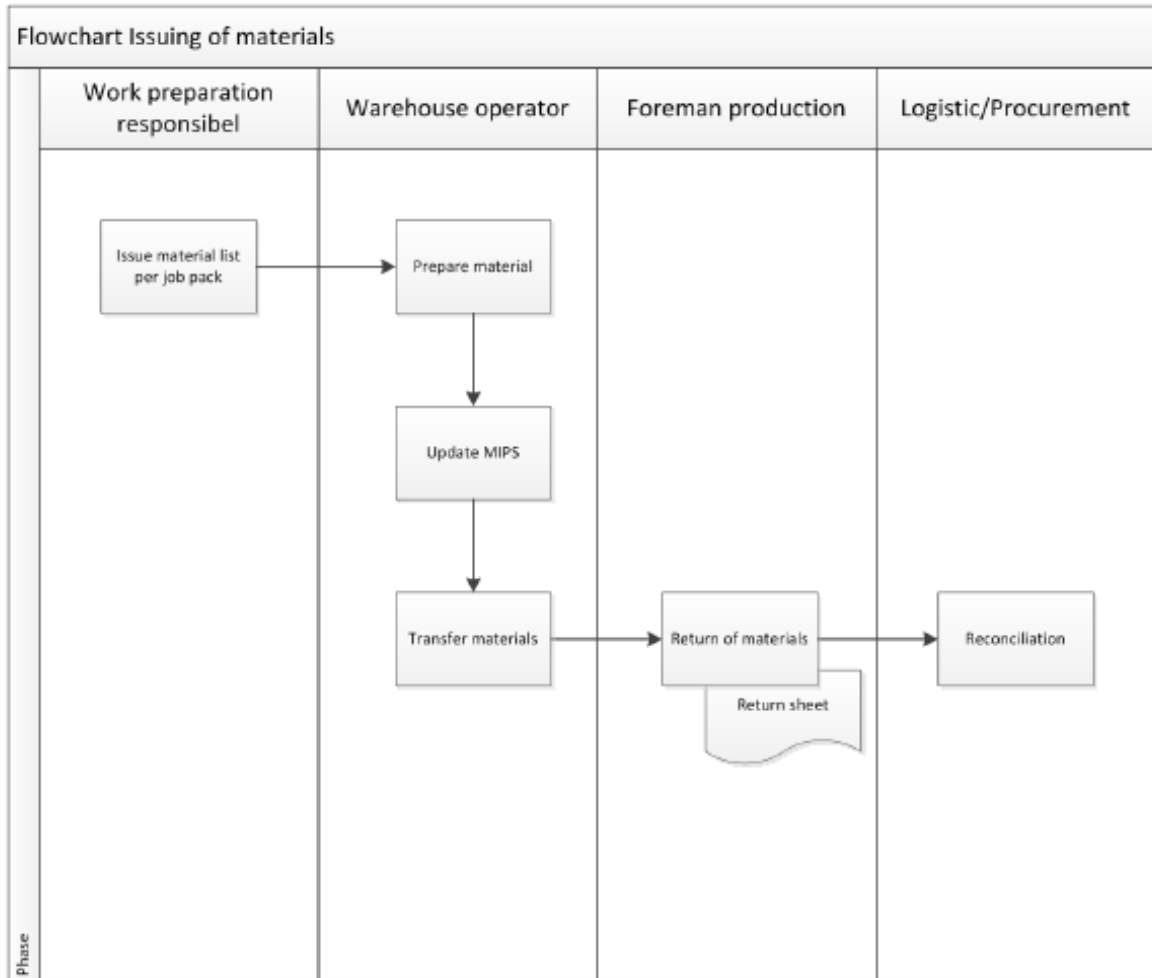
Procedure name:	Flowchart Material receipt and traceability control	No.:	P0154ENYX-05
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Procedure name:	Flowchart Storage of materials	No.:	P0154ENYX-06
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Procedure name:	Flowchart Issuing of materials	No.:	P0154ENYX-07
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Procedure name:	Over Short and Damage Report	No.:	P0154ENYX-08
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	<p>Nyhamna Expansion Project Kværner Stord AS, Nyhamna Over Short and Damage</p>	
<p>From OS&D No NEP-NYH-0001_001-001 To OS&D No NEP-NYH-0001_001-001 From OS&D Item 1 To OS&D ItemNo 1 OS&D Note Yes Selection All Back Cover No</p> <p>Report Description: Over Short and Damage</p>		

Procedure name:	Over Short and Damage Report	No.:	P0154ENYX-08							
	Over Short and Damage Kvæmer Stord AS, Nyhamna Nyhamna Expansion Project									
OS&D Header Information			References							
No	NEP-NYH-0001_001-001	Activated	08.11.2013 Harald Årvik ,Phone:+47 95185051 ,Mail:harald.arvik@kvaerner.com							
Description	40610 GRE PIPES, FITTINGS, FLANG	Passivated								
Rev:	Date Rev:	Execute By								
Code		Responsible								
OS&D Header Note										
Missing certification										
OS&D Item Information										
Item:	1	Qty:	3,00	EA	Vendor:	102075 / Future Pipe Industries	Code	MD	Missing documents	
Activated	08.11.2013	Harald Årvik ,Phone:+47 95185051 ,Mail:harald.arvik@kvaerner.com				Execute By				
Passivated						Responsible				
Article Contractorcode/ProjectCode		PO		MMT		MRR				
Description		Description		Description		Description				
LP064898 LP064898		37-1A-KST-B34-40610-01001		NEP-NYH-0001		MRR NEP-NYH-0001_001				
DN 50mm BLIND FLANGE F.F. 32 bar TO MATCH CL150 ASME B16.5, ISO 14692, FILAMENT WOUND GRE, NON-CONDUCTIVE EDS: NGF1		1 3,00 EA		1 3,00 EA		1 3,00 3,00 EA				
OS&D Item Note Missing Certificate										
Date	08.11.13					Page		1		
Time	07:33:15									
Ref	osdfm02									

Procedure name:	Preservation Damage Report Form	No.:	P0146E-09
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Damage report form for delivered equipment.		No.	
Date:	Area:	Po.no.	
Tag.no.	Description:		
KST Construction, Installation Manager:		Phone:	
Suggested preventive measures:			
Supplier consulted:		Yes	No
Client response:		Work finish.	
System ing.	Date/Sign	System. Ing. Client.	Date/sign
Possible insurance damage		Yes	No
Client response:			
Date	Client sign.		



