



Faculty of Science and Technology

MASTER'S THESIS

Study program/ Specialization: Offshore Technology: Industrial Asset Management	Spring semester, 2016 Open
Writer: Tørresdal, Ingunn (Writer's signature)
Faculty supervisor: Professor Jayantha Prasanna Liyanage, PhD External supervisor: Hans Christian Håstø	
Thesis title: A study of how a Lean approach can be used in dealing with challenges present at DeepOcean Offshore Base and their specialty within logistics-, warehouse- and workshop services	
Credits (ECTS): 30	
Key words: Lean, streamlining, efficiency improvements, lean thinking, quality, EFQM, KPI, management, learning organization, continuous improvement, asset management, optimization, 5S, visual workplace, process flow, flow efficiency, standardization, waste, TPM, TQM	Pages: 113 + enclosure: 11 Stavanger, 13/06/2016 Date/year

A study of how a Lean approach can be used in dealing with challenges present at DeepOcean Offshore Base and their specialty within logistics-, warehouse- and workshop services

By:
Ingunn Tørresdal

A thesis presented to the Faculty of Science and Technology
University of Stavanger

In fulfilment of the requirements for the degree of Master of
Science (MSc) in Offshore Technology



Spring 2016

ABSTRACT

Over the last few years we have witnessed one of the largest drops in oil prices. The industry has become highly competitive and customer oriented, and the offshore companies are facing increasing demands for efficiency; more streamlined and standardized work processes and work methods. The ongoing battle for the current contracts has resulted in an extreme pressure to keep costs down, while still delivering sufficient quality, and therefore makes a number of companies within the oil and gas industry suffer financially. In order to survive in this industry, one should strive for continuously improving the variables that can affect the business at all levels. This also includes a higher degree of supportive and inspiring management, a sense of personal empowerment and ownership by each individual.

This thesis attempts to use Lean as an approach to deal with the challenges the employees at DeepOcean Offshore Base are facing in their daily work. Lean is an approach used to maximize customer value and minimize waste by focusing on flow, streamlined processes, visual management and continuous improvements. By waste means unnecessary use of resources and activities that are not making any value. A study of the Lean concept has been carried out by the author of this thesis in order to form a knowledge base and further insight. In addition, case studies of companies that have implemented Lean to varying degrees have been studied. A qualitative mapping of work processes, interviews, observation and questionnaires have been applied in obtaining relevant information. This thesis encompasses identified challenges and improvement potentials. The results of the study revealed that the employees at DeepOcean Offshore Base are in a situation where they just spend time on 'keeping the business running', due to an arguable amount of inefficient work processes stealing valuable time. There are however many contributing factors that together represent a huge amount of waste at the DeepOcean Offshore Base. Changes are suggested within relevant variables that may affect the business, as well as specific Lean initiatives that can support the necessary changes, and more explicitly enhance flow efficiency.

Lean can be used as an approach in dealing with present challenges at DeepOcean Offshore Base by starting to continuously strive to make things a little better, and constantly maintaining the improvements. Through implementation and sustainment of specific Lean initiatives, waste can be reduced and value may flow without interruptions.

ACKNOWLEDGMENTS

This thesis was developed during spring 2016, and concludes the completion of my degree of Master of Science (MSc) in Offshore Technology with specialization in Industrial Asset Management. This process has been a great experience, and I have simply enjoyed every minute of it. The topic has been highly relevant for the time we are in now, which has strengthened my enthusiasm. I highly value the knowledge I have gained through literature studies, research and conferences.

I need to thank several people for their contribution during the process of writing this thesis. First of all, I would like to thank Professor Jayantha Prasanna Liyanage, my faculty Supervisor, for great help with structuring the thesis and highlighting the ‘red line’. I am grateful that he gave me inspiration and motivation.

I will also like to thank my external Supervisor, Base Manager Hans Christian Håstø for being available for guidance, and for offering an office for me to use at the DO Offshore Base. His high expectations for what this project could do for their workplace made me feel useful and gave me more motivation to harness my potential.

Furthermore, I will like to thank all the employees at the DeepOcean Offshore Base for sharing time, experience and valuable insights. They made it possible for me to reach a certain depth of my study, and to identify the real challenges they struggle with in their daily work. In fear of forgetting all who contributed, I will not mention all by name. Although, I will express great thanks to Ole-Jørgen Abrahamsen, one of the Technicians, for exchange of ideas: You helped me see the bigger picture of how the situation was. Thank you for your time, willingness to share and honesty.

I would also like to thank Torbjørn Gjerdevik and Stein Lilledal for showing me the companies they are working for, and for answering my questions for the case studies. These visits established the foundation for my practical understanding of the topic.

Finally, I will like to thank Christina Jacobsen and Ida Halvorsen Verpe who did the final review of my thesis.

Haugesund, June 2016, Ingunn Tørresdal

CONTENTS

ABSTRACTIII

ACKNOWLEDGMENTS V

LIST OF FIGURES X

LIST OF TABLESXIII

ABBREVIATIONS AND DEFINITIONS XIV

1 PART 1: INTRODUCTION..... 1

1.1 BACKGROUND..... 1

1.2 SCOPE 1

1.3 OBJECTIVE..... 2

1.4 LIMITATIONS 2

1.5 METHODOLOGY 3

1.6 STRUCTURE OF THE THESIS 4

2 PART 2: INTRODUCTION TO DEEPOCEAN AND THE OFFSHORE BASE . 6

2.1 DEEPOCEAN AS 6

2.1.1 Introduction 6

2.1.2 Work Phases 6

2.1.3 Organization of Company 7

2.1.4 HSE Objectives and Company Values 8

2.2 INTRODUCTION TO DEEPOCEAN OFFSHORE BASE 9

2.2.1 General 9

2.2.2 Description of the DO’s Base Hall..... 9

2.2.3 Organizational Structure and Areas of Responsibilities 10

3 PART 3: LITERATURE STUDY: THE CONCEPT OF LEAN..... 12

3.1 INTRODUCTION TO LEAN..... 12

3.2 THE ORIGINS OF LEAN PRODUCTION 12

3.3 LEAN PRINCIPLES..... 13

3.3.1 The Toyota Way..... 13

3.3.2	7 Types of Waste (MUDA).....	14
3.3.3	Six Principles when Implementing Lean	15
3.3.4	Just-In-Time	16
3.3.5	Continuous Improvement.....	17
3.3.6	Organizational Culture	17
3.4	TOOLS	18
3.4.1	5S.....	18
3.4.2	24-Hours Meeting	19
3.4.3	Kaizen Meetings.....	19
3.4.4	A3 Review (Problem Solving)	20
3.4.5	Value Stream Mapping (VSM)	21
3.4.6	Visual Control	21
3.4.7	Kanban	21
3.4.8	Gemba Walk.....	22
3.5	LEAN V.S. TQM AND SIX SIGMA	22
3.6	LEAN V.S. TPM.....	23
3.7	LEAN INCORPORATED WITH THE EFQM FRAMEWORK	23
3.8	IMPLEMENTATION OF LEAN	25
4	PART 4: CASE STUDIES.....	27
4.1	LAERDAL MEDICAL.....	27
4.2	OCEANEERING	30
4.3	HYDRO KARMØY	33
5	PART 5: A STUDY OF THE CURRENT SITUATION AT DO OFFSHORE	
BASE	36
5.1	INTRODUCTION.....	36
5.2	EFQM ASSESSMENT	37
5.2.1	About the Assessment	37
5.2.2	Results of the Assessment.....	39
5.2.3	Limitations of the Assessment	40
5.2.4	Analysis and Discussion of the Results.....	41

5.3	ANALYSIS OF THE MAIN WORK PROCESSES	44
5.3.1	DeepOcean’s Value Stream	44
5.3.2	Activities and Work Processes	45
5.3.3	Analysis of the Main Work Processes.....	47
5.3.4	Identification of Specific Challenges for Work Process 1	50
5.3.5	Identification of Specific Challenges for Work Process 2	52
5.3.6	Discussion of Result.....	55
5.4	IDENTIFICATION OF CHALLENGES IN TERMS OF SIX VARIABLES	56
5.4.1	Leadership	56
5.4.2	Human	57
5.4.3	Method	58
5.4.4	Material	60
5.4.5	Assets (Items/Equipment and Tools)	60
5.4.6	Work Environment.....	61
5.5	IDENTIFICATION OF CONTRIBUTORS, WASTE AND EFFECTS	63
5.5.1	Contributors.....	63
5.5.2	Waste.....	67
5.5.3	Effects.....	68
5.6	THE WAY FORWARD AND POTENTIAL OPPORTUNITIES	70
6	PART 6: IMPROVEMENT SUGGESTIONS.....	72
6.1	INTRODUCTION.....	72
6.2	NECESSARY CHANGES FOR THE VARIABLES.....	72
6.2.1	Leadership	72
6.2.2	Human	73
6.2.3	Method	74
6.2.4	Material	76
6.2.5	Assets (Items/Equipment and Tools)	76
6.2.6	Work environment.....	76

6.3	LEAN IMPROVEMENT INITIATIVES	77
6.3.1	Order and Structure – 5S	77
6.3.2	Visualization of Information	86
6.3.3	Creation of Flow	87
6.3.4	Inventory control	95
6.3.5	Continuous Improvement	96
7	PART 7: CONCLUSION AND RECOMMENDATION FOR FURTHER WORK	106
7.1	INTRODUCTION	106
7.2	CONCLUSION AND DISCUSSION	106
7.2.1	How Lean can be used as an Approach to deal with Present Challenges	106
7.2.2	Challenges related to using Lean as an Approach	107
7.3	RECOMMENDATION FOR FURTHER WORK	109
8	REFERENCES	110
9	APPENDICES	114
9.1	APPENDIX 1: QUESTIONNAIRE	114
9.1.1	The correlation between the questionnaire and the EFQM User Guide	114
9.1.2	The applied version of the questionnaire	114
9.1.3	Calculated results	118
9.2	APPENDIX 2: THE CONNECTION BETWEEN CONTRIBUTORS, WASTE, EFFECTS AND LEAN INITIATIVES	120
9.3	APPENDIX 3: MARKING OF FLOOR AND DESIGNATED AREAS	121

LIST OF FIGURES

Figure 1 – Structure of the thesis	4
Figure 2 – Phases of work performed by DO.....	7
Figure 3 – The Executive Management Team of DeepOcean Group	7
Figure 4 – Main Disciplines of Administration	8
Figure 5 – DeepOcean’s Core Values	8
Figure 6 – Offshore Base, Killingøy	9
Figure 7 – Map of the DO hall	10
Figure 8 – Organizational Structure at the DO Offshore Base	11
Figure 9 – Toyota Production System.....	14
Figure 10 – PDCA.....	17
Figure 11 – 5Ss.....	18
Figure 12 – Fishbone diagram	20
Figure 13 – The foundations of Lean and Six Sigma.....	23
Figure 14 – EFQM Excellence Model	24
Figure 15 – House of CIP.....	28
Figure 16 – “One-piece-flow” at Laerdal.....	28
Figure 17 – Oceaneering’s headquarter in Stavanger, Norway	30
Figure 18 – Items have fixed locations	30
Figure 19 – Tool cabinet	31
Figure 20 – Whiteboard.....	31
Figure 21 – Whiteboard with safety information and aids.....	32
Figure 22 – Focus on people).....	34
Figure 23 – Before the improvement	34
Figure 24 – Visual information	34
Figure 25 – Hydro’s training & education program.....	35
Figure 26 – Lean Iceberg Model	36
Figure 27 – Structure of how the study was performed	37
Figure 28 – Attributes found in the criterion parts of the EFQM Excellence Model ..	38
Figure 29 – Results of the assessment presented with respect to the four attributes ...	40
Figure 30 – Overview of the value stream for DO Offshore Base.....	45
Figure 31 – Work Process 1: Order to delivery of Rental Pool Items	46
Figure 32 – Work Process 2: Reception, forwarding, evaluation, service and storing	46

Figure 33 – Work Process 1: Order to delivery of Rental Pool Items	48
Figure 34 – Work Process 2: Reception, forwarding, evaluation, service and storing	49
Figure 35 – Work process 1: Order to delivery, including evaluation and service.....	51
Figure 36 – Movements of items.....	54
Figure 37 – Ishikawa diagram, six variables.....	56
Figure 38 – Stock storage.....	60
Figure 39 – Storage Area 1	62
Figure 40 – Storage Area 2	62
Figure 41 – Clutter at the workstation.....	62
Figure 42 – Disorganized workstation	62
Figure 43 – Bow-tie: Contributors, waste and effects.....	63
Figure 44 – 10 types of waste.....	68
Figure 45 – DeepOcean hall at Killingøy Offshore Base.....	70
Figure 46 – Shadow tool board	82
Figure 47 – Work Process 1: Order to delivery of Rental Pool items.....	88
Figure 48 – Item Card (A4 format)	88
Figure 49 – Laminated poster fastened at the respective rack section.....	88
Figure 50 – Item Card (small)	89
Figure 51 – Work Process 1, improved flow	90
Figure 52 – Reception of items	91
Figure 53 – Work Process 2, improved flow	93
Figure 54 - Item Card Flow system for Rental Pool items.....	94
Figure 55 – Kanban Card	95
Figure 56 – Kanban system for inventory control.....	95
Figure 57 – The process of establishing KPIs to achieve the target	97
Figure 58 – Target Board	99
Figure 59 – Concern Form for deviations	100
Figure 60 – Action List	101
Figure 61 – Calendar marked with red and green color.....	101
Figure 62 – Daily visualization of rate of completed service against received items	102
Figure 63 – Calendar with week numbers marked with green and red color.....	102
Figure 64 – Concern Form	103
Figure 65 – A3-problem solving	104
Figure 66 – Calculated result	119

Figure 67 – The connection between contributors, waste, effects and lean initiatives 120

Figure 68 – Map of the Logistic and Warehouse/Storage Area with suggested areas for items and floor marking 122

LIST OF TABLES

Table 1 Results of the assessment	39
Table 2 Identified contributors	64
Table 3 5S Plan for DO Offshore Base	78
Table 4 Floor marking.....	81
Table 5 Designated areas for items that are received, shipped, or items that are moved within the hall.....	83
Table 6 Suggestions to KPIs and targets at the Base	97
Table 7 The correlation between the questionnaire and the EFQM user guide	114
Table 8 Applied version of the questionnaire	115
Table 9 Designated areas in storage / logistic area	123

ABBREVIATIONS AND DEFINITIONS

Abbreviation	
CEO	Chief Executive Officer
CIP	Continuous Improvement Philosophy
CPI	Customer provided items
DO	DeepOcean
DP	Dynamic Positioning
EFQM	European Foundation for Quality Management
EVP	Executive Vice President
GNS	Greater North Sea
HR	Human Resources
HSE	Health, Safety and Environment
HSEQ	Health, Safety, Environment and Quality
IMR	Inspection, Maintenance and Inspection
JIT	Just-in-time
KPI	Key Performance Indicator
KSB	Karmsund Service Base
LAMDA	Look, Ask, Model, Dialogue, Act
MHS	Manual Handling System
OEE	Overall Equipment Efficiency
PDCA	Plan, Do, Check and Act
PE	Project Engineer
QMS	Quality Management System
ROV	Remotely Operated Vehicle
SURF	Structures, Umbilicals, Risers and Flowlines
TP	Tool Pool
TPM	Total Productive Maintenance
TPS	Toyota Production System

TQM	Total Quality Management
VSM	Value Stream Mapping
YTD	Year To Date
Translation and definitions of Japanese Lean words	
Anbon Board	A visual control device which displays the status of every production system (Womack & Jones, 2003)
Gemba	The real place
Genchi Genbutsu	Going to the source
Heijunka	Levelling
Hoshin Kanri	A strategic decision-making tool. Also called Policy Deployment. (Womack & Jones, 2003)
Jidoka	Autonomation with a human touch (Womack & Jones, 2003)
Kaikaku	Radical improvement of an activity to eliminate muda (Womack & Jones, 2003)
Kaizen	Continuous improvement of an activity to create more value with less muda (Womack & Jones, 2003)
Kanban	A small card attached to boxes of parts that regulate pull by signalling upstream production and delivery (Womack & Jones, 2003)
Muda	Any activity that consumes resources but creates no value (Womack & Jones, 2003)
Poka-Yoke	A mistake-proofing device or procedure to prevent a defect during order-taking or manufacture (Womack & Jones, 2003)
Other definitions	
Equipment Tool	DeepOcean's equipment/item database
Item	The 'flow object'
Rental Pool/Tool Pool items	Equipment/tools/assets owned by DeepOcean that is rented out to the projects and vessels. This is also the 'flow object'.
Service Base	DeepOcean's service database
The Base / DO Offshore Base	DeepOcean Offshore Base at Killingøy, Haugesund

1 PART 1: INTRODUCTION

1.1 BACKGROUND

Low economic growth and a reduction in offshore activities have characterized the last years. DeepOcean (DO) always strive for positioning their company for winning new subsea projects, but as for other companies in the oil and gas sector, DO also suffer the consequences of the significant reduction in oil prices. Since there are several competing companies delivering similar services, competition is strong. In order to survive in this industry, one should continuously strive for excellence. Due to this situation, DO have fired almost 30% of their offshore staff redundant, and 15% of the onshore staff. It is important, now more than ever before, to deliver excellent performance. Good HSE-results and overall quality are important in order to win new contracts, more so there are higher expectations to efficiency; saving time, and reducing waste. It is important for a company like DO to focus on the elements that really matter to their customers, and take necessary actions to deal with the situation. They should find the balance so that the company can sustain and develop further. Even small changes in the right direction could have significant effects on the result, and that is the core of this thesis.

DO have for many years operated through various logistics activities, warehouse and technical workshop based in 'Hall 4' onshore at the Killingøy Offshore Base. The layout and area available has been challenging, and the elements around the work processes have therefore been experienced as somewhat inconvenient. The contract is now expiring, and DO therefore move their operations to other leased locations at the base.

1.2 SCOPE

The scope is mainly research into the current situation at the DO Offshore Base to reveal challenges that may contribute to waste and undesirable effects. Literature studies as well as visits and case studies of companies have been carried out to support this process. This further supports the foundation for suggestions of how Lean can be used as an approach in dealing with the current challenges. Variables identified as 'subject to change' and specific Lean initiatives have been considered in order to improve the situation.

A close collaboration and dialogue with the Management and the employees at the DO Offshore Base took place during the writing of this thesis. An introduction to the Lean approach was also presented for the personnel in order for them to familiarize themselves with the concept.

1.3 OBJECTIVE

The objective is to find out how Lean can be used as an approach in dealing with the current challenges present at the DO Offshore Base. This includes identifying changes within relevant variables that affect the business, and suggesting specific Lean initiatives that can support the necessary changes, and which fit the business at DO Offshore Base. Implementation of the suggested recommendations could hopefully support DO Offshore Base in improving the current situation. The desired goal for them would be to reach a state where value flows without interruptions, and time can rather be spent on developing and improving their processes instead of falling behind on schedule, struggling to keep the business running. The desired state will not be within reach during development of this thesis. However, the thesis may provide ideas of initiatives that can act as an appropriate beginning of a Lean transformation that may later provide a competitive advantage by increasing DO's ability in attaining new contracts.

A secondary objective is also to motivate and inspire DO's employees at the Base to embrace this way of thinking so that the change initiatives can be perceived more positively.

1.4 LIMITATIONS

Lean is a continuous process which encourages continuous learning. Implementing Lean can be seen as a long-term project of investment. Unfortunately, the project covered by this thesis was temporary and only scheduled to last for approximately six months, which means that most of the implementations will be conducted after the thesis has been submitted.

Another limitation identified, is concerned with the new hall, which is already designed and ready to be built. Consequently, it is not possible to change certain design 'flaws' that would challenge the 'Lean' way of thinking. Due to the current industrial situation, some convenient solutions have even been removed from the design as a cost reducing initiative.

Implementation of the suggested changes and Lean initiatives would require use of sufficient resources. Due to financially challenging times, DO are, like many others, currently downsizing, which makes it difficult to justify costs and resources to be spent on projects and/or initiatives that do not have immediate profit potential, even though it has the potential to significantly support DO financial resources in the long-term.

The fact that the author of this thesis is employed in DO may also be a limitation. The information received from colleagues may unintentionally be biased. However, the author of this thesis has previously been stationed in the DO Main Office and did not have much knowledge to DO Offshore Base before this project started.

1.5 METHODOLOGY

Several methods have been applied in analysing the situation at the DO Offshore Base. Together, the variety of methods aims to strengthen the perception of the reality at the Base. In order to compare the current situation with how an ideal situation could be, a literature study into Lean and associated improvement techniques has been carried out accompanied by three different case studies.

Lean is mainly about continuous improvement processes; hence a questionnaire survey has been applied to assess the EFQM Model in terms of how the culture, identification, and implementation of improvements are experienced at the Base. The EFQM Model was used to establish a more holistic picture of the situation, and presents the employees' experience of the current leadership.

The value stream with DO Offshore Base in focus was created and presented to show an overview of the main processes. An analysis of the work processes was conducted further on a more detailed level where the main activities and responsibilities were made visible using flow charts. This analysis aimed to reveal challenges and identify potential improvements. Both informal communications and more dedicated interviews with the employees at the DO Offshore Base took place with the goal to identify both general and specific challenges. Some information was also collected through direct observation and communication with members in the project teams located at the DO's Main Office.

The results are discussed after the presentation of the results.

1.6 STRUCTURE OF THE THESIS

Figure 1 shows how the thesis is structured. It is divided into seven parts.

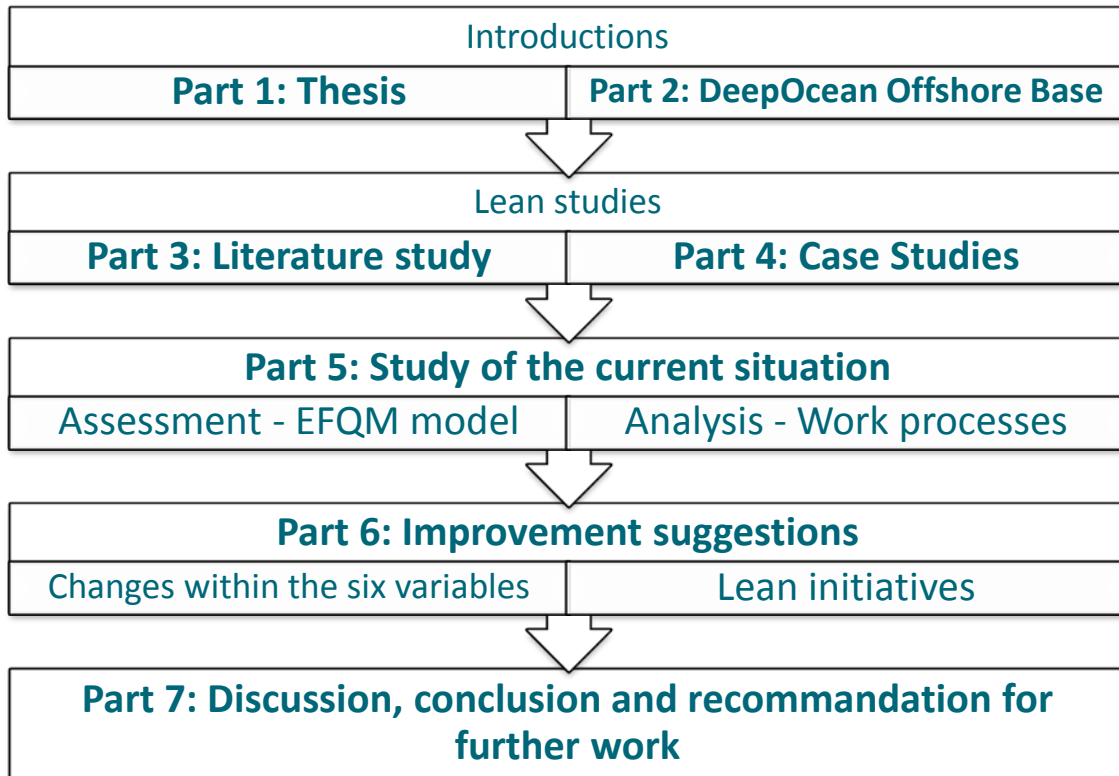


Figure 1 – Structure of the thesis

Part 1 is an introduction to this thesis, such as background, scope and objective, followed by Part 2, which is an introduction to the DO Offshore Base – the chosen focus area of this thesis.

Part 3 presents the concepts of Lean, history, principles, tools and methods.

Part 4 is encompassed of case studies of companies that have started implementation of Lean, and which also practice it today. This part gives a practical idea of how a company can use Lean to become more efficient and encourage systematic improvements in the work processes.

Part 5 includes a presentation of the current situation at the DO Offshore Base. The identified challenges are empirical findings revealed through both the EFQM assessment and analysis of work processes. These are the challenges that contribute to waste and undesirable effects identified further throughout this thesis. The challenges can be categorized into six variables: Leadership, Human, Method, Material, Assets and Work Environment. This process is illustrated by Figure 27 in Section 5.1.

Part 6 presents suggestions to desirable changes that can be achieved through the identified variables and specific Lean initiatives.

Part 7 contains a discussion and conclusion of this thesis, as well as recommendation for further work.

2 PART 2: INTRODUCTION TO DEEPOCEAN AND THE OFFSHORE BASE

2.1 DEEPOCEAN AS

2.1.1 Introduction

The subsea company, DeepOcean (DO) was established in 1999, and is a provider of subsea services and technologies for the oil and gas industry. Their customers are oil production companies such as Statoil, BP, Shell, Nordstream, Total and BG Group. DO offer a breadth of subsea services including survey and seabed-mapping, subsea installations, seabed interventions, inspections, maintenance and repairs (IMR), decommissioning and SURF. The Main Office is in Norway, but DO have also established themselves in the global market with offices in the UK, Holland, Brazil, Mexico and Singapore.

DO, together with their shareholders and partners own a modern fleet of DP2 (dynamic positioning, class 2) ROV-, survey-, IMR- and construction class vessels.

2.1.2 Work Phases

Everything starts with a sale and an invitation to tender. Bid preparations are carried out in the tendering phase. Time and resources are spent to prepare a comprehensive description of the service that the company can offer. Potential customers review this document, and award the most suitable company with a contract. If DO are awarded the contract, they start to review it. Depending on the scope and the extent of the project, a project team is organized, and the planning phase starts. Elements such as resources, schedule, interfaces, administration routines, scope, work procedures, procurement and familiarization are reviewed and/or established. This is the foundation for further engineering where mobilization and demobilization plans, task plans and work procedures are established to prepare for the execution of the project. The project execution itself is carried out offshore using a suitable vessel. When the work is done, the project is closed through the issuing of a project resume.

Figure 2 illustrates the overall phases of the work performed by DO on a regular basis.



