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LOG950 Logistics

Improving Linjebygg Offshore's warehouse logistics

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PREFACE

This thesis is our last mandatory work in the 2-year master program in science of logistics at Molde University College. We have been carry out this thesis in the time span between January and Mai 2011 for Linjebygg Offshore AS, which is a company within the maintenance and modification sector of the oil & gas industry.

The main goal of this thesis is to streamline the supply chain by looking at the work tasks in a project, from planning to delivery of equipment offshore for short notice projects (special projects).

After studying our initial problem formulation, we had to narrow/adapt the topic in the middle of the thesis, because it was too wide. Then, based on information from LBO, we got a new problem formulation with a more limited focus; "Improving Linjebygg Offshore's warehouse logistics".

We would like to thank all the participating employees at Linjebygg Offshore AS for all the information they have been willing to provide. This thesis would have been harder and more complicated to solve without all this important information.

In addition we will also like to thank employees at Molde University College, who have contributed and been helpful in our work with this thesis.

We will also especially like to thank our supervisor Bjørnar Aas for all support and guidance in this process.

Lisa Stormyr Malin Hesthag

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SUMMARY

Linjebygg Offshore is a company in the maintenance and modification sector of the oil and gas industry, which is highly specialized in working at difficult accessible places offshore. Their goal is to get more “short notice”-projects, also called special projects, and here we look at the logistics in their company to see if we can help them to reach this goal.

The thesis starts with an introduction of how we decided the topic and which methodologies that was used to collect necessary data. Here we also describe how our early research led to a change of the problem formulation. Further we present general information about the company and a short overview of different activities within their supply chain. The third chapter is more specifically related to our problem formulation and an introduction to the warehouse is also presented here.

In the first analysis we describe how activities and the organization within the warehouse are handled today. First are the main warehouse activities presented and then all activities are included in the analysis based on our own observations. After this first analysis there is a chapter of relevant theories and a chapter about measurement which we aim to include in our next analysis.

The normative analysis is based on our observations from Chapter 4 and relevant theories from Chapter 5. Based on these chapters we have made suggestions to improve the warehouse logistics. A comparison of the descriptive and normative analysis is the last analysis in this thesis.

The results of the thesis are based on different strategies and theories. Our recommendations are implementations of electronic solutions and management changes. With these implementations, the operations within the supply chain will be improved.

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1. INTRODUCTION

This section introduces the background of the topic we have chosen, and also includes an overview of Linjebygg Offshore AS (hereby named LBO) and its organization.

1.1 Background

In our search of finding a problem formulation we spoke to different people in the organization. Through these conversations/interviews we got an impression of the present situation in the supply chain and where different departments thought there were improvement areas. We also got access to reports from completed projects, where we got specific examples of activities which they wanted to improve. The overall goal of the company is to take on more "special projects", since such projects gives LBO the opportunity to use their custom made equipment and techniques. Special projects are often EPCI projects where LBO contribute with; engineering, procurement, construction and installation. The challenge in these projects is the time pressure; it is often very short time from the contract is signed to the first mobilization. To build an organization that can handle more rush projects, smart logistics in the supply chain is crucial.

The information we got, regarding improvement areas and the company's further business goals, gave us ideas of how we could use our knowledge to write a thesis based on this subject. This leads us to a problem formulation, where we decided to look into how it is possible to make improvements in the logistics of special projects. The whole supply chain, from planning of the project to delivery of equipment on the offshore installation, will be looked into.

By becoming more efficient in such projects, they believe that they will achieve greater customer satisfaction, reduced project costs and also reduced pressure related to the administrative work. More effective in this setting means to make; the material flow smoother. Improvement of routines and work methods are areas we will look into to help improving a better and less time consuming material flow. It will also potentially be of great value for LBO to get our suggestions on how they can obtain even more advantages of their new ERP system that is scheduled to be implemented in the beginning of 2011.

We will look into the whole process, from the stage where the project manager gets to know about a new project until the equipment is delivered offshore. Analysis of different improvement suggestion in each phase will be very important for our solution.

1.2 Problem formulation

Our problem formulation is: *"Improving LBO's supply chain efficiency by looking at EPCI projects"*

Since this is a wide problem formulation we decided to use an exploratory research method. We wanted to get opinions from different point of views to get an objective insight. There are several departments and groups involved in the whole logistic chain we looked into. Therefore we were prepared to use a lot of our time on gathering information throughout the whole supply chain. Interviews were our main information source and also some documentation like procedures, reports from finished projects and financial reports from the company were used in our research.

1.3 Research questions

To solve our research problem we needed to gather information by looking at some more specific research questions. We have through conversations with different LBO employees obtained an impression of different problem areas. Based on this we did formulate a series of sub-research questions to help us get the correct information from different areas of the supply chain. Our preliminary observations are mostly based on information we got from LBO personnel from different departments as well as our own observations through reading reports and participating in the daily work within the organization.

Question #1:

How good is the communication and information flow in the supply chain?

Preliminary observation:

- The information channels between the different members of the supply chain of a project vary and seem to a certain point to be random.

- The type of communication and the extent of information seem to vary extensively between projects.

- It seems to be a lack of understanding of other team members' need for information.

Possible problem/consequence:

- Important information can be lost along the way and team members get confused. They do not know who to deal with, something which makes it difficult to schedule the workforce in advance.

- This variation can limit the flexibility of team member's ability to work with different projects/contracts because they have not the same way of working. Information can be lost because of the lack of fixed routines.

- It could lead to lack of focus in some areas that are important for others because they do not have the understanding of the need for this information in other parts of the supply chain. Valuable information could get lost.

Possible solutions:

- The project teams should have more specified work descriptions. Certain tasks should have restrictions on who are allowed to manage them.

- Processes should be organized / designed in a way so that they can be used in all projects without a lot of project specific adjustments.

- All the involved personnel should be given more knowledge about the whole supply chain, so they are able to see what kind of information which is necessary to perform the process in a satisfactory manner.

Question #2:

How good is the communication within the project organizations?

Preliminary observation**:**

- It seems like the members in the project organizations do not see the value of the whole chain, because they have too much focus on their own area/project.

- Processes appear to vary between different projects which lead to confusions to team members, especially when participating in several projects simultaneously?

- Some team functions seem to be handed tasks which is outside of their field of competence.

Possible problem/consequence:

- Can lead to conflicts between team members and result in suffering projects.

- Team members spend unnecessary time to get to know the different project routines. This is waste of time and gives a higher possibility for mistakes.

- Activities must be done several times by different people to ensure the right quality.

Possible solutions:

- Information meetings with all involved personnel give an understanding of the importance of everybody's role in the project and the possible consequences if cooperation along the supply chain is missing.

- Processes should be generalized so that they could be used independent of projects and contracts. The team members will know their area of responsibility and who to communicate with. This will give a higher quality level of work processes and reduce time and the possibility for errors.

- Redirect jobs to other team members or possibly new functions to increase quality, and prevent insufficient duplication of work.

Question #3:

Which controls and routines are used in the warehouse?

Preliminary observation**:**

- Poor control of inventory caused by manual procedures.

- Time consuming work processes make the warehouse employees vulnerable to changes.

Possible problem/consequence:

- Unnecessary purchases and costs. Little control over returned equipment and no control to detect if items disappear from stock.

- Gives little flexibility which could be critical in EPCI projects where changes can occur close to delivery date.

Possible solutions:

- The inventory management should be handled in an IT system where incoming and outgoing items are registered.

- Automation of the inventory will give the warehouse personnel more capacity to handle possible changes.

Question #4:

How is the return from offshore locations to the warehouse handled?

Preliminary observation**:**

- In many cases the returned container does not contain the same equipment that it did when it was sent offshore. Some equipment can be missing because it is being left on the offshore installation. There is also situation where equipment from other projects on the same installation appears in a returned container.

- Equipment is left offshore and must therefore be replaced by buying new equipment. We realize that this is an unnecessary cost that should be avoided.

- The warehouse employee does not know in advance what kind of equipment they get when a container arrives.

Possible problem/consequence:

- All the equipment will not be returned and the warehouse has no overview or control over all the equipment.

- When a need for equipment in new projects occurs, the warehouse might have to purchase new equipment. It is possible that the company has what they need; therefore this is a waste of money. This is a consequence of the lack of equipment overview.

- This makes it harder to plan the work with the returning containers and also the certification and controlling of the returned equipment.

Possible solutions:

- The foremen should have a list of all the equipment they had offshore when the project started and be responsible for returning the equipment to the warehouse. They should be informed about the consequences if equipment are left at the platform, to encourage them to do their very best to return all of the equipment.

- It might be better if they get a monitoring system, which uses for example a new tracing and tracking technology.

- If this kind of new technology gets introduced, they are able to scan all the equipment when a container arrives at the platform or when the container returns to the warehouse. In this case they will always know where all the equipment is at any time.

Question #5:

How is the coordination of shipments from warehouse, sub suppliers and test facilities done?

Preliminary observation**:**

- In some projects the shipments come from several different locations. These shipments should be coordinated to the base to ensure the same arrival time at the platform.

- The return location of these shipments is not necessarily the same as they were shipped from. It seems like they have no routines of how the information flow about the return of different components should be carried out.

Possible problem/consequence:

- If one of the shipments is late, the platform will not receive all the equipment at the same time. The equipment could therefore be delayed and arrive after scheduled time. This delay might also lead to time pressure to finish the project in time.

- The shipment could be returned to the place it was sent from. The warehouse expects to receive the whole shipment and have no tracking opportunities for the missing equipment.

Possible solutions:

- A new tracing and tracking technology solution could be used to track the different shipments to make the coordination from different locations go smoother. A solution could be to register return location of the equipment on the RFID tag. When the equipment is to be returned, the employees is able to scan the equipment to ensure the right receiver.

1.4 Limitations

We have been identifying the following main challenges and limitations for this thesis:

- Time: For this project we need a lot of information, and we might feel a bit of time pressure if we do not use our time effectively. The time at disposal also function as a limitation for how deep we can go into every part of the supply chain.

- Information: The information we will get from the interviews and generally from the company, will reflect the interview objects point of view. Since we get

subjective information it can be difficult to see if this is the real situation in the company. Therefore there might be information errors that appear while we are working with our thesis.

- New ERP system: While we are working with our project, LBO implements a new ERP system that might cover some of the solutions we will find.

Early in our research period we realized that the subject and problem formulation we have picked was too much to look into. By this conclusion we started a pre-research based on the question listed above. In this phase we interviewed employees from different departments, studied documents and were present in the office head quarter. From this pre-research we got a realistic view of the present situation. This view gave us an impression of which areas that was possible to improve and look further into.

1.5 New focus in the thesis

The information flow is a very important factor to get efficiency in work processes. To streamline the work flow in LBO, we made an overview of the whole process from the time a project occurs to the equipment is delivered offshore. In addition we also studied the flow of information in the return process of equipment.

We realized that looking in to the whole information flow would be too much to include in this thesis. We got the impression that one of the main problems was the information flow between different departments across the organization. We started our research with main focus on improving the information flow to make the processes more effective. In the process of studying the information flow, we observed that one of the largest problems LBO has today seems to be in the warehouse. This appeared to be a bottleneck in the process. Based on this observation, and in consultation with the company and our supervisor, we decided to limit our thesis to focus on the warehouse function and its activities. One of the consequences of narrowing the focus in the thesis, was that we had to change our initial research question; *"Improving Linjebygg Offshore's supply chain efficiency by looking at EPCI projects?"* to "*Improving Linjebygg Offshore's warehouse logistics*".

At this stage we started our focus on the warehouse and their tasks. We made observations of how the staff in the warehouse used their time and how they performed the different work tasks.

The thesis will hereafter deal with these topics:

- Efficiency and cost savings of the warehouse
- Organization of the work flow in the warehouse
- Transportation costs

1.5.1 New research questions

After we changed the focus of our thesis we formulated new sub-research questions. These are supposed to help us on our way to finding improvement areas and solutions of the warehouse logistics. Efficiency is the main focus in these research questions. In the thesis we use the efficiency concept to help improving the work flow regarding cost and time (see chapter 6.1 about efficiency and effectiveness).

New sub-research questions:

Question #1

How can we change work routines to reduce throughput time?

If we can reduce the time the warehouse employees work on each item, the productivity will increase.

Question #2

What can managers do to trigger higher efficiency?

There are some initiatives that can be done by the managers; for example motivation, planning, better structuring etc.

Question #3

Can changes in the physical work environment have positive effects on critical activities?

There may be ways to reorganize the work environment like workstations, computers, testing equipment and so on, to make the work processes more effective.

Question #4

Is it possible to reduce the number of activities?

We expect to find several activities in the work routines that are not directly productive. We will search to find solutions where some of these activities can be avoided.

Question #5

Can new technology replace manual activities in a time and cost efficient way?

An analysis of manual operations will be compared with technological solutions and the possible benefits of an implementation of these.

We will use both real information from warehouse observations and theory from different logistical theories to find answers to these questions.

1.5.2 Limitations

Since we have changed the focus in the thesis, we will come across new challenges and limitations:

- **Time:** Because of the time pressure, the time we will spend on observations in the warehouse might be a bit short. If we have had a longer observation period, the analysis would be more representative in the meaning to understand how an average working day in the warehouse really is.

- **Information:** The information we get from the interviews and generally from the company, is from the interview objects point of views. Since the focus now is mainly the warehouse, we can get different information from the management and the workers in the warehouse. This factor may lead to information errors, which we will reveal in our work with the different information.

- **New ERP system:** While we are working with our project, LBO gets a new ERP system that might cover some of the solutions we will reach during the thesis work. The work of implementing this ERP system also steels a lot of time from some of the workers in the warehouse. Our analysis is a bit misleading because some of the workers are busy with this system, so all the 5 workers are not available in the warehouse to the extent that they normally would be.

1.5.3 Methodology

As mentioned earlier, our main information source will be interviews and own observations.

1.5.3.1 Data collection

According to Yin (2009) there are six sources of evidence: documentation, archival records, interviews, direct observations, participant observations and physical artifacts. We decided to focus on interviews and observations as the main data collection method. We think that through open interviews we can get relevant information that are not written down anywhere, but experience the employees have got. We will carry out open interviews with employees in different parts of the supply chain. In accordance to Yin (2009), there are both strengths and weaknesses by using interviews to collect data.

Strengths:

- "Targeted - focuses directly on case study topics"
- "Insightful - provides perceived causal inferences and explanations"

Weaknesses:

- "Bias due to poorly articulated questions"
- "Response bias"
- "Inaccuracies due to poor recall"
- "Reflexivity - interviewees gives what interviewer wants to hear"

1.5.3.2 In-depth interviews

The interview method we mainly used was in-depth interviews. This type of interview is structured in the way that the respondent is invited to speak freely and express their thoughts about the issue. Therefore the interview is not just a single setting; it will take place over an extended period of time (Yin, 2009).
In our observation period we used this method to get relevant information from the warehouse employees.

An in-depth interview places high demands on the interviewer. The interviewer must have ability to provide social contact and gain the confidence of the person interviewed. The

interviewer must also be good to follow up good answers and get the interviewee to elaborate on this.

In accordance with Selnes (1999) some critical factors in order to achieve a successful interview are:

- Be precise
- Be formal during the session.
- Start to clarify the purpose of the meeting, and what you want to achieve
- Be sure of your self
- Tell why the interviewee is contacted
- Memorize the questions
- Concentrate on listening
- Be critical
- Request the opportunity to follow up
- Other informants (ask the interviewee for suggestions for others to be contacted)

1.5.3.3 Personal interviews

Personal interviews are also an interview method we used to collect data. We did mainly use this method while we were working with our first problem formulation. Such types of interviews are used when the interviewer wants to get answers on predetermined questions. Furthermore, it is also easy to manage open questions that are not fixed in advance. This means that in a personal interview it is possible to catch good information also besides the originally planned questions-

The accuracy of these personal interviews will depend on what you ask for (Selnes, 1999).

Because of the change in focus, we needed to add a new method to collect data. According to Yin (2009), the method that is best suited is a combination between direct observation and participant observation. After studying Lean management we decided to explore more about *Lean Value Stream* (ref. Chapter 5.1.3) in the company. We chose to participate in the daily work in the warehouse and make our own observations and time registrations for a given period.

The *observation in the warehouse* will be our main data collection method in addition to the other methods mentioned earlier in Chapter 1.5.

Observation in the warehouse

While participating in the warehouse as observers we might be affecting the workers in their job. They could feel that we control them and they may be more efficient than they normally would. It is possible to make observations that the workers do not notice, but they will anyway know that we are observing them since we are around almost all the time.

Such observations and measurements can lead to atypical behavior. A general problem with this kind of research is that people often act more rational and reasonable than they really are. The presence of an observer may cause the workers to behave differently from what they normally do. These kinds of observations also require a lot of time to get a representative impression of how the workers perform their task today (Selnes, 1999).
For these kinds of participant observations there are according to Yin (2009) some strengths and weaknesses:

Strengths:

- "Reality - covers events in real time"
- "Contextual - covers context of "case"
- "Insightful into interpersonal behavior and motives"

Weaknesses:

- "Time - consuming"
- "Selectivity - broad coverage difficult without a team of observers"
- "Reflexivity - event may proceed differently because it is being observed"
- "Cost - hours needed by human observers"
- "Bias due to participant observer's manipulation of events"

As we can see from the strengths and weaknesses above, the insightful information we get through this method comes as a result of a quite time consuming operation. In our case we considered the strengths to be important enough to be worth the weaknesses. In our case,

we considered the strengths of this method to have greater impact on the outcome than the weaknesses. Based on this decision we decided to use this method to collect necessary data from the warehouse.

1.5.4 Validation

There are several concepts that describe the quality of research designs. Four tests are common in the process of proving quality of research:

1. Construct validity
2. Internal validity (for explanatory or casual studies only and not for descriptive or exploratory studies)
3. External validity
4. Reliability

Since our research is exploratory we will not go further into the internal validity. The three other tests will now be explained and discussed.

Construct validity:

This first test is to assure that the data used in the study is reliable and representative. It is in this case important to use multiple sources of information to eliminate subjective data. (Yin, 2009).

In our research we have used information given of employees with different point of views. This information comes in addition to written materials like reports, procedures and our own observations. Based on this we will say that our research data has validity because our data come from several different sources.

External validity:

This test focuses on how the results of the study can be generalized, in our case for other comparable companies. It is difficult for us to be sure of this validity, and to be able to comment realistically on this we need to know more about comparable companies' warehouses.
(Yin, 2009).

Notwithstanding, we believe that our conclusions are based on principles that should be representative for other similar businesses even though the improvement would vary in time and cost in every case.

Reliability:
The objective is to be sure that if a different group carries out the same research later, they would obtain the same findings and come to the same conclusion. To be able to do this test, it is necessary to have good documentation of procedures that were followed through the study (Yin, 2009).

We have not focused on making procedures of our work, but the outlines of our research are presented throughout our thesis and should be able to be copied for a later research.

1.6 Further outline of the thesis

To make the reader understand how LBO operates and be able to understand our statements, we will continue the thesis with an introduction of the company and their services. After this introduction a descriptive analysis of our focus area will be presented.

The descriptive analysis will start with describing different activities as they are described in procedures and by LBO employees. Then a part where our own observations are visualized by numbers and are further discussed. After the descriptive analysis we will continue with a chapter presenting relevant theory which we will use to make improvement suggestions. All these theories are tools that we use to make LBO's logistics more efficient both with regard to time and cost. The next chapter will be the normative and concluding analysis. In this section we will use our observations from the normative analysis combined with the theory presented in the previous chapter to describe our suggestions for the company.