Procedure name:	Preservation Weekly report "Example"	NO: P0154ENYX-10
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KVÆRNER	Nyhamna Expansion Project Kvæmer Stord AS, Nyhamna Preservation Weekly Report	
Report Parameters:		
COMMPKG % Contractor Kvæmer Stord AS, Nyhamna LocationOwner (All) Mc Site SUP Mc Phase % Area No % Check Sheet % Press. Week 201345 Discipline % Document Type 78 P & ID	Document Ref. Visible Yes Description Object/ Equ. Object Name Sign Column Yes Megger Info on SheetNo Yes Megger Info Yes Check SheetNo PRCR-E-02 FrontCover Yes BackCover No	
Report Description:		
Preservation Weekly Report		


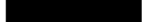

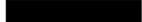









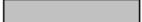




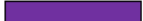


Procedure name:

Preservation Weekly report "Example"

NO: P0154ENYX-12

KVERNER		Preservation Weekly Report Kværner Stord AS, Nyhamna Nyhamna Expansion Project						Week: 201345					
Area	Tag No. Store Tag Main Tag No Special Requirement	Description Store MainTag	Package No Drawing No.	Heat Drawing Name.	MC.Site	MC.Phase	Preservation Ref. No	Commpkg	Mcpkg	Chk.Sht.	Done	Delay	Period(s)
P45	EE-16-4101	Electric motor for Booster Compressor	40251	Y SUP S				1612-C08	1612-C08-E01				
	EE-16-4101		37-1A-KST-078-16160	PROCESS P&ID BOOSTER COMPRESSOR TRAIN 1						PRCLE-01	0	4	
	Sign/Date									PRCR-E-02	0	4	
	Sign/Date	Megger Value	Mohm	Megger Date									
P45	EE 164101-J01	MOTOR,GF	40251	N SUP S				1612-C08	1612-C08-E01				
	EE-16-4101									PRCLE-01	0	4	
	Sign/Date												
P45	EE 164101-J02	MOTOR,GB	40251	N SUP S				1612-C08	1612-C08-E01				
	EE-16-4101									PRCLE-01	0	4	
	Sign/Date												
P45	EL-16-4101	BOOSTER COMPRESSOR HARM FILTER BREAKER TRAIN 1	40251	N SUP S				1612-C08	1612-C08-E01				
	EL-16-4101									PRCLE-01	0	4	
	Sign/Date												
P45	ER-16-4101	BOOSTER COMPRESSOR FREQUENCY CONVERTER (TRAIN 1)	40251	N SUP S				1612-C08	1612-C08-E01				
	ER-16-4101									PRCLE-01	0	4	
	Sign/Date												
P45	ET-16-4101	BOOSTER COMPRESSOR TRANSFORMER (TRAIN 1)	40251	N SUP S				1612-C08	1612-C08-E01				
	ET-16-4101									PRCLE-01	0	4	
	Sign/Date												
Date	07.11.13												
Clock	11:31:49												
Ref	pl_weekrpt												
										Page	1		

Enclosure name:	Colour code for pipe and tig-consumables	No.: P0154ENYX-11
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COLOUR CODE PIPE	MATERIAL SPECIFICATIONS PIPE (EXAMPLE)	MDS	DESCRIPTION	COLOUR CODE TIG-CONSUMABLES		
Black 	UNS S31254	R11, R12, R13, R14, R15, R16, R17, R18	6 Mo	Black		ESAB OK 19.82
Black / Red 	UNS N06625	N01	Inconel 625	Black		ESAB OK 19.82
Yellow 	UNS S31803	D41, D42, D43, D44, D45, D46, D47, D48	Duplex (22Cr)	Yellow		UTP A 6808 Mo
Green 	UNS S32550 UNS S32750 UNS S32760	D51, D52, D53, D54, D55, D56, D57, D58	Super Duplex (25Cr)	Green		ESAB OK 2509
Blue 	A312TP316	S01, S02, S03	316	Blue		ESAB OK 316LSi
Brown 	TITAN GRADE 2	T01, T02	Titan	Brown		UTP Titan Gr.2
White 	API5LGr.B A 106 Gr.B	C01, C02	Carbon (CS type 235)	Grey		Lincoln LNT Ni1
Grey 	A 333 Gr.6 A 671 CC60	C11, C12,	Carbon (CS type 235 LT)	Grey		Lincoln LNT Ni1
Red 	API 5L X52	C21, C22, C23	Carbon (CS type 360 LT)	Grey		Lincoln LNT Ni1
Purple 	SAWL 450 SFD SAWL L450Q (X65Q) WPHY 65, F65		Carbon	Grey		Lincoln LNT Ni1
Consumables for combination Carbon against 316.			Carbon / 316.	Orange		ESAB OK 309 MoL
Some type of consumables can be used in combination against other material. See welding procedure for information.						