Figure 2 – Phases of work performed by DO

2.1.3 Organization of Company

The Board of Directors of DeepOcean is elected by the shareholders, exercising the supreme authority for company activities. Management of DeepOcean is placed under the authority of the Board, which provides for and ensures satisfactory organization of company activities. The Executive Management Team at the DeepOcean Group consists of the following roles/functions making up the organizational structure (see Figure 3):

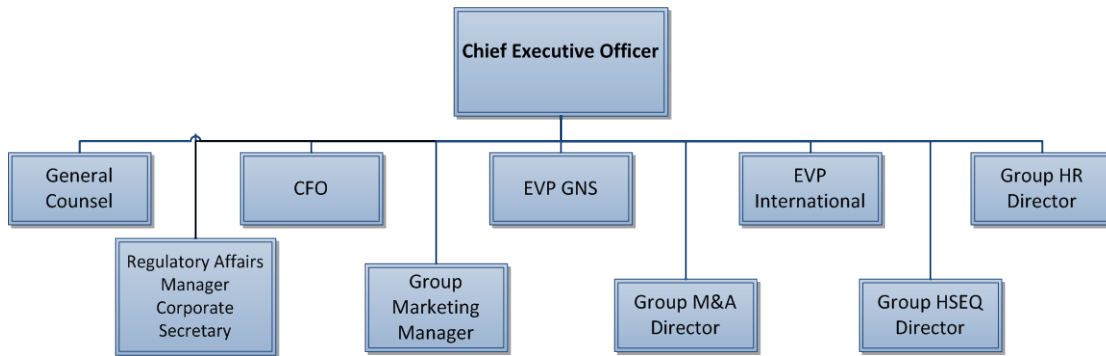


Figure 3 – The Executive Management Team of DeepOcean Group

The DO divisional organization is established in a regular line management structure, headed by the Division Executive (President/General Manager/EVP), who is in-turn supported by the Directors and Regional Managers who have responsibility for departmental disciplines necessary to support their local activities. Several functional disciplines provide expertise and resources across the regions as dictated by project requirements. The administration is divided into the following main disciplines: Commercial, Operations, Human Resources, Regional Management, Finance Accounting, and Health, Safety, Environment and Quality (See Figure 4):

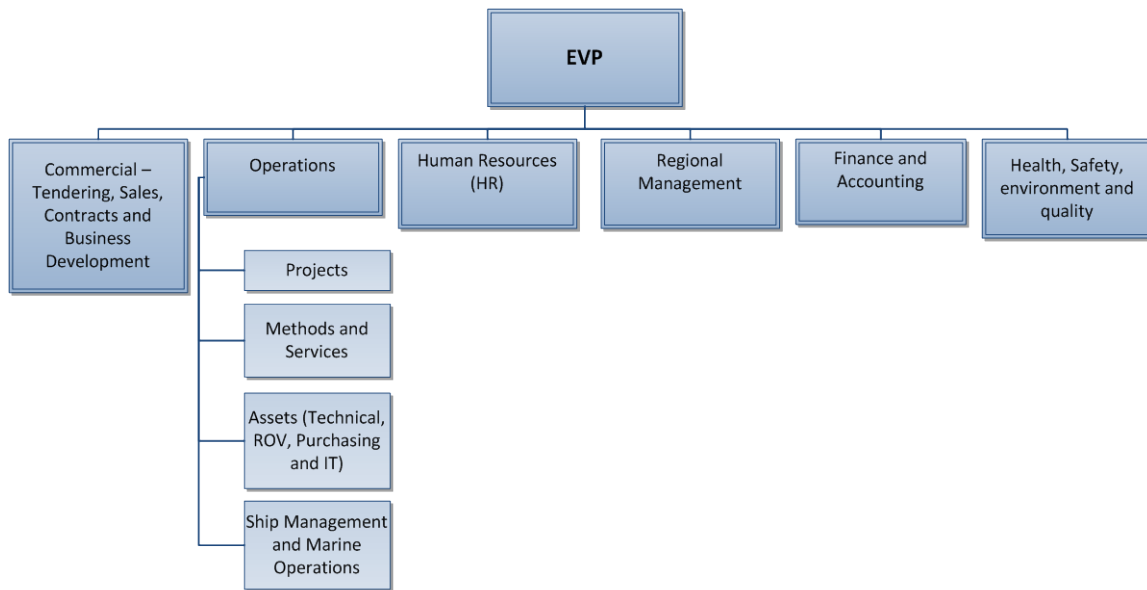


Figure 4 – Main Disciplines of Administration

2.1.4 HSE Objectives and Company Values

DO have high focus on performing work activities without any accidents. They have a zero-policy mind-set, believing that all accidents can be prevented. This includes injury to personnel, material damage and environmental impact. They have also other objectives such as no work related illness, zero damage to property and equipment, good environment and no incidents or near misses with significant or high risk potential. Key Performance Indicators (KPI's) are established in order to monitor and track performance. Corrective actions and responses are then implemented to improve their performance towards HSE. DO have established five core values: Teamwork, safety, customer focus, innovation and integrity (see Figure 5).



Figure 5 – DeepOcean's Core Values

2.2 INTRODUCTION TO DEEPOCEAN OFFSHORE BASE

2.2.1 General

DO operate three offshore bases, onshore across Europe covering the UK, Norway and the Netherlands. The one in Norway is a large-scale offshore base located at Killingøy, Haugesund (see Figure 6). It has a location for mobilization of vessels and equipment, and maintenance and equipment support. The Base offers a vast array of tools to support operations. ROV simulator training is also available here. This DO Offshore Base is the chosen object of the thesis.



Figure 6 – Offshore Base, Killingøy (Vormedal, 2015)

The DO Base area houses three organizational units, providing services for all DO projects. These are Logistic Section, the Rental Section and Workshop Section. These units will be covered by this thesis.

2.2.2 Description of the DO's Base Hall

The Logistics Area is located at the end (left in Figure 7), and has a gate to the quayside. All the tools and equipment that are received and sent out goes through this area. A special reception/dispatch area is used for handling of items. This area is used for packing, unpacking, and reception/forwarding control. One Logistic Customs & Logistics Supervisor and two Logistics Technicians work here. Further into the hall is the main Workshop Area. This has an open space where large equipment can be repaired, such as ROVs. Next to this

area are the Hydraulic Workshop and the Electrical Workshop location. The Mechanical Workshop is also connected to this area, and has a welding and machine container. Two Workshop Sections are located along the wall. Electronic Supervisor and Hydraulic Supervisor run this area together with the Hydraulic-, Electro- and Mechanical Technicians. In addition to the Workshop, there is also a Warehouse in the same hall. This Warehouse is of huge importance to DO's supply chain and logistic system as it provides storage of equipment, tools and other inventories. This Warehouse is mainly managed by the Rental Pool Supervisor. The entire hall is registered as Customs Storage, and contains a mix of non-custom cleared goods and customs cleared goods. The second and a third floor house administrative offices.

Figure 7 shows a map of how the DO Base area is today. It has been divided into areas of specific responsibilities (each color represents one responsible person).

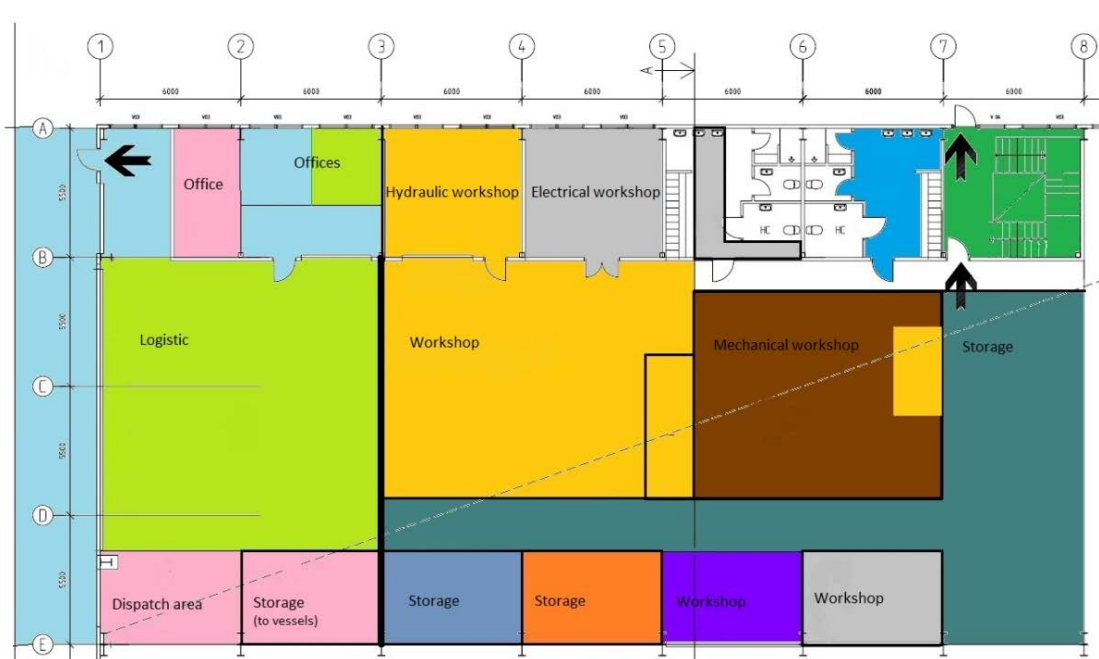


Figure 7 – Map of the DO hall

2.2.3 Organizational Structure and Areas of Responsibilities

Figure 8 illustrates the current organizational structure at the Base. This cannot be described as an official organizational chart as it only covers what is within the scope of this thesis. The Group Asset Manager is located at the DO's Main Office in Haugesund, while the Base Manager and the Technical Manager ROV are located at the Offshore Base at Killingøy. The Logistics Supervisor and Logistics Technicians are based within the Logistic Section, who

have the responsibility of the item reception, customs storage, forwarding and transport. Employees working within the Rental Section have responsibility of asset control and tracking of items. This section rents out items from their 'Rental Pool' to the DO projects/vessels. The employees working under 'Operation', ROV, MHS and Survey are within the Workshop Section, and perform modifications, maintenance and repair of ROVs, handling systems and other electronic, hydraulic and mechanic related equipment.

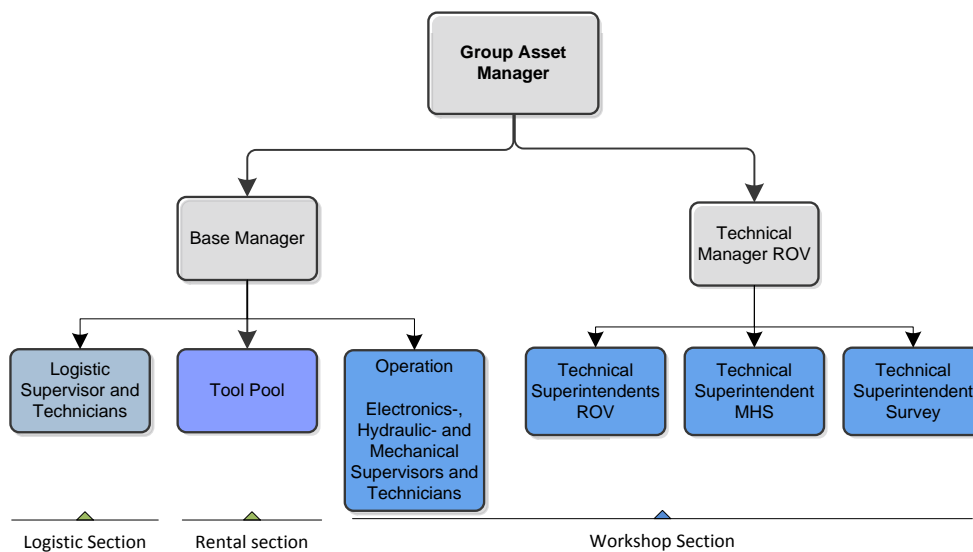


Figure 8 – Organizational Structure at the DO Offshore Base

3 PART 3: LITERATURE STUDY: THE CONCEPT OF LEAN

3.1 INTRODUCTION TO LEAN

The term Lean was first introduced by Womack, Roos and Jones in 1990. Their book ‘The Machine that Changed the World’ describes the result of a five-year study of the world’s automobile manufacturing industry. It revealed how Japanese car manufacturers were achieving excellence performance in almost all areas such as service levels, quality, productivity and time-to-market. The objective of this book was (according to Womack and Jones, 2003) to send a wake-up message to the operators in the manufacturing industry stuck in the old-fashioned world of mass-production. Today, Lean is a widely used approach in improving performance and enhancing customer value in many types of industries. According to Lean Enterprise Institute (2016), Lean is starting to take root in all sectors, even the oil and gas industry, and many companies try to adopt the principles and tools beyond the Toyota manufacturing.

The term Lean Thinking can be defined as a way to specify and provide value to a customer by minimal waste of resources, line up value-creating actions in the best sequence, conduct these activities without interruption, and perform them more and more effectively (Womack and Jones, 1996). In other words, it is about doing more with less human effort, less equipment, less time, and less space, while providing customer with exactly what they want. This can be obtained by focusing on flow, streamlined processes, visual management and continuous improvement.

3.2 THE ORIGINS OF LEAN PRODUCTION

Early automobiles were craft produced from 1880s (Womack, Roos and Jones, 1990). According to Taylor and Brunt (2002), the craft producer uses highly skilled workers who make exactly what the customer wants, item by item. The craft production represents a very expensive way of doing production, and encountered challenges it could not surmount. Mass production, developed by General Motors’ Alfred Sloan and Henry Ford 1920, introduced a cheaper alternative to manufacturing (Womack, Roos and Jones, 1990). The mass producer uses narrowly skilled professionals to design products made by relatively unskilled workers who operate single-purpose machines. This way of producing goods enables a high volume

production as the products are standardized, but since the machinery is so expensive, the mass-producer needs to add many buffers, such as extra supplies, extra workers and extra space to ensure smooth production (Taylor and Brunt, 2002). The Toyota approach to manufacturing can be seen as a contrast to the mass-production and the craft production as it combines the advantages of both. The lean producer employs teams of multiskilled workers, and more flexible and automated machines to produce a higher volume of products in a wider variety, as well as it uses fewer resources, and the products have fewer defects as well as better quality (Taylor and Brunt, 2002). The strategies and mind-set of Lean were developed around 1950s, as Taiichi Ohno together with Eiji Toyoda at the Toyota Motor Company in Japan pioneered the concept of Lean Production (Womack, Roos and Jones, 1990).

3.3 LEAN PRINCIPLES

There are several principles associated with Lean. Some of them originate from Toyota and are typically procedures of how to be Lean, while others are basic principles for how Lean Management should be. Some of the principles that are considered most relevant for this thesis are summarized below.

3.3.1 The Toyota Way

The Toyota Production System (TPS) is an integrated system developed by Toyota, and is an expression of 'The Toyota Way', which is based on a set of principles and values (Toyota-Forklifts, 2010). TPS is defined as a system that “(...) *empowers team members to optimize quality by constantly improving processes and eliminating unnecessary waste in natural, human and corporate resources*” (Toyota-Forklifts, 2010, p.5). In Jeffrey K. Liker's (2004) book 'The Toyota Way', 14 management principles behind the successful approach are described. These are divided into four main sections. Based on Liker (2004), these sections are described below:

The first section is about establishing a long-term philosophy to build a learning organization. Lean is not just something you do, but it is something that develops over time, and is a never-ending process. This is due to the fact that one can always be better in something, and one can always be 'more lean'. Goals can drive motivation and purpose.

The second section covers the focus on the right processes and the quality outcome. This entails creating continuous process flow to reduce and eliminate waste, use pull-systems to avoid overproduction, level out workload, building a culture of stopping to fix problems (achieve quality the first time around), standardizing tasks and processes, and practice visual management.

The third section is concerned with the development of people and partners, which adds value to the company. Growing leaders ensure that the principles are embedded in the organization. In order to maintain a learning organization, employees should be educated and trained. Teams should be developed and employees' stimulated, and professional growth ensured so that individual and team performance are maximized.

The last section refers to the importance of continuously solving root problems. It is important that leaders go out and see for themselves so that they thoroughly understand the situation. Decisions should be made slowly by consensus and considering all options available, and implemented rapidly. This makes the foundation for becoming a learning organization and achieving continuous improvement.

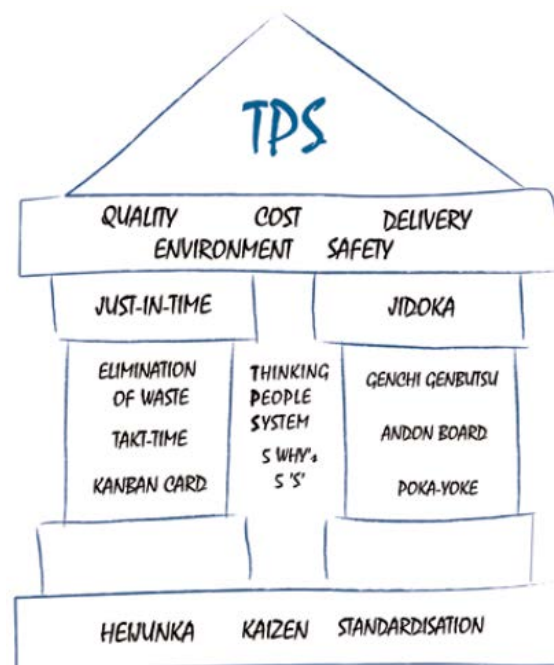


Figure 9 shows the TPS' principle structure. Definitions and translations of the Japanese words in the figure can be found in the Table at page xv.

Figure 9 – Toyota Production System (Toyota-Forklifts, 2010)

3.3.2 7 Types of Waste (MUDA)

Muda is a Lean-term which can be translated to waste. Womack and Jones (2003) define 'muda' as any activity that consumes resources but create no value. According to Womack and Jones (2003), there are usually three types of actions that can occur along the value stream: Many steps would clearly create value, and some would not create value but be

necessary in order to perform the steps that create value. The last type refers to the steps that create no value and are immediately avoidable. The Toyota executive, Taiichi Ohno, identified seven types of waste: Overproduction, Waiting, Transport, Inappropriate Processing, Unnecessary Inventory, Unnecessary Motion, and Defects (Womack and Jones, 2003). The seven types of waste are product/service related loss and process related loss. Wig (2014) also mentions utilization loss as an important source, which refers to unexploited potential: The difference between today's situation and where we potentially can be is considered as loss based on the Lean perspective. Utilization Loss is an important type of waste to consider.

3.3.3 Six Principles when Implementing Lean

The process of implementing Lean is captured into five principles by Womack and Jones (2003): Define and optimize customer value, study and map the value stream, create flow, establish pull and seek perfection. These are all principles that focus on reducing waste. Also a sixth principle can be added: Respect for people (Sugimori et. al., 1977).

Define and Optimize Customer Value

Specifying value accurately is, according to Womack and Jones (2003), the critical first step in lean thinking. Value is defined as “*A capability provided to customer at the right time at an appropriate price, as defined in each case by the customer*” (Womack and Jones, 2003 p.353). In other words; value is what the customer says it is, considers important, and is willing to pay for. It is important to identify what activities create value in order to be able to separate the activities that are not making any value. The customer is simply most interested in the utility value and the benefit that the product provides; not all the things that lead to it.

Study and Map the Value Stream

The second step refers to the value stream that exists behind all products and services. It is a series of activities that creates value, running from raw material to finished good, order to delivery, and concept to launch (Womack and Jones, 2003). Mapping of the value stream is more explained in section 3.4.5.

Create Flow

Womack and Jones (2003, p.24) suggest that the work of functions, departments and firms should be redefined so “*they can make a positive contribution to value creation and to speak*

to the real needs of employees at every point along the stream so it is actually in their interest to make value flow.” Flow in the processes can be achieved by removing storage, stops and barriers. Queues and waiting do not provide any value, but are preventing a smooth and efficient process. Modig (2014) distinguishes between two types of efficiency; resource efficiency, and flow efficiency. Resource efficiency is about utilization of expertise and equipment, while flow efficiency is about the process, and how this process focuses on customer value. According to Modig (2014), the optimal case is when the flow efficiency and resource efficiency are combined. However, one should always prioritize flow efficiency.

Establish Pull

Establishing pull means that the next activity orders from the previous activity. The main idea is to let the customer pull the product or service from you instead of pushing products or services onto the customer (Womack and Jones, 2003).

Seek Perfection

There is no end to the process of reducing efforts, time, space, cost, and mistakes while offering what the customer wants (Womack and Jones, 2003). Seek perfection refers to continuously improving the value stream; revealing sources of waste and impediments to flow so that value can flow faster. It is important to never stop improving. Things change all the time, and by being proactive and innovative, the company would be able to achieve better performance and competitive advantage.

Respect for People

The last step promotes the respect for people. Sugimori et. al. (1977) describe that this is about allowing the workers to fully display their capabilities through active participation in running and improving their own work. It is about embracing employees’ influence results, and prevent that formal control systems restrict innovation and learning.

3.3.4 Just-In-Time

Just-in-time (JIT) is a system for producing and delivering the right items at the right time in the right amounts, developed for Toyota by Taiichi Ohno (Womack and Jones, 2003). The key elements of this system are flow, pull, standard work and ‘takt’ time. Takt time is defined by Womack and Jones (2003, p.352) as *“The available production time divided by the rate of*

customer demand". In other words, it is about delivering the products in the same pace as customer demand. JIT is especially important in an assembly industry whereby the production lead time is greatly shortened by having all processes produce the necessary parts at the necessary time and have on hand only the minimum stock necessary to hold the processes together (Sugimori et. al., 1977).

3.3.5 Continuous Improvement

As already mention previously, development of learning organizations, and continuous change- and improvement processes are elementary in the Lean approach. The PDCA (or Deming) cycle is designed to promote continuous improvement by identifying opportunities (Wig, 2014). The PDCA is a process that never ends; systematically making improvements by following four steps: Plan, Do, Check, and Act (see Figure 10).

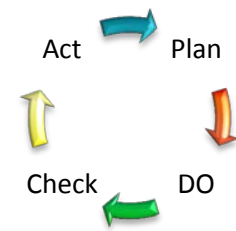


Figure 10 – PDCA

In order to improve, one should obviously make changes, but one cannot always know if the change is an improvement. However, it may be important to make changes as experiments and adjust them according to the effect of the change. This is part of the learning process that could be essential for a company's development. The more changes that are made, the higher would probably the learning rate be. Flood (2002, p.1) states that a learning organization is “(...) *one that continually expands its capacity to create its own future*”, and which is claimed (by Peter Drucker) to be the organizational concept of the future.

3.3.6 Organizational Culture

The methods and tools are not the only things that are important when implementing Lean. The team culture is equally important. According to Wig (2014), only when the organizational structure and systems support a culture for continuous learning, they become sustainable.

Bang (2013) describes organizational culture to be the sets of shared norms, values and beliefs that develop in an organization, and that are manifested through the members' behavior and attitudes at work. Kaufmann and Kaufmann (2003) distinguish between strong and weak organizational culture: It is strong when the values and norms are deeply rooted in

the individuals and the organization. Strong culture can give a feeling of being united, and a connection to the organization. A weak organizational culture is the opposite, and there are consequently need for more regulation and control.

3.4 TOOLS

Some of the most common tools to deal with waste are presented below. These tools serve as improvement measures, and can be used to control whether one is actually making progress. There are also other tools, but since Lean origins from a manufacturing industry, some of them do not directly fit into a workshop- or in a service environment, and hence do not need to be further described in this thesis.

3.4.1 5S

5S is a workplace organization technique, which is most likely one of the most visible tools in Lean (Wig, 2014). The abbreviation 5S derives from Japanese words for order and structure, which can be translated to Sort, Set in order, Shine, Standardize and Sustain (see Figure 11).

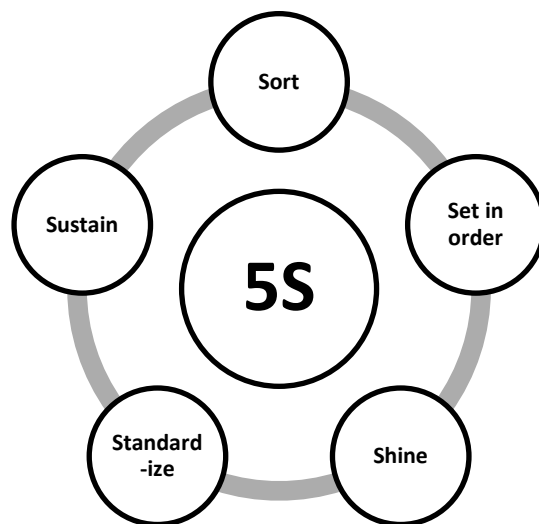


Figure 11 – 5Ss

The first phase is sort. This encompasses the sorting of all items and things around you, and removing the unnecessary items. The second phase of 5S is to set in order so that all necessary items can be easily selected for use when needed. The third phase is shine, which represents cleaning the workplace. The fourth phase is standardize, which means to

standardize the best practice. The last phase is sustain, and is about keeping the order, and ensuring compliance to the other Ss (Wig, 2014). The three first Ss are more concrete, and are about things that we can see around oneself. The last two, however, are about personal behavior. Hence, 5S is not only a measure of order and structure, but also a measure of changing organizational culture.

The 5S technique focuses on organizational cleanliness and standardization to improve profitability, efficiency and safety. In other words, one can obtain better performance of the operation by implementing 5S. Even things that were not directly obvious and visible can be revealed and improved by implementing 5S. It is important to understand that 5S is not only about housekeeping, which is a reactive approach. It is also a proactive approach to order, structure and wellbeing at work, which can be seen as fundamentals to continuous improvement and a good working environment. (Wig, 2014)

3.4.2 24-Hours Meeting

The 24-hours meeting involve all the employees within a function. The meeting time and agenda is structured, and the focus is to ensure that all the processes provide customer value. It is about the daily operation, and should include HSE status, yesterday's planned operations, what is planned today, available resources, problems, and necessary correcting measures.

3.4.3 Kaizen Meetings

Toyota used the word Kaizen, which refers to the endless strive towards continuous improvement. It is a strategy for improving an activity to create more value with less waste (Womack and Jones, 2003).

Kaizen meetings are meetings where focus on continuous improvements is at the core, and can take place at fixed days (weekly or bi-weekly). Ideas and proposals can be identified, and the improvement activities within quality, costs, delivery and HSE can be on the meeting agenda. The board should be illustrative and visualize the ongoing improvements. An A3 format is an appropriate tool to use for these meetings. (Wig, 2014)

3.4.4 A3 Review (Problem Solving)

A3 review can be seen as a structured approach to problem solving and continuous improvement. It is a visual tool for communication, learning and sharing of information. There exist several different A3-types, each imparts the specific information. There are A3 for problem solving, for information, suggestions, and strategic A3 for following up plans. The A3 format should be adjusted to the workplace so that it can fulfil the necessary needs. What is important when using A3, is the learning processes though the use of PDCA (Plan, Do, Check and Act). This is a methodology for implementing improvements. (Wig, 2014)

In a problem-solving process, a root cause analysis is often a useful method in removing problems. Two possible tools to use are the fishbone diagram (developed by Kauro Ishikawa) and the '5 whys'. '5 whys' in Lean context mean to ask 'why' five times in order to identify the root cause of a problem. This problem-solving approach can be used individually or as a part of the fishbone diagram. (Wig, 2014)

A fishbone diagram (also called Ishikawa diagram) are used to systematically analyze how causes (variables) affect a specific event. This cause-effect analysis uses different factors which vary with the type of industry one operates in. In manufacturing, the causes are usually divided into six categories; the 6 Ms (see Figure 12): Measurement, Material, Machine, Mother Nature, Man Power and Method. (Nishadha, 2014)

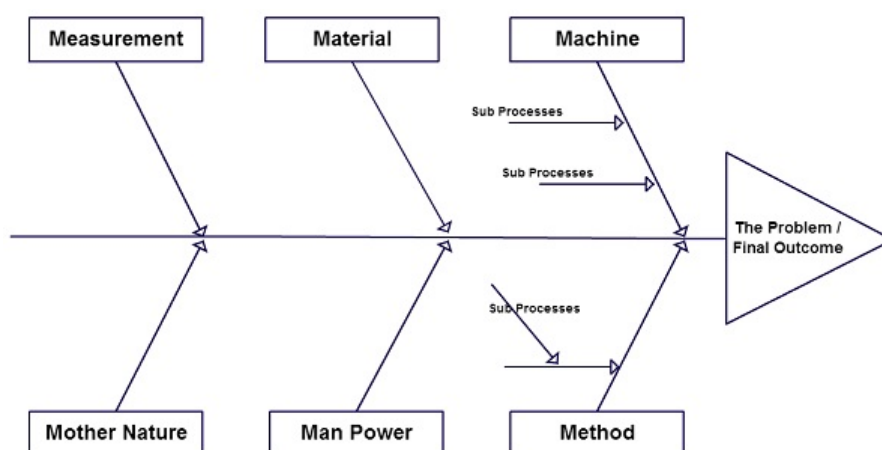


Figure 12 – Fishbone diagram (Nishadha, 2014)

An advantage with the A3 format is the visibility of the process. Everyone should be able to see what the current status is, such as what is done, when it is done, and who is responsible for doing it.

A typical format can include background information, desired situation, current situation, analysis of root causes, proposed countermeasures, plan for implementation, and follow-up.

3.4.5 Value Stream Mapping (VSM)

The value stream is defined by Womack and Jones (2003, p.353) as “*The specific activities required to design, order, and provide a specific product, from concept to launch, order to delivery, and raw materials into the hands of the customer*”. VSM is a technique used to visually map the flow of the processes to identify all the specific activities occurring along the value stream. It can illustrate the current and future state of processes in a way that highlights opportunities for improvement. The main purpose with this technique is to expose waste in the current processes and identify improvements for the future state.