2 GENERAL INFORMATION ABOUT LINJEBYGG OFFSHORE AS (LBO)

LBO (see www.lbo.no) is now owned by the Norwegian energy and power company Istad AS (see www.istad.no). It has its traditions back to 1933, when "Linjebygg" was

established in Molde. Today Linjebygg Offshore AS has 430 employees and offices in Molde, Trondheim, Stavanger and Houston. As mentioned earlier, LBO operates within the MMO (maintenance and modification) sector of the oil & gas industry, highly specialized in working at difficult accessible places offshore (LBO website, 2010).

Figure 1 Offshore workers with RAT equipment (LBO AS, 2010)

LBO is offering services in the offshore industry and aim to deliver time and cost efficient methods to save money for their customers. Typical operations LBO performs in this sector are installations to reinforce structures, removal of old constructions and maintenance of old constructions. Many of these operations are performed in areas with difficult access which makes challenging work conditions.

To be able to perform their services in these areas they use a technique called rope access technique (RAT). Using this technique the operators perform the job hanging from ropes. This saves both money and time, because there is not the same need of installing temporary facilities to get the necessary access.

Linjebygg Offshore's focus areas:

● Design and Engineering

Skilled engineers and supervisors work closely with our clients to meet their challenges.

● Installation and Removal

Difficult tasks are being solved with specialized techniques and custom made equipment.

● Inspection and Maintenance

Engineers with extensive experience establish optimal routines for inspection programs. Long term contracts within the MMO sector on offshore installations and onshore plants.

● Product Development

Their product development is highly focused on utilizing the innovative company culture together with their customers. Testing of methods and training of people in their own innovation and training centre.

Present central contracts:

● Njord, Norne, Heidrun (Statoil)
● Draugen/Ormen Lange (Norske Shell)
● Ekofisk (ConocoPhillips)

LBO aims to be a supplier instead of just a sub supplier, to be a part of this group they need to handle more of the value chain.

LBO's position in the value chain

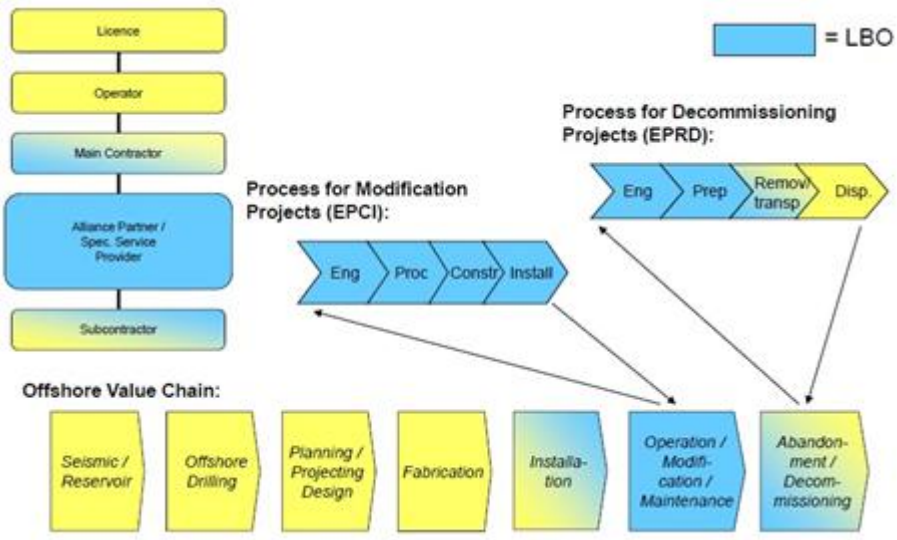

Figure 2 LBO's position in the value chain (LBO AS, 2010)

2.1 Linjebygg Offshore's organization

The main organization is structured as shown in Figure 3. However, the projects are organized as cross functional teams where the project managers require the needed competence and personnel / team members from the different departments / the line organization. The selected team members have their usual tasks to take care of in addition to their project participation, so the team members are seldom 100 % dedicated to one single project.

Flexibility is important for LBO's organization because they aim to serve special projects. Their goal is to be able to take on more EPCI projects which are projects where they deliver products and services within **e**ngineering, **p**rocurement, **c**onstruction and **i**nstallation.

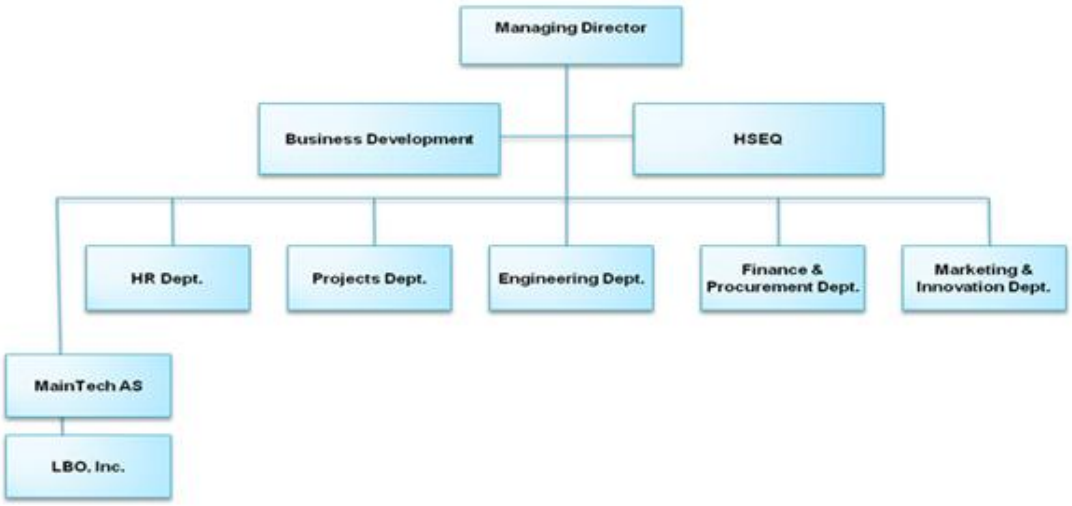

Figure 3 LBO's organization structure (LBO AS, 2010)

2.2 Implementation of the new ERP system

The implementation of the ERP (Enterprise Resource Planning) system "Microsoft Dynamics AX" (www.microsoft.com/en-us/dynamics/default.aspx) started 3rd of January 2011.

The implementation will be carried out in two phases, because there have been delays from Logica (see www.logica.no) which develop special modules for LBO, so all modules will not be ready on the 3rd of January as originally planned. The main modules will be initiated in the beginning of January while some parts of the main modules will be

implemented during the spring. The rescheduled parts are less critical elements of the system that will not replace former systems, but are dealing with new additional processes.

There are several systems that will be integrated into the ERP system and business areas these will handle is;

- Finance/Accounting
- Purchasing
- Warehouse/Logistics
- Rental
- CRM (Customer Relationship Management)
- Time writing and handling
- HR (Human Resources)

These are also shown in Figure 4:

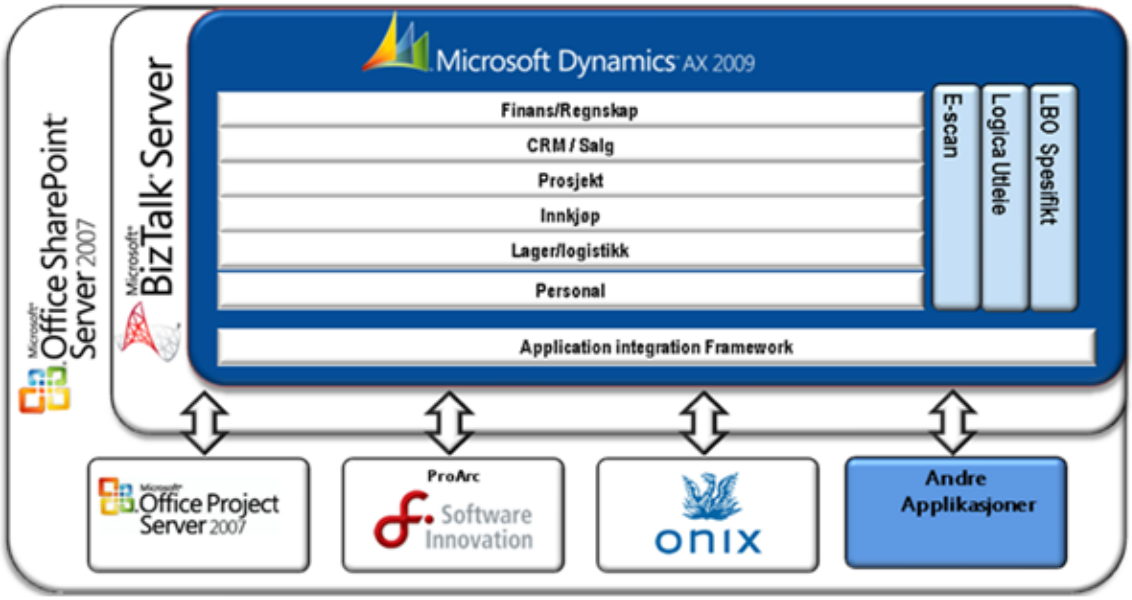

Figure 4 Microsoft dynamics AX (LBO AS, 2011)

The implementation of this system will give the warehouse employees more responsibility. It is crucial that everything that is taken in or out of the warehouse is registered to be able to take full advantage of the system. When all real information is in the system at any time, this will change some of today's work routines and hopefully simplify some of the activities.

2.3 LBO's supply chain

The supply chain of offshore deliveries in LBO is shown in Figure 5. According to the company, a supply chain like this is a typical supply chain for projects. This chain starts with the planning of the project to get the right equipment and materials to the right platform at the right time. By materials we mean prefabrication and installation material that are installed permanently or temporarily. Consumables like protective equipment (e.g. gloves, face masks etc) are another type of materials. By equipment we mean tools and other equipment that is stored in LBO's warehouse and are "sold" to projects.

After the planning process, it is the warehouse's responsibility to find the equipment the project need, and they, or the purchase department, might have to do some purchasing to fulfill the order. When the warehouse staff has packed all the needed equipment, the container is sent to the supply base by truck and then shipped to the platform by offshore supply vessels. In some projects there is a need for larger and prefabricated material, and in this case the subcontractor will ensure for delivery of the shipment to the base. The container, as well as additional prefabricated material (if needed), is returned to the warehouse when the project is completed.

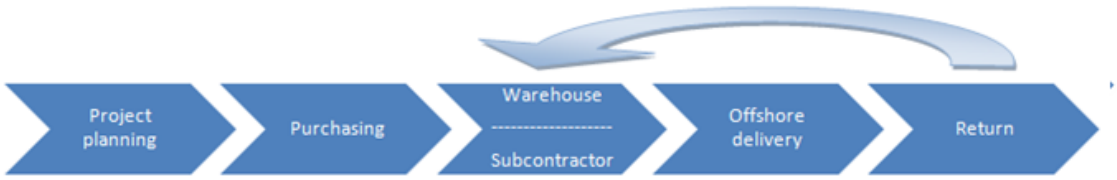

Figure 5 LBO's supply chain

2.3.1 Project planning

Project planning is the first step after a project is accepted, and also an important stage of the project, because it forms the basis of the foundation for further work. Definition of project scope and organization of the project must be established quickly in special projects. The project plan must be well planned so that the team members have realistic plans to deal with. LBO has a pool of project managers that are available for special projects with short deadlines. It is also important to get an overview of which methods that will be used and which equipment that is needed to be able to give the warehouse

employees notification as soon as possible. Picking and packing of equipment will not begin until the warehouse employees receive an order from the project manager.

2.3.2 Purchasing

Projects have different needs in terms of equipment and materials. Prefabricated materials, like custom made steel constructions, are unique for each project and are ordered directly to the projects. The consumables are ordered to the warehouse and are delivered (and sold) to the projects as needed. Some equipment is custom made, and in such cases the purchaser must get detailed information from the engineering department. It is not unusual that the material needed for one project is unique for this particular job and is therefore not available in stock. If an item is not available, the warehouse manager is permitted to purchase the item. Since a minority of the warehouse inventory is managed by help of automated systems, there is high possibility for human errors in several stages.

2.3.3 Warehouse

Figure 6 Container and testing area with overhead travelling crane

The warehouse gets the material requirement from the system when somebody has registered an order. In the EPCI projects we see that the warehouse often gets short deadlines and the demand can be different from project to project, however some components are to a certain extent standard. The warehouse do not have the opportunity to control the availability in a system for the requested items, but must physically go and check if it is in stock or not. This is very time consuming and gives a poor control of

materials in stock. Another factor is the lack of control of the items. This control could be handled through an ERP system if it is used properly.

2.3.4 Offshore delivery and return

Equipment and material needed to do the job offshore, can be shipped either from LBO's warehouse in Molde, directly from the supplier or from a subcontractor. Shipments to the supply base are done by trucks. The shipment is then transported by boat from the base to the platform. The offshore foreman is responsible for returning the equipment after the project is completed. It has been a problem that equipment is left on the platform and is not returned to the warehouse.

By now we cannot see any problems which imply that the foremen at the platform do not get what they need. If the offshore foremen do not notify the warehouse manager of what the returned containers contain, the warehouse employees have no control of incoming shipments.

2.3.5 How the information flow is today

After studying the LBO's supply chain we got a better overview of how it really is. The information overview in Figure 7 shows the information flow in a project in more details than Figure 5. It starts when the project manager informs about a new project.

The project manager sends information to the foreman and the purchaser. The foreman decides what kinds of equipment they need offshore to do the new job and sends the order request to the purchaser. If the project needs special products, like prefabricated products, the purchaser sends an order request to the prefab supplier and receives feedback about the delivery time. The purchaser also sends an order request to the warehouse to get information about what kind of equipment they have in stock and what equipment they will have to order from their suppliers. Both the purchaser and the warehouse are allowed to order when equipment is needed in the warehouse, but costly components are handled by the purchaser.

When a container is packed and ready to send offshore, the warehouse contacts a transport company to pick up the container and deliver it at the supply base. Then the containers are sent continuously to the platform and the platform gets information about the arrival time

from the supply base. When the project is done, the warehouse gets information about the return of the container.

The warehouse is apparently involved in every phase of a project. Planning, transportation, purchases and timing all rely on information and performance from the warehouse employees. The warehouse could be seen as a potential bottleneck because many operations in different phases of a project would be affected if the warehouse operations are delayed or not performed well enough.

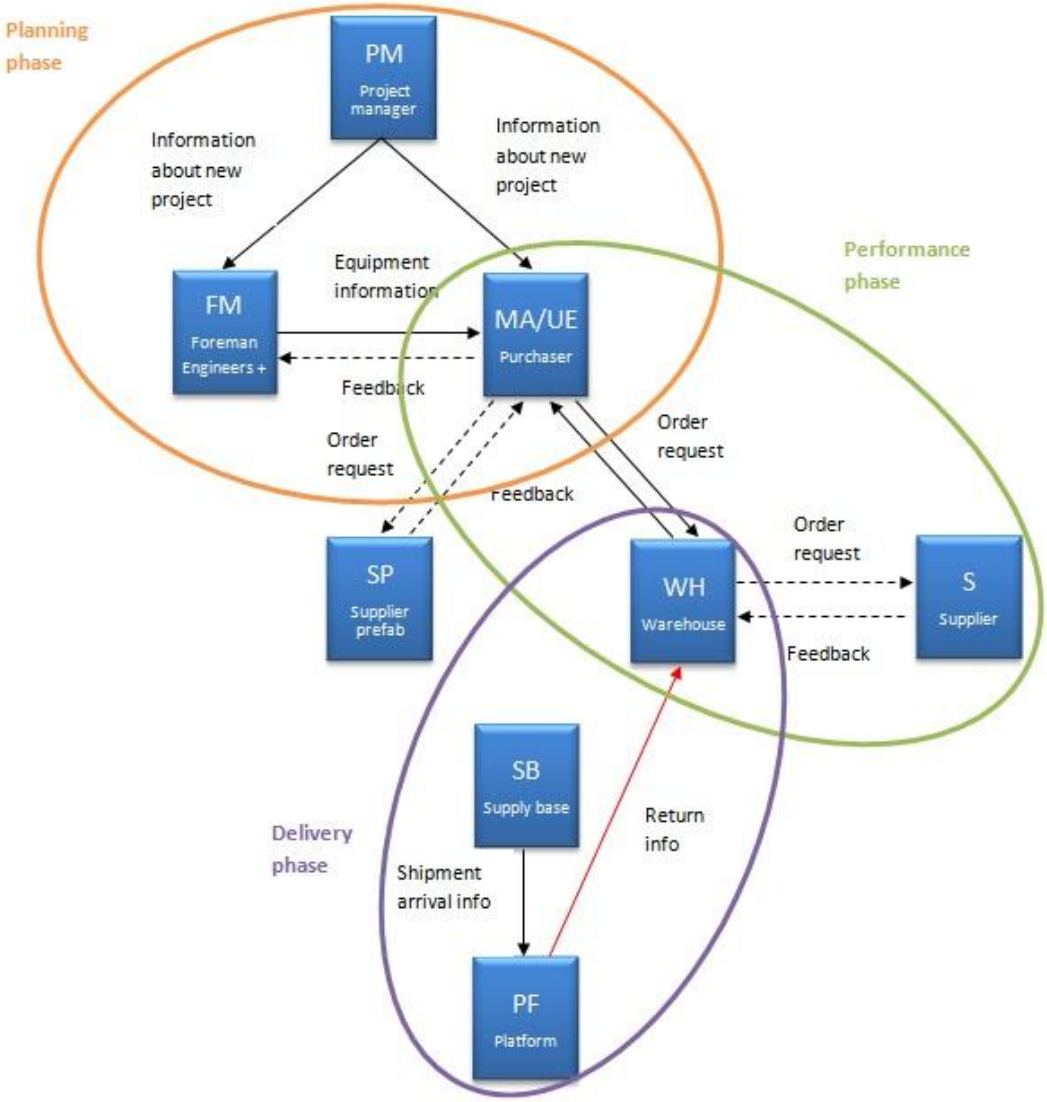

Figure 7 LBO's information flow

Explanation of the figure:

As mentioned earlier, this figure shows the information flow and the arrows symbolize the flow of information.

In this figure there are three different types of arrows: normal arrow, dashed arrow and red arrow.

- The normal arrows symbolize the necessary information flow that exists in a project.
- The dashed arrows show the information flow that might be done in some projects, but only if it is necessary.
- The red arrow symbolizes the return information that is the information LBO gets from the platform about the return shipments. Here the warehouse gets information about when the shipments are sent from the platform and when they can expect the delivery of the returned equipment.

There are also a lot of boxes with abbreviations in the figure that needs to be explained:

- PM - Project manager: the person who is responsible for the project all the way from planning to the final report.

- FM - Foreman: the person who is responsible for the physical work of the project out at the work area. In this case the platform.

- P - Purchaser: have the responsibility of buying equipment that is needed for the project, though only if the equipment is not available in the warehouse. The purchaser also sends the order request to the warehouse.

- SP - Supplier prefab: some projects need equipment that is not standard equipment and the prefab supplier then make these equipment when they receive an order.

- WH - Warehouse: this is the place where all the tools and equipment are stored and where all repairs of equipment take place. Packing and unpacking of the containers are also done here.

- S - Supplier: they deliver standard equipment. The purchaser forwards an order to the supplier and the supplier provides for delivery of the requested equipment.

- SB - Supply base: at this location all the containers arrive before being transported by ship to the platform. This is also an intermediate for containers that need to be transferred back to the warehouse.

- PF - Platform: this is where the work takes place and where all the containers with equipment are needed.

3 WAREHOUSE – AN INTRODUCTION

Up to this point we have described mainly general information, to give an overview and impression of the core activities in the company. In this next chapter we will go more into details and describe specific work tasks as they are performed inside the warehouse today. It is necessary to go in detail to be able to give useful improvement suggestions.

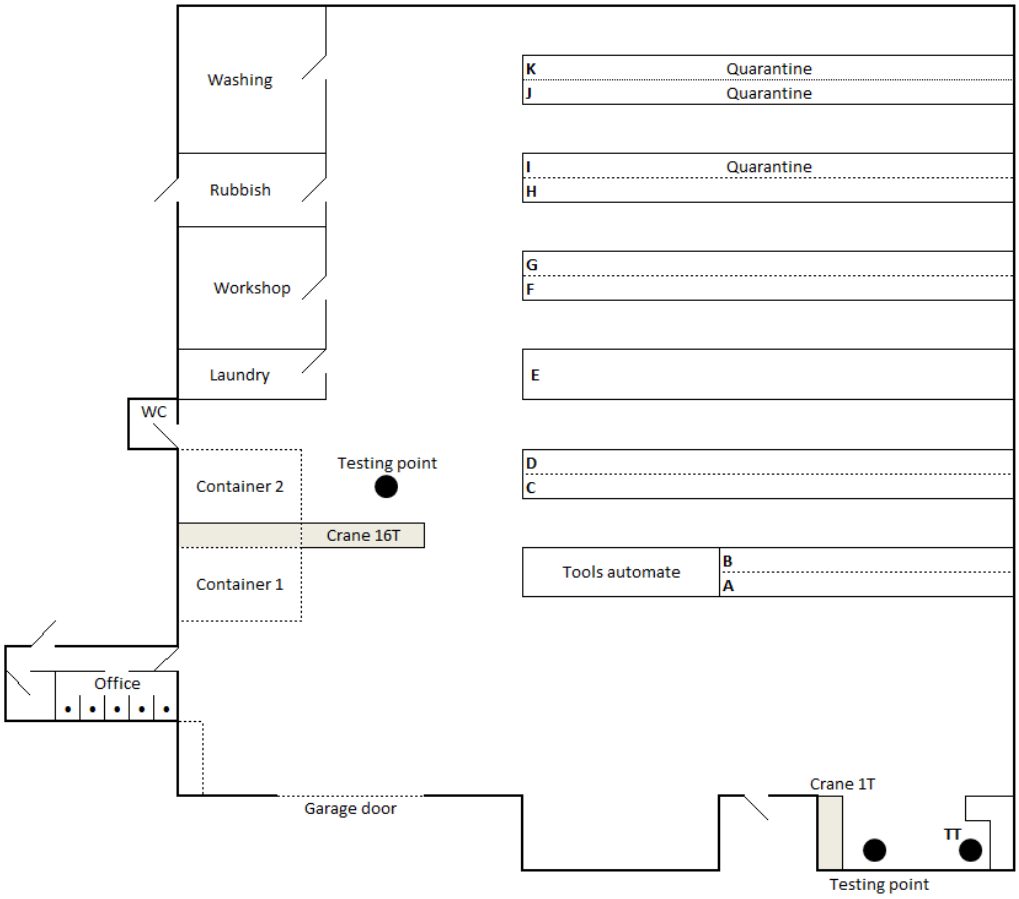

Figure 8 LBO warehouse

LBO's warehouse is located in Molde in the same building as the main office. Today there are six employees working in the warehouse, one of them is the warehouse manager. Their jobs consist of picking, packing and sending equipment and materials requested by the project managers. Control and certification of returned equipment is also one of their main tasks. Returned shipments must also be taken care of. All equipment that is returned from

offshore installations must be washed and tested; the majority of the components must also be certified. Main types of equipment that are stored in the warehouse are; lifting equipment, scaffold used to create long term work conditions in the height, equipment for rope access technique and special equipment developed by LBO for instance radio controlled grip arms, work platforms and other customized devices.

Figure 9 Warehouse shelves

There are two terms that are used to describe the warehouse facilitation. “Quarantine warehouse” which is the three racks at the back of the warehouse, see Figure 8. This is where the equipment that has not yet been controlled is placed. If there is not enough capacity to do the control immediately after unpacking a container, the equipment is placed in the quarantine warehouse. The main warehouse/main storage is the rest of the racks that contain equipment that is controlled and certified and is ready to be picked for transmission. Most equipment is rented to the specific projects from the warehouse, while smaller components and consumables are sold directly to the projects. It is therefore important to empty incoming containers to stop the rent for the projects of the returned equipment.

In the offshore industry there are high standards of safety regarding equipment that is shipped offshore. Equipment that is returned from offshore installations must be washed and then checked and certified before it can be used again. Because the certification

process has not been done on the equipment in the quarantine warehouse, the equipment is not really available for new orders.

We will now present a descriptive analysis of our observations and describe how the processes and work flow in the warehouse is today. A part of this analysis will highlight some of our findings which we aim to improve through recommendations of specific changes.

4 DESCRIPTIVE ANALYSIS (how it is today)

In this section we will first present the different tasks inside the warehouse, to give an overview of the necessary activities that are taken care of by the warehouse employees. Then a presentation of our own observations of their work will be described in Section 4.3.The chapter starts with an illustration of the work flows; one for receiving equipment from offshore installations and one for the outgoing shipment of equipment from the warehouse to offshore installations. These figures describe the work activities based on the information we got from LBO employees and by reading procedures and work instructions.

We have noticed some routines that are very time consuming. In addition to the time consuming routines, they also lay behind schedule.

This situation make the warehouse respond poorly to changes and tight deadlines. Our solutions should aim to help the warehouse employees to get back on track and stay there.

A major challenge in the warehouse today, is the fact that they are not able to keep up with the workloads. Several containers are usually left outside the warehouse because they are not prioritized. To get a better overview, there would be sufficient to obtain some numbers of the current turnover rate. This means the turnover rate from the time the equipment arrives at the warehouse, until it is ready for use again. However, this was not possible to obtain because it depends on the need of different equipment at the specific time. It is then difficult to have exact information by numbers.

Because of the lack of information, the purchasers sometimes buy new equipment they actually do not need. There is a possibility that the requested equipment is not unpacked

from a container. As long as the container is placed outside the warehouse, the employees have no possibility to check the content electronically. We want to make adjustments that they can manage to handle their tasks in a way that make them keep up with the workloads and to be more cost efficient. By cost efficient in this setting we mean to avoid; costly transportation by being capable to handle orders on time, overtime for the warehouse employees to deliver on time and waste of time on unnecessary activities.

4.1 Main warehouse activities

In this chapter we will look further into how the warehouse activities are carried out according to LBO's procedures and preliminary interviews with the administration.

Workflow - outgoing shipment

As we can see from the Figure 10 and according to Appendix A, there are four main activities within this workflow, starting with picking of equipment.

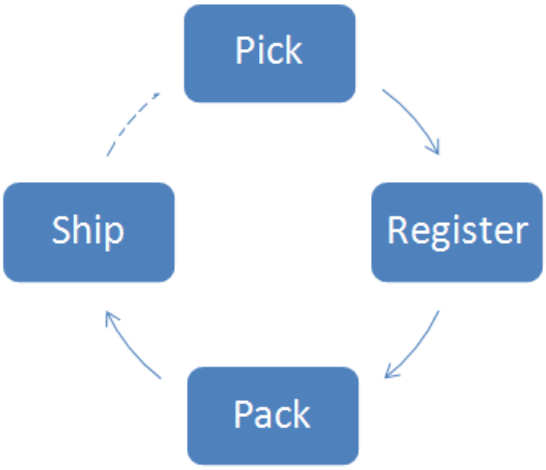

Figure 10 Workflow outgoing shipments

Workflow - incoming shipment

The workflow of incoming shipments is more comprehensive and includes more activities than the outgoing shipments. The workflow of incoming shipments is, according to Appendix B, illustrated in Figure 11.

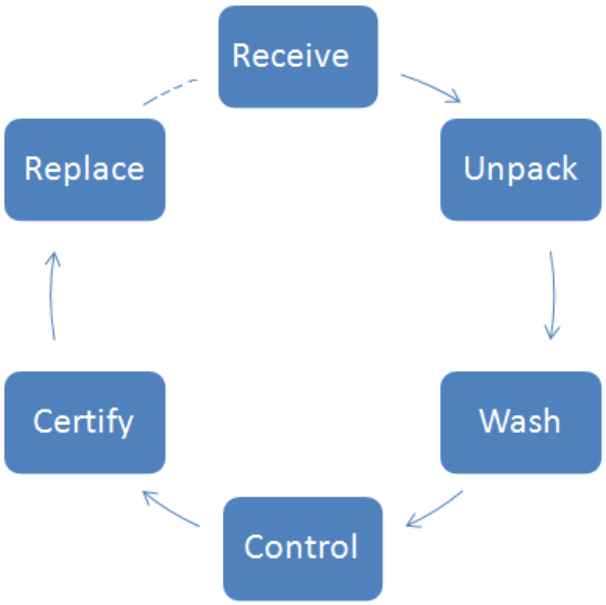

Figure 11 Workflow incoming shipment

4.2 Explanation of the figures

First we will give a short introduction of how the warehouse employees gets the information they need to start the picking of an order.

The warehouse employees receive order lists from the project department, through the ERP system. They print the order list and go out to the warehouse to check if the items on the list are in stock. This is necessary because they do not have an updated system where they can check availability. If the requested items are not in stock, the warehouse manager has the authority to purchase the missing items, as long as the items are not very expensive.

- Picking and packing items

If the requested items are in stock, it is picked from the main storage and placed in the container. In addition to the actual equipment on the packing list, all certificates must also be printed and shipped together with the container. Equipment with serial numbers must be registered in the system and marked with the color of the year before it can be packed and sent. The equipment that has a unique serial numbers is lifting equipment and RAT (Rope Access Technique) sets. All equipment with unique serial number has certificates that must follow the equipment. Without this documentation the warehouse cannot send the

equipment offshore. All documentation that belongs to the equipment in the container are printed out and placed in a binder inside the container.

- Registration

All lifting and RAT equipment and other equipment with unique serial numbers that are picked to be a part of a shipment must be registered in the ERP system. This registration gives the opportunity to find out where each item is sent. All serial numbers are noted when the employees pick it from the shelf and are then registered in the ERP system connected to the right order.

- Transportation arrangements

When containers, or smaller units like pallets, are ready to be shipped, somebody must arrange transportation to the supply base. Everything is shipped by truck, mainly by one or two companies. Everything that is sent from the warehouse must be marked with the name of the final destination and which company it belongs to. This information is printed out, placed in a waterproof folder and attached to the shipment. The date of when containers must be on the supply base is important, and must be agreed with the shipper to get on time. If the carrier is given a short deadline, LBO must pay a higher price for the transport. Since this is costly it is important to send a request to the transport company early.

- Receive shipments

When a container is shipped from an offshore istallation to the warehouse the offshore foreman sends an e-mail to the warehouse manager with a list of the equipment that is returned to the warehouse (also see Figure 7). After the shipment arrives at the warehouse, the employees in the warehouse must register all received equipment in the computer system.

- Unpack returned containers and make registrations of returned equipment and materials

If the list e-mailed from offshore is not accurate, this error results in an extra check for the warehouse employees, because the employees have to go through the container and register all returned equipment. When they check the returned shipment they use the original order list and set a mark for every item that is returned. This is very time consuming because they must find the right line with the right serial number and match it

with the printed number on each item. All this information must be registered in the ERP system; the warehouse employees takes the data from the handwritten sheet and enters it into the computer system.

- Wash and oil equipment

When everything in the container is checked against the equipment list, all the reusable equipment and materials are moved to the washing area. Everything is washed and they also oil the equipment if that is necessary. The equipment is located in the washing area until it is dry and can be moved. Two things can be done with the equipment after it has been washed; it can be put in the "quarantine warehouse" until somebody have time to perform the inspection, or it can be moved to the certification area for instant control and certification.

- Control, reparation and certification

Lifting equipment such as hoists, shackles and chains as well as RAT equipment must be controlled and certified in accordance to Appendix C. Everything that is placed in the "quarantine warehouse" must pass a control before it can be placed in the main storage area. Every type of equipment has a control form based on procedures that must be followed by the controller. In some of the test areas there are computers available for the controller to verify the control form on the computer immediately. In other control areas, the employees need to use pen and paper before they enter the information on the computer. During the control sequence it may be necessary to make some reparations to ensure that the equipment meets the standard of the certification. When the equipment has passed the certification, a sticker is placed on the equipment, showing which month and year the equipment was certified, this according to Appendix D. All equipment that has a unique serial number also has a physical certificate that must follow the equipment when it is sent offshore.

- Replace certified equipment

After the equipment is controlled and ready to be used again, the employees must place the item in the main warehouse. First they pick up the certain equipment in the washing area, mainly by truck, and unload it in one of the testing areas. After the testing and controlling is finished the pallet of equipment is moved to the right location in the main warehouse. Different equipment is transported to their dedicated locations in the warehouse. The

warehouse employees know in which location most of the equipment belongs, but if there are some components that are rarely used they can check the location in the ERP system.

4.3 Observations

In a period of ten days we stayed in the warehouse together with the workers and thoroughly examined how they carry out their work. While participating in the warehouse, we did a lot of observations of how everything is done and how a normal day is in the warehouse.

We observed what the warehouse employees did throughout their work day, in order to determine the proportion of time they used on the different activities. We observed the activities and the amount of time on each activity for two employees each day.

Further in this chapter we will focus on two terms that is central in the Lean philosophy; Value adding activities and non value adding activities. These terms are crucial to detect in order to eliminate waste in the process.

Value adding activities:
From our observations we have twelve different types of activities. We divide the different activities into 2 groups; value adding activities and no-value adding activities.

The value adding activities in this case are:

- Inspection/repair of lifting equipment
- Inspection/repair of RAT equipment
- Cleaning of equipment
- Packing

There are more no-value adding activities than value adding activities.
These non value adding activities are:

- Office
- Retrieve and replace
- Other encumbrances
- Telephone

- Open door/reception or transmission
- Help hired workers
- Small talks
- Various odd jobs

All these non value activities absorb resources, but they do not make any value for the customer or the company. Therefore LBO will do better if they are able to reduce as much as possible of these non value activities and maybe replace some of them with value activities.

Our analysis will focus on improving efficiency by doing things right and effectiveness of doing the right things. Since LBO delivers both short run and long run projects, it is important that we consider both situations in our improvements (ref. Chapter 6.1)

In total we observed three different employees. It was only three LBO employees working in the warehouse these two weeks, because one was currently dedicated to work with the new ERP system and its implementation, and another employee was on sick leave. There were additionally 2-4 hired helpers who handled the small jobs. Various small jobs include cleaning, moving and washing of items and in addition emptying containers and all activities related to this.

The results of the observation:

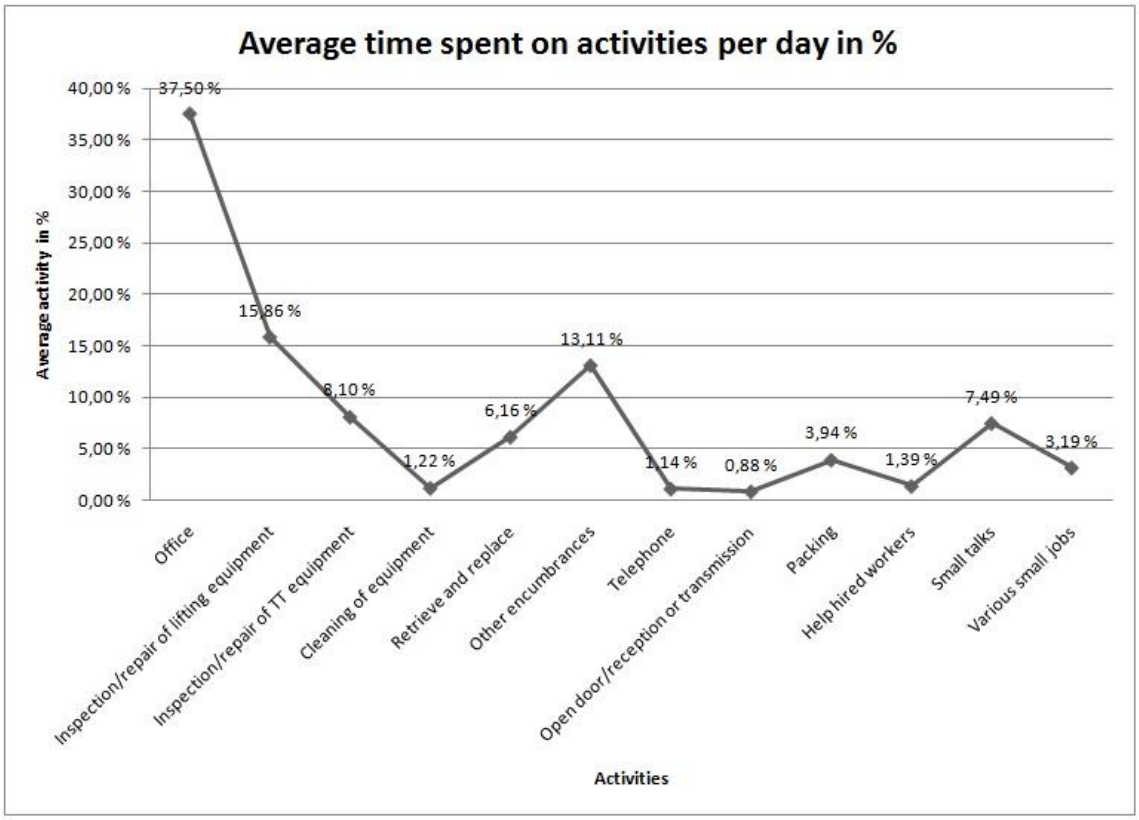

Figure 12 Average time spent on activities per day in %

Due to different reasons the observation period per day varied, but all numbers are based on the average working hours these two weeks. After ten days of observations, we got a real insight on which activities are executed /carried out in the warehouse. To analyze further, we divided the observations into twelve activities. The numbers presented in Figure 12 are the average times each employee worked with the specific activity each day in percent.

The warehouse employees are supposed to have 30 minute break during a day. They are working from 8.00 am to 16.00 pm and get paid for 7.5 hours.

The reader will recognize some of the same headings as in Section 4.2, but in this section we will describe the activities based on how the warehouse employees performed the activities during our observation period.

4.3.1 Office

This activity implies registration in the ERP system of the equipment that:

- is going to be packed in a container and be shipped offshore

- has been returned from the platform
- is controlled and have to be moved from the quarantine warehouse to the warehouse

They also have to print the order requests and print certificates of the equipment in the office.

Each of the warehouse employees have their own work desk with computers, located in the same room/office. All breaks are spent in this room in front of the computer.

Office work is according to our observations the most time consuming activity; actually it consumes as much as 37, 5 % of their time. In some periods all employees were located in the offices and nothing was going on in the warehouse. We did not observe exactly what they were doing on their computers but we suspect that some of the time was not productive/work related.
The management has installed a couple of computers inside the warehouse. These are supposed to be used for controls so that the employees do not have to leave the warehouse to do the registration. We noticed that these computers were never used. They listed the numbers of all equipment they controlled and then took this handwritten sheet in to the office and began the registration. Most of the registrations require the serial number to be entered; this is a long number with both digits and letters. Since this number has to be entered several times, it is a high risk of errors.

We also suspect that they use more time on the computer when they sit in the office, than they would if they made the registrations on the computers that are placed in the warehouse.

4.3.2 Cleaning of equipment

Cleaning the equipment before inspection or repairs is performed in this stage. This is mainly because of all the salt water that corrodes the equipment. When the container is emptied, the first station is to wash all of the equipment before it is moved to the quarantine storage or control area.

Figure 13 The cleaning area

The different items are hanged up or placed in convenient positions in the washing area and then hosed off. In our observation period, this task was dedicated to the hired helpers, so LBO personnel used little of their time on this task, actually only 1.22 %. We realize that this activity will take a larger percentage of the warehouse employees' time when no hired personnel are available.