3.4.6 Visual Control

Visual control is a concept that is used to ensure that the processes are clear, simple and direct, and that status of a system or operation can be understood at a glance by every single employee involved (Womack and Jones, 2003). In practice, this means that it should be possible to immediately observe that everything is going well, or detect when something goes wrong. This may advantageously be replaced with complex process control systems in order to establish flow. Especially making the exchanges between functions visually is important in the relay of information. Information on white boards can be a useful tool in order to provide easy access to important information (Wig, 2014).

3.4.7 Kanban

Kanban is a scheduling system for just-in-time production developed for Toyota (Womack, Jones, Roos, 1990): This was originally a way to coordinate the flow of parts within the supply system on a day-to-day-basis. Kanban cards can be an effective tool to visual the flow, and to make the state of condition of the processes easily accessible and clear to everyone. Kanban means ‘signs’, and is a method of regulating the flow of goods/items, based on signal

cards that indicate when something is needed or completed. The purpose of Kanban systems is to reduce waiting time, and to eliminate waste from inventory and overproduction.

3.4.8 Gemba Walk

Gemba is a Japanese term for ‘the real place’, which refers to the place where customer value is created (Wig, 2014). It is a philosophy where the focus is to get out and spend time to observe what is actually going on where the real action occurs. A Gemba walk promotes a deep and thorough understanding of real-world issues by observation and by talking with the employees at the lowest organizational level (Wig, 2014).

LAMDA is problem solving process when going to Gemba. It stands for Look, Ask, Model, Dialogue and Act. This approach could help the decision-makers to see and fully understand the actual problem by going out to the employees and speak to them. (Wig, 2014)

3.5 LEAN V.S. TQM AND SIX SIGMA

Lean incorporates many of the Total Quality Management (TQM) and Six Sigma principles. Wig (2014) even states that Lean is a rediscovery of TQM practiced in Toyota, which is a proven, systematic approach to planning and managing activities. TQM can be defined as a “(...) *structured approach to organizational management that seeks to improve the quality of products and services through ongoing refinements in response to continuous feedback*” (Rouse, 2005). This approach emphasized a total approach to quality by integrating management, processes, and tools, and focuses on customer satisfaction (Oppenheim, 2011). In other words there is quality on all levels; management quality, quality of human behaviour, quality of work processes, quality of work environment, and quality of the products and services provided to the customers. Today, most of the key elements of TQM have endured and are integral to Lean Thinking (Murman et. al., 2002). In the early 1990s, TQM evolved into another quality initiative known as Six Sigma. This new approach came from Motorola, and was a result of a drive for product and corporate quality, rooted in the belief that defects could be prevented by doing everything right the first time (Tennant, 2001). Lean and Six Sigma are both tools for process improvement, but the main difference is that Six Sigma focuses on a disciplined, statistically based top-down approach to limit variation, while Lean

focuses on value streams and elimination of waste through optimizing flow. Figure 13 shows the foundations of Lean and Six Sigma, and illustrates the similarities and differences.

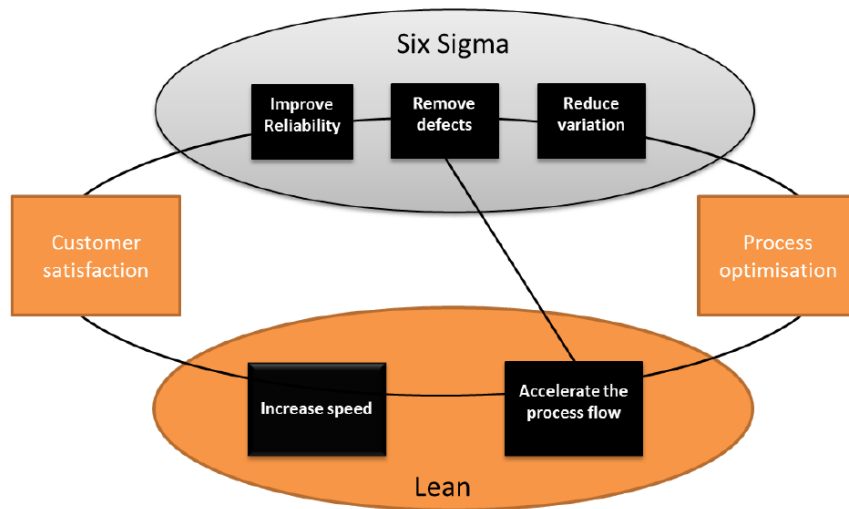


Figure 13 – The foundations of Lean and Six Sigma (EFQM, 2013, p.8)

3.6 LEAN V.S. TPM

The term Total Productive Maintenance (TPM) was introduced as an approach to planned preventative maintenance in the 1950s. It can be regarded as an integral part of Lean Manufacturing with its main focus on machines. TPM techniques aim to ensure that every machine and every worker are in proper condition to perform their required tasks when needed (Womack and Jones 2003). Lean and TPM have different origins, however there is some overlap: According to McCarthy and Rich (2004), the common thread is that both TPM and Lean Manufacturing highlight areas of historically accepted or hidden waste, and both approaches aim to improve effectiveness. Both Lean and TPM are converging towards a common goal, and use some common tools and concepts, despite some clear differences: While Lean Thinking focuses on sharpen the definition of value, TPM focuses more on reliable processes, and provides the route map to zero breakdowns and continuous improvement in equipment optimization (McCarthy and Rich, 2004).

3.7 LEAN INCORPORATED WITH THE EFQM FRAMEWORK

EFQM is short for European Foundation for Quality Management, and was founded in 1989 with the objective to increase the competitiveness of European organizations and support the

sustainable development of the European economies (EFQM, n.d.a). They have created a platform where organizations can learn from each other to continuously improve their performance.

The EFQM framework can be used to assess an organization’s progress towards excellence (EFQM, 2003): By assessing the progress, an organization can be more aware of its strengths, and areas for potential improvement. This follows a cycle of evaluating and taken action repeatedly, which leads to continuous improvement. EFQM (n.d.b) states that the EFQM Excellence Model is the most popular quality tool in Europe, used by more than 30.000 organizations.

Lean can be used within the EFQM Framework as the EFQM Model and Lean techniques complement each other. EFQM (2013, p.5) even states that “(...) using Lean on its own might create a profitable company without necessarily achieving improvements in other areas or an excellent organization overall. Using a holistic approach such as the EFQM Excellence Model can address this and can complement Lean”.

The EFQM Excellence Model is supposed to lead an organization towards performance excellence by following nine criteria divided into five enablers and four results (see Figure 14 below): Leadership, policy and strategy, people, partnerships and resources, and processes indicate how the objectives can be achieved, while customer results, people results, society results and key performance results indicate what the intended objectives are. All these nine criteria should be considered in order to lead the organization towards a sustained performance excellence.

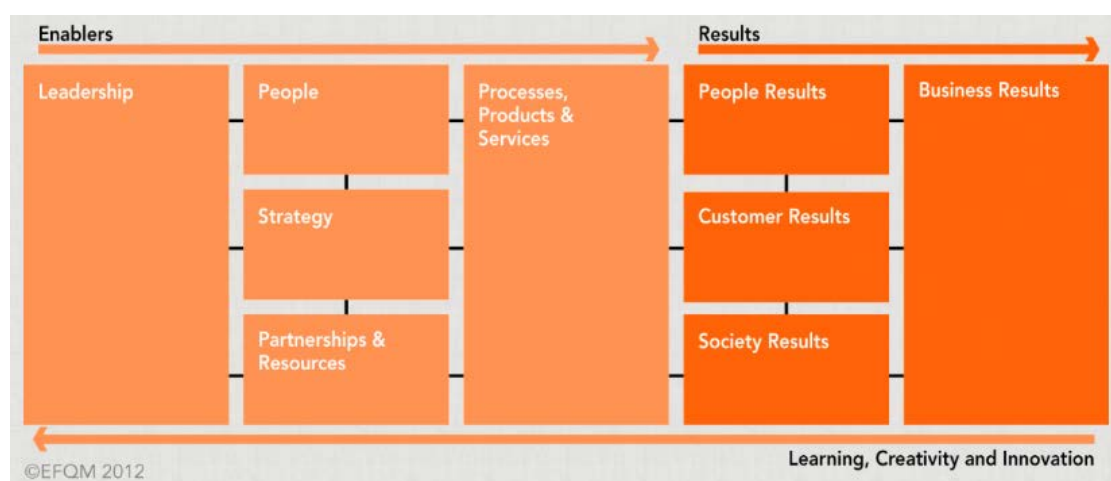


Figure 14 – EFQM Excellence Model (EFQM, 2012)

The Excellence Model is described in terms of these criteria based on the EFQM brochure (2003): Good *leadership* includes good leaders that are *people* oriented; they focus on the employees' needs, release the full potential of their people. They care for, communicate, reward, recognize and motivate the staff. A good *leadership* builds commitment so that the *people* can use their skills and knowledge for the benefit of the organization. External *partnerships, suppliers* and *internal resources* can provide and balance the current and future needs, and support the organization's *policy* and *strategy*. An organization is normally not self-supporting, but is dependent on different types of procurement from other agencies. Value-creative *processes* that are designed, managed and continuously improved would satisfy and generate values for customers and other stakeholders. *Processes* drive *customer results, people results* and *society results*. These are measured in terms of performance indicators. Adjustments and changes are done by the leadership of the organization in order to improve.

3.8 IMPLEMENTATION OF LEAN

Based on what Womack and Jones learned from examining successful transformations across the world, they have developed an action plan of specific sequence of steps and initiatives that is supposed to produce the best result (Womack and Jones, 2003). The action plan is divided into four phases: Get started, create a new organization, install business systems, and complete the transformation. These phases go over a five year period.

The time frame for the first phase of Womack and Jones' action plan is six months. The steps of this phase are listed below:

1. Find a change agent
2. Get lean knowledge
3. Find a lever
4. Map value streams
5. Begin doing improvements
6. Expand your scope

(Womack and Jones, 2003)

Nevertheless, there are no pat answers of correct ways of starting or implementing Lean. Each organization should figure out where they are, where they want to go, and how they should get there. It would be essential that the company creates a culture and structure for improvements, before starting to implement improvements.

Womack and James (2003) suggest that when Lean thinking has been applied to transform the organization, and when the process is irreversible; one can start to look at up- and downstream far beyond the boundaries of individual firms to optimize the whole.

There are companies that have successfully achieved world class levels of excellence through Lean Thinking, but according to Netland (2015), two of three Lean programs fail to achieve their initial objectives. From his research, he summarizes five critical factors for succeeding with Lean implementation. These are: Commit to the Lean program, train the workforce, have a plan and follow it up, allocate resources and share gains, and use lean tools and methods. These are quite general and are intended for factories, but they are at least as much applicable for other sectors as well.

4 PART 4: CASE STUDIES

4.1 LAERDAL MEDICAL

Laerdal Medical delivers simulation equipment for life saving purposes. They started with Lean Thinking already in the 90's, but first in 2003 they started to work systematically towards improving their processes by use of the Lean approach. Their company statistics illustrate good results based on the improvements in across different parameters, such as cost and time savings. The information of how Laerdal is working with Lean was obtained through a visit to their factory in Stavanger and personal communication with the Factory Manager; Torbjørn Gjerdevik (2016a).

The visit to Laerdal's factory in Stavanger showed how Lean was implemented with every single team: Order and structure, white boards and Kanban systems are some of the visible Lean tools they are using. The work is organized in the most optimal way in terms of a streamlined value chain where the focus is to provide value to customers. The Factory Manager's enthusiasm when he explained how they work with Lean initiatives in practice indicates a strong commitment from Top-Management. Although, he admitted that the greatest challenge with using Lean as an approach was the team leaders; to get them understand and to take the initiatives seriously. Gjerdevik (2016a) stated that if someone were used to do things in a certain way, it could sometimes be difficult to change their routines and practices.

The whiteboards all over the offices location and the factory contained valuable information, such as KPI status, objectives, action lists, formats for effective problem solving, plans, PDCA process, and plans and status for weekly management reviews. By having all this information on whiteboards, a minimal effort could be made to get the information about status, what the next improvement projects are, and other relevant information that affects the daily work. Important information is easily accessible, which enables involvement at all levels of the organization and allow everyone to be involved in the flow of information. All the departments are using A3s, and the team leaders collect the relevant information and forward it further up in the organizational structure so that the information is relayed to the decision makers at the higher level in the organization. More challenging problems can then be solved by support from the Top Management.

Laerdal are practicing a philosophy of continuous improvement (CIP), which seems to be the fundamental in their work; they are continuously striving to make things a little better, and are actively using the PDCA as an internal process of improving new and existing practices. Policies and goals are established, and a yearly plan makes the basis for what to accomplish during the year. The first step in this process is called Hoshin planning, where the purpose is to define the direction. The next step is to use A3 thinking when evaluating the current condition, establishing targets and then use PDCA to put it into practice. Every team also makes internal plans on how to cope with challenges and meet their internal goals. Gjerdevik (2016a) emphasized the importance of constantly maintaining the improvements that have been made, at the same time as new improvements are being implemented.

Figure 15 gives a visualization of Laerdal’s CIP philosophy. We see that the three fundamentals are basic stability (capability, availability and flexibility), standardization and leveling. These are important in order to produce products according to specifications, reduce deviations and waste, and avoid overproduction (Gjerdevik, 2016b).

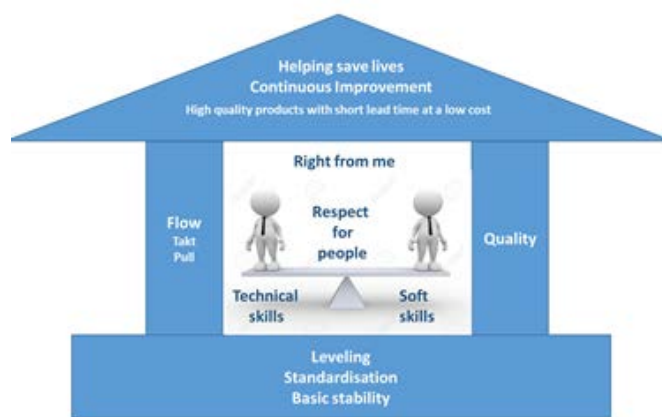


Figure 15 – House of CIP (Gjerdevik, 2016b)

An essential part of Laerdal’s manufacturing is the focus on flow and quality, which form the pillars of the house. This is obtained by producing a single product at the time, and performing quality checks after each

step. When one step is completed, they start to produce a new product, and so on. They call this approach ‘One-piece-flow’, where they use ‘takt’, sequence and balancing to create the optimal flow in the sense of delivering the products in the same pace as customer demand. Figure 16 illustrates the ‘One-piece-flow’ in a

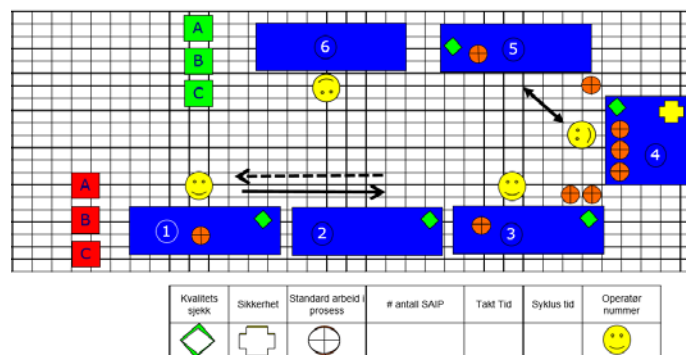


Figure 16 – “One-piece-flow” at Laerdal (Gjerdevik, 2016b)

horse shoe shaped cell. Gjerdevik (2016a) stated that this is not always a logical approach for

everyone; hence it can be a potential challenge to actually get people to practice it. Since the layout and the production sequence are facilitated for this way of producing, bottle necks or overproduction can occur if it deviates from the specific sequence. It is therefore important to ensure that the planned sequence is readily followed.

In order to obtain flow, the pull approach and Kanban system are also used. Pull is established by the next activity orders from the previous one. In order to avoid production stops due to missing parts, Kanban cards are used to ensure that the needed parts are available at all times. Value stream mapping has been used to identify current condition and desired condition.

Gjerdevik (2016a) stated that the establishment of flow and use of PDCA are the applied principles that have given the most important effects in term of improvements. He elaborated further and claimed that 5S is just a basic tool that helps to achieve order and structure, but it does not bring any direct value to the customer.

Laerdal integrate all the various functions together in a team where they are product oriented instead of function oriented. By being function oriented they focus on the flow item, which is the product. Lean is about always focusing on flow efficiency before resource efficiency (Modig, 2014), and this is what they do in Laerdal. So, instead of being busy with problems that occur between the functions and units, they eliminate waste of spending time on this non-value-creating activity, and can spend it on value-creating activities such as producing the products.

In the heart of the CIP philosophy we find an important principle; 'Respect for people'. This is practiced through visual leadership that shows respect for the employees, focuses on teamwork and develops people through empowerment. This is supported through Gemba Walks, establishment of common goals, and employee training, ensuring good team work and accomplishing the common goals. Laerdal is benefiting from the knowledge and skills that the teams represent, and the teams are benefiting from a present, visual and focused management.

4.2 OCEANEERING

Oceaneering is a global oilfield provider of engineered services and products, primarily to the offshore oil and gas industry. One of their regional headquarters is located in Stavanger, Norway (see Figure 17), where they started to implement Lean in 2011. In 2013 they received an award for their pilot project on standardization of production of one specific component. During a visit to their workshop in Stavanger, the Workshop Department Manager Stein Lilledal (2016) showed the workshop and explained how Lean initiatives were implemented there.



Figure 17 – Oceaneering’s headquarter in Stavanger, Norway (ForusProsjektet, 2014)

Oceaneering started the Lean implementation by collecting the already proposed improvements that had been written and submitted previously. There were quite a few, and they had never been reviewed. They therefore established a team that would review them, and ensure the implementation of improvement measures. They realized that the most of the problems identified could be solved by 5S. ‘Samarbeidsutvikling’ was

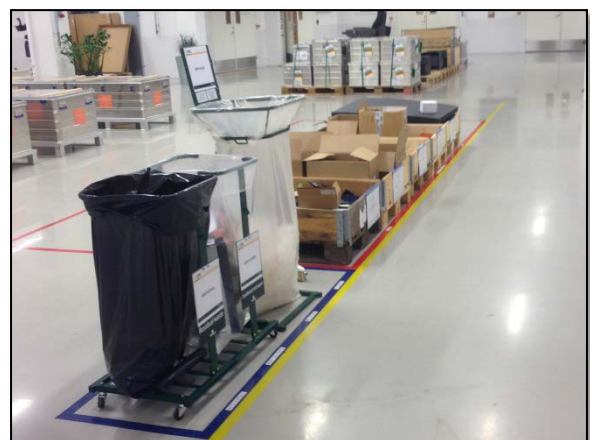


Figure 18 – Items have fixed locations

involved as an external unit, offering Lean training and support.

The Oceanering's headquarter is in total 42.000 m² divided into offices, workshops and warehouse. When walking around in the workshop, it was very obvious that things were organized and structured. It was very clean, even the floor was shining. The floor was taped with various colors to mark where items had fixed places, where things could be moved (and put back), and where things were not to be placed. See Figure 18.

The tool cabinets were lined up against the walls, and had pictures at the front that illustrated what (and where) tools were to be found (see Figure 19).



Figure 19 – Tool cabinet

Whiteboards containing KPI's, HSE and quality status, plans and resources, statistics (YTD), were located various places in the workshop (see Figure 20) as well as whiteboards containing safety information and aids (see Figure 21). The team leaders use

to have a short status meeting with their teams every morning, and bring the information further up to the Department Managers. These meetings reveal details about why operational delays are occurring, and then countermeasures can be implemented rapidly to eliminate unfortunate consequences.



Figure 20 – Whiteboard

In addition to the 24- hours meeting, they have 5S meetings where the appointed 5S team discusses 5S projects and performs checks of the 5S system. An example of a 5S project is the standardization of a valve pack for ROVs. A million NOKs were invested during a six months period of evaluation and testing. They managed to reduce the production time from 40 hours to 9 hours. Lilledal (2016) stated that this valve pack could not be produced in Norway if they had not managed to reduce the time in that extent. Some key factors are workstations with an optimized layout, correct sequence, production of one valve pack at a time, and tablets to collect the parts (fixed place).



Figure 21 – Whiteboard with safety information and aids

When the workshop at Oceaneering started with improvements in terms of 5S, some employees were quite skeptical; some did not fully understand the principles. Eventually, they started to see the benefits of a better workflow, and are now embracing the changes that have been made. Lilledal (2016) claimed there was a positive development for the working environment after the implementation of Lean started.

Lilledal (2016) admitted that the visual tools such as 5S and whiteboards are the only tools that are used from the Lean approach. A Kanban system is not in place at Oceaneering yet; there is no automatic system and no signals warning when an item is out of stock. The Lean philosophy is not entirely adhered to as the Senior Management does not currently have it on their daily agenda, and they are rarely attending the morning meetings or 5S meetings. The challenge is not to get the people adhere to the systems, but lack of commitment and involvement from the Top Management makes it difficult to develop a culture inspired by Lean Thinking. It is not enough that the management is supporting the Lean projects financially and expecting results. It is also necessary that they make demands and set the policies and communicate them 'down' to the lowest level of the organizational structure. Instead they are making decisions without involving the people that can be affected by it.

We see that Oceaneering have come quite far with the implementation of 5S system that facilitates for order and structure, but they have a long way to go to fully become Lean.

4.3 HYDRO KARMØY

Hydro is a manufacturer and global supplier of aluminum, with 3.400 employees nationwide (NorskHydroASA, 2016).

An article on Hydro's web page is about their successful use of lean-principles, and is saying that Hydro have participated in the science program called 'Lean Operations', where use of lean techniques in Norwegian companies has been studied (Hager, 2014). Their production system, which is called AMPS (Aluminium Metal Production System) is their foundation for continuous improvement. AMPS is based on five principles, which are standardized work processes, defined relationship to customers and suppliers, optimized flow, dedicated team, and a visual management. By use of this system, they have achieved some great results. According to Hagar's (2014) article, Hydro have saved approximately 1,5 billion NOK yearly since the program started in 2008.

Bernt Nagell participated in the TPM Lean development at Hydro Karmøy Aluminium for over 12 years, and is considered as one of the main architects behind the Lean approach used in Norway today. The information in the rest of this section is based on a conference that took place in Haugesund, where Nagell (2016a) talked about his experiences of improvement work in Hydro Karmøy.

Nagell (2016a) focused primarily on the employee's role, and the involvement and participation of all the employees when implementing and developing Lean. Before the improvement work started, the main focus was on the machines, not the employees. They thought that if the machines were the best and up to date, the risk of downtime and breakdown would decrease. This thinking did not consider the fact that the people operating them are the most important resource. Hydro started to focus on the employees, and teams were used to carry out organized improvement work. They started to look at the interaction between man and machine, and started to teach the people how to use the machines and the materials (see Figure 22). Some of the results were an increase in the overall equipment efficiency (OEE), use of less resources, and more determinedly and satisfied employees. Figure 22 shows that the results are within the areas of productivity, quality, cost, safety and morale.

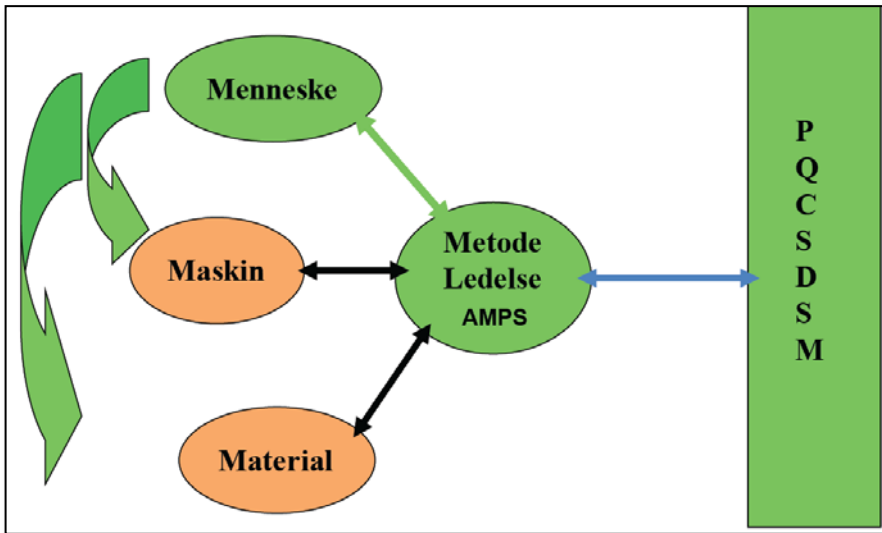


Figure 22 – Focus on people (Nagell, 2016b)

Cleaning of the machines, distribution of responsibilities and more visual information were some of the measures that solved many of the previous challenges at Hydro. Figure 23 illustrates how it could be before the improvement project started, and Figure 24 shows an example of how information was made available to all employees.



Figure 23 – Before the improvement project at Hydro (Nagell, 2016b)



Figure 24 – Visual information (Nagell, 2016b)

A training and education program was developed in Hydro in the aim of achieving world class results (see Figure 25). The main goal was zero losses, and the strategy to achieve this was to train the employees in 16 types of possible losses, optimized and autonomous maintenance, and vertical start-up of new equipment.

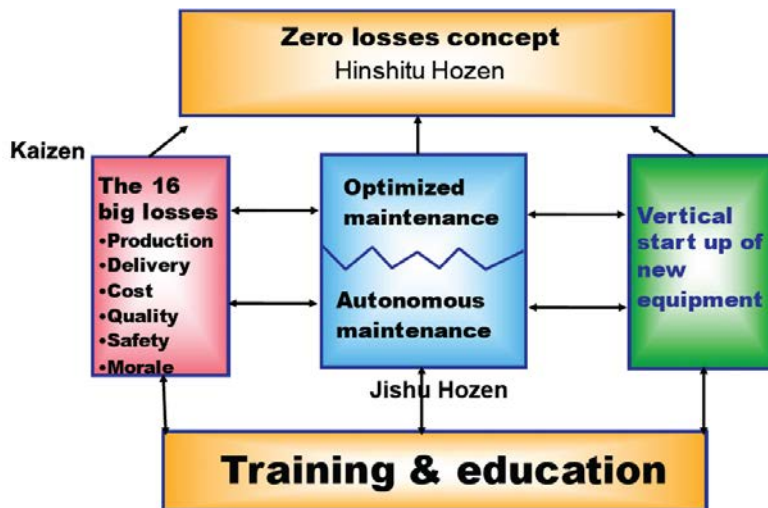


Figure 25 – Hydro’s training & education program (Nagell, 2016b)

The employees were encouraged to submit suggestions for improvements. Nagell (2016a) stated that the practical arena should be involved and given opportunities to make decisions. They are the people that most often know what the improvement potentials are. Hence, a KPI on the amount of improvement proposals was used, with a target of 1 improvement per person per month. Every month, the best suggestion was awarded, and a cake delivered to the shift that came up with it. Nagell (2016a) explained that positive feedback was (and still is) extremely important in order to create a good working environment where the employees are motivated and perform their best on behalf of the company.

Nagell (2016a) emphasized that the details are important: *“The sum of all the small details are much more important than the big innovations”*. This requires continuous hard work, and the improvement process should be on a daily- and weekly basis so that proactive measures can be implemented based on the status. In order to improve, it is important to be able to learn from mistakes; one should dare to take chances and try new things. Common goals are important; hence KPIs should be established on the practical arena, and they should be in accordance with the KPIs decided by the Senior Management. It is also important that they are visible and understood by all.

The improvement work at Hydro is a continuous process that never ends: Hydro still works on their AMPS to obtain and maintain a good culture and practice in the company where involvement of all employees is in focus (Hager, 2014).

5 PART 5: A STUDY OF THE CURRENT SITUATION AT DO OFFSHORE BASE

5.1 INTRODUCTION

A study of the current situation at DO Offshore Base has been carried out to identify potential challenges and reveal areas for improvements.