4.3.3 Inspection/repair of lifting equipment

The inspection and repair of all the lifting equipment they use offshore is included here. In one of the warehouse procedures it is stated that at least two employees should perform controls of equipment, both lifting equipment and RAT equipment. There are three stations where control of lifting equipment can take place. Depending on the different items they control they can use cranes and test stations to perform testing, oil up and make necessary repairs to verify the equipment. In the two-week-period we were observing the activities within the warehouse, it was a very short period of time that two persons were controlling equipment at the same time. This observation is according to Appendix E a deviation from work instructions from the management. The problem is not that two employees do not control simultaneously, but it tells us something about how they are interrupted. Generally we saw that they were very often distracted in their work, so the time they worked continuously with controls was quite low. At average they used 15.86 % of their time on control of lifting equipment. It is very important that all the equipment that is shipped from the warehouse is 100 % safe and works properly. Consequences of delivering equipment

that is not 100 % safe; is in worst case, injuries or death, poor or delayed work and bad reputation for the company and economic loss. All the disruptions could be a factor that influence the quality of the controls and should be avoided.

4.3.4 Inspection/repair of RAT equipment

All the inspection and repair of RAT equipment belongs to this category. RAT equipment is what offshore personnel use when they are climbing offshore. One test station is dedicated to the control of RAT equipment. Ropes, carbines and other components are checked mainly by hand and without other aids such as cranes. There are not so many repairs on these equipment; if a rope is damaged it is discarded. Even though one can save some time on repairs, it is a lot of different and small components that must be checked and it is time consuming. This activity had lower percentage of work hours than the control of lifting equipment; actually only 8.10 % of their time is spent on control of RAT equipment. In this activity we observed the same as for lifting equipment, that the controller was very often distracted so the continuous work with control was quite low here as well. The distractions were to an extent caused by others, but a lot of them were also self-inflicted. The consequence of errors in the control of RAT equipment could potentially be life threatening and all types of interferences should be kept to a minimum.

4.3.5 Retrieve and replace

This includes all the activities they do while retrieving and replacing equipment that is going to be repaired, or equipment that has been repaired. Equipment must be moved several times; from the container to the washing area and then to the quarantine warehouse if they are not able to do the control at once. From the quarantine warehouse it must be moved to the test areas and then back to the main warehouse or directly to a container. The relocation of equipment is done by use of truck or pallet jack.

6.16 % of the employee's times are spent on this activity of moving equipment from place to place. The number of different locations of equipment should ideally be as low as possible. The time of finding, loading, unloading and moving different items are time they could spend on more productive activities.

4.3.6 Other encumbrances

These encumbrances are interruptions they get while performing their daily tasks. Encumbrances we noticed which interrupted their work were; meetings, examiner in the training center, personal affairs, people coming in to talk with them (salesmen or other LBO employees coming in for a talk or to get help). 13.11 % of their time is spent on encumbrances; this is no productive time so the manager should assure that this activity is reduced to a minimum.

4.3.7 Telephone

Incoming calls causes interruptions from the work when the employees answer. Each employee has their own cell phone and answers the phone wherever they are. Our observations were that all the time they spent talking on the phone was due to calls they received.

All in all, they did not use much of their time on the phone. As we can see from the illustration, less than 2 % of their time is spent on talking in telephone. The average number of incoming calls per worker per day was only 1. We have also counted the number of incoming calls because this is very important since this creates a disturbance / distraction / interruption even for short conversations. This seems not to be a critical or time-consuming activity.

4.3.8 Open door/reception or transmission

These are the interruptions they get from the visitors from transport companies while receiving or sending equipment. Salespeople and other visitors that need to get into the warehouse are also included in this category. Even though they spent less than 1% of their time per day on this activity, it causes a lot of interruptions in their work. When they get visitors, one of them must leave their station to let them in. We observed that this interruption often led to longer breaks from their task, caused by conversations with the visitors or coworkers. If we only look at the fraction of time they used on this activity we will not consider it important, but the number of interruptions from their work and the fact that this interruption seem to lead to longer breaks makes it interesting.

4.3.9 Packing

Outgoing shipments is mainly sent in containers. This activity is based on a packing list. Each item on the list must be taken from the storage and packed in a proper way to be shipped in a container. All lifting equipment must be shipped with a certificate for the unique serial number on the item. All certificates are organized in a binder that is shipped along with the equipment in the container.

Because of the restriction with the certificates, the warehouse employees must take notes of each serial number they place in the container and then go to a computer and print the right certificates. Some components are stored in pallets, some in shelves in the container and some are hung up inside the container. In our observation period this activity claimed 3.94 % of the warehouse employee's time. This is excluding the time they used on printing certificates and manuals, because this time is included in the "office" category. The time used on this activity is of course related to the orders coming in from the projects, so it can be high in some periods and low in other.

4.3.10 Help hired workers

Helping and training of hired personnel in the warehouse has lately been added as an extra activity for the warehouse employees. Local offshore employees are told to come and work in the warehouse when there is a lack of jobs offshore. When a job offshore comes up, these employees leave the warehouse again. This situation result in a number of various employees coming by, and naturally the length of their stay varies. Lately some help are hired from other companies as well, but usually just for a few weeks at a time. A result of the variation in the work force is that the warehouse employees must use some of their time to instruct and teach these "drop-by" workers. It is also difficult for the warehouse manager to plan how much capacity to rely on because they can be called offshore in one-day notice. In our observation period, the time spent on training hired personnel was only 1.39 %. This is however not quite representative since our observations was done in the middle and end of their period, and the training of such personnel is necessarily taking place in the beginning of the period.

4.3.11 Small talks

This includes discussions and disreputable talks between the workers. These small talks are often small job related discussions that turns out in disreputable and non-job-related

discussions. Conversations and discussions with salesmen and project managers are also considered as small talks. 7.49 % is the fraction of time the employees spent on small talks. In addition to the time spent on talking, these talks also represent an extra interruption of their work. From our observations we have calculated the number of interruptive talk between coworkers to be in average 10 per day. This means that some of the employees are disturbed more than once an hour. Conversations with other visitors are in addition to this.

4.3.12 Various small jobs

These various small jobs are small jobs that have to be done; such as cleaning, clearing and other necessary small tasks. Warehouse employees randomly do these tasks when they see it is necessary.

According to our observation period, these various small jobs took 3.19 % of the employees' time and are not considered a critical activity.

4.4 Findings

- **Lack of certified equipment;**

The first problem area we observed is that equipment seems to build up in the quarantine warehouse. Instead of controlling the equipment that is returned to the warehouse they just wash it and place it in the quarantine warehouse. The warehouse employees do not keep up with the controls, which leads to a full quarantine warehouse and a lack of equipment in the main warehouse. In today's situation they often face that they have to go to the "quarantine warehouse" to get items on the order list, then certify it and put it directly in the container. This way the equipment is never in stock before it is sent offshore again. This leads to several disadvantages. A major disadvantage is; when a new picking list is received they cannot just go and pick the items from the warehouse shelves. They must go and look for the item in the quarantine warehouse, which can be time consuming because everything is placed randomly. The items must then be controlled before it can be picked to the container. This work process makes the picking and packing more time consuming than if they just could pick the right item from the shelf and pack it directly into the container. This is not optimal when LBO wants to take on more special projects with tight time limits.

It is probably also the case that some of the equipment which is in the quarantine warehouse must be discarded or repaired. A result is that new equipment must be ordered, and then the lead time may be problematic if they do not notice this before the equipment is needed.

- **Inefficient use of personnel;**

The fact that all extra help from hired personnel and LBO offshore employees, just include washing and moving equipment to the quarantine warehouse, is not optimal. This will of course give the warehouse employees more time to perform controls, as they do not have to spend time on washing and empty containers. Extra help on controls would have had a more positive effect through getting more equipment to the main warehouse, and shorten the picking phase. But to do this work, the employee need to be an approved inspector, so it might be better for the company to hire a full-time employee.

- **Poor leadership;**

Another area of improvement we noticed is concerning the warehouse employees. In our observation period there was a lack of leadership in the warehouse. Each employee seemed to be self managed and they decided which activity to prioritize themselves. We also got the impression of low motivation and a sense of despair of never getting the chance to get ahead of time.

- **Time consuming manual operations;**

As a part of our observation we also took the time to empty a container to get first hand information of how this is handled and to get an idea of how this process could be improved. Our main observation here was that the majority of the time spent on this activity is used on looking for serial numbers. First we must look all over the item to find the serial number, which in some cases is faded because of corrosion. When we have found this number, we must search in the packing list which is attached to the container to find the matching serial numbers. Every item that is returned to the warehouse must be registered in the system and this is a manual operation which is very time consuming.

In all manual operations it is room for errors, and especially when there are so many different items with complex serial numbers.

After our observations we found that the figures we presented in Section 4.1 are actually not representing the real work flow. We have therefore adjusted these in accordance with our observations so that they now show the "real-life" process:

- **Workflow incoming shipment - revised**

Here, in Figure 14, we illustrate that after incoming equipment is received and washed, it is not instantly controlled and certified, but instead placed in the quarantine warehouse.

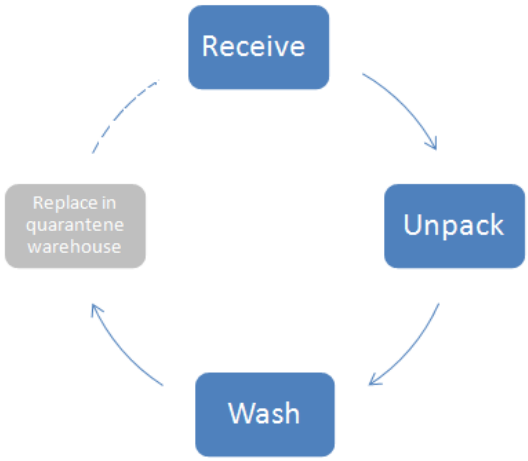

Figure 14 Workflow incoming shipment

- **Workflow outgoing shipment – revised**

The changes in the activities regarding the incoming shipments result in changes related to the outgoing shipments as well. Instead of picking the items from the warehouse shelf, the warehouse employees pick the items from the quarantine warehouse and must first control and certify the equipment.

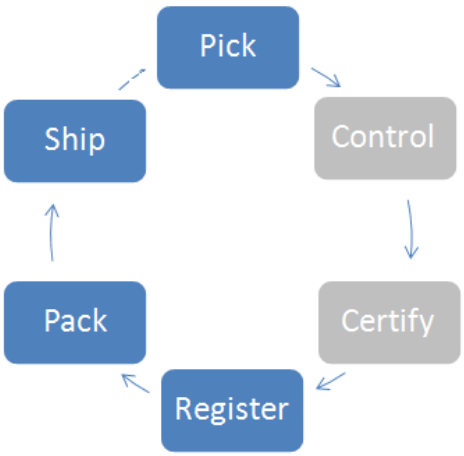

Figure 15 Workflow outgoing shipment

If we compare these “real-life” figures with the previous “normative” figures, we can see that the outgoing shipments in reality have more activities involved which indicates that this process is more time consuming. On the other hand the number of activities involved related to incoming shipments are now reduced because “control” and “certification” is moved to the outgoing shipment activities.

This means that the time saved on the receipt, is the use of longer transmission time and more ineffective time.

Even if this saves time in the short run when a shipment is received it is clearly not an optimal solution for the long run. To move the control of equipment to a later stage is only to postpone the problem. The current routine of just emptying the container and place equipment in the quarantine warehouse make it possible to empty containers and stop the rent on equipment even when there is no time to carry out controls. However there are several negative effects of this quick solution. The time to complete an outgoing shipment will be longer than if the needed equipment was ready to be packed. To be able to deliver on time, there will be higher pressure on the warehouse employees to focus on the specific shipment. Consequences of this could be overtime and neglect of other duties. This conflicts with the company's goal; to deliver the project quickly and be flexible.

Figure 16 Returned containers from offshore

Complete overview of the warehouse operations as they are today:

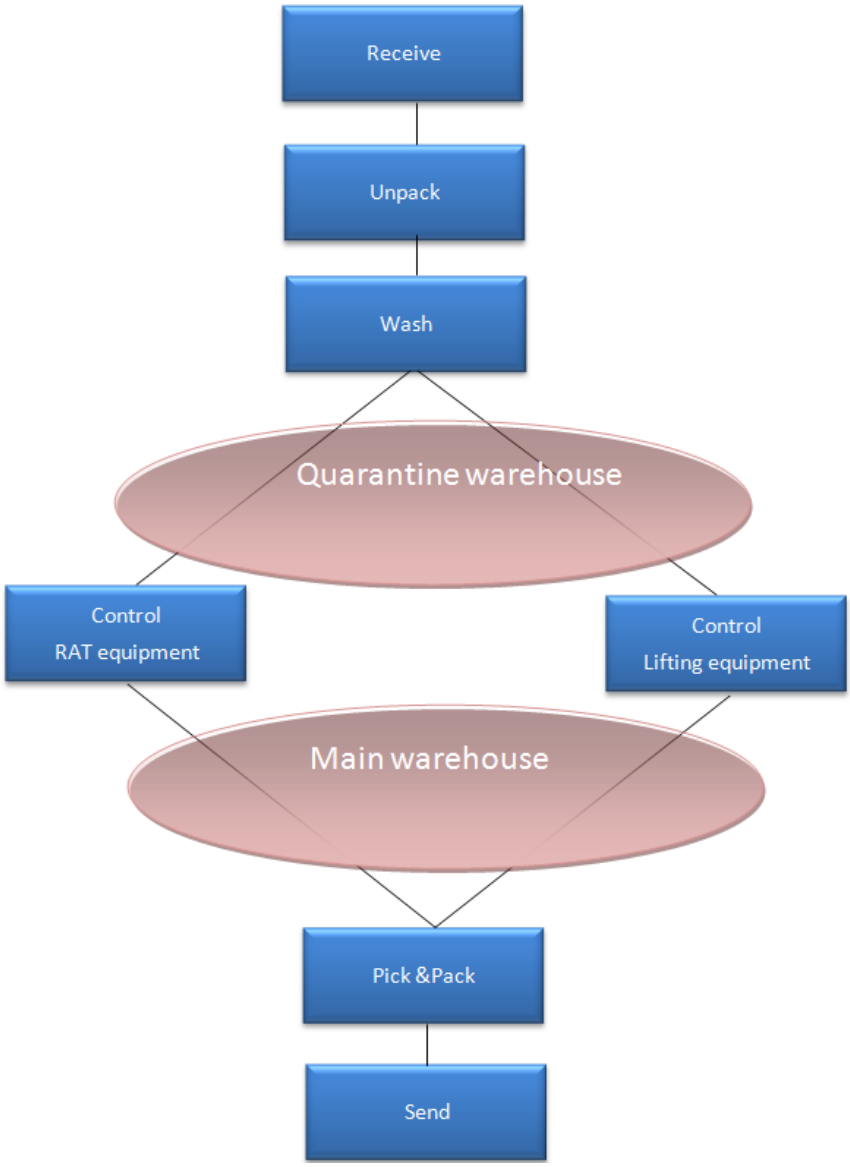

Figure 17 Warehouse operations

Figure 17 illustrates how the warehouse activities actually are carried out and how the material flow is. The blue boxes are each of the main activities involved in the warehouse process while the red areas show where equipment is stored between activities.

5 THEORY

In this chapter we will present different theories that we will use in our analysis to suggest improvements. The main theory that we base most of our statements on is Lean.

According to our problem formulation, our goal is to improve the warehouse logistics. We think that the value of lean which focus on increasing the customer's value and decrease waste in the process will fit our approach well.

5.1 Lean

"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.org Website, 2009)

5.1.1 The philosophers behind Lean

There are several important philosophers that through the years have contributed with theories and studies that have developed into Lean. We will look closer into some of these in this chapter.

Frank and Lillian Gilbreth (1868-1924, 1878-1972) and their Therbligs:
These philosophers formed the basis of Lean with their redesign approach.

Figure 18 Frank and Lillian Gilbreth (Gilbreth network website, 2000)

According to Gilbreth network website (2000), the Gilbreths started with motion studies in the early 1900s. Frank observed brick layers and discovered that each individual developed

their own techniques and methods. These observations led him to seek the best way to perform tasks and reduce motions involved.

Frank and Lillian continued with their motion studies and as a part of it they developed the term "therbligs". Therbligs is the fundamental elements in a work structure.
Therbligs are used to qualify the parts of processes (operations) to find out if they add value or not, if they can be avoided or not.

The Therbligs:
- Search - Transport loaded
- Find - Transport unloaded
- Select - Pre-position for next operation
- Grasp - Release load
- Hold - Unavoidable delay
- Position - Avoidable delay
- Assemble - Plan
- Use - Rest to overcome fatigue
- Disassemble - Inspect

(The Gilbreth Therbligs Website, 2000)

The most important Therbligs are the "value adding Therbligs". These Therbligs are the activities that create value in the operation.

There are 3 categories:

- Assemble (Put together, join, connect, pack and attach)
- Use (Reshape, transform, change, utilize)
- Disassemble (Take apart, cut, disconnect, unpack, detach)

All the other activities are no-value adding activities.
(Aas, 2009)

Further work will focus on analysis of processes to look for possible changes to reduce the number of non –value adding activities.

Frederick Winslow Taylor (1856-1915) with his Taylorism:

According to Netmba website (18.03.2010), Frederick Winslow Taylor published his first work of "The principles of scientific management" in 1911. His philosophy was based on the goal of reducing process times, also called Taylorism or the stopwatch approach.

Figure 19 Frederick Winslow Taylor (Resource systems consulting website, 2011)

"The principles of scientific management" describes how process times can be reduced and productivity increased through training of the workers to perform in the best way. Through time studies Taylor found that workers must be trained how they should work to be most efficient, workers who lead them self would rarely have the same productivity.
After years of studies and experiments Taylor presented four principles of scientific management:

1. Replace rule- of-thumb work methods with methods based on a scientific study of the tasks.

2. Scientifically select, train, and develop each worker rather than passively leaving them to train themselves.

3. Cooperate with the workers to ensure that the scientifically developed methods are being followed.

4. Divide work nearly equally between managers and workers, so that the managers apply scientific management principles to planning the work and the workers actually perform the task.

(Netmba Website, 18.03.2010)

Differences between Taylor's and Gilbreth's approaches:

There are two approaches that represent the main difference between these two philosophers, these are the stopwatch and the redesign approaches.

Taylor was more unilateral focused on bringing down the time on different activities, thus the stopwatch approach. On the other side, Gilbreth was more focused on redesign as a agent to, among other things, bringing down the time on activities.
(Baumgart.A, Neuhauser.D, 2009)

Henry Ford (1863-1947) with mass production and his Fordism:

Henry Ford was the first person that implemented mass production or Fordism/ the assembly line approach; as the way of production and working method is called.

Figure 20 Henry Ford (Auto evolution website, 2008)

He integrated this strategy in an entire production process which he called flow production. With this process he produced components with short throughput time and perfectly fitted for the other parts of the vehicle. To keep up the high process time, the variety of the product was kept to a minimum. Therefore he always kept standard designs in production for as long as possible, without changing over to a new product. Changing over to a new product is costly for the company.
In this way Henry Ford's strategy is one that is leading to the Lean strategy.
(Womack, Jones, Roos. 2007)

Taiichi Ohno (1912-1990) with his Toyota production system:

Figure 21 Toyota (Jm autodeler website, 2011)

After world war II, Toyota looked into improve this process to handle a higher number of variety as well. This led to the Toyota Production System. (Lean.org Website, 2009)

In 1950 Taiicho Ohno went on a pilgrimage out to different Ford plants to investigate how they did their production and try to find a better way to do it. Ohno knew he needed a new approach and he implemented his thoughts in the Toyota production and this strategy became Lean.
To avoid the high costs, Lean manufacturer combines the advantage of craft and mass production.
To reach this goal, lean producers employ multi-skilled workers. They do this at all level of the organization. They also produce quantities of products in enormous variety with better and more automated machines.
(Womack, Jones, Roos, 2007)

Toyota found several actions that could be taken to obtain low cost, high variety high quality, and very rapid throughput times to respond to changing customer desires. These goals could be achieved through right-sizing machines for the actual volume needed, introducing self-monitoring machines to ensure quality, lining the machines up in process sequence, pioneering quick setups so each machine could make small volumes of many part numbers, and having each process step notify the previous step of its current needs for materials.