The study started with an assessment by use of the EFQM model to establish a more holistic picture of the current situation. Where DO Offshore Base is in relation to Lean and improvement routines is strongly connected to how leadership is experienced in the company; hence leadership is considered an important variable in this thesis. Hines et. al. (2008) have developed a Lean Sustainability Iceberg Model (see Figure 26) that illustrates that tools and processes are not enough when trying to stay Lean. It is also important to consider the factors that are not so visible; such as having a clear strategy, leaders that have respect for their employees, leaders that are committed and engaged, and who promotes a positive organizational culture. The EFQM assessment could give some indications on these enabling factors.

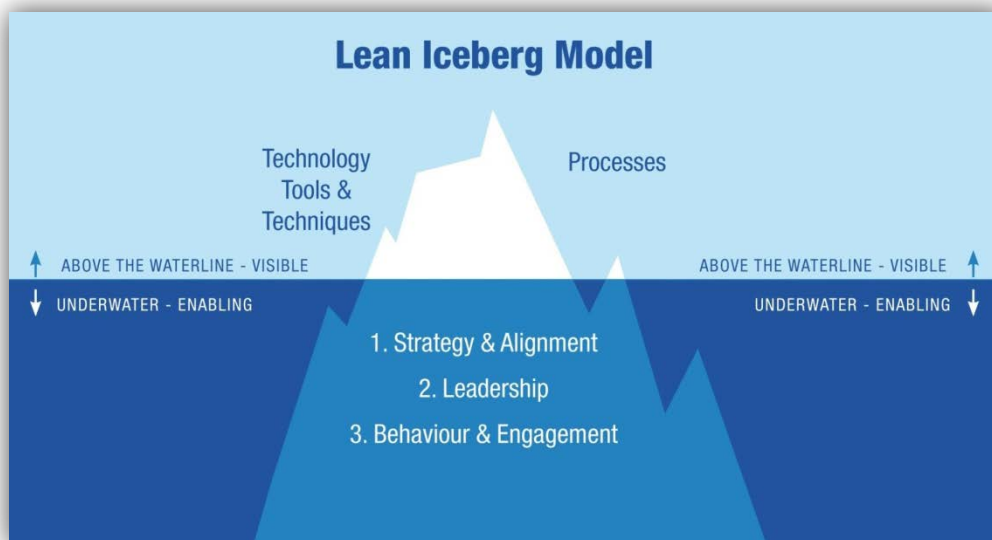


Figure 26 – Lean Iceberg Model (Hines, 2008, p.17)

An analysis of the main work processes at DO Offshore Base was carried out to identify more specific challenges that are affecting the daily work. The mapping was based on both informal communications and more in depth interviews with the employees at all three sections at the

DO Offshore Base. This has provided a valuable insight to the current situation as they are the people that best know the work processes and the situation. However, the employees may not be able to recognize all the potential challenges since they are present within the Base every single day; hence some information was also collected through direct observation and communication with members from project teams. Some issues often require a new set of eyes to see. This analysis also revealed more general challenges that were categorized into five variables: Human, Method, Material, Assets, and Work Environment.

The challenges and potential areas for improvement identified through the use of the methods mentioned above, contribute to waste and undesirable effects. Figure 27 illustrates the structure of how the study was performed and the types of challenges that were revealed.

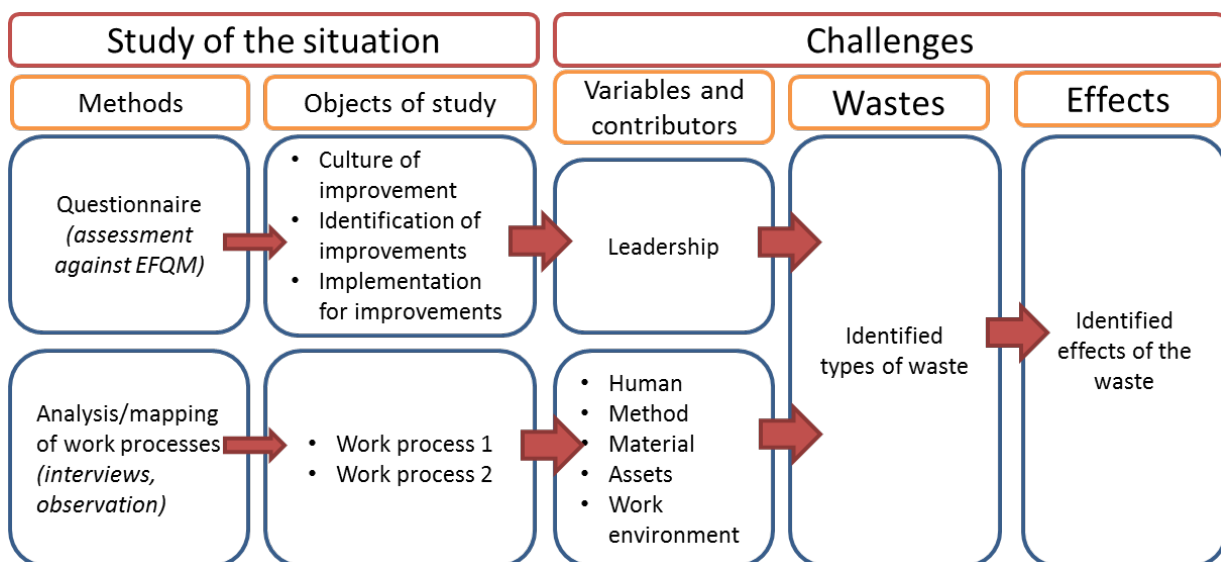


Figure 27 – Structure of how the study was performed

5.2 EFQM ASSESSMENT

5.2.1 About the Assessment

A questionnaire based on EFQM (2013) was used for the EFQM assessment. It aimed to assess the five enablers (see Figure 28) in the EFQM Model, and the connection to ‘Lean attributes’ in terms of improvement routines. The questionnaire was issued and submitted by employees at the DO Offshore Base. Results were analyzed, presented and interpreted. Areas

for improvements were revealed, from which improvements can be made by making adjustment in the leadership style.

EFQM (2013) presents what a structured deployment of Lean should contain, approached from an EFQM perspective. These are divided into four Lean attributes: Lean (general), creating a culture of improvement, identifying opportunities for improvement, and implementing improvements. Figure 28 visualizes where these attributes can be found in the criterion parts of the EFQM Excellence Model:

	1. Leadership					2. Strategy				3. People					4. Partners & Resources					5. Processes, Products & Services				
	a	b	c	d	e	a	b	c	d	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e
Lean (General)				■	■				■	■	■	■	■	■				■	■	■	■	■	■	
Creating a culture of improvement				■					■	■	■	■	■					■	■	■	■	■	■	
Identifying opportunities for improvement								■										■	■	■	■	■	■	
Implementing improvements				■														■	■	■	■	■	■	

Figure 28 – Attributes found in the criterion parts of the EFQM Excellence Model (EFQM, 2013)

A ‘Likert Scale’ was applied using a five-level format, and with one answer per statement. It was also possible to answer ‘don’t know’.

- 1 = Strongly disagree
- 2 = Disagree
- 3 = Neither agree nor disagree
- 4 = Agree
- 5 = Strongly agree

The “Likert Scale” was converted into a percent scale where 1 = 0%, 2 = 25%, 3 = 50%, 4 = 75% and 5 = 100%. The ultimate goal for all organizations should be 100%. The improvement potential depends upon the score.

The correlation between the questionnaire and the EFQM User Guide, the applied version of the questionnaire, and calculations of the results can be found in Appendix 1.

5.2.2 Results of the Assessment

The questionnaire was submitted by nine people at the DO Offshore Base; including two Technicians, two Superintendents, Base Manager, and four employees who preferred their positions to be anonymous.

The results are presented in term of the four attributes (Lean, culture of improvement, opportunities for improvement, and implementation of improvements) with the connection to the five enablers from the EFQM model. The average score within each area has been calculated based on the number of answers between the range from 1 to 5. These are represented as the average score in Table 1; the blue column contains the average score of each attribute. The ‘don’t know’- answers are not included in these calculations, but are presented as additional results (grey area). The average score in the horizontal row is the score of the EFQM enablers, but they will not be directly focused on further. It is the three last attributes that are of value for this assessment.

Table 1 Results of the assessment

		EFQM criteria (enablers)					Average score	% of answers that were “don’t know”
		Leader-ship	Strategy	People	Partners & Resources	Processes, Products & Services		
Lean Attributes	Lean	37%	33%	32%	40%	38%	36%	10%
	Creating a culture of improvement	41%	33%	32%	39%	NA	36%	8%
	Identifying opportunities for improvement	NA	40%	38%	41%	38%	39%	22%
	Implementing improvements	34%	NA	38%	41%	39%	38%	8%
Average score		37%	37%	32%	40%	38%		
% of answers that were “don’t know”		2%	39%	0%	0%	16%		

The results are presented graphically in Figure 29. We see that the answers are approximately in average 40% evenly distributed on all four attributes. The results indicate that they all should be subjected to improvements. Approximately 10% of the answers are ‘don’t know’ for three of these attributes. There is an increase of employees that do not know what the company does to identify opportunities for improvement.

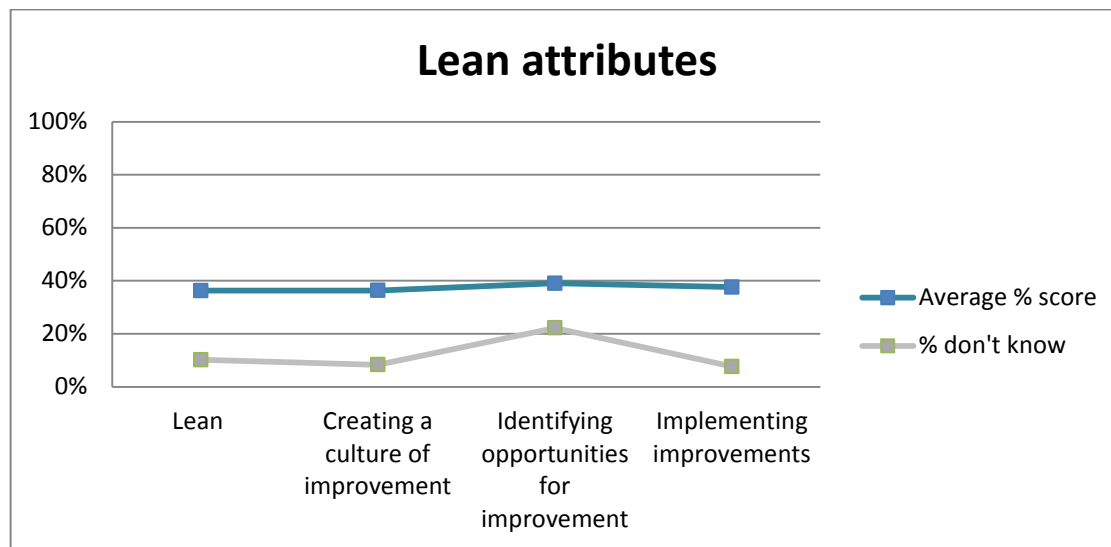


Figure 29 – Results of the assessment presented with respect to the four attributes

5.2.3 Limitations of the Assessment

There are several factors that can affect the results of this questionnaire. One of them is the ongoing downsizing process. Some people are unhappy with the way things have developed resulting in the risk of losing their jobs. Poor work atmosphere and dissatisfaction characterize the work environment, resulting in employees answering the questions based on feelings instead of a factual and true opinion.

Another limitation is that the DO Offshore Base is physically separated from the Main Office, and the information flow and communication might not be as good as if they were located in the same place. Some of the employees at the Base might only care about the things that are occurring at the Base and what affects them directly, and therefore would not know about how the Top-Management are managing the organization.

Another important limitation is that there may be different answers depending on the roles of the employees. People with different roles have different knowledge and access to

information, which can affect the answers provided. The results submitted from the Technicians showed a fairly lower score than the answers submitted by the Superintendents and Base Manager.

5.2.4 Analysis and Discussion of the Results

We see from Figure 29 that there is a gap between the average score and 100%. Even though there are some limitations of the assessment, the answers provide an important indication of the current situation. The fact that the score is fairly low, may not only show that the situation is poor, but it can be questioned further why the perception of the situation is indeed that poor. The interpretation of the results takes two factors into consideration; the result of the assessment and what DO actually do as a company. This information comes from personal experience and communication with relevant people at DO.

According to results, it does not seem like organized improvement processes are in place in DO. This is elaborated below. Some of the prerequisites to the various attributes may not be of good quality, while others are better and more focused.

Creating a Culture for Improvements

The results indicate that the company has in an arguably low degree created a culture for improvements. According to EFQM (2013), this could mean lack of clear communication to ensure alignment between improvement activities and the organization's overall strategic objectives. DO's improvement activities are usually aligned with the strategic objectives, and monitored and communicated through use of the defined KPIs. The problem seems to show that these KPIs are not sufficiently communicated to the employees at DO Offshore Base. Company statistics are updated on a monthly basis, and presented on a screen at the Main Office. The vessels regularly report data and make it accessible for the projects and the statistics responsible at the office, who further prepares the raw data and sends a presentation back to the vessels. This works as feedback where the statistics are presented in relation to the KPIs; both on a monthly basis and on a year to date (YTD) basis. It also enables for comparison between the different worksites. The DO Offshore Base is not included in this feedback loop. They were encouraged to create their own objectives and KPIs from a Management Review Meeting, however this has not been sufficiently communicated to the employees at the Base, hence not implemented.

A prerequisite for the creation of a culture for improvement is according to EFQM (2013) that there are training programs seeking to give people appropriate understanding of Lean principles to support improvements activities. Lean cannot be identified as an applied approach at DO, thus Lean training programs does not actually exist. The training programs that are offered to the employees are based on the required competence in relation to his/her work tasks, not specific to improvement processes.

The last prerequisite for the creation of culture for improvement is, according to EFQM (2013), that leaders are promoting a culture of empowerment, creativity and innovation that encourages and enables employees to suggest and actively contribute to improvement actions. DO consider their culture to be characterized by empowerment, innovation and entrepreneurial, where they rely on new ideas and innovation from skilled individuals. However, new solutions that are developed in this company often remain on project level, and are often just documented in a design report. Most of DO's resources are focused on customer satisfaction by being solution oriented at the time required, and not by pursuing long-term research and development of new and sustainable innovation. DO may not have a long-term philosophy because they are simply trying to survive in the current moment, but by not prioritizing a long-term philosophy, they would suffer even more in times where efficiency is required and would provide the most important competitive advantage. The reputation of being flexible and solution oriented gives DO a high score on customer satisfaction, which again can generate more job offers, but the Engineers and Technicians sometimes put a lot of unnecessary time and effort in the planning of a project, and there is often limited time to find more favorable solutions that can be used as a best practice in similar jobs. There seem to be a best practice and certain standardization within the most frequent jobs, however it seems like these are rarely subject for improvements.

Identifying Opportunities for Improvement

To be able to identify opportunities for improvement, DO should have clearly defined measures, feedback loops from the customers, and understanding of the customer value (EFQM, 2013). According to results of the assessment, the routines for identifying opportunities for improvement can be described as unsatisfying. This is the employees' perception, but DO have indeed a system for identifying opportunities for improvement; it is called Synergi, and is DO's reporting system where all the HSE incidents, deviations, proposed improvements and quality cases are submitted. Actions are registered and appointed

to a responsible person who is supposed to further follow them up. Many employees do not use this system, and the reason may actually be due to the experience of lack of response after submitting information.

An old company procedure exists for (external) customer surveys, however this version seems out of use at the present time. In general, the work performed is a result of close communication with the customer so that needs and expectations are understood (note that the customer can also be understood as the next internal function in a work process, not just an external client). The employees at the DO Offshore Base have close communication with the projects and vessels that they support, and receive feedback, especially when something goes wrong. Incidents are being reported in Synergi and handled according to the actions. The routines are in place, but how they are followed up and used to ensure prevention of recurrence may not be experienced as being optimal today.

Implementing Improvements

When implementing improvements, there are some important elements that need to be in place, such as available resources, structured processes, and improvement teams (EFQM, 2013). The impression of DO is that they are experts in what they do; they are highly flexible, and they focus on the customer's needs when performing the job. They become very busy with work that provides immediate value, and therefore may struggle to spend time and resources on projects that may not give immediate profit. It may seem like they struggle to balance the tension between short-term profit demands and the necessity for long-term investment in capabilities and growth opportunities.

There has been more focus on the processes within DO the last few years; the need for re-organizing the company structure came as a consequence of the cost saving focus that characterizes the industrial situation today. Some departments in DO have reviewed their processes in order to reveal improvements, and the QMS Department is now more engaged in the alignment and integration of the company processes. Attempts are being made to develop an overview of the processes at the DO Offshore Base, however it is not experienced as providing a structured and functional process overview. Structuring the work is important so that next opportunities can be revealed and implemented.

Improvement teams are not established to improve process efficiency and effectiveness. The implementation of necessary measures is the appointed case owner's responsibility, but the responsibility of ensuring continuously improvements on process level has not been appointed to anyone.

Summary of Results

Lack of measures and KPI's, structured processes, improvement training and teams, feedback and response, and improvement and standardization of best practices, can be summarized as the most important missing elements revealed from this assessment.

5.3 ANALYSIS OF THE MAIN WORK PROCESSES

5.3.1 DeepOcean's Value Stream

An overview of the value stream for DO is presented in Figure 30. This is made by use of CS Odessa Inc.'s (2016) value stream mapping symbols. The overview illustrates the transfer of information and items running from order to delivery, and from reception to storage: It starts where the Engineering Department receives a Work Order, and sends an order of needed items to the DO Offshore Base, where it ends with the forwarding and storing of items that are received back from the vessels. Details about time and number of employees required for the various activities are left out because the processes seem to be different each time.

The value stream is presented just to better see the connection between the activities at the DO Offshore Base and the whole value stream. The activities outside the 'box' in Figure 30 will not be focused upon during this thesis. This is arguably a limitation of the analysis. Nevertheless, some challenges rooted in other processes outside this scope, which affect the Base, will be mentioned.

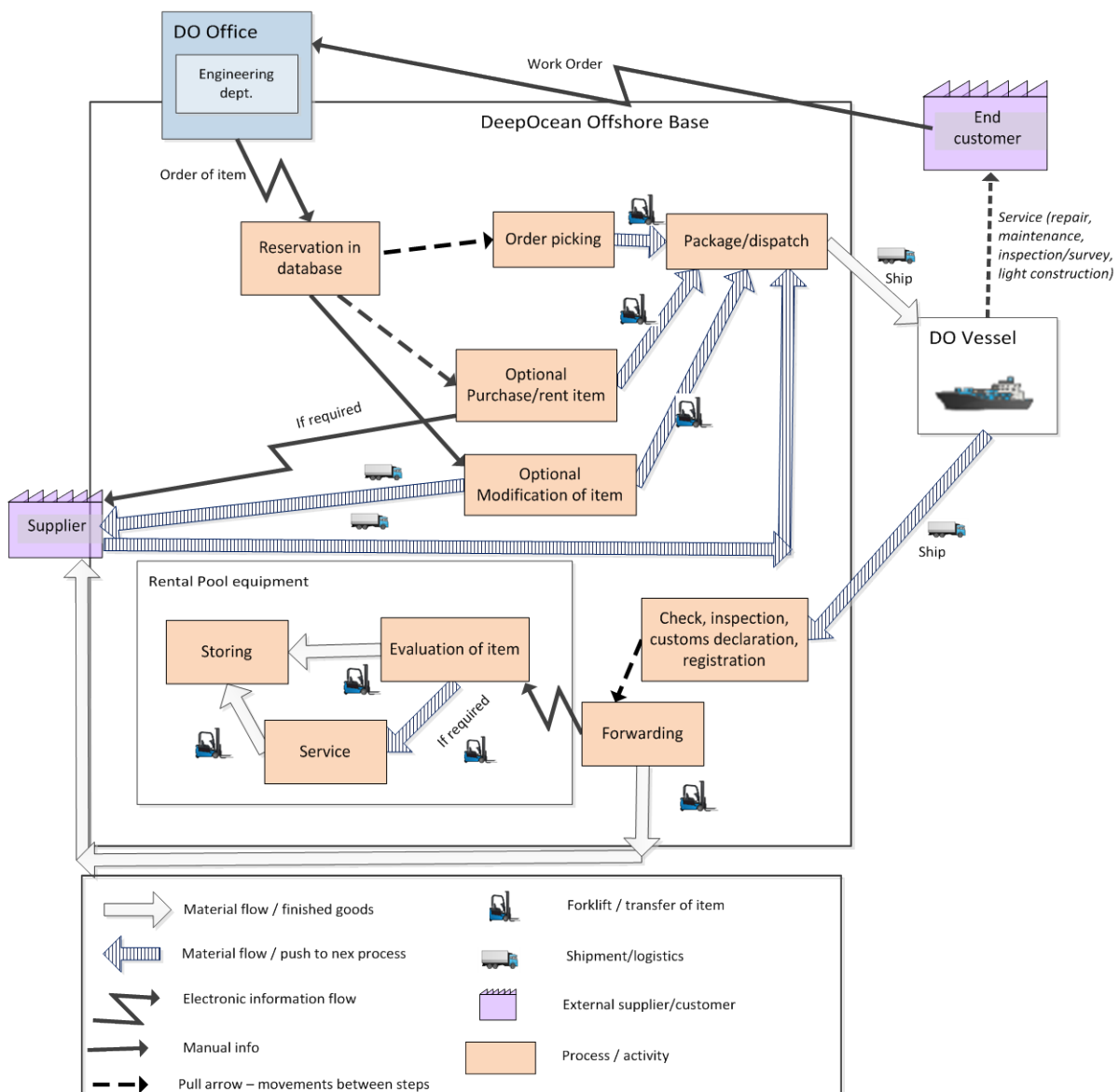


Figure 30 – Overview of the value stream for DO Offshore Base

5.3.2 Activities and Work Processes

The key activity at DO Offshore Base is to support their customers (which are the DO projects and DO vessels) in vessel mobilizations and demobilizations, technical maintenance, and equipment support. These activities are incorporated in two main processes. The first is reception and handling of order from project, order picking, preparation and dispatch of ordered items (see Figure 31), and the second process is reception, forwarding, evaluation, service and storage of items (see Figure 32). These work processes are described below the figures.



Figure 31 – Work Process 1: Order to delivery of Rental Pool Items

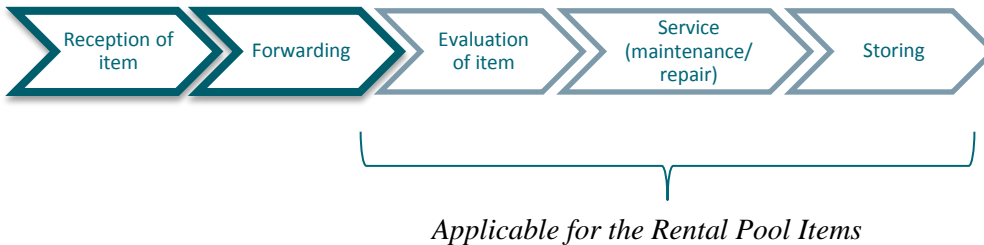


Figure 32 – Work Process 2: Reception, forwarding, evaluation, service and storing

Work Process 1

The first process starts with a reception of order from a project. This goes to the Rental Section, which has the responsibility of asset control and track of equipment. They check if the item is available and ready to use, and update their database. Necessary items are rented or purchased from external suppliers if it is not in stock at DO locations. Order picking of the item is performed by Rental Section. If there is a need for modifications of an item, the Workshop Section becomes involved and cooperates with a project Engineer/Design Engineer. If this work is too comprehensive and requires machines that are not available at the DO workshop, an external provider becomes engaged. When the item is ready, it is delivered to the Logistic Section, which makes it ready for dispatch and transmission. This section is responsible for transport, loading/unloading, and customs declaration.

Work Process 2

For the second process, the Logistic Section is responsible for the reception when the item is received back from the vessels, and all other items received. After the item has been registered, controlled and been through the routines of customs declaration, the item can be forwarded to the company/person/unit/project that has ordered the equipment. The three last phases in Figure 32 show the steps for the internal items (Rental Pool items). These are forwarded to the Rental Section that registers the equipment in their database. In cooperation with the Workshop Section, the item is then evaluated and sent to Workshop Section for

service if necessary. What is done is registered in the Service Base, and the item is stored until it is needed again.

5.3.3 Analysis of the Main Work Processes

The main work processes contain several sub-activities and decision-making processes that are carried out by responsible employees in all three sections at the Base. This is illustrated in two flowcharts (see Figures 33 and 34). The details are important. In order to ensure that waste does not go unnoticed, the processes is zoomed in and analysed.

The flowcharts of the work processes are created in order to be able to see how the flow of an item is in today's situation, and who is responsible for the various steps. The first flowchart in Figure 33 illustrates the flow from order to delivery (Work Process 1), and the other flowchart in Figure 34 illustrates how items flow from the reception area and further into the hall, or forwarded to the respective receiver (Work Process 2). The three sections at the DO Offshore Base have their own responsibilities, which is illustrated by vertical lines. The horizontal lines represent the various phases within the process. These correspond to the phases in Figures 31 and 32. The purple boxes refer to the start of a process. The yellow boxes refer to the decisions that are to be made. The boxes with dashed boarder lines represent actions that need to be considered or done before moving to the next step. The white boxes illustrate the last step of that specific process. The forklift represents the physical movement of the item.

A 'backward' approach is used when designing the flowchart; this means that the last step in each process have been the starting point of the mapping. This is to better see the purpose of the work processes: We see that the final step of Work Process 1 is the delivery of items to the customer (which is the vessel/project). This is the purpose for which all the other activities lead to. For Work Process 2, the last step is the marking and storage of the item, so that it can be ready and available when needed. The aim of this analysis is to find out if the purpose of the work processes can be fulfilled or not, and expose the waste that can prevent it from being fulfilled. Identifying underlying challenges at DO Offshore Base can expose waste.

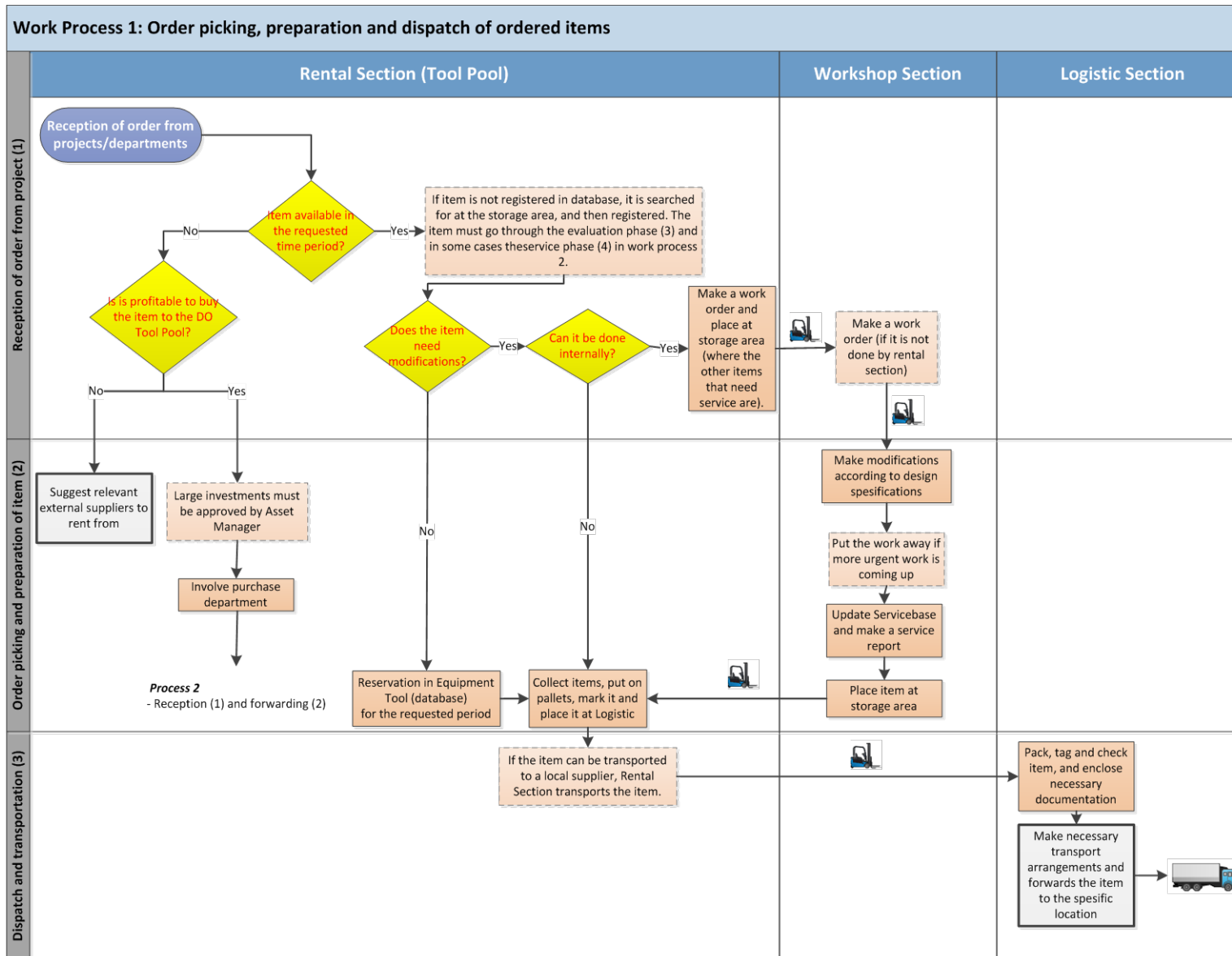


Figure 33 – Work Process 1: Order to delivery of Rental Pool Items

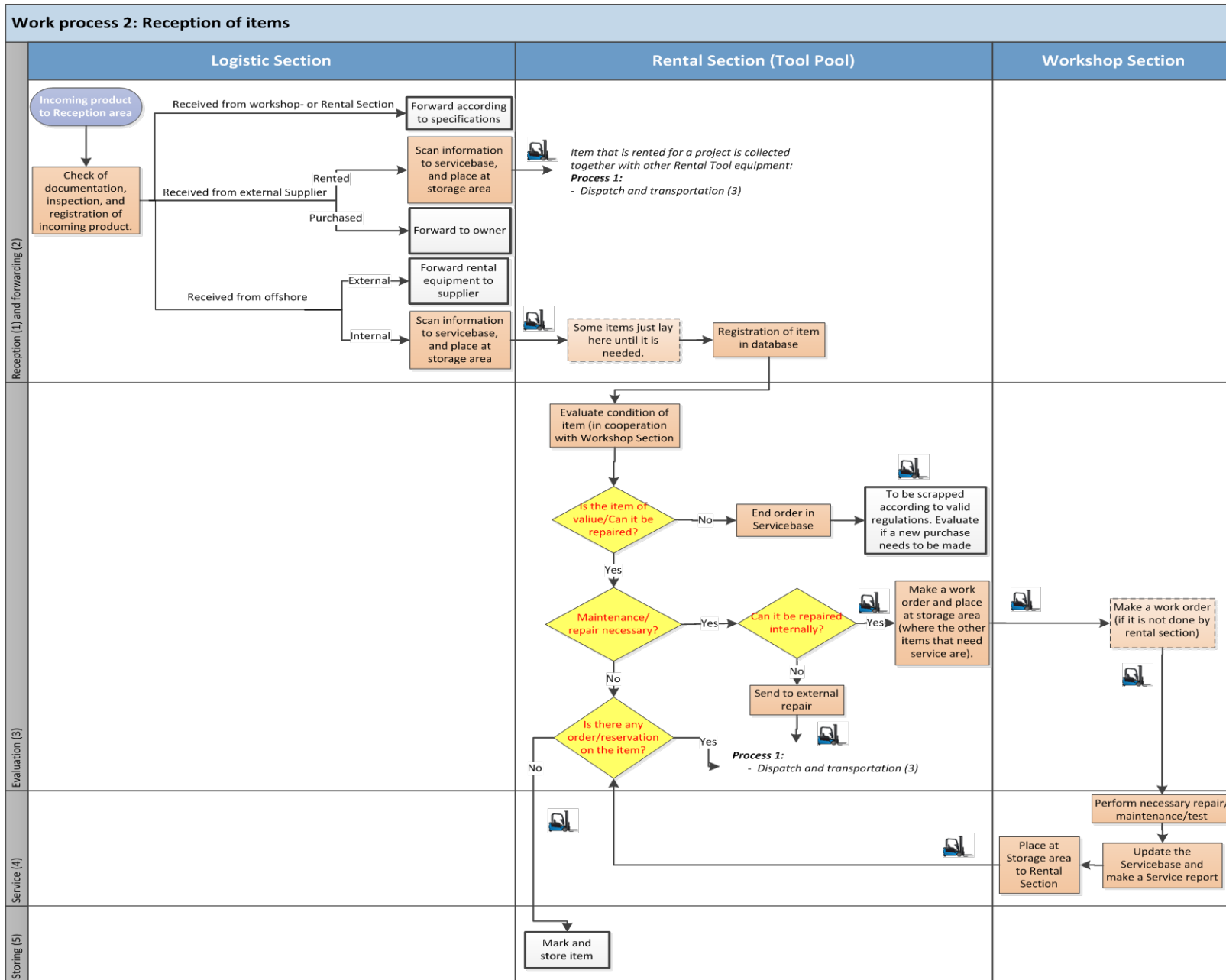


Figure 34 – Work Process 2: Reception, forwarding, evaluation, service and storing

5.3.4 Identification of Specific Challenges for Work Process 1

Phase 1: Reception of order from project

The first process (see Figure 33) starts with an order of item. The Project Engineers are usually ordering items for a project or vessel, but they have limited access to information concerning the Rental Pool items. Their only way to find correct information about equipment specifications or availability is through contact with the Rental Section at the Base. During ordering of items, several clarifications between the engineers and the Rental Section are sent as ‘ping-pong’ mails every day. A lot of time is spent on this activity. Rarely are the engineers coming to the Base to look at their project equipment, even they are responsible for ordering the correct equipment. Equally rare are Base employees invited to project meetings at the office.

The interface between the projects and the Base is compounded by internal communication problems between the engineers: The Rental Section sometimes experience that two engineers are working at the same project and are ordering items without agreeing on clear responsibility areas. Two item lists that include some of the same equipment can be sent from both the engineers. This can make frustration, and it becomes easy to make mistakes. A lot of time is wasted on these types of conflicts.

If we look at the step where the Rental Section has to find out if the item is available, a major challenge is exposed: There is a chance that the item is not registered in the database, even if the item is received at the DO Offshore Base a long time ago. It is not possible to be sure whether an item has come back from the vessel, or if it is still offshore. This result in a searching activity, and if the item is found somewhere at the Storage Area, the item should go through the evaluation phase and in some cases the service phase. These steps are normally performed in Work Process 2, but have been skipped; hence these steps should be carried out in Work Process 1 instead (see Figure 35). The time between order and delivery would then be increased, and there is a risk of not being able to deliver the item within the time limit. This issue is elaborated in the next section about the Work Process 2.

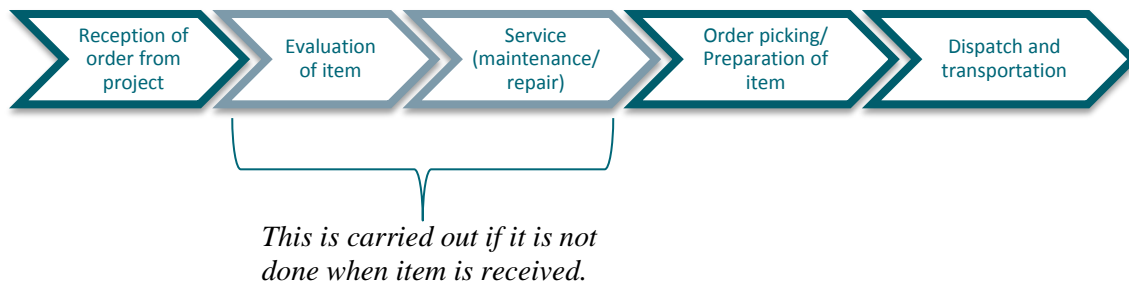


Figure 35 – Work process 1: Order to delivery, including evaluation and service

When ready (after an item is found and is indeed available) the Rental Section together with the Project Engineers can start to evaluate need for further actions. When the item is to be modified internally, it is the Rental Section’s responsibility to make a work order in ‘Service Base’ (database) so that the Workshop Section receives information on what to do with the item. Rental Section cannot always find time to make a work order; hence the item is sometimes delivered without. This requires the Workshop Section to search and ask for information, and they are forced to make the work order themselves.

Phase 2: Order Picking and Preparation of Items

When a work order is made, the item is placed at the Storage Area (on the floor), where also the other items that are to be maintained, repaired or modified are placed. The Workshop Section receives a work order or information regarding the item, finds it, and starts the work. Other work may be put away if this is considered urgent work. This challenge is elaborated further in the next section, which is concerned with Work Process 2, where the most worrying issues occur. When the item is ready, a service report is made, and the finished item is placed at the Storage Area. The Rental Section can then collect the item and make it ready for the project that has ordered it.

The process of purchasing can be a challenge: There does not seem to be a functional Purchasing Department controlling the purchasing process at the DO Offshore Base. Hence, many employees are involved in the purchasing process, and routines for selecting and approving the optimal supplier is severely lacking. This can result in missed opportunities for savings. It can also be difficult to keep control of customs duties, taxes, and other expenditures that could support the business’ finances.

When an item is to be collected at (or transported to) Karlsund Service Base, it is sometimes transported without arranging transportation for other items at the same time. Others may need to transport something else, and this information is not always communicated. KSB is just 8 km away, but the total time wasted due to logistical inconsideration within a year can be significant.

Phase 3: Dispatch and Transportation

Communication issues resulting in unnecessary transportation and additional expenses can also occur in the last phase. The Logistic Section relies on rapidly, accurate and updated information regarding transportation of shipments to the vessels. Many units are involved during a project, and changes and adjustments happen all the time in project activities. This makes it even more important to have a quick response approach in order to be time and cost efficient. Items that are going to the same destination are sometimes shipped separately, causing unnecessary and expensive shipping costs. This occurs due to many employees being involved in the same project, and communication between them is poor. In addition, the coordination between the Base, the Office and the vessels can be fairly poor. A significant problem also arises when items are shipped last minute – as it often becomes costly. Sometimes, the items are even sent to the wrong location because the correct information has not reached the DO Offshore Base. This can be information in the software used for purchase orders, information from the vessels, or information from the Engineering Department. There are cases where new items have been purchased because it could take more time to send it back from the wrong location and to the correct location.

5.3.5 Identification of Specific Challenges for Work Process 2

Phase 1 & 2: Reception and Forwarding

Lack of information is one of the largest issues for the Logistic Section. A specific example of such a challenge has been when a received package lack information about who the receiver/owner is. When equipment comes from a vessel, the manifests can be lacking some important information. This makes the work at Logistic Section difficult, and a lot of time is wasted because of it.

Another problem has been when items are coming from a completed project, and the responsible Engineer is no longer on the contract and takes some time off after an offshore

trip. Then, the item is received at the Logistic Section, but no one knows what to do with the project equipment. It causes congestion of items at the Base, which could be avoidable through better communication.

When a Rental Pool item is received at the Logistic Section, there are routines for forwarding information to the Rental Section, but actions are not always made in order to register the item in the database. Neither is a check performed to ensure that Rental Pool items actually come back after the renting period is over. This is an issue when another project/vessel has ordered the item, and it is still on board a vessel. The information that is sent has therefore no value. Logistic Section then just places it on the floor in the Storage Area or Workshop Area so that it can be taken care of when the item is needed. When Rental Section has time, they sort them and update their database, but it is often not done before the item is ordered for a new project. If the item is not registered by Rental Section, it is not sent to service. The items are then congested at the workshop/storage floor, unmarked and not registered. They are blocking aisles and block for the order-picking of other items on that rack. Often are items moved from the floor into the rack just to free up space, and it is forgotten before it is marked and registered in the database. After a while, it is unclear what equipment it is, and where it belongs. Since the equipment is not registered properly, it can be missing when it is needed again. These are items that could have been repaired, registered and stored a long time ago, instead of right before the item is needed on a project/vessel. This is the problem mentioned earlier in Work Process 1.

There are no designated areas for incoming items to Rental and Workshop Section. As already mentioned, the items are just placed at the Storage Area, which is far from the Logistic Section. The items that go to service (Work Phase 4) have to be moved back and into the Hydraulic or Electric workshop. The black arrows in Figure 36 illustrate the unnecessary movement of items.

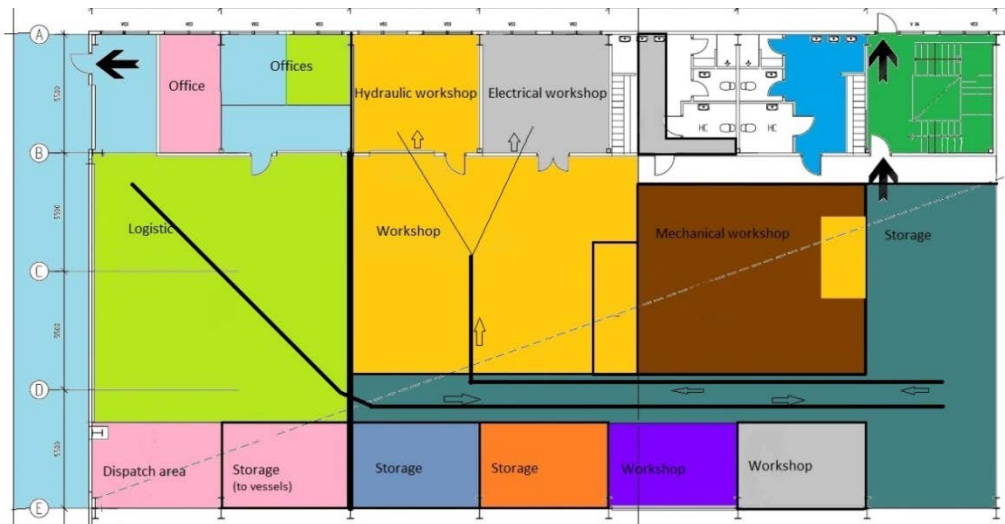


Figure 36 – Movements of items

Phase 3: Evaluation

The Rental Section is not always capable of evaluating the condition of an item; hence it is performed in cooperation with the Workshop Section. This step follows after the item has been registered in the database by the Rental Section. The Rental Section has not added any value to the item, just registered it. This extra step causes a bottleneck effect. It can be questioned why the Workshop Section (or someone with the right competency) is not evaluating the item before it goes to the Rental Section to avoid this. This cannot be acknowledged as an optimal sequence of performing these work tasks.

The Rental Section does not always have time to make a work order on items that need to be repaired, so the Workshop Section has to do it after searching and asking for information (same as for Work Process 1).

Phase 4: Service

As mentioned in the previous section; items sometimes have to be put away during service because something else should be prioritized. This is not an efficient way of working, and it deviates from the 'One piece flow'-principle. Things are stopping up, queues are created, and items are congested. The same happens when work on an item stops because parts are missing and should be ordered after the work has started. Again the item is put on hold until the missing part is received challenging the customer deadline for the item.

Missing tools/equipment can also be a challenge during this phase. Employees are wasting time searching for it. The workshop lack inventory lists/pictures and vinyl shadows to ensure that all the tools are placed back to their designated place - every day.

Phase 5: Storing

The last phase is storing, which includes registering information in the database, marking of items, and placing the items on the appropriate racks. At DO Offshore Base, the items do not seem to have a designated place at the racking; they are simply just stored at an available place.

The storing can be a time consuming activity if items are blocking aisles and rack sections (as mentioned earlier).

5.3.6 Discussion of Result

One can see that the final step of Work Process 1 is the delivery of items to the customer (which is the vessel/project). This is the purpose for which all the other activities lead to. For Work Process 2, the last step is the marking and storage of an item, so that it can be ready and available whenever it is needed. The aim of this analysis was to find out whether the purpose of the work processes can be fulfilled, and expose the waste that can prevent it from being fulfilled or if it is just using resources without creating any value. The customer just wants the utility value and the benefit that the item and service provide, and the activities that contribute to deliver what the customer wants are in this case value creating activities. After analysing the specific steps involved in the work processes, we see that the findings are many. Most of the steps cannot immediately be eliminated because they are simply not redundant. However, there are some steps that clearly add no value; they are waste, and are therefore targets for elimination.

We see from the analysis that storage, stops and barriers are preventing smooth and efficient processes. It seems like the main focus has been on resource efficiency; the utilization of expertise and equipment, and not the flow efficiency. By focusing on the flow item first, one can reduce queues, stops and waiting. Despite poor flow efficiency, so far DO have always managed to deliver the ordered item to the vessel/project on time. From a risk perspective, there is a possibility that they someday fail to deliver the item in time, and maybe the vessel

will have to wait for items. The flow of the item is very vulnerable as there are many things that prevent it from flowing smoothly. There are also many external factors outside the Base that affect the work situation, and contribute to an inefficient flow. These will not be directly covered by this thesis.

5.4 IDENTIFICATION OF CHALLENGES IN TERMS OF SIX VARIABLES

The causes of the challenges can be considered as sources of variation, and necessary adjustments can be made within the variables to improve the current situation. Six variables, which are considered to cover the processes and activities at the DO Offshore Base, are identified. These are Leadership, Human, Method, Material, Assets and Work Environment. Leadership was identified as the first variable from the EFQM assessment in section 5.2. Section 5.3.4 and 5.3.5 describes specific challenges in each phase of the work processes, but more general challenges were also revealed during the analysis. The specific challenges can together with general challenges be summarized and categorized into the other identified variables. Figure 37 is based on the Ishikawa (fishbone) diagram and contains the six variables applicable for the DO Offshore Base.

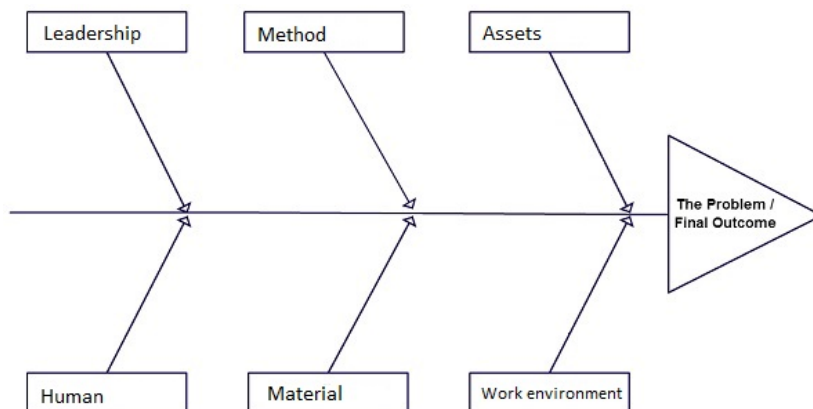


Figure 37 – Ishikawa diagram, six variables

5.4.1 Leadership

We see that the culture for continuous improvement should be better developed, and the management should facilitate this process so that every employee can contribute in improvement activities. When a culture is developed, and the structure of the work is optimized, the identification and implementation steps can be more easily achieved. A

significant ‘show stopper’ in the improvement processes is that the Senior Management at DO struggles with justifying improvement projects that have the potential to provide the company with long-lasting future value. The company is currently in a difficult position facing pressure from the board of directors, where savings and cost reductions are the main focus. Unfortunately, they do not seem to focus on the factors that can give a competitive advantage because it requires them to invest resources before results can be visible.

For the DO Offshore Base, it seems like the Senior Management is not visible enough, and is not sufficiently communicating the expectations they have of the DO Offshore Base, to the DO Offshore Base. This results in a large gap between the DO Offshore Base and the rest of the company. The gap may therefore result in that employees feeling disrespected and unappreciated. If they feel that they are not respected, they are not sufficiently motivated to come up with improvement suggestions that are beneficial for the company as a whole. This is crucial because a lot of the operational details are known at this part of the company.

5.4.2 Human

Human refer to anyone involved in the work processes.

It is experienced as obvious that the employees wish the best for DO, and always act on behalf of the company. They feel a strong commitment to their work, and they seem to have an invaluable engagement. The strong culture can be a barrier when it comes to implementing changes, which means it can be difficult to make the needed improvements. Even though they express a need and desire for improvements, it can be a challenge to get them to think differently, and to change their routines and strong habits to embrace new ones.

According to a group of employees working at the Base, one issue is the work overload. It seems that there has always been too few people working here, and some associated effects are overtime and negative stress. The number of Project Engineers at DO’s Main Offices has increased significantly the last years, while the Base had to settle with more work and the same number of employees. With dedicated and loyal employees with great responsibility for their work, they manage to do the required work despite capacity limitations. It seems like they are always trying to survive in the current moment; hence they have not the ability to devote time to reach a certain level where the work is more controlled and planned, and where

items flow without interruptions. This issue has been addressed and submitted to the company's reporting system several times, but nothing has been done to solve it. Unclear responsibilities worsen the situation as some responsibilities are shared between too many employees while some areas lack employees who have responsibilities to ensure work is done. Necessary tasks may therefore, as a consequence, be forgotten or overlooked.

The 'human chain' is not fully connected; there are barriers that prevent an optimal interaction and cooperation between the employees across functions. The people working at the DO Offshore Base are extremely skilled personnel, and every individual has a valuable insight and control of his/her own tasks and areas. Some of them have worked at DO since the start-up eight years ago, and have contributed to how the work practices are today. The DO Offshore Base is relatively small with only 16 permanent employees, of which only 7 Technicians and Supervisors are working permanently in the hall on a daily basis. It is not seem to be difficult for these individuals to obtain control and overview of the processes and tools/equipment that are found internally at the Base. It is the boundaries that are between the functions/units that creates the most issues. Problems can also occur when new personnel are working at the workshop, when an employee is sick, or when certain employees are on vacation.

5.4.3 Method

Method refers to how the process is performed; how things are done at the DO Offshore Base, how the routines are and the specific requirements for doing them, such as procedures and regulations.

The methods at the Base have been developed over several years. They have utilized the space and layout, and managed to perform well in a hectic workday. External factors have changed drastically during this time, but it does not seem like the established standards have changed much at the Base. Their routines and ways of working are very rooted, and the challenges have just been dealt with as they occur.

There are some challenges connected to routines, procedures and responsibilities, which arguably affect the daily work at the Base. There are contradictory regulations, and out-dated procedures and workshop manuals. This is normally not an issue for the employees that are

working at the workshop on regular basis, but there can be problem for employees that are hired in for a short periods of time. Unclear routines are also a concern for safety matters. Routines of forwarding, receiving and using information is fairly poor within and between the units. The information flow within the three sections at the DO Offshore Base is mainly based on oral communication. Their routines for information transfer are very vulnerable as it relies on people's memory - things can easily be forgotten. They have a daily morning meeting where status and important information are communicated, but many things may change during the day.

In general, there is limited access to relevant information, and important information is not visible. There is an agreement among many of the employees at the Base that the information flow and communication between other units (such as vessels, projects, and other departments) is poor. This is especially the case for information regarding projects, shipping locations, dates for mobilizations/demobilizations, and project items. The analysis revealed that some of the problems are changes being made without informing relevant people, and manifests that lack information.

There is a physical separation that creates a type of barrier between the Base and the Main Office (even though they are only a few kilometres apart). It required a little more effort to actually meet with the engineers, in person, that are planning a job that involves the Base. The most information goes through mail or phone.

The connection between the Base and the Senior Management is perceived as quite poor. This is also identified through the EFQM assessment (in section 5.2). It seems like the frustration has built up during a long period of time, and not rooted in specific incidents. Employees at the Base may feel that they are forgotten, and that decisions that affect them are made without involving them. Representatives from Senior Management have limited time to visit the Base, and therefore cannot see what is really going on in this part of the organization.

5.4.4 Material

This is material and parts that are used to modify, repair and maintain the items.

Spare parts are critical during service of the items; it is a serious challenge if spare parts are out of stock. It prevents the flow of the items. The routine has been that the person taking something from the stock storage (see Figure 38) signs out the item on a sheet of paper. This can be about 20 items per day. Once a day, the person responsible for the stock storage takes the sheet of paper and manually registers the items in a database. There has been no good routine for ordering new parts when minimum stock has been reached (although there is a digital signal in the database they are using). This has been addressed in the company reporting system: The problem still seems to be that too many employees are involved, and at the same time there are no clear areas of responsibility when it comes to ordering. An issue has also been that employees do not sign out the spares they are taking.



Figure 38 – Stock storage

5.4.5 Assets (Items/Equipment and Tools)

Assets include all the items, equipment and tools that are flowing in the processes. So far, there are no cases where DO have failed to deliver ordered items to the vessel/project in time, but items have been in a poor condition when delivered. This occurs when the items have not been through the service phase. When they are not in an optimal condition when delivered, it has to be taken care of by the people working at the vessel. They are often very busy, and the cost of service is often much higher than it would have been on the DO Offshore Base.

In general, it is challenging to control the assets; both company owned assets and rental assets. There are some examples of cases: Rental equipment have been forgotten on board the vessel and consequently not sent back to supplier, and there are cases where rental equipment have been sent back to wrong supplier and then disappeared. There have been cases where company owned items have been sent back missing different parts, or not been sent back at all. There are also cases where other companies have stored equipment at the Base without being invoiced; such equipment is unnecessary inventory. These types of cases cost DO a lot of money each year. There is no functional application system for asset management that can

keep control of the items by providing information about all types of equipment that are located on the vessels. Several systems, databases and software are in use to keep a certain control of the assets and processes, but these are all of different types, and do not interact with each other; hence, things are missed out and forgotten. A system that can be used to control and coordinate work have been discussed, but not implemented properly. The employees at the Base seem to be aware of the benefit of a well-functioning system, but lack of available resources that can prepare and manage it, and approval from the Senior Management to buy the extended licence, puts it on hold.

Many of the challenges are normally not rooted at the DO Offshore Base, but at the vessels and projects. Anyway, these problems become more visible at the Base, especially at the Logistic Section: The vessels/projects order items they need right before they leave the port, and the items are first received at the Logistic Section that has to ensure that the items are shipped before the vessel leaves. After the items are shipped, it is not unusual that the vessel has some other items that also need to be shipped.

When the vessel sends some items in return to the Base, there have been several cases where these items are not sent together, but separately. It seems like employees do not talk with each other on the vessel: The responsibility areas are specified in detail; hence it can prevent communication across functions.

Also, the control of inventory is experienced as inadequate, and equipment that is used by various employees/departments disappears – Employees are then wasting time searching for tools/equipment that are missing. For some equipment, there have also been several instances where the equipment is located but is not in an operative condition.

5.4.6 Work Environment

Work environment refers to the condition of the work location, and includes the physical order and structure of the work place.

Challenges regarding space and layout are one of the most direct and visual challenges that affect all sections at the DO Offshore Base. Items stacked in height, items blocking in the aisle or in the picking column in the rack section, missing items and items that are difficult to

find, congestion of items that are not in use, and items that are placed at impractical places, are some of the issues related to limitations of space and layout. The cleaning routines are not always adhered either. The workshop is divided into areas where dedicated personnel have responsibilities, but it is still not adequately adhered to. It is especially difficult to maintain when new/hired personnel work at the workshop; they do not feel responsible and sense of ownership to DO, and cleaning routines are overlooked. Figure 39 and 40 illustrate how chaotic it can be at the Storage Area, and Figure 41 and 42 illustrate the clutter at the various work stations.



Figure 39 – Storage Area 1



Figure 40 – Storage Area 2



Figure 41 – Clutter at the workstation



Figure 42 – Disorganized workstation

The most of the reported synergies from the Base are about challenges related to lack of order and structure. Concerns regarding risk of falling objects, disorganized storage hall, clutter in working area, and lack of shelves, has been addressed by the employees working here.

5.5 IDENTIFICATION OF CONTRIBUTORS, WASTE AND EFFECTS

The challenges identified from the EFQM assessment and the specific and general challenges revealed by the work process analysis are contributing to different types of waste. The waste is categorized into 10 different types, which cause certain effects. A bow-tie model in Figure 43 illustrates this.