(Lean.org Website, 2009)

According to consultant Taiichi Ohno there is eight kinds of waste (Ackerman, 2007):

- **Overproduction:** there will be too much inventory in the warehouse that will take much space and then it is categorized as waste. With overproduction there will also be waste of materials.

- **Waiting:** this is waste of time, especially if we are talking about working in warehouses.

- **Motion:** if there is unnecessary movement of cargo, there is a waste in materials handling.

- **Over-processing:** when a company produces more that necessary, there will be a waste in production.

- **Poor inventory control:** in this case there is always a risk of those stock-outs is frequent and this will then lead to waste.

- **Unproductive movement:** when workers need to be involved in hunting for missing equipment or materials, it is a waste.

- **Defective parts:** an error in delivering or receiving of goods or equipment results in a waste in manufacturing.

- **Unused employee creativity:** this will always be a waste for the company.

5.1.2 Lean value stream

The lean value stream is essential because; the observations and identification of activities within the value stream is the basis of our work.

By thinking Lean, most of the focus is at the customer and according to Kerber.B, Dreckshage.J.B (2011) there is five Lean principles:

- *Specify what creates value from the customer's perspective.*
  The company has to look at the situation from the eyes of the customer and find out what the customer are willing to pay for the good. Then they must examine what they have to offer.

- *Identify all steps across the whole value stream.*
  In a company there is 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*.
  In this principle, the goal is du 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.

When activities and challenges throughout the value stream are identified this next theory about TQM will help us with actions that are useful to be more cost efficient.

5.1.3 TQM - Total Quality Management

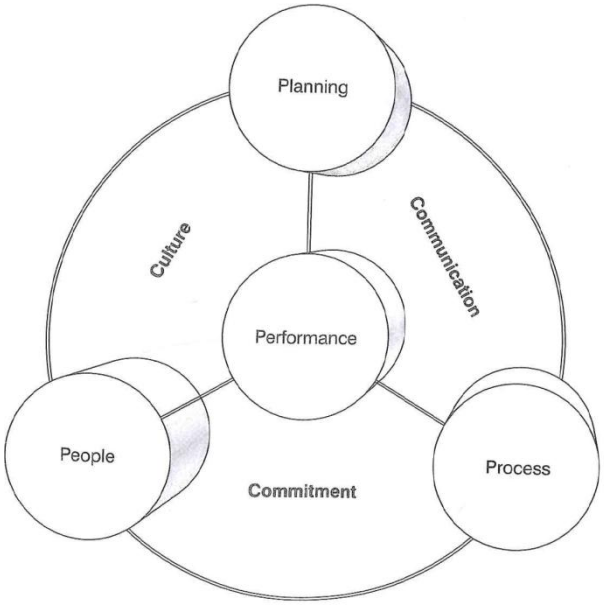

Figure 22 Total Quality Management (Oakland, 2003)

In the early 1980s organizations began to take interest in quality and how to manage it. During this period a variety of lists and framework were constructed to help with this process. In the same period the understanding of "Total quality management" developed. TQM approaches were linked to direction, policies and strategies of business or organizations. These approaches were then gathered as a basic framework in the TQM model (Figure 14). "The key was to integrate the TQM activities, based on the framework, into the business or organization strategy" (Oakland, 2003).

TQM is related to Lean because these two different concepts are built and influent of each other. For Lean management to achieve their objective, we can say that they are using the TQM as one of their prime tools.
(Lean manufacturing concepts website, 2008)

TQM is an approach for organizations to improving their competitiveness, effectiveness and flexibility. The approach is a way of planning, organizing and understanding each activity, and depends on each individual at each level. TQM is also a way to eliminate

duplication of work and unnecessary time consuming efforts by including everyone into the process of improvement, so that results are achieved in less time (Oakland, 2003).

The four P's and three C's of TQM

- *Planning:* The development and deployment of policies and strategies; setting up appropriate partnerships and resources; and designing quality.

- *Performance:* Establishing a performance measure framework - a "balanced scorecard" for the organization; carrying out self-assessment, audits, reviews and benchmarking.

- *Process:* Understanding, management, design and redesign; quality management systems; continuous improvement.

- *People:* Managing the human resources; culture change; teamwork; communications; innovation and learning.
(Oakland, 2003)

The three C's; culture, communication and commitment are looked at as the "soft outcomes" compared to the "hard management necessities" in the P's. The TQM model is not complete before these soft and hard constraints are integrated and can successfully improve organizations.
(Oakland, 2003)

While TQM is an approach to assure quality within the company, the next term we will introduce is an extension to this. It is a way to ensure continuous improvement. If the warehouse achieves better results after implementing a new strategy, they should not settle with this, but aim for event better result for their next project.

5.1.4 PDCA cycle

Figure 23 PDCA cycle (Project steps blogspot website, 2009)

In business processes the most important is the customer's satisfaction. And this cycle makes it easier for the managers in a Lean management to analyze the activities step by step, to find out where the problems lies in the process and make changes to achieve better results (Sherratt, Nicholson, Meek, 2009).

"Continuous operation of the PDCA cycle is very important in creating a lean organization. This technique will be used to attack the inefficiencies or the wastes of the organization in its lean journey"
(Lean manufacturing concepts website, 2008).

The different steps in the PDCA cycle:
Plan: At this stage, the management discovers an opportunity to improve and begin planning a measure /different strategy.

Do: The new strategy/change is implemented at this stage, and the performance for this implementation is measured.

Check: This stage is the analysis stage, where all the results is identified and we realize what you have learned in relation to future prospects.

Act: Here the management does actions based on what they have learned. If the improvement did not get better results, start all over again in the beginning of the circle. If the improvement was successful and the performance good, we implement these changes and intend to make these even better. Then start at the first step in the circle again (Tague, 2005).

According to Tague (2005) there are some situations, when it is good to use the PDCA cycle in a business process:

- It is good to use it as a template for further improvement.
- If a new improvement project is supposed to be started, it is wise to start with the PDCA cycle
- When there is any change to implement
- When there is a repetitive work to define
- Actually always when there is any change that is going to be implemented

As we can see the PDCA cycle is a tool that is under TQM, thus a concept that originates from the Lean philosophy.

TQM is an approach to ensure quality but while we are thinking Lean, we need to know how the managers should manage the company and the employees. The next section tells us about this kind of management.

5.1.5 Lean management

Most of the Lean processes focus on manufacturing businesses, but the theory can be applied to service businesses like Linjebygg Offshore as well, and the effectiveness can be just as effective as in manufacturing. This will be the warehouse manager's responsibility to carry out in the warehouse department.

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

- *Involve the people who do the work.* Make them understand their work process in terms of value-added and no-value-added activities. Before you can teach them this

you should introduce them to the sources of wastes so they can be able to recognize wastes in their own work processes.

- *Focus on identifying and eliminating Non-value-adding work people do*. Make the involved employees describe the activities their job includes and decide which of these activities are value adding or not.

- *Look for and formalize best practices and turn them into repeatable processes.* In workplaces where there are many stations, employees or locations and practices can develop in different directions. Same process, but different quality of performance. Do a research and identify the best practice and pass this on to the other.

- *Look for opportunities for cost reduction in the infrastructure.* It is easy to get the main focus on the front end like the service of the products the customer purchase. It can then be difficult to give focus to the infrastructure that is necessary to be able to deliver the particular service. It is important to assess the infrastructure from time to time.

- *Recognize interfaces with technology.* It's more difficult to recognize where in the process waste and high cost builds up in service processes.

An aspect none of the previous theories has discussed is the planning strategy. We want to present the positive and negative effects of two different strategies and use our improvement suggestions to support the chosen planning strategy.

5.1.6 Pull replaces push

In a general MRP (material research planning) strategy, one is operating with a push system. This means that the products are produced with respect to the forecasts.

In a Lean strategy they are operating with a pull system. In this way the production starts as soon as an order is received from a higher level. The product is then pulled through the system. This is the same strategy that they use in JIT (just in time) (Ackerman, 2007). See Figure 24.

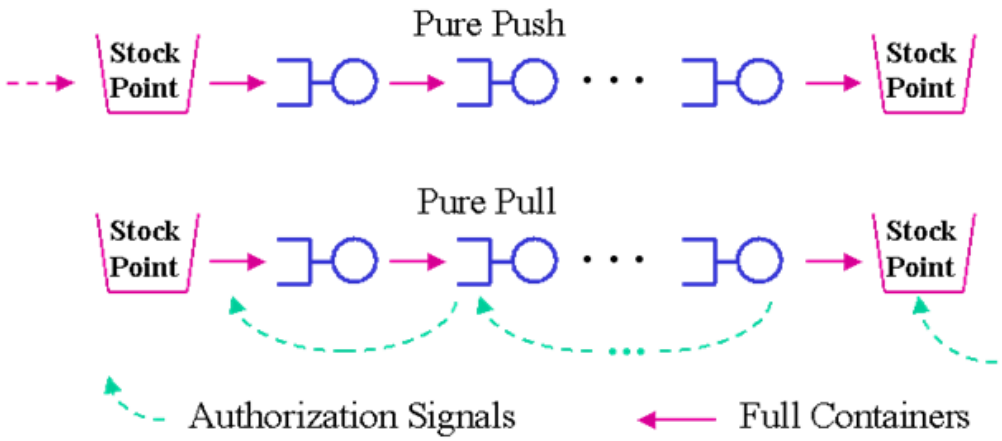

Figure 24 Pull/Push system (factoryphysics.com 2011)

Benefits of pull systems:

- *Efficiency;* with less average WIP (work in process) the pull system reaches the same throughput as a push system. Then the cycle time is shorter with a pull system.

- *Productivity;* there is more time spent on adding value to the process because of less WIP. This is because there is less encumbrances that interfere with the process.

- *Ease of control;* the pull system creates a much more manageable process. This is because it places emphasis on putting easily controllable WIP levels.

- *Quality improvement;* the low WIP system constitute a higher sensitivity to quality. By improving feedback and learning curves it facilitates. (George, 2010)

There is also another aspect none of the earlier presented strategies have discussed. This is the physical work conditions in the work area, which in our case is the warehouse. This next theoretical contribution will help us to deal with this issue.

5.1.7 Building a lean warehouse

According to Ackerman (2007):

"Whether you plan to build a new distribution center or rehabilitate an older one, you should find ways to keep it lean"

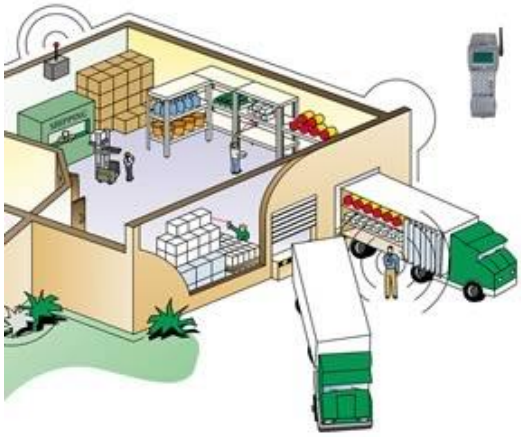

Figure 25 Lean warehouse (Supply chain logistics consulting website, 2011)

For typical warehouse operators, building a new warehouse is the largest investment the operator will do, but it also might be the best investment.

In the planning phase of building a new warehouse it is very important to involve the workers that work in the warehouse every day. Because of their experience, they know best about how it works in a warehouse.

The main point of building a new lean warehouse must be to get a structure that streamlines the operations and with less maintenance. (Ackerman, 2007)
There are five S's involved in the process of a creation of a lean workplace:

- Sortation (Eliminating and sort unnecessary items from the work area)
- Straightening (Careful storage so the job can be done effectively)
- Shining (Clean the work area to make the work easier)
- Standardization (Cooperate with the staff, find the best practice and bring it to the table)
- Sustaining (Implement the new changes)

(NAW website, 2004)

Up to this point the approaches have focused on improving only the warehouse performance. Taken into account that there are several other participants involved in the supply chain, this next strategy will introduce some important points to achieve success beyond the warehouse activities.

5.1.8 SCM (Supply Chain Management)

According to Christopher (2005) the definition of supply chain management is: "The management of upstream and downstream relationships with suppliers and customers to deliver superior customer value at less cost to the supply chain as a whole."

The focus in the supply chain philosophy is the relationship between all parts. The point is not to get a most profitable solution for one of the parts, but instead find the best outcome for all the parts in the chain.
The goal in the supply chain management is to increase their competitive advantage, value adding and reducing cost (Christopher, 2005).

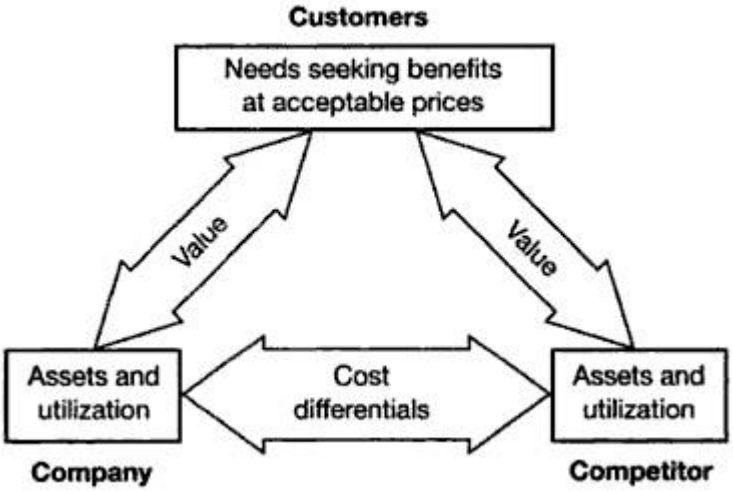

Figure 26 Competitive advantage of the three C's (Christopher, 2005)

In Figure 25 we can see the three-way relationship between the company, customers and competitors.

Many companies start with a small supply chain where they by time increase and include more supply chain participants. So when all the parts, the company, their customers and the suppliers all know each other and their goal for the future, it is easier to do the planning process together if they are willing to cooperate. This cooperation leads to cost savings, quality improvement and service enhancement (Wisner, Tan, Leong 2009).

The goal of the SCM is the relationships between the different parts in the chain. To reinforce these relationships, it may be helpful to use some tools. We will in the next section look further into what kind of tools that could be appropriate to take advantage of.

5.2 RFID and Barcodes

We have now presented the Lean theory about eliminating waste. It is now natural to introduce RFID because it is an important relationship between Lean and RFID.

RFID is a tool that, in combination with the Lean theory, can be utilized to help eliminate waste.
With this combination the working process gets more effective and the workers have more time for other preparations. When the employees are more effective at their tasks, it gains in higher quality.

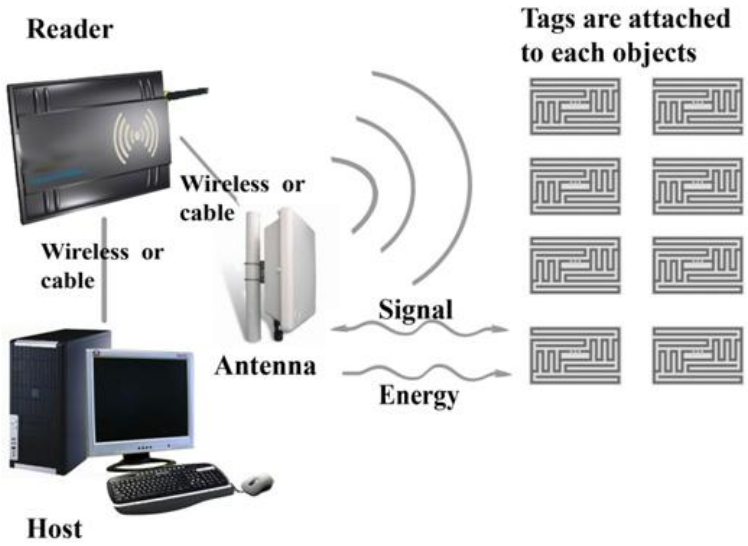

Figure 27 RFID system (Tags at work website, 2011)

RFID stands for Radio Frequency Identification and is used to identify objects. We can compare the purpose of the RFID with the magnetic strips on the visa card. We need a scanner to read the information from the magnetic stripes, like we need a scanner to read the RFID tags as well (Technovelgy Website, 2011).

So the components we need to have a complex RFID system and a complex process are: Tags, Scanners/Readers, Antennas and Host.

This technology is today in use in many companies, for further detailed information about this technology, read (Jones, Chung, 2008).

Barcodes is the most used and known type of automatic data capture (ADC) technology that is used today (Jones, Chung, 2008).

Figure 28 Barcode (Zorox website, 2003)

All the information of the product lies in the stripes in the tag. It is necessary with a scanner to read these tags and then get the information about the products. A good example of this is the products in a grocery store. All the products need to be scanned to get the price of it on the computer so the customer is able to pay.

RFID versus Barcodes:

RFID and barcodes both contains information about the product, but there are important differences between these two kinds of systems.

If we compare RFID and barcodes, RFID have the same benefits as bar codes, but you have several options when selecting RFID:

- RFID reader can be read from longer distances and don't require a direct line between the scanner and the tags to read the information. In use of barcodes, the system requires direct lines between the scanner and the tags. The tags are also unreadable from long distances.

- RFID scanners read the tags much faster than the scanners read the barcodes.

- As mentioned above, the RFID tags are easier to read than the barcodes because barcodes require a direct line. But the RFID tags are also easier to read because it is more rugged and it is possible to implant the tag inside the product and it is still possible to be read.

- An RFID reader can communicate with the tag and convey all the information the tag allows. This is not possible with barcodes.

- A RFID system is more expensive than a barcode system (Technovelgy Website, 2011).

For a good overview of the equipment that the warehouse send offshore, the tagging of equipment is an important part. This is also an important part when it comes to the return of the equipment. RFID tags are then a good option to use (Technovelgy Website, 2011)

To those of the reader who want to learn more about RFID, we would recommend the following website: www.rfid.org

The employee's attitude is also a factor that influences the quality and efficiency. Ways to give encouragement and push employees to work effective is described in the next section.

5.3 Material management

To encourage employees to work harder and more correct, there are several ways to measure performance.

Measuring warehouse performance:

- *Handling productivity*

1. Units
2. Lines
3. Total handling

- *Space utilization and productivity*

1. Percentage of total space available for storage.
2. Percentage of usable storage space used for storage.
3. Storage cost per unit of product.

- Accuracy

1. Percentage of items picked correctly.
2. Percentage of orders picked correctly.

- Damage

1. Percentage of items picked that are undamaged when received by the customer.
2. Percentage of orders picked without damaged merchandise.

- Service

1. Fill rate.
2. Order cycle time.

(Mentzer, Myers, Stank, 2007)

In a warehouse there are a lot of processes and the most of the processes have an impact on the materials, directly or indirectly.
Some of the processes that have directly impact on the material management are:

- "Reduce the labor cost per unit handled"
- "Reduce the frequency of error"
- "Improve measurement and performance"

(Ackerman, 2007)

According to Ackerman 2007 there are also five steps that is nearly always used while moving materials. These five steps are:

- Unloading
- Checking
- Storing
- Picking
- Loading

All of these activities are not always going as smoothly as they should. It is also often "no-value" activities between these five steps that can be eliminated. These kinds of activities are called waste or muda (Japanese for waste). It is also called "no-value" activities because they absorb resources, but they don't create any value.
Each company pay for space every month, so poor utilization of space is also a waste.
(Ackerman, 2007)

To make materials handling leaner, according to Ackerman (2007) there are five steps:

1. Isolate the fast-moving items and place them in “golden zones”. Be sure to review inventory activity frequently to be current on separation of fast and slow movers.

2. Maintain productivity records on every aspect of materials handling.

3. Consider adding additional work shifts.

4. Attack productivity barriers by:
    - Being sure your people know what you expect;
    - Providing adequate job training;
    - Screening out people not capable of doing the job;
    - Removing organizational barriers
    - Motivating or eliminating workers with a negative attitude

5. Audit the order picking operation against the goals of improving customer service, enhancing inventory management, reducing labor costs, reducing freight expense, and improving space utilization.

6 MEASUREMENT

Measuring according to new implementations is about comparing different situations to find the best solution.

We will present two different aspects of measurement that we will look into.

6.1 Efficiency - Effectiveness

These two different words are often used as synonyms, but there are also differences between these words and they are used in different settings with different meanings. (Enotes Website, 2011)

According to Chaffey (2011)'s statement about that "... you really need both types of measures when identifying the most suitable goals and measures to assess your marketing or business effectiveness. It's fine to say the difference doesn't matter especially, but I think that understanding the difference helps you create a better set of measures!" (Smart insights Website, 2011)

The differences between efficiency and effectiveness:

- "Efficiency means doing the things right, whereas effectiveness is about doing the right things."

- "Efficiency focuses on the process or "means", whereas effectiveness focuses on the end."

- "Efficiency is restricted to the present state whereas effectiveness involves thinking long term."

- "Organizations have to be both effective and efficient in order to be successful." (Differences between website, 2011)

These two terms will help us focus both on improvement on the daily basis as well as improvement in the long term. To analyze how big the difference between the present

situation and the preferable situation is, we need to introduce another form of measurement; GAP analysis.

6.2 GAP analysis

A GAP analysis is a tool in business and economics that is used to achieve certain goals. In this analysis the workers compare the company's actual performance with the potential performance.

The main questions that need to be answered and compared before performing a gap analysis are:

- *Where are we now?*
  This is the descriptive analysis where we can see how it is today.
- *Where do we want to be?*
  This is the normative analysis where we explain how the potential performance is supposed to be after what we have observed.

The main question to solve the gap analysis is:

- *How to get there?*
  Here we have to explain how to delete the gap between the descriptive and the normative analysis.

(Ehow website, 2011)

Figure 29 GAP analysis (Marketing teacher website, 2011)

As shown in Figure 29, the goal of a GAP analysis is to find the GAP between the optimized allocation and the current level of allocation. When the company has found this GAP, their goal is to close this by using different strategies and procedures (Digoo website, 2011).

The quality of the analysis is best if you involve staff from as many areas as possible in the company, so that multiple perspectives will appear. This helps the company to get an insight in which areas that can be improved. The basis for the analysis work is interviews with employees. These interviews are tailored to each individual employee and their responsibilities and knowledge area, so that the analysis will have a result where most of the areas are involved. These results from the analysis are a good basis for the management to do good decisions, both on short and long term decisions (Det norske veritas Website, 2011).

7 NORMATIVE ANALYSIS (how it is supposed to be)

By studying the results of our work and the theories (ref. Chapter 5), the normative analysis shows how it is supposed to be. The normative analysis will be our improvement suggestions based on our observations and theory. We have revealed several improvement areas. In this chapter we will present specific action which we strongly believe will improve the current situation. We will present our normative analysis with focus on the warehouse activities and link relevant theory and improvement suggestions to each of them. Some suggestions will have impact on several different activities while some only will address one single activity.

7.1 Planning

One possible improvement is to have a higher focus on plans and responsibility for each employee in the warehouse.

The first improvement of the planning activity is through the use of total *quality management (TQM)*. Each activity must be understood by the planner, in this case the warehouse manager, to be able to plan resources and activities in order to obtain the

desired quality and effectiveness. This is also connected to the planning phase of the *PDCA* approach to achieve improvement in the supply chain.

We suggest that the warehouse manager introduce a "Monday morning meeting" with his staff where he gives a briefing of the expected jobs for the coming week. Further; ***An overview of each job's priority should be visualized in a priority list / work list so that employees easily know which jobs to continue when the current job is completed.***

This priority list, with the activity due dates, could have been put on a light-board inside the warehouse. This overview will help the warehouse workers to have control of which job to continue on and focus on delivery dates. The light- board should also contain information about which activities that is dedicated to the different employees. Each employee should have one main area of responsibility for a given period of time. We suggest one or two weeks with the same responsibility before they switch. This is to get a more continuous flow of work when they first are dedicated to an exact task, and can avoid restructuring of work every day. A variation in responsibility is also important to assure commitment and motivation, so more than two weeks would probably be a too long period performing the same activity.

To handle changes more smoothly we have also introduced an idea of having one area as first priority and another area as a second priority each week. If for instant the employee that is responsible for packing finishes on Thursday and no more shipments are expected the same week, he switch over to his second priority activity. If some of the employees are missing, the manager should be the one to make priorities on how to cover up for these activities. This process can be done effectively by making plans to follow.

Based on the importance of plans and structured work conditions from TQM and PDCA we outlined a tool the warehouse manager can apply to achieve improvements in this area. We made a suggestion on how a priority plan can look like for the warehouse employees, and we have chose week at each station. Each of the numbers 1,2,3,4,5 represents one employee.

First priority
Second priority

	Week 1					Week 2					Week 3					Week 4					Week 5				
Area of responsibility / Employee	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Control lifting equipment																									
Control RAT equipment																									
Unpack and wash incomming shipments																									
Pick and Pack outgoing shipments																									
Office related activities and odd jobs																									

Table 1 Priority plan

A rotation like the one showed in Table 1 will ensure that all workers have the ability to perform all kinds of tasks. This also leads to reduced vulnerability if there is sickness or other absences like meetings or personal errands.

In addition to having a week plan as we just described the warehouse manager should outline goals for each activity for the upcoming week. Each employee should make an effort to reach their goal. There are several ways to measure performance (ref. material management) and to have some kinds of measures will trigger the employees to make an extra effort and the whole throughput time will therefore be reduced. To begin with, we suggest that the warehouse manager set weekly goals for each area of responsibility and that last week's performance is discussed on the following "Monday morning meeting". Such meetings will give the employees a goal to work toward and will most likely be visual through higher effectiveness. Numbers on i.e. order cycle time can be presented to the employees to encourage them to work harder in order to see improvements. Visualizing different performance measures (Chapter 5.3) makes it more real and easier for the warehouse employees to relate to.

To analyze finished projects and improve upcoming projects based on the *PDCA circle* (Chapter 7.5) to find improvements will be useful for the warehouse manager. To achieve continuous improvements and regularly eliminate waste in processes it will be helpful to follow the 4 steps: plan, do, check, and act.

Plan: When the warehouse manager receives information from the project department about an upcoming project, he can begin planning a strategy. This phase gives them good opportunities to make changes and possibly achieve better results either in time, money or quality.

Do: The new strategy is implemented in the warehouse and it is important that the performance of the implementation is measured.

Check: In the third stage the information is analyzed. The results of the analysis will reflect the outcome of the strategy implementation, and the manager will use this information and knowledge for future projects.

Act: The warehouse manager now act according to the analysis in the previous step. If he failed to achieve better results, he must start the process all over again from the first step of the circle. If the new strategy gave better results, these actions should be implemented. The next focus is to make the results even better for the next project so that the warehouse manager should start at the beginning of the circle again.

By following this strategy they will continually find improvements every time they start on the circle all over again.

7.2 Incoming shipments

The number of shipments that returns to the warehouse from offshore installations varies. It should anyway be possible to plan this work since the project managers register in the ERP system when each project are expected to be finished. There is also lead time from the returned equipment are registered in the system to the equipment arrives at LBO.

7.2.1 Receive

It is often major differences between the return list and the actual container content. The employees must therefore check every item in the returned container and make registrations in the system of each unique serial number. This is a very time consuming part of the process and this activity is one of the reasons why the employees spend over 37 % of their time in the office. A way to make this activity more effective and reduce the time spent in the office is to initiate an investigation to determine whether radio frequent identification (RFID) or similar concepts can be suitable tools to increase efficiency (ref. Smart management TAGHUB, 06.04.2011). Another initiative to improve this situation is to charge the projects of the missing equipment. Economic disadvantages will put a higher

pressure on the offshore foreman to assure correct return shipments.

We suggest RFID registration of all equipment to get better overview and to be more efficient when packing and unpacking a returned container.

As we can see of the observations from the warehouse, the employees use a lot of time in the office. A lot of the time is spent in the office because they need to register all the serial numbers on the equipment for outgoing and incoming shipments.

Sometimes when several shipments arrive simultaneously, the warehouse employees cannot unpack everything instantly. In these cases they should register which equipment that has arrived so they can stop the rent to the projects. Since today's work method is so time consuming, the registration is not done and nobody knows what equipment that has been returned before the container or pallets are unpacked. With RFID implementation, they would only need to scan the equipment every time they move it to another place. This will save them a lot of time, since they do not have to search through many lists to find the exact number that is matching the equipment. A quick scan of the container content when it arrives at the warehouse will give LBO the overview they have a lack of today.

When it comes to the RFID marking of equipment, there are several options. The company may mark all equipment, only the critical/expensive equipment or only mark the containers. If the equipment in the container always matches the lists, it is enough to just register the arrival of the container. In this case we recommend LBO to mark all equipment because of today’s poor track of the equipment. There would be no point to only mark containers, because the equipment in the container never/rarely matches the equipment list that follows. Marking of all the equipment will give a better overview and make it easier for the company to prepare for future shipments.

The scanning should be used in all activities which imply transfer of equipment. Another problem regarding lack of information of incoming shipments is the economic aspect, if the load is lost. LBO will in this case not have any documentation to verify the content; which obviously will be problematic when it comes to the insurance settlement.

7.2.2 Unpack/Wash

When a container or pallet is unpacked, the warehouse employees move the equipment by truck, pallet jacks or by hand to the washing area. After everything is washed they move it again to the quarantine warehouse. We observed that much of the equipment was transported from the container to the washing area in pallets and then moved from the pallets to be washed. After everything dried, it was packed down in pallets again before the transport to the quarantine warehouse. It should not be necessary to pack and unpack the equipment that many times, this is waste because of unnecessary motions (ref. Tachino).

The cleaning process is just about removing the seawater to prevent formation of rust. This is to extend the life of the equipment as long as possible**.**

To avoid duplications when it comes to the relocation of equipment, there would be an option for LBO to invest in other pallets. If they had plastic pallets with lot of holes, they would have the opportunity to clean the equipment without removing it from the pallet.

This solution would eliminate the "waste" (ref. Chapter 5.1) of moving equipment from pallets on to another devise in the washing area.

7.2.3 Replace in stock

The warehouse operates with two storages (quarantine and main), so in many cases they move the same equipment to storage several times. The equipment are first moved from the washing area to the quarantine warehouse and then from the quarantine warehouse to the control area and then from the control area to the main warehouse. If the use of the quarantine warehouse can be avoided, they will save the time of finding the equipment here and moving it to the control area. The equipment will now instead be moved directly from the washing area to the control station, and then finally to the main storage. This leads us to the push and pull strategies to find better solutions.

As we observed, today LBO are operating with a pull system for preparation of equipment. I.e. they do the preparation after they have received the order list.

It would improve the logistics to move from a pull strategy to a push strategy in the situation when they receive a returned container, and then use a pull strategy when they are preparing an outgoing shipment (ref. Chapter 5.1.6).

If they do the preparation of equipment after receiving a returned container, they spend time to prepare equipment that is not yet requested. It might sound like a waste of time, but a push philosophy in this case enables a better way to work. This is because they will lie ahead of time and would in a push strategy avoid having a quarantine warehouse which would reduce the time spent on replacement and movement of equipment.

After they have used the push strategy to clarify returned equipment, it is more efficient to use the pull strategy when they prepare a new container to be sent offshore. The pull regime is now more efficient, because they have used the push strategy in advance. To use a push strategy in the control of equipment gives immediate availability of equipment when the order arrives. This push-pull strategy results in a shorter order cycle time than if they were using a pull-pull strategy.

The additional cost associated with preparing equipment that is not immediately requested, is quite low. They will save more time and money by implementing this push strategy. As mentioned earlier, they will also avoid having a quarantine warehouse, which will give them more space for the main warehouse. If a situation arises where the warehouse have both push and pull tasks that are waiting because of insufficient staffing, it is important that the pull tasks are prioritized first. In the short run, this is the best option, but in the long run it is not. In a situation like this, they have to operate with pull, until they get enough employees to start working in the push strategy again. It is necessary to have a small quarantine stock that can be used in the periods where pull activities must be prioritized.

When it comes to the question about when to work overtime, it will be necessary to work overtime when they are behind with pull tasks. It is also important to work overtime when there are push tasks that has to be done, for instance if there are certain types of equipment that are missing in the main warehouse, so they do not fall behind schedule.

The push activity focuses on the long term effectiveness while the pull activities must be prioritized in periods when efficiency in the short run is important.

In a working structure, as the push philosophy forms, there might be changes in the warehouse to make a better equipment flow;
To improve the way of moving equipment inside the warehouse, there will be an idea to change the physical layout of the warehouse based on a lean warehouse philosophy. An example of this is shown in the Figure 30.

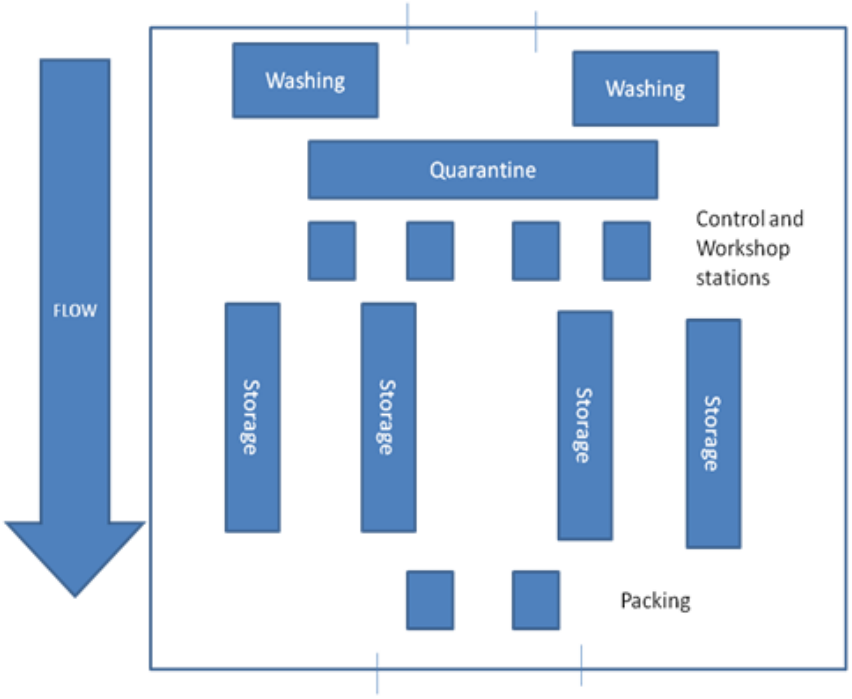

Figure 30 Layout of the warehouse

In this layout of the warehouse there is a better flow and the employees do not have to move the equipment unnecessary back and forth. This physical layout of the warehouse might be perfect for a push philosophy. The flow of equipment is streamlined and the size of the quarantine warehouse should be kept to a minimum to force a push strategy. Other aids that can help us create a lean warehouse are the five S's mentioned in Chapter 5.1.4.

- **Sortation.** The work area, mainly the control areas but also the rest of the warehouse should contain only necessary items. Machinery and other equipment that are seldom used should be removed to improve the work conditions.

- **Straightening.** Every item should be stored correctly to make every part of the job as effective as possible. Both offshore equipment and the warehouse employee's tools and equipment that they use in their controls and repairs should be stored carefully.

- **Shining.** The warehouse hallways, work stations and storage should all be cleaned. This will make the work easier.

- **Standardization.** Find the best practice through cooperation with the warehouse employees and make it the only practice.

- **Sustaining.** Implement and keep the new changes

7.3 Outgoing shipments

Like the incoming shipments, the outgoing shipments also vary a lot. The summer season is the busiest period, and has more projects going on at the same time than during the winter season.

7.3.1 Pick

In the situation the warehouse face today they pick the majority of all equipment from the quarantine warehouse. This means that they have to pick the items from the shelf in the quarantine warehouse and then bring it to the control area to make the necessary certification and then pick it again. In addition to the extra picking, they also use time to locate the right items in the quarantine area because this area is not organized and structured properly; items are just placed wherever there is available space. This work method makes the picking activity unnecessary time consuming. Since the equipment is in various conditions, it is difficult to estimate how much time a control would take, also because reparations are done simultaneously. It is also difficult to predict what kind of reparation that will be necessary before the control is started. This aspects eliminates the possibility to calculate the necessary time to pick and prepare orders. This practice represent an unnecessarily high uncertainty.

By reducing or eliminate the quarantine storage and operate with a push strategy as mentioned earlier, the picking activity will be much more efficient and save time on outgoing shipments.

7.3.2 Control/Certification

Figure 31 Testing areas

All lifting equipment, RAT equipment and other equipment that needs to be controlled are tested in one of the three control stations. One control station is dedicated to RAT equipment while the other two handle everything else. Since the equipment varies much in both size and weight, the control methods vary as well. The two cranes in the warehouse are in most cases involved in the testing, especially of lifting equipment. As we have mentioned earlier, the control of equipment is done when the equipment is needed for an order. As long as the needed equipment is not in the main warehouse the employees must pick the requested items in the quarantine warehouse and then control each one of them. This gives little continuity in the control job. Different equipment dictates different types of controls, and the testing facility and tools might change for each one of them. The set up time between each control will because of this be unnecessarily high. Another factor is that the time pressure to get the order ready in time can result in quick and less accurate controls than desired.

If they perform controls of all the equipment in the quarantine warehouse, they should design all identical controls consecutively to avoid restructuring/set up times.

7.3.3 Register

When the controls are approved, a control form must be updated with the date of when the control was performed. Most of the equipment LBO uses, also has a certificate that follows each serial numbered item. These certificates must be printed from a computer or copied if they are stored in binders because they must be available for control at any time. The manual work of gathering these certificates is very time consuming and is one of the main reasons for the high number of working hours, the warehouse employees spend in the office.

Figure 32 RFID tools (Iddictive website, 2011 and Alibaba website, 2010)

A solution to reduce the time spent on paperwork and registration is to register the information in a RFID tag that follows the equipment.

One scanner with a display at each offshore installation in addition to a couple in the warehouse should be enough. The offshore foreman should be responsible for this scanner and the activities related to it. If someone offshore needs to see the certificate for a certain item the offshore foreman can scan the tag and get the information electronically. This way the warehouse employees only have to register the certificate to an item one time, and only update the control dates after each control.

According to Appendix F; there are no regulations that determine that the certificate needs to follow the equipment physically; it should therefore not be a problem to keep all information electronically.

7.3.4 Pack

Most deliveries are shipped in containers while smaller orders are sent on pallets. The different equipment and devices are packed in containers either in pallets, hanged up inside the container, or placed in the racks which are installed in the container. Our improvement suggestion is linked to the paper work and accuracy related to the packing activity. The improvement in this area will also come from implementation of RFID. Every item is then scanned before it is packed and the registration of packed items is updated in the system. This will reduce time of the manual registrations of every item marked with a serial number. This could also give the opportunity to check the list of everything that is packed against the order list to detect errors before the order is sent.