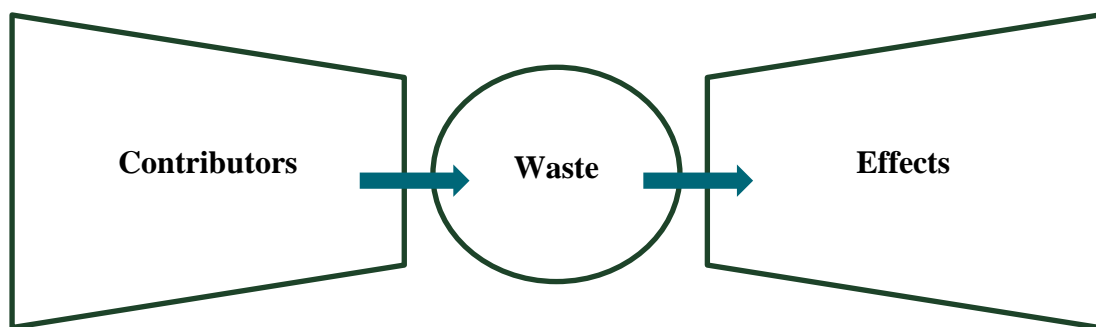


Figure 43 – Bow-tie: Contributors, waste and effects

The connection between the contributors (variables), waste and effects can be found in Appendix 2.

5.5.1 Contributors

The identified contributors are presented in Table 2, categorized into six variables (Leadership, Human, Method, Material, Assets and Work Environment).

The challenges in the Table below have all been mentioned previously; hence this list is just a summary of all challenges that are considered contributors.

Table 2 Identified contributors

Variables	Contributors
Leadership	Lack of clearly defined measures and KPI's (at the Base)
	Employees not sufficiently involved in improvement processes <ul style="list-style-type: none"> • Lack of training regarding improvement processes • No evident improvement teams • Lack of response after submitting an improvement suggestion
	Leaders do not adequately encourage and enable people to suggest and actively contribute to improvement actions.
	Leaders are not focusing on a long-term philosophy when it comes to developing new and sustainable solutions that could be a standardized “best practice” (already established best practices are not subject for improvements).
	Inadequate routines for receiving feedback from external and internal (vessels, projects) customers. Following up and use of the feedback is not optimal.
	Tension between short term profit demands and the necessity for long-term investment in capabilities and growth opportunities. Struggle to justify investments in improvement projects that aim to reduce waste from a long-term perspective.
	Work is not structured so that opportunities can be revealed
	Senior management not visible at the Base
	Decisions that affect the people at the Base are sometimes made without involving them.
Human	‘Human chain’ is not fully connected; there are barriers that prevent an optimal interaction and cooperation between the employees across functions.
	Lack of human resources: Limited time – work overload
	Strong culture – skeptical to changes

Method	<p>Limited access/lack of information concerning</p> <ul style="list-style-type: none"> - Rental pool items for the engineers - Project- and vessel plans, dates for mobilizations/demobilizations - Shipping location - Owner/receiver of items - Items received from vessels: Manifests lack important information, and Project Engineer is not available for sorting out the items. - Changes in plans, dates and location
	<p>Poor interface/coordination/communication between and within different units</p> <ul style="list-style-type: none"> - Projects, vessels and the Base - Purchase department and the Base - Not optimal purchase routines: poor control of expenditures. - Units on vessels – items are sent off the vessel and to the Base separately. - Within sections at the Base: the routines for information transfer are based on oral communication. This is vulnerable as things can easily be forgotten.
	<p>Internal communication and coordination sometimes fail internally on the Base.</p> <ul style="list-style-type: none"> - Transportation of items between Killingøy and KSB. - Items sent to the same vessel separately from different people
	<p>Not logical sequence of work tasks and allocation of responsibilities.</p>
	<p>Obstructions during service - work put aside due to urgent work</p>
	<p>Lack of designated area for incoming items to Rental and Workshop Section.</p>
<p>Outdated procedures and manuals</p>	

	Contradictory regulations
Material	<p>Poor stock control</p> <ul style="list-style-type: none"> - No action taken when minimum stock is reached - Signing out spares - Responsibilities
Assets – Items/equipment and tools	<p>Lack of control of assets</p> <ul style="list-style-type: none"> - Poor routines of registering received Rental Pool items – loose the control and overview of the available items, and causes service routines to not be carried out. - Not checking if Rental Pool items are received after the renting period is over - Fail to check if owned and rented equipment on the vessels are going off. - Storing other company’s assets without sending them an invoice.
	Poor control of tools: Lack of inventory lists/pictures and vinyl shadow
	Congestion of items/equipment due to unknown or unavailable ‘owner’/responsible person
	Lack of designated areas for equipment and tools that are used frequently at the Base
	<p>Shipping of assets</p> <ul style="list-style-type: none"> - Items shipped in the last minute - Sometimes shipped to wrong location - Several shipments from and to the same location

Work environment	<p>Congestion of items – prevents an effective flow of the item</p> <ul style="list-style-type: none"> - Unidentified items - Not market and registered Rental Pool items blocking the aisle or in the picking column in the rack section - Items that are going to service
	<p>Space limitations</p> <ul style="list-style-type: none"> - Items stacked in height - Items blocking in the aisle or in the picking column in the rack section - Too few shelves
	<p>Untidy, clutter, disorganized</p>
	<p>Dirty area, tools and equipment</p>
	<p>Unclear roles and responsibilities for keeping order and structure in the hall.</p>

5.5.2 Waste

As introduced in chapter 3, the commonly accepted types of waste in the Toyota Production System are Overproduction, Waiting, Transport, Inappropriate Processing, Unnecessary Inventory, Unnecessary Motion, and Defects. The main waste at the DO Offshore Base is categorized into 10 main types (see Figure 44): Searching for items / missing items, searching for information / missing information, rework, waiting for items/parts, missed opportunities for earnings and savings, equipment not delivered back in time, unnecessary motion, unnecessary transport, unnecessary inventory, and unexploited human potential. These are all exposed from the identified challenges.

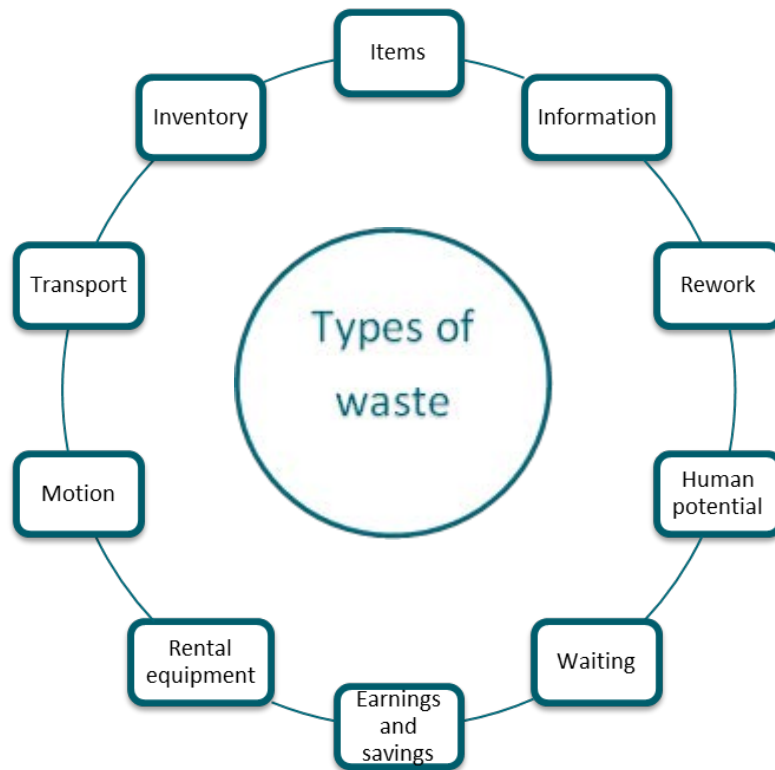


Figure 44 – 10 types of waste

5.5.3 Effects

The identified types of waste could result in certain loss and negative effects. These are described below.

Work Overload

It is registered a huge amount of overtime hours at the DO Offshore Base, of which many of them have been due to logistic work after normal hours. Some of these hours have been necessary due to support activities for vessels that follow a schedule that goes beyond normal working hours. The overtime that is an effect of different types of waste is important to consider, even though it does not constitute that much every day. It is the small things that eventually make up the vast wastage of hours.

Negative Stress

Stress can be caused by external factors from the physical working environment, and when there is not enough time to do all the work. The tension from the amount of work can sometimes be so pressuring that it has a negative effect on employees. The employees' desire

to perform can further add onto the stress. This is an effect from the waste that steel extra time. It can be closely linked to the work overload.

Moral

Employees' moral can be challenged due to the identified waste. Moral is about what people consider is right and wrong. When factors in the daily work deviate from best practices and logical solutions, it can be natural to doubt the existing procedures and routines. The identified waste that are not providing a meaningful use of the employees' time, and can therefore contribute to a poor morale.

Productivity

It is quite obvious that the most of the waste are causing low productivity; preventing employees from spending time on work that actually provides value. Time is spent on searching for items and information, disjointed work causing work to stop, unnecessary transportation and movements of items takes extra time, unnecessary inventory causes unproductive work due to space limitations, and rework is work carried out a second time because something went wrong the first time. The current poor effectiveness in converting inputs into useful outputs is rooted in the contributing factors.

Cost

Cost is a common effect of all the waste and underlying contributors. Most of the economic losses are due to extra working hours, extra transportation, extra inventory, breakdowns due to missing equipment on the vessels, project delays, unnecessary purchasing of equipment, and not delivered rental equipment back within time.

Quality

Quality in this case is strongly concerned with doing things right the first time. Time that is squandered due to the waste can sometimes require time saving actions that compromise quality. Missing information can also result in a quality issue because lack of information can prevent good decisions to be made.

Safety

Lack of information can be a concern for safety matters because regulations and routines regarding safety should be known in order to be followed. Also the unnecessary inventory can

create an unsafe situation for employees: Equipment stacked in height represents a risk of dropping objects, and items that are placed on the floor can represent a slip-, trip- and fall hazard. Increased motion would consequently increase the risk of undesirable incidents. As for quality, safety can be compromised due to time-consuming waste.

Delivery

Delivery refers to the delivery of internal and external items to the vessels, and back to external suppliers. This can include missing items/part when delivered/received, poor condition of an item when delivered, and items not delivered back on time. The types of waste that cause extra time to be spent will also affect delivery.

5.6 THE WAY FORWARD AND POTENTIAL OPPORTUNITIES

DO are moving to a new leased location at the Base in the middle of April 2016. This hall is twice as big as the old one with a floor area of 3680m². The workshop hall has 470m² and the Logistics and Warehouse hall is 600m². Figure 45 shows the old and the new hall at Killingøy Offshore Base.

Many of the challenges could automatically be decreased when moving into the new hall, especially considering the space and layout limitations. The moving can be seen as a fresh start, and an opportunity to perform better. However, there is a chance that most of the challenges follow the new hall if they are not dealt with prior to the moving process. When there is space, there can be a tendency to fill up empty areas with scrap and items that are not in use. Order, structure and routines should therefore be planned and known to every employee prior to the moving process.



Figure 45 – DeepOcean hall at Killingøy Offshore Base

When this improvement project started, DO had not implemented any Lean principles. Few employees had even heard of Lean, but when they first did, and understood what the project was about, they started to explain willingly about all the challenges present within their daily work. They were eager to bring up everything that they considered an improvement potential. It is crucial to include the employees at the DO Offshore Base from the start so that they feel ownership and commitment to the changes that are to be made. The way forward is to do small changes that can eliminate or reduce some of the challenges they are facing, maintain the changes that are made, and continuously make new improvement steps. This process should never end; it should always be possible to perform better, and with less effort and less use of resources.

6 PART 6: IMPROVEMENT SUGGESTIONS

6.1 INTRODUCTION

The suggested improvements below are made based on the study of the current situation at the DO Offshore Base. The identified contributors from Part 5 are the most important to focus on since the waste is rooted in them. In order to cope with them, the identified variables should be subject to improvement. Hence, changes should be made in the areas of Leadership, Human, Method, Material, Assets and work Environment. These changes are discussed in 6.2, while more specific improvement initiatives by use of Lean tools and principles are suggested in 6.3.

6.2 NECESSARY CHANGES FOR THE VARIABLES

6.2.1 Leadership

The process of reducing identified challenges is dependent upon the commitment of Management, and how they approach it when involving the staff. They need to be more visible and engaged at the DO Offshore Base, and involve the employees when making decisions that affect them. An improvement process should be initiated by the management, and be a collaboration between the employees at the Base and the Senior Management. The employees would feel they are important if they are being involved, and it also strengthens motivation. Good leadership builds commitment so that the employees can use their skills and knowledge for the benefit of the organization. According to European Foundation for Quality Management (2003), good leadership includes focusing on the employees' needs, and release the full potential of their people.

In addition to be committed, there are certain expectations to the Senior Management: They should set the vision and goals, develop the strategy, establish key priorities, and providing their means to achieve. The Management should facilitate for the environment in which employees can become fully involved in achieving the company's objects. A prerequisite for this is that the vision, goals, and strategy are communicated and made available for the employees, and they clearly show what is most important to focus on.

The Management should encourage the employees to always look for better methods and solutions, and to communicate them further up so it can be included in new procedures and

routines. Supervisors and Managers should start to take all improvement suggestions seriously, and give a rapid and proper respond to all. This is how the old ways of doing things at DO can be challenged, and new and better methods can be taken into action setting the new standard. Employees within the organization should also be encouraged to share more ideas and experience across the functions.

In order to be sustainable and increase competitive advantage, the management should balance the tension between short-term and long-term philosophy; they should seek growth opportunities by continuously searching for potential improvements that aim to provide the company with future value, not just focusing on projects that provide immediate profit. The Managers should not use the current situation as an excuse to abandon any efforts to improve their current operations. By not investing in initiatives that can prevent the company from wasting capital, it would be far more expensive not to implement it. In this instance, the question is: How long can DO afford to wait?

6.2.2 Human

Employees are DO's largest asset, and their potential should be unlocked to drive performance and competitiveness. After all, it is the people in the organization that create the value. Without them, the company is not able to deliver their products/services. When the management has laid the foundation for involvement and started to harness people's skills through team work and problem solving, the people working in DO should take ownership and responsibility and participate as best they can. It is in the most humans' nature to be critical to changes, to try to stick to what is considered safe and familiar. It often requires time to readjust a new environment, practices and routines. That is why it is so important to involve the people that are affected by the changes, as well as having an adequate planned process of change. When employees are involved from the bottom up, and they starts to understand why we need to continuously improve, and they would probably be more open to changes.

Lean Thinking promotes that company culture should go through a process of change in order to obtain the various principles of Lean, but the strong existing culture at the DO Offshore Base should not be put through drastic changes; it should instead be embraced and exploited. They all should all be involved in making small changes so that employees may feel more

ownership to the process, and so it become in their interest to make value flow. Changes would most likely be perceived as more positive for the employees at DO Offshore Base if they are made jointly.

The employees are strongly needed in order to lift the current situation at DO Offshore Base to the desired state where more controlled and planned processes take place. Hence, the ongoing downsizing process in the company, including the Base, is very unfortunate. There are relatively few employees at the DO Offshore Base, and they all seem to be very busy with their daily work already. This means it would be more difficult to deal with the challenges and to come up to a desired state. It would increase the tendency of just trying to survive in the current moment, and more stops and delays would occur within current activities. Also the risk of negative stress and sick leave among the employees at DO seem to be increasing. The current downsizing process and improvement processes are therefore not compromising each other. This results in a vicious circle where the people at the Base are not able to spend time on improvement work. They may just be able to struggle to keep the business running. So, in order to avoid this, available resources should be allocated and time should be devoted to establish systems and routines so that time and resources are not wasted later. Resources are also required to maintain the established systems, but far less resources than to just run the business in the current situation.

The thread of communication should be connected in order to obtain an efficient flow of the items/services. The boundaries between the functions/units can be removed by integrating all the various functions together in one team. This enhances interaction and cooperation across functions. Instead of being busy with problems that occur between the functions and units, they can spend time on value-creating activities. The focus should change from being function oriented to be item/service oriented.

6.2.3 Method

Some of the methods and routines at the Base should be subject for review and improvements. When moving in to the new hall, new opportunities open for a more structured work. The space and layout can be utilized in a total different way, and the processes should be adapted to the employees and the location.

When improving internal routines at the Base, the focus should be on the activities that can contribute to an efficient flow of items. The important element that has created a bottleneck is the congestion of items after they are received. Hence, routines for rapid registration of incoming items, and forwarding them to the workshop section should be established. The allocation of responsibilities should also be reviewed in this process. The “Base Manual” should be updated with new established standards for best practice, as well as all the applicable procedures and regulations. It should be easy to find out what procedures are applicable for the various worksites, including the Base, and to avoid contradictory regulations. If a procedure cannot be adhered to due to impractical execution, it should be reviewed and revised.

The developments in information and communications technology results in that the employees in an organization can have access to all kinds of information. However, lack of information is still a problem because the company does not exploit and use this technology optimally. The criteria for which information is required and who should access this information is not always defined, hence the information does not reach the relevant people. The communication and coordination between all involved can be improved by use of more visual information. It is crucial that the information is easily accessible so that we do not have to invest any effort in order to access the information relevant. The aim is to establish a functional process as well as structuring the work so that the next opportunities can be revealed and implemented.

More visual information can also improve the interface between different units. As mentioned earlier, integration is important for ensuring communication, coordination, and control among the different units in an organization. The boundaries within the organizational structure increase the need for more control mechanisms (that can be considered as waste) to coordinate and control all the units and departments. More integration and routines for product/item orientation should therefore be developed. This will not be a specific recommendation for the DO Offshore Base as it would require the whole organization to be involved.

6.2.4 Material

In order to obtain better stock control; minimum stock should be defined and parts should be ordered when minimum stock level is reached. This system can be electronic, but it can also be a system based on visual signals. Both would require some manual work, but this work can be limited by use of a signal-controlled system if only the routines are in place. This is supported by Lean Thinking as it is reliable and easy to use. A system for inventory control is suggested later. For some stock parts, an electronic system should be used for parts that must be registered on various projects.

6.2.5 Assets (Items/Equipment and Tools)

An application system for asset management would most likely improve control of assets, both internal company assets and rental assets. DO cannot be considered a small organization anymore, and has become more complex over the last few years; hence, it is difficult to keep control of everything without using the benefit of an information system. Information about orders, received items at the Base, stored items, location, availability, maintenance, dates for delivering equipment back to supplier or the Base would be available to relevant employees as the system can enhance the information flow between the different units/sections. Also routines for purchasing tools and equipment and the routines of ordering spare parts before they are out of stock could be improved by a proper asset management system. This system is an example of an investment that could save DO a lot of money. However, a Lean alternative to the asset management application system is a system that is easy to manage, enables visual control, provides needed information to relevant employees, and where obtaining information takes little effort. By use of a more visual information system, less control systems are needed. Today, the control of the assets relies on the current knowledge by the employees at the office, the Base and the vessels. It is especially difficult to maintain control at the vessels since the personnel working there, are only working certain periods.

6.2.6 Work environment

Many of the current challenges would obviously not exist when moving into the new hall, however it is important to create systems and structure the work to prevent the same challenges to occur on the new site. When larger amounts of space are available, it is easy to store too much, even things that should be scrapped. It is also easy to loose things in such a large location. It is more than ever important to mark the floor, keep it clean and tidy, and

make sure all the loose tools and equipment have their designated place. Areas of responsibility should be defined and adhered to. When the standard for how the routines should be executed is defined for the new hall, it should be ensured that employees working at the Base are informed and able to adhere to it.

6.3 LEAN IMPROVEMENT INITIATIVES

There have been discussions in regards to some necessary changes for the six variables at the DO Offshore Base, and some change processes can be supported by use of specific Lean tools and principles. The suggested Lean initiatives aim to do something about the contributors so that value can be provided to the customer by minimal waste of resources, value-creating actions are lined up in the best sequence, and that these activities are conducted without interruption and performed more and more effectively.

As previously mentioned, it is important to look at Lean as a continuous process that never ends, and which aim to improve and develop the organization. Recommended Lean initiatives should be rooted in the Lean principles, tools and methods and be adjusted to the empirical findings. They are made based on what is possible to achieve for the DO Offshore Base, and does not include specific initiatives for the whole organization. The initiatives are considered an acceptable way to start, considering DOs Offshore Base current situation. They are mainly ‘low-hanging fruits’; easy to implement but could have a significant positive effect.

Appendix 2 also contains the connection between the variables (of which the contributors are incorporated) and the Lean initiatives.

6.3.1 Order and Structure – 5S

5S facilitates for a more visual work place to reduce the time spent by searching, asking, or waiting for items. Hence, a good way to start the Lean journey can be implementation of 5S. This can be beneficial for the DO Offshore Base because real problems can be solved by obtaining a better system for work place organizing and housekeeping. The result of implementing 5S will hopefully be an orderly workplace, and it can also enable more visual control. 5S is a good Lean tool to start with because it lays the foundation for other improvements: When there is order and structure it is easier to reveal other sources to waste

and implement counter measures. A 5S program should be implemented and maintained through continuous improvements in order to reduce waste and optimize productivity.

A 5S Plan

A 5S plan is made for implementation (based on Brady Worldwide Inc., 2014) at the DO Offshore Base (see Table 3). The implementation is divided into five steps, which represent each S: Sort, Set in order, Shine, Standardize and Sustain. It is recommended that step 1, 2 and parts of step 3 are carried out in April 2016 prior to moving into the new hall. The Base Manager is responsible for execution, but all the steps require participation of all employees at the Base. A Lean Coordinator should be involved and support the Base Manager in Lean and 5S training, the 5S steps, and perform audits after each step is completed. This coordinators role can be filled by the author of this master thesis during the spring.

Table 3 5S Plan for DO Offshore Base

Step	Plan for 5S	Responsible	April	May	June	July	August
1	Sort						
1.1	Set criteria for what to scrap and what to keep, and identify unnecessary items through sorting.	Base Manager					
1.2	Remove unnecessary items. When in doubt, scrap it.	Base Manager					
1.3	Completion of step 1: Audit	Lean Coordinator					
2	Set in order						
2.1	Identify needed work items (tools/equipment).	Base Manager					
2.2	Take pictures of how it is today.	Base Manager					
2.3	Order tools/equipment that are missing.	Base Manager					
2.4	Order necessary boxes and other storage items	Base Manager					








2.5	Designate a place for every item (tools, machines and machine parts, equipment, tool cabinets/carts) so that it is easy to find it.	Base Manager					
2.6	Use the map of the new hall to plan for the marking of the designated places, and order necessary 5S marking tools.	Base Manager					
2.7	Plan for the labeling of items and shadow vinyl	Base Manager					
2.8	Plan for where the first aid equipment is to be placed	Base Manager					
2.9	Completion of step 2: Audit	Lean Coordinator					
3	Shine						
3.1	Clean equipment and machines.	Base Manager					
3.2	Tag items that need to be repaired.	Base Manager					
3.3	Repair the broken items that are tagged.	Base Manager					
3.4	Completion of step 3: Audit	Lean Coordinator					
4	Standardize						
4.1	Define best practice for cleaning and order.	Base Manager					
4.2	Perform visual control of machines, tools, items/equipment, and take photos of the cleaned area and the tools/equipment at their designated places.	Base Manager					


4.3	Make a check list of how the standard is to be.	Base Manager					
4.4	Include the best practice, photos and checklists in a 5S manual for the hall.	Base Manager					
4.5	Fasten the 'after'- pictures on the tool cabinets and crafts	Base Manager					
4.6	Mark the areas with tape according to 5S color codes	Base Manager					
4.7	Label items and use shadow vinyl so that it is easy to find them and to place it back to its designated place.	Base Manager					
4.8	Place the first aid equipment where it is planned for.	Base Manager					
4.9	Completion of step 4: Audit	Lean Coordinator					
5	Sustain						
5.1	Ensure that a responsible person is assigned to each area.	Base Manager					
5.2	Establish a plan for control and check of the hall to verify compliance to the standards that are established.	Base Manager					
5.3	Establish a system for continuous improvements; identification and problem solving of problems.	Base Manager					
5.4	Ensure continuous monitoring and follow-up of the 5S work.	Base Manager					
5.5	Define new targets for the improvement work.	Base Manager					
5.6	Completion of step 5: 5S Audit	Lean Coordinator					

Marking of the floor

Floor marking is a technique that can be used at the Base to display pedestrian paths, work areas, hazardous areas and safety areas, designated areas for tools/equipment, areas for scrap, incoming items and items that are ready to be forwarded. A suggestion of how this marking should be is presented can be found in Table 4. According to Brady Worldwide Inc. (n.d.), there are no current government-mandated or widely accepted industry standards that prescribe what colors to use for floor marking. The suggested colors are made based on Brady Worldwide Inc.'s (n.d.) standard for 5S Floor Marking Color, and in cooperation with the Base Manager.

Table 4 Floor marking

Color		Description
	Yellow	Pedestrian paths, aisles, work area
	Blue	Tool carts and equipment that have a fixed place, but can be moved when in use (e.g. pallet trucks, trash cans).
	Black	Items that shall not be removed from its designated place.
	Orange	Work in progress / Incoming items
	Green	Finished goods / Ready to be forwarded
	Black and yellow strips	Hazard area (e.g.: risk of slip, trips and falls, dropped objects, hazardous waste, driving forklifts)
	Red and white stripes	Safety area - Areas to be kept clear for safety reasons (e.g. areas in front of electrical panels, firefighting equipment, and safety equipment)

	Tape with red and white stripes + yellow tape	Walk ways where forklifts are crossing
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Recommendations to how the marking can be set up at the Logistics- and Warehouse Area are made in Appendix 3. Specific recommendations are not made for the Workshop Area because the employees were too busy to participate. The importance of being involved is discussed previously in this thesis, and has where possible, been taken into account when suggestions have been developed. They can use the recommendations formulated in this chapter to find ideas and practical solutions to prepare further within the Lean concept. The places and areas are, where possible, decided based on Lean principles; such as clearly marked places, visible from the work area, and the tools/equipment used most often are located near where it will be needed.

Organizing Work Stations, Tool Boards and Tool Cabinets

Visualization techniques are also beneficial when organizing the work stations, tool boards and tool cabinets at the Workshop Area. Inventory lists / pictures, vinyl shadows (see Figure 46) could ensure that everyone know where to put the tools and equipment after use.

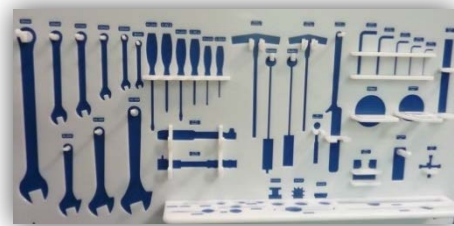


Figure 46 – Shadow tool board (Dave Barry Plastics Ltd., n.d.)

Designated Areas

It is part of the 5S implementation plan to mark areas in order to standardize the best practice for the 5S work. Designated areas for items that are received, ready to be shipped, or items that are moved between the sections within the hall, are identified and suggested in Table 5. Some of them are already used today in the old hall, but space limitations make it impossible to have designated places for all these items. Existing practices are mentioned in addition to new suggestions with regard to marking/defining the designated area and the responsible section for placing the item at this area. The suggested areas are marked in a map of the Logistics- and Warehouse Area in Appendix 3, which also contains descriptions of which types of tools/equipment are at the map, and how the designated area should be defined. Each department is responsible for the organizing of items within their own department. The respective sections should also have the responsibilities of keeping order in their own areas. The Supervisors should then provide their employees with designated areas of responsibility.

Please note that the suggestions in Table 5 are in accordance with how the steps in the work processes should be in order to improve flow. The flow of the item is further described in section 6.3.3.

Table 5 Designated areas for items that are received, shipped, or items that are moved within the hall

	Designated area	Type of item	Existing practices	Suggestions
a)	Items ready to be forwarded / shipped	Project equipment, Rental Pool equipment, CPI, ordered/ purchased items, rental equipment, maintained /repaired items. Transportation is arranged for these items and will be shipped within short time.	Placed at Logistics (dispatch) Area. No defined area.	Green floor marking, marked as a lane (queuing system) at the logistic area. Responsible for placing item at the designated area: Logistic section (external items) and Rental Section (Rental Pool items)

b)	Incoming items from vessels (offshore)	Project equipment, Rental Pool equipment, CPI, rental equipment	Placed at Logistics (reception) Area. No defined area.	<p>Orange floor marking, marked as lanes (queuing system) at the logistic area.</p> <p>Four movable signs to be available for use saying: “Customs clearance required” / “Må tollklareres”. All the four orange lanes can be used during demobilizations when a lot of items are received simultaneously.</p> <p>Responsible for placing item at the designated area: Logistic Section</p>
c)	Incoming items from external supplier (and from workshop section)	Ordered items, purchased items, rental equipment, modified/repaired items These items are to be checked, inspected, and registered. Forwarded to the respective owner.	Placed just inside the gate at Logistics (reception) Area. No defined area.	<p>Orange floor marking, marked as a lane (queuing system) at logistic area (reception area, just inside the gate).</p> <p>A sign that says where the items are to be placed.</p> <p>If this lane is occupied, another orange lane (b) can be used in addition. Remember to remove sign saying: “Customs clearance required”, and replace it with a sign saying: “Not customs goods” / “Ikke tollvarer”</p> <p>Responsible for placing item at the designated area: Logistic Section</p>

d)	External items to be sent directly to vessels	Received items that are ordered by the vessels (from an external supplier) are moved to this place. Items are shipped when the vessel arrives at the port.	There is one pallet for each vessel at a rack section. A paper is fastened at the pallet containing vessel name.	Laminated paper fastened at the racking for each vessel. The pallets are above their signs at the racking. Sign at the rack section: “Ordered vessel items” / “Bestilt utstyr”. Responsible for placing item at the designated area: Logistic section
e)	Items going to service (red tagged)	Rental Pool items received, checked and customs cleared. Service required - work order is made.	Placed at the floor in the Storage Area, picked up by Workshop Section when they have time.	Racking in Workshop Area. The rack is divided into electric and hydraulic sections (market). Responsible for placing item at the designated area: Rental Section
f)	Items that are going on a later project	Project equipment and rental equipment for future projects. Items are shipped when the project is mobilising the vessel	There are pallets for each project at a rack section. A paper is fastened at the pallet containing project and vessel name.	One pallet for each project/vessel at a rack section in Logistics Area. A paper fastened at the pallets with info regarding mobilization date, project/PE and vessel. Sign at the rack section: “Future projects” / “Fremtidige prosjekter” Responsible for placing item at the designated area: Logistic Section (external items) and Rental Section (Rental Pool items)

g)	Unclarified project equipment	Project equipment (received from completed projects). Project Engineer / Project Manager is notified so that further action can be taken.	Pallets are just stored wherever there is space. No existing routines on what to do with items that are not sorted by the project.	Pallets at a rack section in Logistic Section. A paper fastened at the pallets with info regarding date received, potential scrap date, project/PE and vessel. Sign at the rack section: “Unclarified project equipment” / “Udefinert utstyr”. If no action is taken by the project within 4 weeks, a notification/warning is sent. If no action is taken within new 4 weeks, the pallet with the unclarified project equipment will be scrapped. Make an event in outlook for the due dates where the involved project staff is invited. Responsible for placing item at the designated area: Logistic Section
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6.3.2 Visualization of Information

Visualization techniques can be used to display important information that makes it easily accessible, right when it is needed. The information should be in a format where it is easy to understand it. This initiative can eliminate waste in forms of searching, asking and waiting for information. The Base needs to define what information is important for them, and establish routines for getting this information, and making it visible.

Whiteboards

Information can also be made more visible and accessible by use of whiteboards. Below are some suggestions of information that could be useful to the various sections at the Base.

Whiteboards located in various places in the halls and offices can be a source of valuable information if they are updated continuously. Information that could be valuable for the Logistic- and Rental Section are as follows:

- Dates for mobilizations/demobilizations
- Shipping location
- Planned transport activities
- Ongoing and future projects

Information that could be valuable for the workshop section is:

- Items in need for services (date and rack section, which are ongoing)
- More comprehensive services coming up
- Workload and available resources

Target boards, team boards and action lists

A target board could be made for visualizing KPIs in order to view the status and progress, and team boards should be used to visualize internal objectives and concerns. These boards and the targets and KPIs are described in detail in section 6.3.5.

The other suggested initiatives are also based on visualization techniques.

6.3.3 Creation of Flow

Some adjustments are suggested for functions and activities in the work processes that aim to enable the value flow without interruptions. In addition, a few improvements related to unnecessary moving activities and stops during work processes are suggested as well as a system for enhancing the flow of the Rental Pool items. The system is applicable for both work processes and involves the two employees working in the Rental Section.

Improved Flow in Work Process 1



Figure 47 – Work Process 1: Order to delivery of Rental Pool items

For the first work process (see Figure 47), the flow can be improved by providing the Rental Section with the ability to immediately know if the item is available or not. The database has certain limitations; hence it is difficult to search and find out if the item is actually available, busy or sold. Using unique item IDs and Item Cards can solve this problem. There should be one Item Card per Rental Pool item in A4 format containing serial number (TP ID), name of item, storage location, and inventory list (see Figure 48). These should be used in the Rental Section office where the orders are received. The cards for the available items should be placed in one wall pocket under the correct item category, and the unavailable items should be placed in another. There should also be one wall pocket for ordered items for future projects, and one for service and modification. The Rental Section can then have better control of its items; the items that are busy, ordered items and the items that are available.

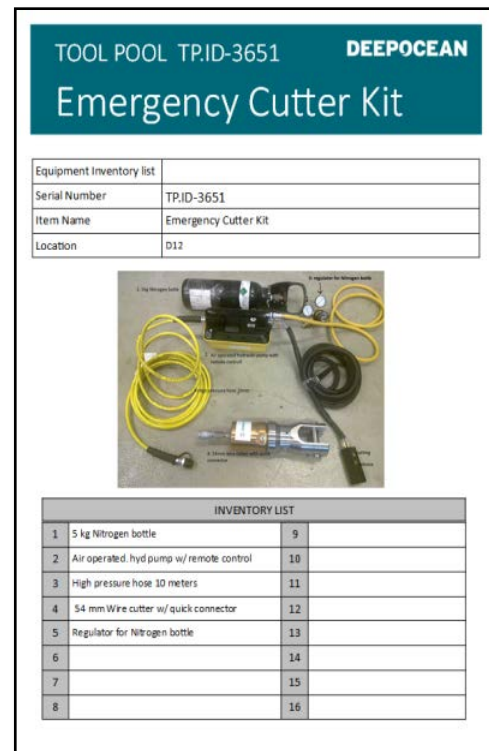


Figure 48 – Item Card (A4 format)

Each item has its own TP ID and its designated place. This place is defined by a laminated poster (see Figure 49) fastened at the respective rack section (under the pallet containing the item). The pallet can then be used when shipping the item so that manual handling is avoided.

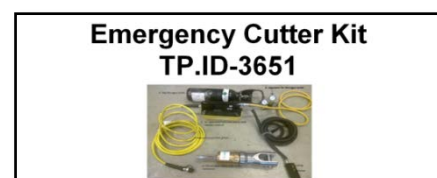


Figure 49 – Laminated poster fastened at the

Another Item Card (see Figure 50) should be a small card containing serial number (TP ID), name of item and storage location. These should originally be in a folder on the racking where the item is stored. These can be used to ensure that all items are actually received when they are supposed to, so that the rental period can be ended. With this system, it is also easy to find out where the equipment is at any time, and where it should be placed when received back.



Figure 50 – Item Card (small)

When picking/collecting the ordered item, the corresponding Item Card is to be moved from its folder (rack section) to a board at Logistics Area under correct vessel and project number. The planned rental period should also be written on the board (the flow of the Item Cards is illustrated in Figure 54 including both Work Process 1 and 2).

When an item is to be modified internally, the work orders should be made by Rental Section, and immediately placed at the rack section in Workshop Area (see Table 5, e). The modification should be performed according to the work order and the required date of completion, and not be stopped. This can only be done if the required parts and tools are available, and if they are not interrupted by other work processes. Figure 51 is a flowchart showing a more optimal work process with regards to the flow of the item. A picture of an Item Card is used to illustrate movement of Item Cards as well (more details in Figure 54). The designated areas suggested in section 6.3.1 (See Table 5) are also referred to.

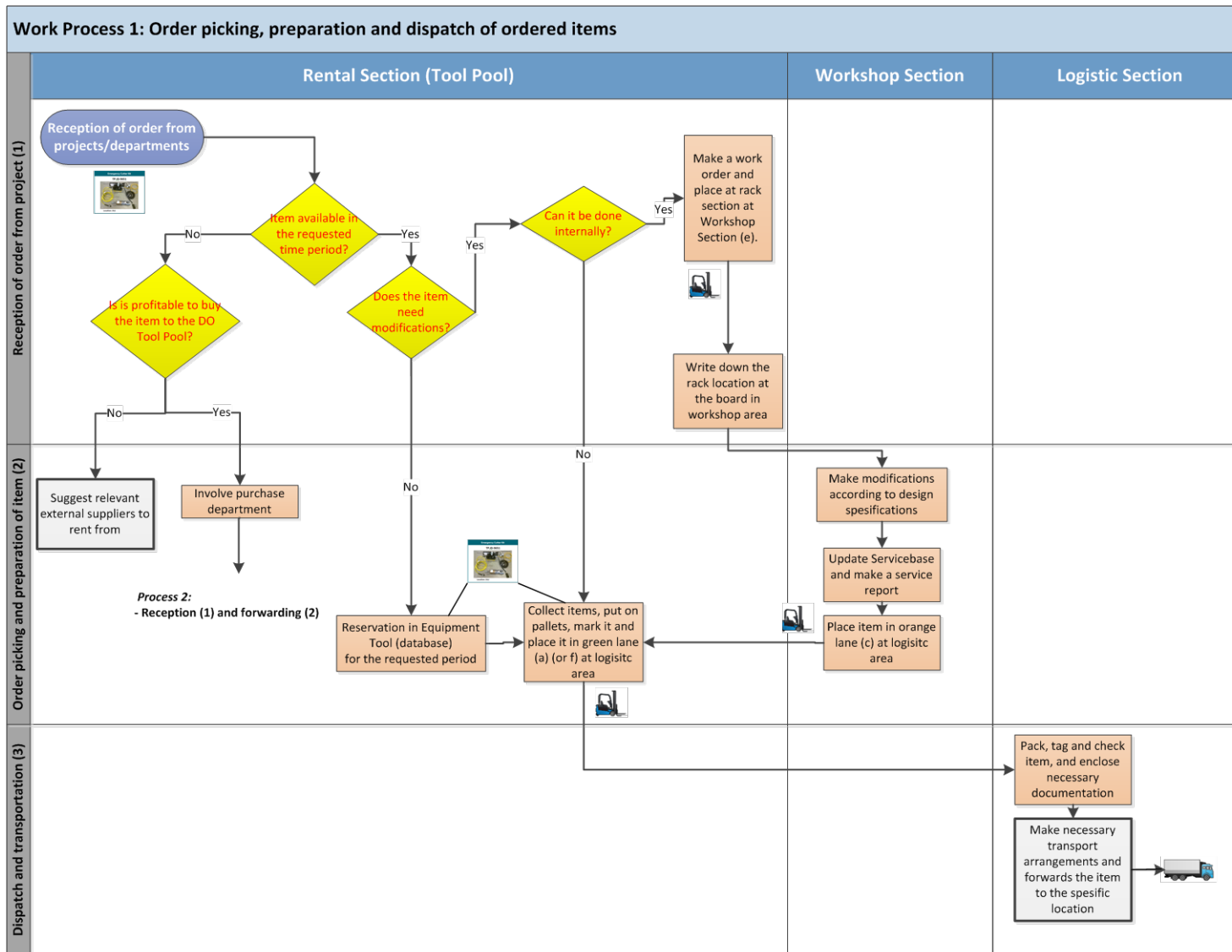
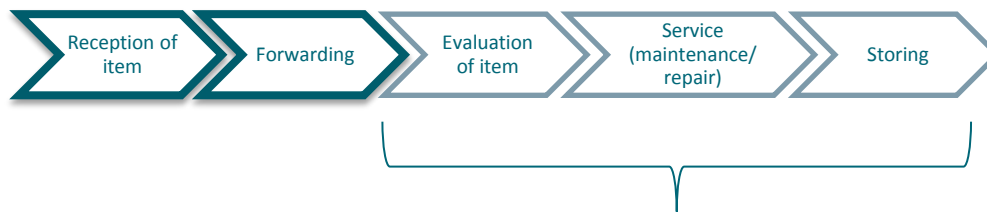


Figure 51 – Work Process 1, improved flow

Improved Flow in Work Process 2



Applicable for the Rental Pool items

Figure 52 – Reception of items

The flow in Work Process 2 (see Figure 52) can also be improved by use of the Item Cards as described above, and by eliminating some extra steps and unnecessary movements of items.

The registration and service of received items should be carried out as rapidly as possible, and not be congested on the floor in the Storage Area as the existing practice show today. Rental Pool items and attached manifests should be checked according to Item Card on the board at the logistics office to ensure that all items are received.

The planned practice in the new hall is as follows: Logistic Section places pallets at a designated rack section for incoming items to Rental Section (Warehouse/Storage Area), and Rental Section makes work order and moves item to Workshop Area. This should not be the case, because items should instead be moved directly to the Workshop Area to avoid congestion. Taking away the temporary placement of items could decrease unnecessary movement of items. The optimal situation is that service can be done right away and then be stored or sent to a new project/vessel, but this seems impossible for the Base due to the lack of resources; hence the items should normally be placed on a rack section at Workshop Area first. The various sections in the rack should be numbered. The ‘Service Base’ should be updated by Rental Section with exact location so that the items are easily found.

When the item is going to service, the Item Card should be moved from the board to the Service Board (see Figure 54). These should be next to each other at the logistics office. When the Item Cards are hanging on the service board, the renting period is over and can be registered in the database.

When the service is completed, the Workshop Section delivers the item to Logistics Area (ref.: Table 5, c). Then, the items should not be placed at a rack section for incoming items to Rental Section as a temporary placement, but should be moved directly from the Logistics Area to the item's designated place at the Storage Area by the Rental Section. When service is completed and item is placed back to its place at the rack section, Rental Section moves the Item Card back from the item board at Logistics Area to the folder at the rack section, and moves the Item Card in A4 format from the 'busy' wall pocket to the "available" pocket.

One of the two employees working in the Rental Section would have the responsibility of the received items (RS 2), and place the Rental Pool items in the racking (Storage Area) so that it can be picked and sent when needed by the other employee (RS 1) that works in the Rental Section. The responsibilities of these two are specified in Figure 54 by use of vertical lines separating them.

Figure 53 is a flowchart Work Process 2 that is more optimal with regards to flow of the items, and it also illustrates when the Item Cards need to be moved.

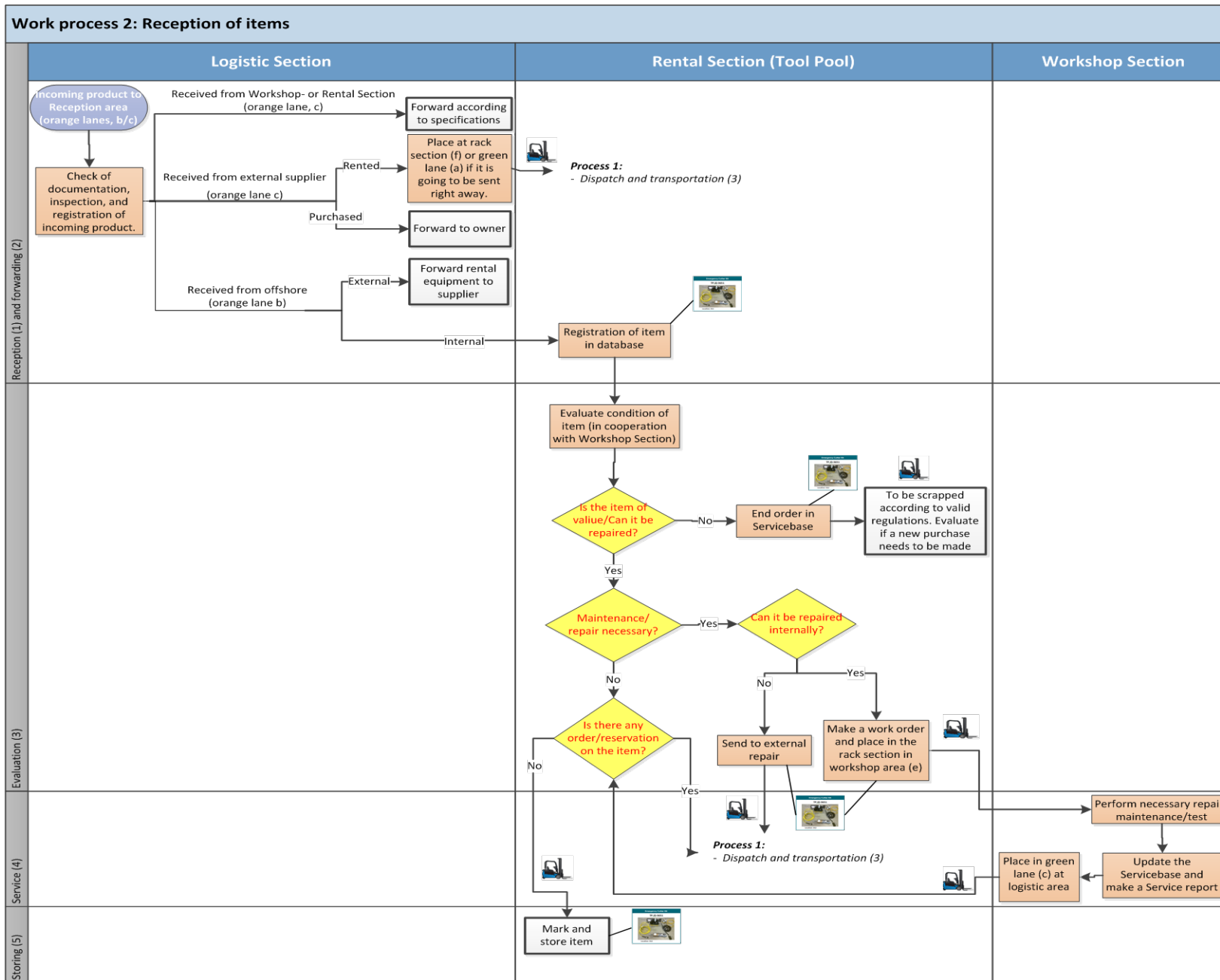


Figure 53 – Work Process 2, improved flow

Figure 54 illustrates the flow of the Item Card during the two main work processes. The system of the Item Card is based on a visual workplace, where information is easily accessible by all relevant personnel.

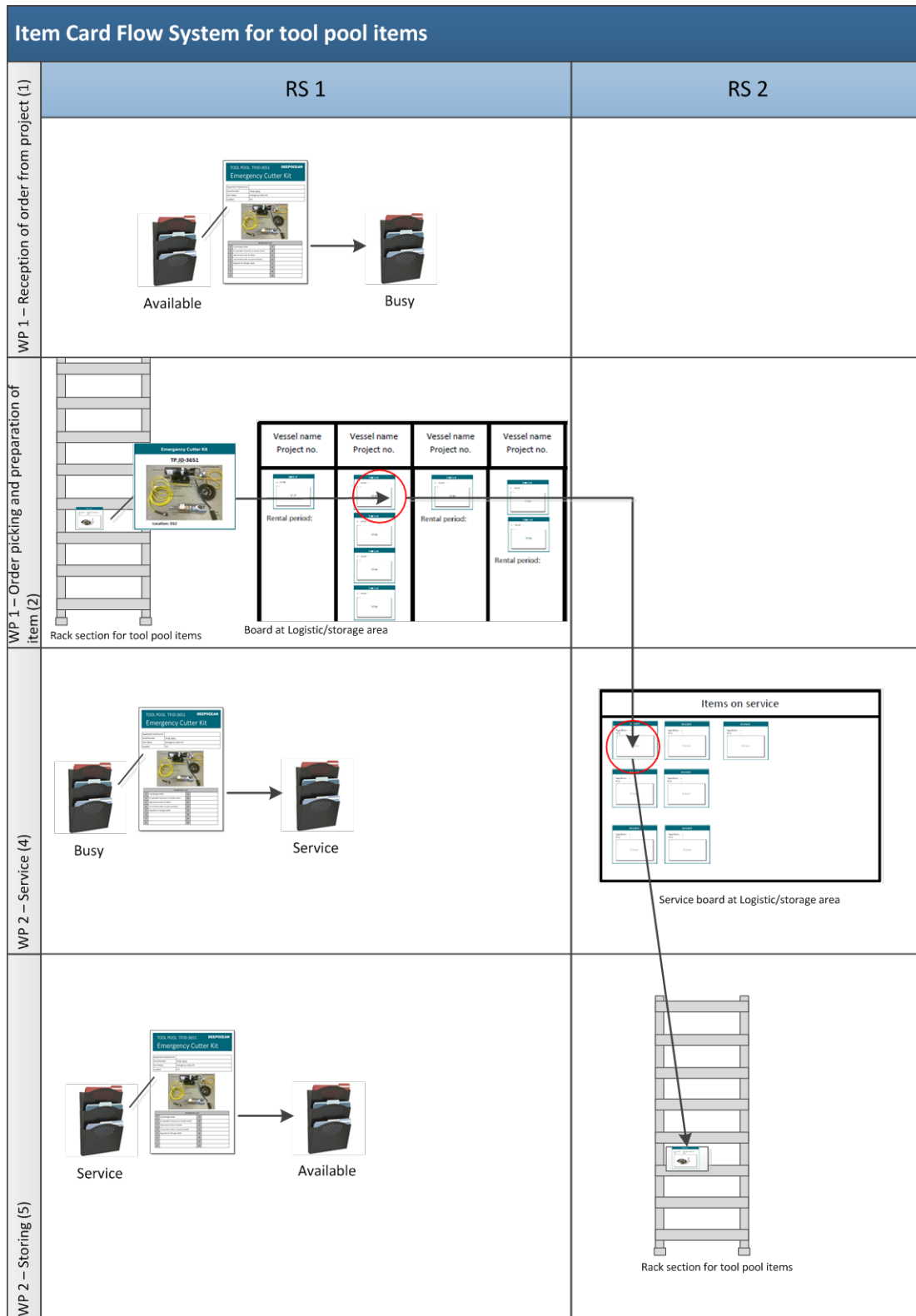


Figure 54 - Item Card Flow system for Rental Pool items

6.3.4 Inventory control

Lean can be used to manage inventory by use of a manual information system; the Kanban system. This can be done very simple at the DO Offshore Base by using minimal stock signals.

The suggested Kanban system is illustrated in Figure 56. When the last item from one bin is taken (reached minimum stock level), a Kanban Card (see Figure 55) is exposed. The card is then moved to a card rack. These are collected daily by the employee responsible for stock storage, who then also orders the item. When the stock items are received, the Kanban Card is placed back at the bin containing minimum stock level. It is important to ensure that the last bin contains the amount of items that are defined as minimum stock level.

Kanban Card For stock storage
Item:
Location:
Qty.:
Cost no.:
Supplier:

Figure 55 – Kanban Card

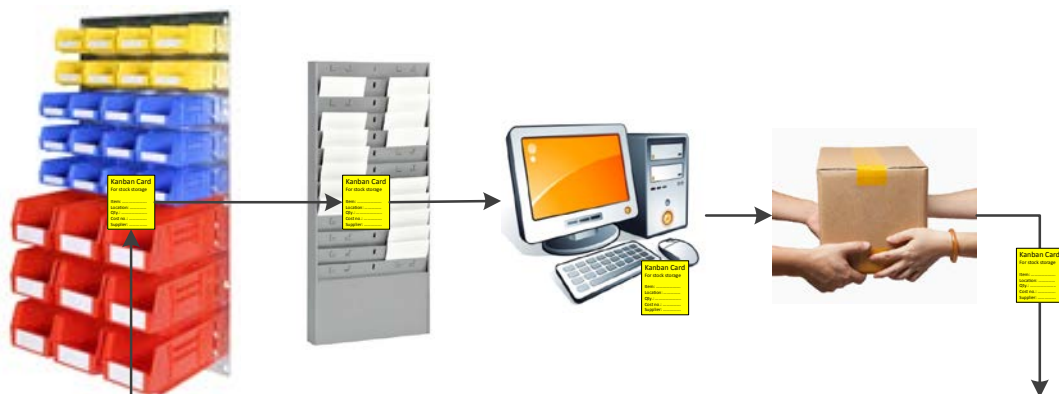


Figure 56 – Kanban system for inventory control

By using this system, stock parts can be ordered before the stock is empty; hence waiting time would be reduced so that customer requirements can be met in a timely manner. This can enhance the flow and reduce risk of disjointed work. Under stocking and overstocking are also avoided. A prerequisite is that the stock storage is sorted and minimum and maximum stock level defined.

6.3.5 Continuous Improvement

As DO Offshore Base start the improvements of the work processes and activities, it should become obvious that there is no end to the process of reducing additional waste. There will always be room for improvements.

For DO Offshore Base, the foundation for improvement processes can be established through KPIs and targets, systems and routines for feedback, improvement teams, Kaizen meetings that focus solely on improvement projects, Gemba Walks and analysis for problem solving.

Defining KPIs and Targets

Behind a successful organization is a management system that is developed, implemented and continuously improved. The leaders at DO ensure that values, objectives, missions and visions are developed, and that they form the organization's policy and strategy. DO's values define how they undertake all of the activities, and are (according to the company's intranet site) selected by the employees. It is important to define the values, objectives, missions and visions in order to define what the organization will strive towards. This forms the basis of development and improvement, and prevents stagnation.

KPIs are defined in order to measure results with respect to the key elements of the company's policy and strategy. The KPIs at the Base should be linked to DO's strategic KPIs, and they have to be logical and easy to measure for the type of work they perform at this worksite. It is important to measure and visualize the progress on a daily- and weekly basis to enable people to act quickly and make necessary adjustments. Also, there should be a year to date (YTD) overview to measure the progress. Measurements of different metrics would be important for logging and documenting waste, which can be used later to justify improvements. It is important for the Base to be looking at the previous days - not just looking forward. The whole PDCA process should be conducted - not just the planning and execution part.

As a start, targets and related KPIs should be defined, and then the KPIs can provide an indicator of where they are in relation to targets. Adjustments and changes can be made when deviations are detected. Figure 57 illustrates this process.

The KPIs should not necessary focus on errors and mistakes, but desired attainments. When targets are met, it should be celebrated in some way. This may increase motivation.

In Table 6 are some suggestions for specific KPIs they could use. The employees at the Base should also find their own KPIs based on what they consider important. When defining the KPIs, it is important to think of what the customer wants, and ask; what makes the customer satisfied? That should be the ultimate

goal for all organizations. According to Lean principles, the time and effort used between order and delivery should be as low as possible; hence, the KPIs should be developed based on how the activities can contribute to meeting that goal. Many factors are playing a role in this process. In addition, the KPIs should be made as a focus to reduce potential sources of waste.

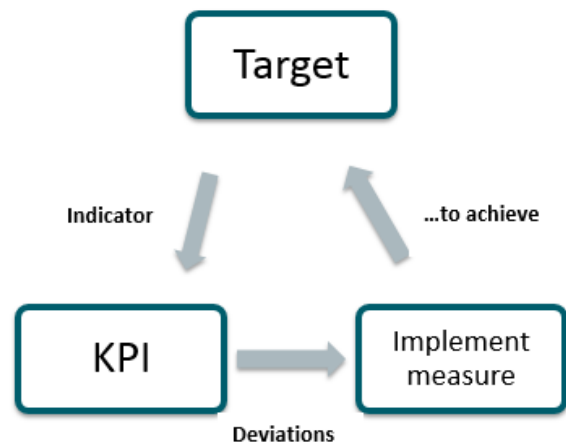


Figure 57 – The process of establishing KPIs to achieve the target

Table 6 Suggestions to KPIs and targets at the Base

KPI		Target	Applicable for
Services	<p>Rate of completed service on items against received Rental Pool- and ROV items =</p> $\frac{\text{Completed services (green tagged)}}{\text{Received items (red tagged)}}$ <p>By measuring the number of services in relation to the received items that need service, the focus on completing services will hopefully increase, and the congestion of items will decrease.</p>	<p>The target could be set to 1, which indicates that all received items have been green tagged, and ready to be stored or delivered. The result can also be above 1 if services have been performed on items received previously.</p>	Workshop Section

Shipments	All the goods that are shipped to and from the vessels go through the Logistic Section at the Base. Successful and not successful shipments should be logged so that root causes of recurring issues can be tracked back to the variables causing the problem.	The goal is correct items shipped to correct location, on time. Target could be zero unsuccessful shipments.	Logistic Section
Rework	Rework refers to the extra time it takes to do something that could have been avoided under other circumstances, or correcting of defective or failed work.	The target could be set to less than 2 hours per day. All the hours spent on rework should be logged.	Logistic Section Rental Section Workshop Section
Deliveries of internal items	Internal items are the company owned items. Cases where parts are missing when received, items not delivered back to the Base, missing items or similar should be logged.	The target could be set to zero cases per day.	Workshop Section Rental Section
Deliveries of external items	External items are the rented items (owned by external suppliers). Cases where parts are missing, items not delivered back in time, missing items or similar cases should be logged.	The target could be set to zero cases per day.	Rental Section
HSE	Health, safety and environment should have a high focus. Any incidents, deviations and non-conformances should be reported in DeepOcean's reporting system, but also visualized on the target board so that all can have an insight of the status and progress of HSE related matters.	From a safety perspective, the target should always be zero incidents.	The whole Base (including the office personnel)

Quality	Quality cases related to the repair, modifications and maintenance work could be logged. This metric can be dependent upon feedback from the ‘customers’ - the users of the items.	The target could be set to zero cases per day.	Logistic Section
			Rental Section
			Workshop Section

Visualizing KPIs and Targets

The layout for a target board (see Figure 58) should contain the KPIs and the registration of achieved results on a daily- and weekly basis, and also a year-to-date overview.