7.3.5 Ship

Transportation from the warehouse to the supply base is done by truck. The shorter notice the transportation company get from LBO, the higher is the transportation cost is. If we can get a routine where the warehouse employees book transportation shortly after the order and delivery date is received, LBO would get the cheapest transportation cost possible. For this to work, the warehouse employees must be able to finish the order in time.

Through *supply chain management* across different departments LBO will have potential to reduce their transportation cost. If they take advantage of their ERP system, the warehouse employees can get access to the orders that project managers work on, and see due dates for shipments early. The project department can work on the order quite a while when they discuss what type of equipment is necessary. Usually a part of the order is finished early, this could be basic equipment that they agree on early. If the ERP system allows the warehouse employees to see everything that is approved by the project department in an order at any time, they could start to work on the order before it is completed. This will to a certain point smooth the work pressure in the warehouse and also give better planning options, which should result in an early delivery date and lower transportation costs. There will be no lead time between the project department and the warehouse. This will give the warehouse employees the opportunity to book transportation from the warehouse to the supply base early, and by this get the lowest rate possible from the transportation company.

The ERP system is a tool that supports the supply chain management to form a relation between the different parts of the supply chain. A solution like this will be an advantage for several departments and the company overall.

7.3.6 Retrieve and replace

As we mentioned earlier in Chapter 7.1.3, we will be able to reduce this activity. By introducing a push strategy on the control of equipment as well as a lean warehouse, we will decrease the number of movements.

7.3.7 Open door/reception or transmission

If the priority plan we suggested is adopted, one person will be in charge of the office activities in each period.

We suggest that the employee dedicated to office activities also handle the jobs related to reception, transmission and opening the door when necessary. This way the personnel working in the warehouse with value adding activities would not be disturbed.

All value adding activities are performed inside the warehouse so it is more efficient if the employee working in the office handles these small interruptions. If RFID are implemented, the number of computers should be reduced to a minimum since the controls would be handled through the handheld RFID scanner, something which would reduce the need for computers inside the warehouse. One or two desks with computers in the office should be enough. By moving this activity to the person working in the office, one will get better working conditions for the employees working with value adding activities in the warehouse.

7.3.8 Small talks

We think that this “activity” can be reduced significantly through creating more enthusiasm among the employees. By giving each of them commitment through responsibility for dedicated activities and make them understand the processes in other parts of the supply chain by focusing on TQM and SCM, we expect to get more hours used

on value adding activities. Methods from material management will encourage the employees to focus on productivity since their performances are being measured. It could also lead to some form of competition of getting the best results between the employees as well, which will make them focus on producing results instead of talking to each other.

If the warehouse achieves this kind of engagement from the employees, through measurement and further competition, it will have a positive effect for the company.

7.3.9 Office

As we have mentioned earlier in this chapter we believe that one employee in the office is enough when some or all of our improvement suggestions are taken into account. Even if they continue with the same strategy as they have today, we are sure they could reduce the number of computers and office spaces down to two. Since they in addition to this also have two computers in the warehouse it should be enough. This will force them to do all short registrations in the warehouse computers, and will this way reduce the time in the office. The total spent on the computer will probably be reduced as well since it is easier to use more time than necessary when they have a private office.

8 GAP ANALYSIS (actual performance versus potential performance)

This gap analysis will look at the differences between the actual performances that we have been observing in Chapter 4 (descriptive) and the potential performance in Chapter 7 (normative). We will here follow the recipe of the GAP analysis mentioned in Chapter 6.

The calculations of the effect LBO can expect will also be presented, given certain limitations in the calculations. By finding more efficient solutions cost savings could be reached in several areas. To improve work processes, routines, planning and performance LBO can save cost of man hours and transportation costs.

This GAP analysis is divided into sub-conclusions in relation to the improvements we have found. The main improvements are within RFID implementation and Lean management.

8.1 RFID improvement:

Where are we now?

Today's methods regarding keeping control of equipment are manual and very time consuming. The serial numbers are registered in the system when the equipment is moved outside the warehouse and then again registered when it is placed in stock again. There are no opportunities to see which equipment is planned to be shipped or planned to arrive at the warehouse. Because of the lack of information, there are no or few possibilities to make good and efficient plans in order to optimize the utilization of warehouse personnel and equipment.

All paper work that is related to the handling of equipment is the most time consuming job of all the non value adding activities. LBO operates with many different items that require documentation. All documentation is handled manually and must be done for every single shipment that contains lifting equipment or RAT equipment (almost every shipment). A reduction of the time the warehouse employees spend on these activities would in the long run be very significant.

Where do we want to be?

It is desirable to have all information about the equipment in the ERP system. Not only when it is shipped or received as today. It should be possible to see what equipment is planned shipped, what equipment is on the quarantine warehouse and main warehouse, what is expected back from the offshore installation and when and what equipment that is received but not yet unpacked at the warehouse. If this information is available, it will give the purchaser the opportunity to plan the use of equipment between projects. This is desirable because LBO can save money on more efficient use of their equipment instead of buying new equipment that they really do not need.

It is also desirable to reduce the non value activities like moving equipment to different locations inside the warehouse, and spend more of the time on the value adding activities. More efficient work methods through RFID technology instead of manual operations will reduce the time on several of the non value adding activities, like registrations of serial numbers for outgoing and incoming shipments and printing of all certificates.

How to get there?

To implement RFID on all equipment, that requires certification, will help LBO getting in the direction they want. All relevant equipment should be marked with a chip that contains each item's certificate, manual and control date. Warehouse employees and the offshore foremen should have hand -held scanners to read these chips. The scanners have options on how to make registrations on the chip; for a start certification and location. The variation of different equipment is large, so there will be a challenge to get a chip on to everything. There will possibly be a need for different types of tags as well. Two scanners at the warehouse and one in each offshore installation should be enough.

Potential in money

If RFID technology is implemented in the LBO organization there are potential to save money through better time management. The goal is to minimize the non value adding activities, and an implementation of RFID will be a step in the right direction. From our observations we could see that handling of equipment documentation and manual registrations on the computer was the most time consuming jobs of the non value adding activities. With RFID technology; the time spent on these activities will be significantly reduced. At minimum 50 % time reduction on these activities should be achievable, which reduces the time on these activities to 18,75 %. In addition to this saving, there will be time reduction in several other parts of the process as well, even though these are harder to measure.

The economic advantages in this improvement suggestion are not necessarily very high, in the short run, when we take in to account the implementation cost of RFID. We have little information of the cost of this implementation. Taken into account, the number of items that will have to be tagged it will be a noticeable start up cost. There are other advantages; one of them is the extra time to focus on the control activities. More focus on the controls will reduce the possibility for errors. With today's work routines they do not have the necessary continuity and focus on equipment controls to assure right quality and correct delivery to projects, this according to Appendix G, H and I. Higher focus on controls will also give an opportunity to increase the amount of equipment in the main warehouse and reduce the content in the quarantine warehouse.

8.2 Lean management:

Where are we now?

Today the warehouse can clearly be improved in relation to the management. We observed that the warehouse employees manage their days as they want and there are no or little participation from the warehouse manager. Routines and work habits are carried out without focusing on what is most time and cost efficient.

Where do we want to be?

The goal in this area is to involve management more and structure activities and methods to be as time and cost efficient as possible. The warehouse manager should be more visible in the warehouse and plan and structure the work based on incoming and outgoing orders. Higher time efficiency could be achieved by increasing the time spent on value adding activities and reducing time used on non value adding activities.

Through working smarter and be ahead of time, the company can be more cost efficient. This will save the extra expenses of being late, like higher transportation fares and overtime on the warehouse employees needed to finish orders on time.

How to get there?

We have suggestions, both regarding leadership/management and how to structure specific activities; "Monday morning meeting", priority plan, RFID, plastic pallets, warehouse layout etc. (ref. Chapter 7). Lean management is the main tool in the process of improving these areas.

Potential in money

When we focus on lean management, savings can be achieved through spending as much as possible of the warehouse employees' time on value adding activities. Accurate calculations of these savings are difficult to estimate.

In the calculation of savings, we will look at the average percent of productivity. We will focus on the value adding activities in the warehouse. The goal of this calculation is to increase the productivity of the value adding activities and decrease the non value adding activities.

Value adding activities	Percentage	Cost
Inspection/repair of lifting equipment	15,86 %	1 144
Inspection/repair of TT equipment	8,10 %	584
Packing	3,94 %	284
Cleaning of equipment	1,22 %	88
Sum	**29,13 %**	2 100

Table 2 Value adding activities

As we can see from the results of our analysis; today the percentage of the value adding activities is 29,13 %. This percentage is very low, but not unusual for the industry they are operating in.

According to conversations we have had with lecturers and professors at Molde University College, there are many companies in this industry which is actively working to improve this proportion of value adding activities. Many aim to reach at least 50 %.

No value adding activities	Percentage	Cost
Office	37,50 %	2 704
Retrieve and replace	6,16 %	444
Other encumbrances	13,11 %	945
Telephone	1,14 %	82
Open door/reception or transmission	0,88 %	63
Help hired workers	1,39 %	101
Small talks	7,49 %	540
Various odd jobs	3,19 %	230
Sum	**70,87 %**	5 110

Table 3 Non value adding activities

To increase the productivity of value adding activities, we need to cut in other activities. The costs in the tables are based on the average salary per day, considering that there are 5 people working every day.

The average salary per worker per day is estimated to be NOK 1442, and the average salary per day for all five workers is then (5*1442) = 7210. This number is excluded other personnel expenses the company have in addition to the salary.

Every percent LBO manage to move from non value adding activities to value adding activities could be considered as savings. If we can set a goal for LBO to reach 50 %, like

other companies in the same sector, the saving of non value adding activities will be 20,87 %. In NOK this gives 391 300 in a year (52 weeks). This is equivalent to a full time position of a warehouse employee.

If LBO implement all or some of our suggestions we have no doubt that this cost saving is reachable. “Office” and “small talks” will be decreased significantly while the control activities will take more of their time. An overall improvement of the management and a more positive attitude among the employees will give higher efficiency in places where it is hard to detect low efficiency today.

The main goal of all improvement suggestions is to reduce the time spent on non value adding activities. The value of spending more of the warehouse employees’ time on value adding activities goes beyond the economic aspect of it. The quality aspect of the control is also a very important factor. We have gathered information that revealed that there have been several cases where the shipments from the warehouse have contained equipment with flaws. For instance have parts of the RAT equipment been installed incorrectly, errors like this can lead to serious injuries. Luckily, these errors have been detected of offshore personnel before the equipment was used. Improvement that will increase the safety and reduce the possibility for errors, like this, will be of greater value than only the costs.

9 CONCLUSION

Our problem formulation and goal of the thesis was “Improving Linjebygg Offshore’s warehouse logistic”.

By studying the warehouse activities at LBO, we found several improvement potentials for the company. We have presented different improvement suggestions, some probably more efficient and realistic to accomplish than others. When it comes to improving the company’s warehouse logistics; there are two main improvements that should be initiated in the warehouse. These are the implementation of RFID and Lean management. Both of the improvements will help to streamline the supply chain at LBO; to increase efficiency, effectiveness and reduce costs.

The conclusion of this thesis is based on the GAP analysis were we compared our descriptive analysis to the normative analysis.

LBO will save expenditure in relation to purchase new equipment and salaries to the workers as well as reduced transportation costs. The workers will work more efficiently with lean management and the equipment is easily traced by the RFID system. LBO will take advantage of the improvement suggestions. Our suggestions will not only have financial benefits. The benefits will also include higher quality of equipment controls which lead to safer health, security and environment conditions.

Our recommendations will lead to better flexibility related to changes in projects and warehouse staff, and shorter delivery time to projects. Higher flexibility and shorter order processing time also means that the warehouse is able to take on more orders at short notice, without exceeding the deadlines on other projects they work on. LBO wants to be capable to increase the number of special projects and we believe that this is achievable through implementing the recommendations we have presented in this thesis.

LBO is continuously expanding in the MMO sector. By implementing the improvements presented in this thesis, the company will achieve better results. The gain of the improvements will be even higher as the company continues to expand. There will be more value in circulation and even more to save by these measures.

10 SUGGESTIONS FOR FURTHER WORK

In this chapter we will recommend some further work to get better logistic improvements for LBO.

Our master thesis was written as a qualitative thesis and our focus was to find improvements in the warehouse according to qualitative theories and approaches. Further research could look into the more quantitative part of the warehousing like; minimum stock, order quantity and lead times, to find other improvement areas. Our focus was also on lifting equipment, RAT equipment and other small components stored in the warehouse. LBO has also some long term contracts where scaffold is the main equipment. Scaffold takes up a lot of storage space and is expensive, so the planning and handling of it should be as precise as possible. Improvement suggestions for these types of projects could therefore also be looked into to give better logistical performance.

Since the company is implementing a new ERP system, it would be interesting to give an analysis of the logistics related to the use of the system. A research of this aspect can be done after the system is fully integrated at every level.

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Appendix:

- Appendix A: Prosedyre for utsendelse av utstyr og materiell (LBO AS, 2011).
- Appendix B: Prosedyre for varemottak fra prosjekt (LBO AS, 2011).
- Appendix C: Prosedyre for sertifisering og oppfølging av sertifisert løfteutstyr og løfteredskap (LBO AS, 2011).
- Appendix D: Prosedyre for merking av utstyr og materiell (LBO AS, 2011)
- Appendix E: Organisering og styring av sakkyndig virksomhet (LBO AS, 2011)
- Appendix F: Regulations, documentation of lifting equipment http://www.sjofartsdir.no/no/Regelverk2/Rundskriv/RSV_12-2008_Elektronisk_oppbevaring_av_sertifikater_og_annen_dokumentasjon_for_kraner_og_lost_lofteutstyr/
- Appendix G: Report 1; errors on delivered RAT equipment (LBO AS, 2011)
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Appendix

Appendix A

LINJEBYGG
OFFSHORE

PROSEDYRE

FOR UTSENDELSE

AV UTSTYR OG MATERIELL

Id 8906

Gyldig dokumentasjon oppdateres kun i TQM

FORMÅL OG OMFANG
Formålet med denne prosedyre er å sikre at korrekt utstyr/materiell blir plukket, pakket, merket og levert fra hovedlager, og at forsendelser fra LBO går uhindret til rett mottaker.

MÅLGRUPPE
Denne prosedyren gjelder for lagerpersonell.

ANSVAR OG MYNDIGHET
Lagerleder skal:
Påse at prosedyren følges
Følge opp alle forsendelser og utnevne ansvarlig person for ordren/plukklisten (ordreansvarlig). Vedkommende vil også være sikringsansvarlig for forsendelsen.

Ordreansvarlig skal sørge for at
Riktig utstyr og materiell plukkes iht. plukkliste
Utstyret er komplett og uten skader (visuell sjekk)
Pakke utstyr slik at skader unngås
Hensiktsmessig merking av forsendelse iht. ordre
Bestille transport i forhold til leveringsdato/sted
Prosjektleder (og OPC) og innkjøper/logistikkperson får nødvendig informasjon om forsendelsen så snart den blir sendt fra hovedlager
OLF regler i forbindelse med forsendelsen overholdes

BESKRIVELSE
Generelt
For enhver sending skal det foreligge en ordre på materiell og utstyr.

Om kunden har spesielle krav til dokumentasjon, skal dette opplyses av bestiller.

Følgende dokument skal avhengig av leveransen, følge forsendelser:
Pakkseddel
Fraktbrev
ADR dokumentasjon
Datablad
Sertifikater
Kontrolldagbok
Krav iht. Norsok Z-015
Utstyrsavhengig dokumentasjon
Dokument for å dekke evt. særskilte krav
Plukking
Utstyr og materiell plukkes iht. plukkliste generert av ordre. Plukkede varer kontrolleres mot plukkliste før registrering av plukking i lagerstyringssystemet.

Dersom lager av en eller annen grunn ikke har den bestilte varen, men har tilsvarende vare på lager skal evt. endring av levering avtales med bestiller og ansvarlig innkjøper/logistikkperson.

Pakkseddel tas ut i to eksemplarer, som lagres sammen med godslister og fraktbrev.
Pakking og merking

Varer skal pakkes hensiktsmessig i forhold til aktuell transport og det skal sørges for at utstyr og materiell er forsvarlig sikret.

For enhver transport skal fraktbrev/pakkseddel fylles ut, disse skal som minimum inneholde:
Avsendingsdato
Mottaksadresse
Installasjon
Ordre og/eller prosjektnummer
Transportørens navn
Spesifisering av pakkene
Type, antall, bruttovekt og volum

ADR deklarasjon fylles ut når forsendelse krever dette.

Forsendelser merkes tydelig og hensiktsmessig med transportlapp og pakkseddel.
Containere og lastebærere merkes med merkelapp og både mål og bruttovekt skal oppgis.

Flerkolli skal merkes med stigende løpenummer.
Sending
Transport bestilles ved ferdigstillelse av ordre, transportavtaler bør benyttes.

Ved forsendelser fra lager skal normalt følgende papirer medsendes:
Pakkseddel og i tillegg sertifikater når dette kreves.

Containere skal plomberes ved utsendelse iht. OLF retningslinjer for godkjent leverandør.
Dette betyr at container går uåpnet fra LBO til installasjon/arbeidssted.

Pakkseddel festes på forsendelse og en kopi oppbevares av lager sammen med kopi av andre forsendelsesdokumenter.
Restordre
Eventuelle restordrer sendes fortløpende eller iht. avtale av ordreansvarlig.

Appendix B

PROSEDYRE

FOR VAREMOTTAK

FRA PROSJEKT

Id 8907

Gyldig dokumentasjon oppdateres kun i TQM

FORMÅL OG OMFANG
Formålet med denne prosedyre er å sikre at det gjøres et kontrollert varemottak samt at det utføres nødvendig kontroll og vedlikehold på materiell og utstyr som kommer fra LBOs prosjekt og oppdrag.

MÅLGRUPPE
Denne prosedyren gjelder for lagerpersonell.

ANSVAR OG MYNDIGHET
Lagerleder skal sørge for at prosedyren følges.

Lagerpersonell skal:
Kontrollere mottak i forhold pakkseddel og returdokument
Kontrollere forsendelse for skader (inkl. innhold i forsendelse)
Gjennomføre varemottak i lagerstyringssystem
Arkivering av dokumentasjon på mottatt forsendelse
Tømming og vasking
Plassering på riktig lagersted

BESKRIVELSE
Generelt
Det gjøres et kontrollert varemottak for å sørge for rett innmelding av returer fra prosjekt/oppdrag samt for å sikre at nødvendig vedlikehold og sertifisering blir utført.

Varemottak
Følgende skal utføres:
Pakkseddel og fraktpapirer kontrolleres i forhold til returmelding for å sikre at varemottak blir gjennomført fra riktig prosjekt/oppdrag.
Forsendelsen kontrolleres iht. antall kolli på returmelding for å sikre at alle kolli er mottatt.
Kontroll for evt. transportskader gjøres fortløpende ved varemottak.
Mottatt mengde kontrolleres i forhold til returmelding.
Utstyr/materiell som ikke tilhører LBO skal skilles ut og lagres på eget område mens prosjekt undersøker eierforhold. Etter ca 3 mnd blir utstyr/materiell kassert.
Ved mottak av container blir internleie på utstyret stanset
Varemottak registreres i lagerstyringssystem iht. mottatt mengde

Dokumentasjon
Pakkseddel, fraktpapirer og returmeldinger for alle varemottak skal arkiveres i mappe ved LBO lager.
Returseddel genereres fra lagerstyringssystemet etter at varemottak er registrert. Denne lagres sammen med den andre dokumentasjonen på varemottaket.
Rengjøring/vedlikehold
Mottatt utstyr rengjøres før det plasseres på vedlikeholdslager. Utstyret vedlikeholdes og kontrolleres fortløpende og plasseres på riktig lokasjon på lager etter at det er godkjent.

Materiell sjekkes og kun det som kan sendes ut pånytt blir tatt inn til lager. Materiell som ikke kan benyttes skal kasseres.

Appendix C

LINJEBYGG
OFFSHORE

PROSEDYRE FOR

SERTIFISERING OG OPPFØLGING AV

SERTIFISERT LØFTEUTSTYR

OG LØFTEREDSKAP

Dokument nr	:	LBO-10.005
KS-nivå	:	I
Revisjonsnr.	:	2
Revidert av	:	A. Frostad
Godkjent	:	07.03.2005
Godkjent av	:	K. B. Jenssen
Eksemplar nr.:		_____

FORMÅL OG OMFANG

Formålet med prosedyren er å beskrive hvordan sertifisert løfteutstyr skal følges opp, merkes, kontrolleres og evt. resertifiseres, for å sikre at kun utstyr som er godkjent blir benyttet.

MÅLGRUPPE

Denne prosedyren gjelder for alt personale som er ansvarlig for bestilling, forsendelse, bruk og kontroll av sertifisert utstyr.

ANSVAR OG MYNDIGHET

Bedriftens fagansvarlige medarbeider er ansvarlig for det etablerte systemet for oppfølging av tilstanden og status på alt sertifisert løfteutstyr, taljer og spill.
Fagansvarlig skal enten selv eller ved hjelp av godkjent firma sørge for resertifisering.
Kontroll kan utføres av utnevnt kontrollør som har opplæring og kunnskaper vedrørende det utstyr som skal kontrolleres. Kun sakkyndig virksomhets sertifiseringsorgan utnevner kontrollører.

Innkjøpsansvarlig er ansvarlig for at originalsertifikater leveres til fagansvarlig medarbeider. Dette gjelder også ved innkjøp direkte til anlegg.

Fagansvarlig medarbeider har ansvaret for at deleliste og norsk reparasjonsmanual forefinnes, eller innhentes der det er nødvendig, samt at prosedyre for sertifisering utføres iht regelverk og produsentens anbefalte intervall for eventuell skifting av deler.

Fagansvarlig medarbeider oppbevarer alle originalsertifikater og skal sørge for å melde fra når utstyr skal resertifiseres eller kontrolleres.
Lagerleder er ansvarlig for at usertifisert utstyr eller ukontrollert utstyr ikke blir sendt ut fra lager. Ved utsendelse må det også vurderes hvor lang tid utstyr blir på anlegg før det kommer inn igjen.
Lagerleder er ansvarlig for å sende kopi av sertifikat og kontrollbok ut på anleggene, og at utstyr er påsatt merke og årets farge er godt synlig for identifikasjon.

Stedlig leder er ansvarlig for at usertifisert utstyr tas ut av bruk. Utstyr som krever årlig kontroll skal også tas ut av bruk når ny kontroll kreves. Defekt utstyr tas umiddelbart ut av bruk for reparering, resertifisering eller kontroll.

BESKRIVELSE

Kjøp av sertifisert utstyr:
Innkjøper av utstyr er ansvarlig for å få alle nødvendige sertifikater og spesifikasjoner med leveransen. Originaler av alle sertifikater med underliggende nødvendig dokumentasjon, leveres sakkyndig medarbeider for arkivering.
Utsendelse av sertifisert utstyr
Forsendelsesadvis(rekvisisjon) utstedes av avdelingene og rekvireres hos innkjøpsleder, som ved hjelp av lagerleder finner fram og pakker sertifisert materiell. Sammen med forsendelsen sendes også kopi av sertifikater, kontrollbok og nødvendig dokumentasjon.
Kun kontrollert og sertifisert utstyr sendes ut.
Bruk av sertifisert utstyr

Utstyr skal behandles i henhold til forskrifter og brukerveiledning. Bruker skal daglig påse at utstyret fungerer og ikke har skader. Utstyr som er beskadiget eller ikke fungerer som forutsatt, samt utstyr som er blitt overbelastet, skal straks tas ut av bruk. Det er ikke tillatt å foreta reparasjoner eller skifte ut deler uten at utstyret resertifiseres. Utstyret som er tatt ut av bruk av årsaker som nevnt ovenfor skal kontrolleres av fagansvarlig medarbeider, eller godkjent kontrollør, før det kan frigis til videre bruk.

Defekt utstyr merkes umiddelbart med godt synlig merke "DEFEKT" og hvitt merke.
Utstyret returneres til lager i Molde eller leveres til godkjent verksted for reparasjon, kontroll og resertifisering.
Original av kontrolldokument eller nytt sertifikat sendes fagansvarlig medarbeider.

Når tiden er kommet for årlig kontroll, returneres utstyr til lager i Molde eller til annen sakkyndig virksomhet.
Kontrolldokumentasjon evt. nytt sertifikat sendes fagansvarlig medarbeider.

Blir utstyr kassert, skal den som forestår kassering melde fra til fagansvarlig medarbeider som tar dette ut av systemet.
Kontroll og resertifisering av innlevert utstyr
Fagansvarlig medarbeider har ansvaret for at sertifisert utstyr testes og at prøveløft foretas iht forskrift og produsentens opplysninger.

Fagansvarlig medarbeider er også ansvarlig for at alle kontroller registreres:

Innkommet utstyr rengjøres, repareres, kontrolleres og eventuelt resertifiseres før det merkes med årets farge og klargjøres for ny bruk. Fagansvarlig medarbeider vurderer eventuell kassering. Alt kassert utstyr males hvitt og/eller ødelegges/skjæres i stykker.

Oppfølging av sertifisert utstyr
Innkjøpsansvarlig melder hver måned fra om hvilket utstyr som skal ha årlig kontroll/resertifisering innen neste måned.

Innkjøpsansvarlig fremskaffer oversikt over hvor slikt utstyr befinner seg, og liste leveres ut til produksjonsavdelingene som er ansvarlig for at utstyr oppdateres/evt. innsendes for kontroll og sertifisering.

Appendix D

LINJEBYGG
OFFSHORE

PROSEDYRE

FOR MERKING AV

UTSTYR OG MATERIELL

Id 8909

Gyldig dokumentasjon oppdateres kun i TQM

FORMÅL OG OMFANG
Formålet med denne prosedyre er å sikre at utstyr blir merket på en slik måte at kun utstyr som er kontrollert og godkjent blir brukt.

MÅLGRUPPE
Denne prosedyren gjelder for lagerpersonell og kontrollører.

ANSVAR OG MYNDIGHET
Lagerpersonell skal:
Merke nytt utstyr og registrere det i lagerstyringssystemet
Merke nytt materiell med fargemerking
Merke alt defekt utstyr
Kassere defekt utstyr/materiell
Sørge for at utstyr og materiell er kontrollert, godkjent og påsatt kontrollmerke og TAG-merke før utsendelse fra lager

Kontrollør sakkyndig virksomhet skal:
Merke godkjent sertifisert utstyr med kontrollmerke og årets farge

BESKRIVELSE
Generelt
Hensikten med kontrollmerking og fargemerking er at brukerne på en enkel måte skal kunne se at utstyr og materiell er godkjent for bruk og at det tilhører LBO.

Kontrollmerke: Dette er et selvklebende merke som viser kontrolldato og neste kontroll.
Årets farge: Strips med årets farge.
TAG-merke: Messingskilt påhengt eller påskrudd for å forenkle registrering av unike utstyrsnummer ved bruk. Benyttes der det er lange serienummer på sertifisert utstyr.
Fargemerking: Fargespray med oransje farge som er LBOs farge.
Varemottak nytt utstyr
Utstyret merkes med TAG-merke ved varemottak.
Serienummer inngraveres på utstyr ved behov.
Materiell merkes med fargemerking ved varemottak.

Ved mottak av utstyr fra prosjekt
Utstyr blir sjekket og merket ut fra tilstand.

Defekt utstyr merkes defekt
Annet utstyr merkes ”skal kontrolleres”
Ved utsendelse av utstyr
Utstyr påsettes kontrollmerke og årets farge og kontrolleres mht TAG-merking
Materiell kontrolleres mht fargemerking.

Appendix E

LINJEBYGG
OFFSHORE

ORGANISERING OG STYRING

AV SAKKYNDIG VIRKSOMHET

Id 10423

Gyldig dokumentasjon oppdateres kun i TQM

FORMÅL OG OMFANG
Formålet med dokumentet er å sørge for at sakkyndig virksomhet får nødvendige ressurser til å gjennomføre arbeidet og at ressursstyringen mellom lager og sakkyndig virksomhet gjøres på en god måte i forhold til oppgavene.

MÅLGRUPPE
Lagerleder, faglig leder sakkyndig virksomhet, kontrollører og lagerpersonell.

ANSVAR OG MYNDIGHET
Faglig leder sakkyndig virksomhet (Faglig leder) er ansvarlig for å avrope personell fra lageret og lagerleder skal skaffe nødvendige ressurser.
Faglig leder skal sørge for styring av arbeidet som utføres av kontrollørene og at resultat av kontroller blir rapportert iht. rutiner.
Faglig leder er ansvarlig for å sørge for at det er tilstrekkelig med godkjent personell innen firmaet til å gjennomføre aktivitetene som sakkyndig virksomhet er ansvarlig for.

Lagerleder skal sørge for at det er minimum to personer avgitt til arbeid ved området sakkyndig virksomhet. Dersom det ikke ved behov er ressurser til å øke bemanningen utover 3 personer på sakkyndig virksomhet skal innkjøpssjef kontaktes for prioritering av ressursbruken.
Dersom lageret samtidig har behov for økt bemanning skal denne dekkes opp uten at det skal gå ut over sakkyndig virksomhet.

BESKRIVELSE
Organisering
Sakkyndig virksomhet har ingen fast ansatte innen egen virksomhet. Området er organisert som et eget område under daglig leder og skal tildeles ressurser i forhold til behov. Tildeling av personell skjer fra lageret.

Sakkyndig virksomhet har ansvar for gjennomføring av følgende oppgaver:
Kontroll, vedlikehold og godkjenning av sertifisert løfteutstyr
Kontroll, vedlikehold og oppbygging av TT utstyr
Kontroll, vedlikehold og oppbygging av fallsikringsutstyr

Dersom Faglig leder er fraværende skal fagperson som innehar nødvendige kvalifikasjoner tre inn i denne funksjonen. Dette kan gjøres ved at det er en fast stedfortreder for leder sakkyndig virksomhet, ref organisasjonsplan.

En person skal normalt være kontrollør og arbeide med kontroll og vedlikehold av sertifisert løfteutstyr og en person skal arbeide med TT utstyr og fallsikringsutstyr. Dersom det er behov for mer personell skal det minimum være 3 mann i kontinuerlig arbeid innen sakkyndig virksomhet.

Kompetanse – opplæring
Faglig leder er ansvarlig for at personellet har de kvalifikasjoner og godkjenninger som trengs for å utføre arbeidet.

Mål sakkyndig virksomhet

Utstyr som kommer inn til ”vedlikeholdslager” skal så snart som mulig gjennom eventuell rengjøring, kontroll reparasjon og service før det godkjennes og kan legges inn på hovedlager og være klart for ny utsendelse.
Målet er at utstyr som kommer inn skal være ferdig sjekket og være klar for ny utsendelse i løpet av maksimum 2 uker.

Kontroll og vedlikehold av sertifisert utstyr
Utstyr som skal kontrolleres skal leveres ferdig rengjort fra lager. Utstyr kontrolleres iht. utarbeidet sjekkliste. Utstyr som ikke overholder krav skal repareres eller kasseres.
Utstyret skal vedlikeholdes iht. leverandørs krav.

Kontroll, vedlikehold og oppbygging av TT utstyr
Kontrollør er ansvarlig for kontroll, vasking og vedlikehold av innkommende utstyr.
Utstyret skal vedlikeholdes og kontrolleres iht. etablerte rutiner.

Kontroll av fallsikringsutstyr
Kontrollør er ansvarlig for kontroll, vasking og vedlikehold av innkommende utstyr.
Utstyret skal vedlikeholdes og kontrolleres iht. etablerte rutiner.

Appendix F

Sjøfartsdirektoratet
Norwegian Maritime Directorate

Rundskriv - Serie V

Mottakere av rundskrivet: (sett kryss)

Sdir	: Sjøfartsdirektoratet
A:	16 spesielt bemyndigete arbeidskontorer
U:	Utvalgte utenriksstasjoner
P:	Produsenter av utstyr ev. undergrupper
OFF:	Offshorerederier / plattformsjefer / operatører
Hov:	Hovedorganisasjoner
Andre:	

Nr.:	**RSV 12-2008**
Dato:	16.12.2008
Saksnr.:	200836153 AWA
Gjelder til:	31.12.13
Opphever:	
Referanse til:	Regler for fiskefartøy, flyttbare innretninger, lasteskip og passasjerskip.

Elektronisk oppbevaring av sertifikater og annen dokumentasjon for kraner og løst løfteutstyr

Sertifikater, samt dokumentasjon fra kontroll som iht. forskrift kreves innført i kontrollboken, kan nå lagres og utarbeides i et elektronisk system. Dersom en velger å benytte elektronisk oppbevaring, så skal alle ovennevnte dokumenter legges inn i det elektroniske systemet. En kan altså ikke velge et delt system, der noe er papirbasert, mens andre deler er elektronisk. Kravene til slikt elektronisk system er de samme som for papirbasert system. Installasjon og system må oppfylle internasjonale bestemmelser.

Gjeldende regelverk:

- Forskrift av 17. januar 1978 nr. 4 om laste- og losseinnretninger på skip
- Forskrift 4. juli 2007 nr 854 om dekkskraner mv. på flyttbare innretninger
- Forskrift 13. juni nr. 660 om konstruksjon, utstyr, drift og besiktelser for fiske- og fangstfartøy med største lengde på 15 meter og derover.

Krav til system for elektronisk oppbevaring:

Tilgjengelighet:

- Det kreves at dokumentasjonen er tilgjengelig for eier, myndigheter og andre som er bemyndiget.
- Eier av laste- og losseutstyret skal også eie den elektronisk lagrede dokumentasjonen.
- Eier skal ha uavbrutt tilgang på dokumentasjonen.
- Eier må uten opphold kunne gi myndighetene eller personer som skal utføre kontroll av utstyret tilgang til dokumentasjonen.

Sporbarhet:

- Det kreves at det elektroniske systemet inkluderer elektronisk signatur. Loven om elektronisk signatur regulerer rettsvirkninger av elektroniske signaturer.
- Dokumenter, inkl. utstyrshistorikk, skal være beskyttet mot overskriving, sletting og endringer**.**
- Systemet må klart identifisere person som har utført kontroll samt dokumentdato.

Oppbevaring:

- All dokumentasjon skal være tilgjengelig så lenge utstyret finnes ombord.
- Sertifikater og andre dokumenter som kun finnes på papir, må kunne skannes og legges inn i systemet.
- Data i et elektronisk system må være beskyttet og lagret i en sikret database.
- Det skal finnes tilfredsstillende prosedyrer for reserveløsning, samt operasjonsprosedyrer.
- Gjenoppretting må utføres ved kryptert kobling.

Installasjon:

- Installasjonen må skje i samsvar med gjeldende regler for elektroniske installasjoner og elektronisk kompatibilitet.

Dokumentasjon:

For slikt elektronisk lagringssystem skal følgende dokumentasjon finnes om bord, og sendes inn i de tilfeller Sjøfartsdirektoratet ber om det:

- Erklæring fra installatør om at systemet er installert i henhold til fabrikantens retningslinjer og gjeldende regelverk, samt at systemet er funksjonstestet og funnet i orden.

Ergonomi og nattsyn:

- Dersom systemet installeres i en arbeidsstasjon på bro, i forbindelse med navigering og manøvrering, skal installasjonen være i henhold til ISO standard 8468 punkt 6.1 eller MSC/Circ.982 punkt 4.
- Belysning av skjerm og betjeningspanel skal følge bestemmelsene i ISO 8486 punkt. 6.3.4 eller MSC/Circ.982 punkt 5.3.6.

Sigurd Gude
fung. Sjøfartsdirektør

Ove Tautra
Avdelingsdirektør

Appendix G

Hendelsesnummer: 10781

Fakta:

Dato for hendelse:	05.06.2010
Ansvarsområde:	LBO / S-6 Lager, logistikk
Underområde:	Varemottak, Utsendelse
Aktivitet:	
Hendelsestype:	Avvik
Måleparametre:	**Generelle måleparametre:** Leveringspresisjon / LBO / **Materiell/utstyr** Fagområde / **TT** Involvert personell / **LBO ansatt** **Måleparametre for underområdet:** Utsendelse / **Funksjonsfeil**
Prosjektområder :	
Beskrivelse:	Det kom ut nytt TT-utstyr til stans jobben på 2/4-Tor.Eg gikk gjennom dette utstyret og monterte opp alle selene. Jeg oppdaget da at brystklemma på den ene selen var montert oppned.Heldigvis vart dette oppdaget før selen vart tatt i bruk.Tok av brystklemma og monterte den riktig.
Strakstiltak :	
Forslag til forbedring/langsiktig tiltak:	
Alvorlighetsgrad:	Høy
Status:	Lukket
Hendelse registrert:	05.06.2010
Registrert av:	Rune Aasheim

Appendix H

Hendelsesnummer: 10770

Fakta:

Dato for hendelse:	01.06.2010
Ansvarsområde:	LBO / S-6 Lager, logistikk
Underområde:	Varemottak, Utsendelse
Aktivitet:	
Hendelsestype:	Uønsket hendelse
Måleparametre:	**Generelle måleparametre:** Leveringspresisjon / LBO / **Materiell/utstyr** Fagområde / **TT** **Måleparametre for underområdet:** Utsendelse / **Funksjonsfeil**
Prosjektområder :	
Beskrivelse:	40335 Fakkeltipp EldB, EldFTP, Tor Kom ut 2 stk TT-sett til SD10 på ELDB, der det manglet koblingsstykket mellom brystklemme og innfestingen nede på selene. Dette manglet på alle 6 selene i det ene settet. De var heller ikke løse i kassene.
Strakstiltak :	Sendt mail om å få de sendt ut med personell som skal til ELDB.
Forslag til forbedring/langsiktig tiltak:	Bedre sjekk og kontroll før utsendelse.
Alvorlighetsgrad:	Middels
Status:	Lukket
Hendelse registrert:	01.06.2010
Registrert av:	Bjarte Midtbø

Appendix I

Hendelsesnummer: 11586

Fakta:

Dato for hendelse:	22.02.2011
Ansvarsområde:	LBO / S-6 Lager, logistikk
Underområde:	Varemottak, Utsendelse
Aktivitet:	
Hendelsestype:	Avvik
Måleparametre:	**Generelle måleparametre:** Leveringspresisjon / LBO / **Materiell/utstyr** Involvert personell / **LBO ansatt** **Måleparametre for underområdet:** Utsendelse / **Feil antall** Utsendelse / **Feil type**
Prosjektområder :	40310 CoPNo - Arbeid for SV
Beskrivelse:	BC13 har nylig fått ut ny kontainer (KA 1416). - En av to wirejekker var feil. Fikk 081568 wirejekk HIT 16 WLL 1600 kg H56 . Skulle fått K82 080133 - Jekkene manglet jekkespaker. - Fikk også sendt ut 15 stk. WLL 3 T 0,5 m fiberstopper. Disse er for korte og kan ikke benyttes i vårt arbeid. Nye stropper er bestilt. Utover dette var det knakende flott med ny kontainer.
Strakstiltak :	
Forslag til forbedring/langsiktig tiltak:	Kanskje man skal finne en ordning som gjør at man husker å legge ved jekkespaker, f.eks. å føre disse opp i pakkseddelen slik at dette fungerer som en huskelapp?
Alvorlighetsgrad:	Lav
Status:	Under gjennomføring
Hendelse registrert:	22.02.2011
Registrert av:	Christian Foss