It should be easy to change the calendars and graphs formats at the end of the month and year. The colors and graphs should be drawn on a day-to-day basis, directly on the sheet of paper fastened to the board.

	HSE	Quality	Services	Rework	Internal item deliveries	External item deliveries
Daily						
Weekly						
<i>YTD</i>						

Figure 58 – Target Board

The deviations should be written with few words below each KPI on the target board (case name, counter measure, responsible, date and status). A concern form (see Figure 59) can be used if there are any deviations or needs for adjustment. It should be available by the target

board. This is organized according to the KPIs on the target board (HSE, quality, service, internal and external deliveries, shipments and rework).

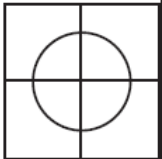
Concerns		Counter measures	Due date	Responsible	Further actions required?		Status (PDCA)
HSE	Date:				Action list	A3 - Problem solving	
Quality							
Service							
Deliveries (external)							
Deliveries (Internal)							
Shipments							
Rework							

Figure 59 – Concern Form for deviations

An action list can then be used if there is need for more comprehensive corrections and adjustments (see Figure 60), and if the same problem occurs repeatedly, a more comprehensive problem solving technique should be implemented (see Figure 61).

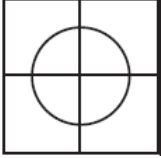
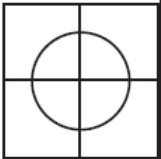
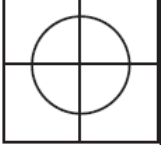
Name of concern/issue:				
Purpose:				
Action step / method	Responsible	Support resources required	Due date	
				
				
				

Figure 60 – Action List

A type of calendar (with dates) can be marked with red color if the actual results deviate from the defined target, and marked with green color if the target is met (see Figure 61).

1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				

Figure 61 – Calendar marked with red and green color

Below are suggestions of how the target and the real accomplishments could be visualized for the service target. Figure 62 illustrates how it could be visualized on a daily basis, and Figure 63 illustrates the same on a weekly basis.

KPI: Services	Monday	Tuesday	Wednesday	Thursday	Friday
Target	1	1	1	1	1
Real	0,5	1,2	1	0	1,5

Figure 62 – Daily visualization of rate of completed service against received items

In order to measure the weekly KPIs, a type of calendar with week numbers can be used. The amount of services and the received items can be written as a fraction, and the week number can be coloured either green (if target is met) or red (if target is not met):

1 13/13	2 6/6	3 4/3 = 1,3	4 15/15	5 10/13	6 11/11	7 7/5	8 9/11	9	10	11	12	13
14	16	17	18	19	20	21	22	23	24	25	26	27
28	29	30	31	32	33	34	35	36	37	38	39	40
41	42	43	44	45	46	47	48	49	50	51	52	

Figure 63 – Calendar with week numbers marked with green and red color

Team Boards

Each section should also have their own team board where concerns regarding daily operations and strategic issues can be addressed. Figure 64 is a form that can be used for this purpose. If the countermeasure can be implemented easily without too much effort, this form is enough. If the countermeasures cannot be fixed internally within the section, but require some more actions, the steps that have to be done can be filled in an action list (see Figure 60). If it is a recurrent abnormality, a problem-solving activity should be initiated. An A3 format can then be used in order to analyze root causes and implement countermeasures. A team board can be used as both routine and improvement work. The Section Leader (Supervisor) should lead this work and meetings.

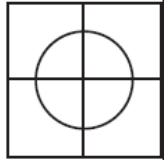
Concerns		Countermeasures	Date	Responsible	Further actions required?		Status
Date:					Action list	A3 - Problem solving	

Figure 64 – Concern Form

Each section at the Base should also have their own targets visualized on the team board. The internal targets can reflect desired performance. These should be achieved within a defined time frame, and handled by use of the PDCA methodology. A separate team/section meeting should be held at least once a week to see where they are in relation to their objectives. These goals should be defined by the section itself, and updated on an annual basis.

24-hours Meeting

The daily morning meeting should be a board meeting where everyone can be informed and updated about incidents occurred yesterday, current status and future work. A suggestion to the agenda is listed below:

- HSE status
- Yesterday’s planned operations
- What is planned today
- Available resources
- Problems
- Necessary correcting measures

The agenda for this meeting should also include updating the target board information. Having this meeting every day would ensure documentation of problems/delays (it is easy to remember what happened yesterday), and they are revealed early so that countermeasures can be implemented right away. The PDCA process is then supported during this meeting.

Use of A3 and Fishbone Analysis when Solving Problems

If a problem cannot be solved easily, but requires more resources and effort, an A3 can be used. Figure 65 is a suggested format of an A3 that include background information, current situation, analysis of root causes, desired situation and proposed countermeasures, plan for implementation, and follow-up.

A3 – Problem Solving

To: _____
 By: _____
 Date: _____

<div style="border: 1px solid black; padding: 2px;">Name of A3:</div>									
<div style="background-color: #e0f2f1; padding: 2px;">Background</div> <div style="padding: 5px;">Background and information of the problem</div>	<div style="background-color: #e0f2f1; padding: 2px;">Desired condition</div> <div style="padding: 5px;"> Explain the ideal situation/process/condition/state. Countermeasures Define measurable targets </div>								
<div style="background-color: #e0f2f1; padding: 2px;">Current condition</div> <div style="padding: 5px;"> Why is the condition not ideal? Refer to observations and measurements. </div>	<div style="background-color: #e0f2f1; padding: 2px;">Plan for implementation</div> <table border="1" style="width: 100%; border-collapse: collapse; text-align: center;"> <tr> <td style="padding: 2px;">What?</td> <td style="padding: 2px;">Who?</td> <td style="padding: 2px;">When?</td> <td style="padding: 2px;">Where?</td> </tr> <tr> <td style="height: 40px;"></td> <td></td> <td></td> <td></td> </tr> </table>	What?	Who?	When?	Where?				
What?	Who?	When?	Where?						
<div style="background-color: #e0f2f1; padding: 2px;">Cause analysis</div> <div style="padding: 5px;"> List problems, and analyse root causes in terms of the six variables by use of a fishbone diagram. Ask 5 times why. <div style="text-align: center; margin-top: 10px;"> </div> </div>	<div style="background-color: #e0f2f1; padding: 2px;">Follow up</div> <table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <th style="padding: 2px;">Plan</th> <th style="padding: 2px;">Actual results</th> </tr> <tr> <td style="padding: 5px;"> How to check the effects. How often to check. </td> <td style="padding: 5px;"> Date of checks. Results. Desired results? </td> </tr> </table>	Plan	Actual results	How to check the effects. How often to check.	Date of checks. Results. Desired results?				
Plan	Actual results								
How to check the effects. How often to check.	Date of checks. Results. Desired results?								

Figure 65 – A3-problem solving

Feedback Systems

Feedback is an essential factor that drives continuous improvement; Lean thinking provides a way to make the work more satisfying by providing immediate feedback so that waste can be reduced and value can increase.

In many cases, feedback is necessary in order to identify potential improvements. The vessels and projects should be encouraged to give feedback with regards to the items they rented from the Rental Section at the Base. It could be about delivery time, the process of ordering the item, and the condition the item is in when received. Both positive and negative feedback

should be registered. The already established reporting system could be used for this purpose. In the case of an undesirable incident, the report should include a good description of how to avoid that the same thing happens again, and an action list at the Base could be made based on that report.

The Base should also be included in the monthly statistic feedback for benchmarking. They can then be compared and measured against the corporate KPIs and targets.

Improvement Teams

Establish an improvement team that focuses on improving process flow, efficiency and effectiveness. The team should work systematically with already identified problem areas, negative trends in measurements/KPIs, undesirable incidents/deviations, and strategic improvement projects. It could be one employee from each section (Rental, Logistics and Workshop) that together facilitate for involvement and further improvements at the Base. The team should include employees that are interested in improvement work and have a 'make-something-happen' mind-set. They could arrange improvement meetings (Kaizen Meetings), and they can be in charge of the target board, action plans and A3s, and ensure they are used and followed up. The team should also be given some Lean training of the improvement processes.

Gemba Walks

The Management has a significant role in creating Lean Thinking through Lean management, hence the Supervisors and Manager(s) at the DO Offshore Base should perform Gemba Walks where they visit the operators and observe and communicate with them to gain insight in regards to issues experienced and so on. These walks can be conducted on a weekly basis, and the LAMDA (Look, Ask, Model, Dialogue and Act) approach could be used during these walks to help the Managers to see and understand the employees' experienced problems.

7 PART 7: CONCLUSION AND RECOMMENDATION FOR FURTHER WORK

7.1 INTRODUCTION

The last part of this thesis will present a conclusion and discussion based on the study, and recommendation for further work at DO Offshore Base. The results of the analysis and assessment have been summarized and discussed after each method through this thesis, hence this section will not discuss the details of the results, but seek to present a more holistic context.

7.2 CONCLUSION AND DISCUSSION

The conclusion will attempt to answer objectives set for this thesis and discuss whether they were achieved or not. It will look into various challenges at the DO Offshore Base related to implementation of Lean, as well as simple recommendations for what it takes to overcome them. Some of these recommendations are critical success factors if implementation of the Lean approach at DO Offshore Base becomes a reality.

7.2.1 How Lean can be used as an Approach to deal with Present Challenges

The results of this study revealed that the DO Offshore Base is in a state where focus is on just 'keeping the business running'. Ineffective methods steal valuable time, and many small details result in major losses related to time and money. The Lean approach can be used to deal with present challenges at DO Offshore Base by considering all the variables that are affecting the organization, through attempting to continuously strive to make things a little better, and constantly maintaining these improvements. Through implementation and sustainment of specific Lean initiatives, waste can be reduced and value can flow without interruptions that are present today. Then, time can instead be spent on developing and improving internal processes. The reality is that DO Offshore Base has a long way to go before reaching this ideal state. They have started the establishment of order and structure by use of the 5S implementation plan, however none of the other improvement initiatives have been considered yet. An issue is therefore presents itself by the time it actually takes to implement such a concept and to adapt it to their type of business. Most importantly is it, that they have already started to see benefits of using the Lean approach, and that it is perceived as positive and applicable for their logistics-, warehouse- and workshop services. Most likely,

the effects of using the Lean approach will rapidly show results. There are many potential areas for improvement that require low effort to be dealt with, but would make drastic changes to the business. When the challenges are dealt with, one can start to look at how other business benefits can be delivered through the application of Lean Thinking.

As a prerequisite for successful development, the Lean approach should be fully supported by Management – in particular the Senior Management lays the foundation for the performance of the employees through the decisions made at the top. They should believe in the valuable human potential, otherwise, they could lose out on valuable skills and potential that their employees possess. The Lean approach will ensure better dialogues, hence better solutions. With this approach, it is not just the Management that makes the decisions, but it facilitates for the employees to be involved and included in the decision-making processes. The front line employees have the best knowledge of their work, and very often have the best solutions. An objective for DO Management should be to create an environment where employees are able to, and want to, continuously improve. This is why the implementation of Lean should be based in the concept that the employees are capable of performing if conditions are right.

7.2.2 Challenges related to using Lean as an Approach

It can be a somewhat challenging to start the necessary change and learning process for various reasons. The capacity at the Base is at its limit already; they have not been able to focus on anything other than what comes next. They should attempt to use the whole PDCA process in order to improve, and they are advised to start investment of time and resources for improvement and learning purposes. This could be essential for their development and their future position. When they stop using the excuse of being ‘too busy to improve’, they may very likely be able to gain better performance through meeting their customers’ needs more effectively, improving internal efficiency and reducing costs.

The employees at DO Offshore Base are, as established above, facing ‘unnecessary’ challenges in their daily work, in despite that employees at the Base do not consider some of the issues as challenges – more than likely because they have never been introduced to another way of doing set work processes. These are arguably the hardest challenges to deal with, as the employees need to somewhat embrace the reasons for change before change initiatives can be successfully implemented and sustained. The employees are the

organizations most important resources; hence commitment should be established to make them feel valued for their expertise.

It is easy to focus just on the tools and principles that Lean promotes, but using Lean as an approach should come from a deeper desire to change and continuously develop. Instead, one should capture the essence of the philosophy. The concept should be integrated in the culture and style of leadership. The tools and methods are only sustainable when the organizational structure and systems support a culture for continuous learning.

At DeepOcean, Lean is not fully known or embraced. It seems like Lean Thinking is relatively new to them. Some have heard of it, few have experience and/or knowledge within the area, but no one has the competence to initiate and develop the concept. The lack of knowledge in relation to the Lean approach seems to result in various concept misconceptions. A particular problem is that Senior Managers seem to have a financial mind-set that can take precedence over the day-to-day realities of specifying and creating value for the customer. Management mainly see the opportunity for saving costs immediately through eliminating jobs. This mind-set is arguably one of the reasons the implementation of the Lean approach may be unsuccessful. The focus should be changed, and a rethinking of value from the perspective of the customer should take place: Lean should be seen as an approach to maximize the long-term value of Managers and employees - not removing them from the organization for immediate savings, but harnessing these skills for growth opportunities. In order to follow the correct path and avoid pitfalls, the Managers should ensure that they fully understand the Lean thinking before starting implementation of Lean. Knowledge can be obtained through individual-studies or training. It is also possible to appoint a company Lean support group that receives the necessary Lean training, and who teaches the Management and employees after. A consultant can also be hired to follow up the process. However, it is very important that the knowledge is gained inside the company so that learning and information continues to flow within the company after the consulting period is over.

As a general recommendation, DO Offshore Base should make an effort to avoid initiatives being stopped half way through the process, and seek to ensure integration of Lean in their everyday operations. This is seen as a critical success factor for DO Offshore Base.

7.3 RECOMMENDATION FOR FURTHER WORK

It is recommended that the Lean approach is expanded to involve the whole organization. As mentioned earlier, some of the challenges cannot directly be dealt with by DO Offshore Base alone, but require additional efforts by other internal departments: There is a need for a cross-functional approach and involvement of all DO units, sections and departments.

It is recommended that the company start making a long-term plan as well as more detailed action-plans based on these phases. By use of a good planning and ‘turnaround’ strategy of Lean implementation, it could maybe be possible for DeepOcean to conduct the elementary phases of a Lean transformation (introduced in section 3.8) within five years. They would then be in a better position to face the current industrial challenges. It will be important to follow up the plan that is made for implementation, and not just put it away and use excuses such as lack of time, resources and money. An effort should be made in form of training, communication and regular meetings.

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9 APPENDICES

9.1 APPENDIX 1: QUESTIONNAIRE

9.1.1 The correlation between the questionnaire and the EFQM User Guide

The statements are developed based on the EFQM Framework where Lean is in focus, but the statements from the EFQM User Guide (EFQM, 2013) do not directly correspond to the same statements in this questionnaire. Table 7 shows which statements in the questionnaire that correspond to the EFQM User guide.

Table 7 The correlation between the questionnaire and the EFQM user guide

Questionnaire	EFQM User Guide
1a - 1c	1d
1d - 1f	1e
2a	2b
2b	2d
3a	3a
3b	3b
3c - 3d	3c
3e	3d
4a	4a
4b	4d
4c - 4d	4e
5a - 5b	5a
5c - 5d	5b
5e - 5f	5d
5g	5e

9.1.2 The applied version of the questionnaire

The applied version of the questionnaire is shown in Table 8 (in Norwegian). Leaders are in this case leaders on group-level, thus not Managers in the daily operation at the Base, such as Supervisors or Base Manager. Customers are also in this case the users of the services and products provided by the Base; that are vessels and projects.

Table 8 Applied version of the questionnaire

1. Lederskap: Ledernes aktiviteter og adferd	1	2	3	4	5	Vet ikke
a. Ledere inspirerer og fremmer en kultur som består av involvering, eierskap, selvstyring, forbedring og ansvarliggjøring gjennom sine handlinger, atferd og erfaring						
b. Ledere ser fordelen av å lære raskt og reagere raskt når det er nødvendig, for å være konkurransedyktig.						
c. Ledere fremmer en kultur som støtter generering av nye ideer og nye måter å tenke, som stimulerer til innovasjon og organisasjonsutvikling.						
d. Ledere administrerer effektivt endring gjennom strukturert prosjektledelse og fokusert prosessforbedring.						
e. Ledere bruker en strukturert tilnærming for å generere og prioritere kreative ideer.						
f. Ledere vurderer ideene, og fordeler ressurser til å realisere de mest lovende ideene.						

2. Strategi og Policy: Hvordan organisasjonen inkluderer deres kvalitetsmål og verdier i en overordnet planlegging.	1	2	3	4	5	Vet ikke
a. Trender blir analysert for drift-prestasjoner for å forstå de nåværende og potensielle evner og kapasiteter, og for å kunne identifisere hvor utvikling er nødvendig for å oppnå de strategiske målene.						

b. Mål blir etablert basert på sammenligninger av deres prestasjoner med andre organisasjoner, organisatorisk kapasitet, og strategiske mål.						
--	--	--	--	--	--	--

3. Personalledelse: <i>Hvordan organisasjonen utvikler og involverer hele arbeidsstaben for å oppnå forbedringer i organisasjonen</i>	1	2	3	4	5	Vet ikke
a. Det er klare definerte ytelsesnivåer for personal som kreves for å oppnå de strategiske målene (personlige planer).						
b. Organisasjonen sikrer at sine folk har den nødvendige kompetanse, ressurser og mulighet til å være i stand til å maksimere deres bidrag ve å utvikle de ansatte.						
c. Personlige mål og team mål eksisterer og blir justert, og det er tilrettelagt for de ansatte å realisere sitt fulle potensial.						
d. Det er skapt en kultur for kreativitet og innovasjon på tvers av organisasjonen som sikrer at ideer blir tatt imot.						
e. Det er utviklet en kultur der en stadig søker å forbedre effektiviteten av samarbeid og teamarbeid gjennom hele verdikjeden.						

4. Ressursledelse: <i>Hvordan organisasjonen's nøkkelressurser (eks.: IT ny teknologi) blir justert etter mål og verdier.</i>	1	2	3	4	5	Vet ikke
a. Det arbeides sammen med partnere for å oppnå gjensidig nytte og økt verdi for sine respektive interessenter, og støtter hverandre med kunnskap, ressurser og kunnskap.						

b. Teknologi blir brukt for å støtte kreativitet og innovasjon.						
c. Metoder er etablert for å engasjere relevante interessenter og kollektive kunnskap blir brukt til å generere ideer og innovasjon.						
d. Ideer blir omformet til virkelighet innenfor de tidsrammene som maksimerer fordelene som kan oppnås						

5. Prosesser, produkter og service: <i>Hvordan organisasjonen kontrollerer de kritiske prosessene</i>	1	2	3	4	5	Vet ikke
a. Det er utviklet en blanding av ytelsesindikatorer (KPI`er) og tilhørende resultatmål						
b. Data og statistikk på ytelse i arbeidet er brukt til å drive kreativitet, innovasjon og forbedring.						
c. Det blir aktivt jobbet mot å skape noe nytt, og skape verdier for kunder, involvere dem og andre interessenter, eventuelt i utvikling av nye og innovative produkter, tjenester og opplevelser.						
d. Det er brukt markedsundersøkelser, kundeundersøkelser og andre former for tilbakemelding til å forutse og identifisere forbedringer, som skal styrke spekteret av tjenester/produkter.						
e. Det er utviklet en effektiv verdikjede for å sikre at det som er lovet kan leveres						
f. Organisasjonen fokuserer på sine styrker og muligheter til å forbedre og maksimere verdien som blir generert for kundene.						

g. Erfaringer og oppfatninger fra kunder blir kontinuerlig overvåket og gjennomgått for å sikre at prosesser er tilpasset til å reagere riktig på alle tilbakemeldinger.						
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9.1.3 Calculated results

A percentage average of the score on level 1 (criteria) and the score of the four different attributes connected to Lean and improvements, have been calculated based on the number of answers between the ranges 1 to 5 (see Figure 65).

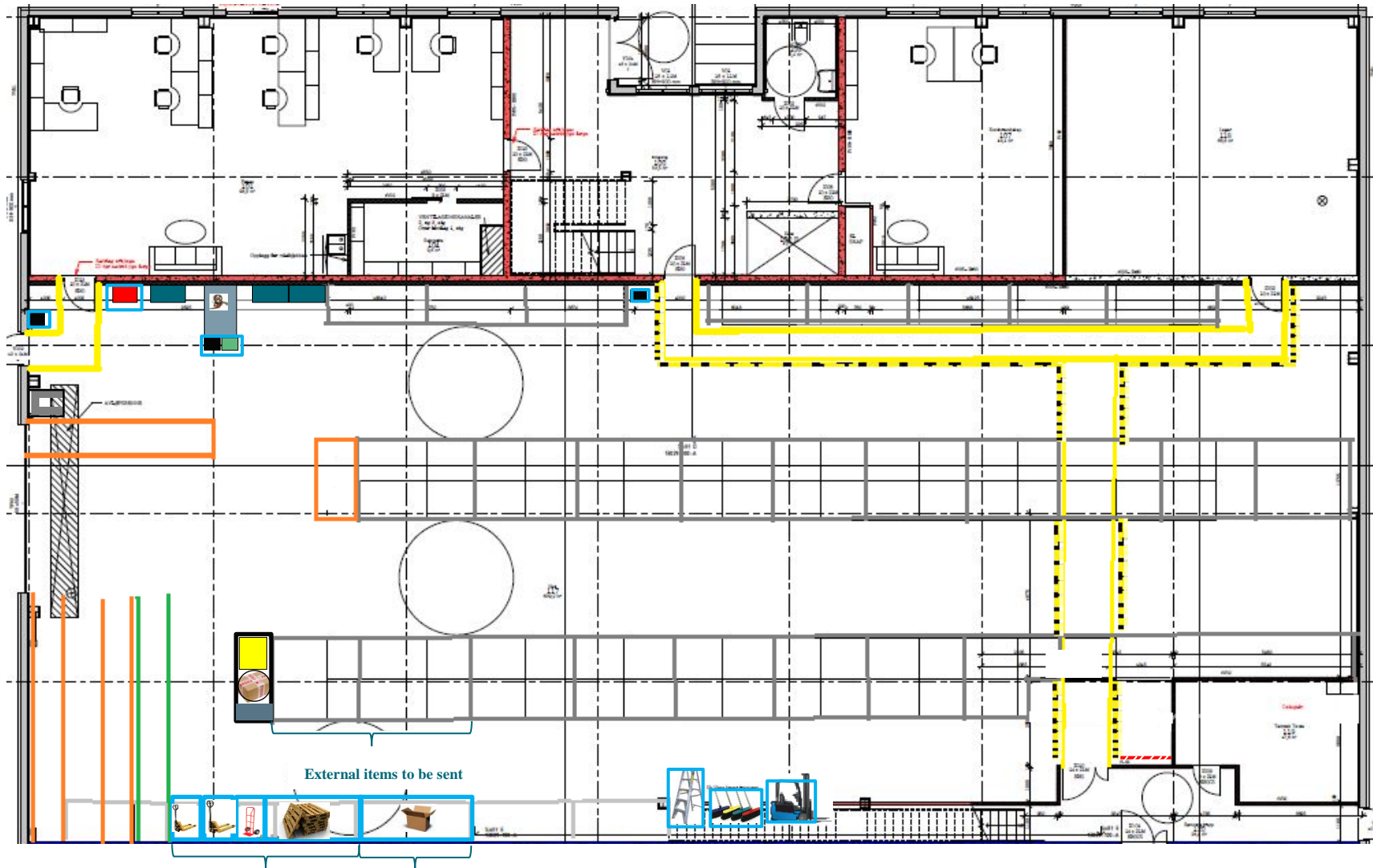
9.2 APPENDIX 2: THE CONNECTION BETWEEN CONTRIBUTORS, WASTE, EFFECTS AND LEAN INITIATIVES

●	●	●	●	●	Work environment	●				●						●	●	●	●	●	
●	●	●	●	●	Assets - equipment and tools	●				●				●						●	
●	●	●	●	●	Material	●				●				●						●	
●	●	●	●	●	Method	●				●	●	●	●	●	●	●	●	●	●	●	
●			●		Human	●				●	●	●	●	●						●	
●					Leadership	●				●	●	●	●	●	●	●	●	●	●	●	
4					Contributors											1					
Continuous improvement	Inventory control	Creating flow	Visualization of information	Order and structure	Lean initiatives The connection between the 1) variables (of which the contributors are incorporated) and the types of waste 2) waste and effect 3) effect and the Lean initiatives 4) variables (of which the contributors are incorporated) and the Lean initiatives	Waste	Searching for items / missing items	Searching for information / missing information	Rework	Waiting for items/parts	Missed opportunities for earnings and savings	Equipment not delivered back in time	Unnecessary motion	Unnecessary transport	Unnecessary inventory	Unexploited human potential					
							Effect	2													
●	●	●	●	●	3	Work overload	●	●	●	●			●	●	●	●					
●	●	●	●	●		Negative stress	●	●	●	●				●	●	●	●				
●	●	●	●	●		Morale	●	●	●	●				●	●	●	●				
●	●	●	●	●		Productivity	●	●	●	●				●	●	●	●				
●	●	●	●	●		Cost	●	●	●	●		●		●	●	●	●				
●	●	●	●	●		Quality	●	●	●	●				●	●	●	●				
●	●	●	●	●		Safety	●	●	●	●				●	●	●	●				
●	●	●	●	●		Delivery	●	●	●	●			●	●	●	●	●				

Figure 67 – The connection between contributors, waste, effects and lean initiatives /

9.3 APPENDIX 3: MARKING OF FLOOR AND DESIGNATED AREAS








The suggested areas are marked in Figure 67, which is a map of the Logistics- and Warehouse hall. Table 9 contains descriptions of what type of tool/equipment is at the map, and how the area should be defined.










Items going on later projects. f) Unclarified project equipment, g)

Figure 68 – Map of the Logistic and Warehouse/Storage Area with suggested areas for items and floor marking

Table 9 Designated areas in Warehouse / Logistics Area

Warehouse and Logistics Area			
	Type of item	Symbol	Define area
1.	Forklift + charge station		Blue floor marking
2.	Trash can	■	Blue floor marking
3.	Trash can	■	Blue floor marking
4.	Trash can	■	Blue floor marking
5.	Plastic for reuse	■	Blue floor marking
6.	Brooms		Blue floor marking
7.	Work desk	■	NA
8.	Items on work desk		Picture of the specific item at its designated place
9.	Packaging equipment		Blue floor marking
10.	Pallet truck		Blue floor marking
11.	Package trolley		Blue floor marking
12.	Pallets and pallet collars		Blue floor marking

13.	Equipment cabinet		NA
14.	Equipment cabinet		NA
15.	Equipment cabinet		NA
16.	Package weight		Black floor marking
17.	Package machine		Black floor marking
18.	Tool cabinet		Blue floor marking
19.	Ladders		Blue floor marking