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Time compression in ETO Production Networks: A Case Study of Ulstein Shipyard

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Preface

This master's degree thesis is the final stage of the Master of Science in Logistics degree at Molde University College, Molde, Norway. A research proposal was submitted and accepted in December 2014, becoming the starting point for this research. The work on the thesis started in January and extended through May 2015. The thesis has been a part of a research project, SMARTprod, between Møreforskning Molde, Molde University College, Ulstein Shipyard AS and WestCoat AS.

During the course of writing this thesis, the researchers received guidance from some important people, and would like to express their gratitude to them:

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Our families: For their love and support.

Molde; May 23, 2015

Tarek Nader and Kazi Tanvir Ahmed

Summary

This study is an independent project conducted on Ulstein Shipyard. The focus of the thesis is on an analysis of the time compression in engineer-to-order (ETO) production networks of Ulstein Shipyard. The purpose of this thesis is to compress the total cycle time of Ulstein ETO production networks by integrating the value stream of a key supplier, WestCoat, into the Ulstein Shipyard value stream.

This is a qualitative study and the design follows an exploratory case study. The research questions are linked to each other, meaning that solving the first research question gives a presumption to solve the next, in accordance with the exploratory research design. Literature review, with respect to ETO total cycle time compression, buyer-supplier relationship, lean construction and value stream mapping guide this study to add value to existing theories of ETO time compression in shipbuilding from the perspective of supplier value stream integration in the system.The data used in this study was collected through interviews, observations and the available performance reports of Ulstein Shipyard and WestCoat. All the data have been analyzed later with the objective of adding value to existing theories.

The empirical findings show that there are significant wastes due to the nature of the buyer and supplier relationship, buyers' feeble project planning, and a mismatch between planning and execution. Waste of time and material, and other wastes were identified in WestCoat's activities. More importantly, the major findings and issues were observed in Ulstein Shipyard's planning activities. All these findings show that the total cycle time of Ulstein Shipyard's production networks is increasing and there are opportunities to compress the total cycle time by integrating WestCoat's value stream into that of Ulstein Shipyard. Thus, alternatives of the way forward have been presented to reduce the total cycle time. In addition, a current state value stream map has been drawn and a future state map of the supplier activities in the buyer value stream has been developed as a model to achieve the value stream integration of WestCoat into Ulstein Shipyard.

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List of Abbreviations and acronyms

ATO: Assemble-to-order

CODP: Customer Order Decoupling Point

DCP: Decoupling Point

ETO: Engineer to Order

TBM: Time Based Management

MTO: Make-to-order

MTS: Make to Stock

SCM: Supply Chain Management

TCT: Total cycle Time

TPS: Toyota Production System

VSM: Value stream mapping

1.0 Introduction

The Norwegian offshore industry is one of the world's largest and most modern in terms of technology. Shipbuilding companies engaged in this industry participate in all phases of petroleum activities—from initial seismic surveys to production and, finally, decommissioning of non-producing fields. Nowadays, the shipbuilding market is too competitive in delivering ships with advanced technology, high quality and on time to customers. Thus, this industry needs to deliver ships on a competitive delivery time frame.

During the 1980s and 1990s, most of these shipyards activities were outsourced and generated many competitive suppliers in the industry (Guvåg et al., 2012). Therefore, quite a large number of suppliers providing different products, material, services and solutions offer their services to these shipbuilding companies. These companies also require the suppliers to remain competitive. As many shipping companies outsource their core activities to these suppliers in different scale, there is a growing necessity to compress the ships' delivery time along with integrating the suppliers into the shipbuilding companies.

1.1 The ship building industry in Møre og Romsdal

Møre og Romsdal is the most mentionable shipbuilding industry in Norway. The maritime industry in Møre og Romsdal consists of about 212 companies. Among them are 165 suppliers of maritime equipment and services, 14 shipyards, 15 ship consultants and 19 shipping companies. In 2012, this cluster had a calculated turnover of around 47 billion NOK. The number of permanent employees the same year was about 15,000. Including hired labor, the maritime cluster employed around 20,000 workers (Hervik et al., 2012).

In a research about the ripple effect of STX OSV, a shipyard now known as VARD, Oterhals, Johannessen and Hervik (2011) found that Norwegian suppliers supplied 66 percent of equipment and services. For suppliers in Møre og Romsdal, the share was 42 percent. The share purchased from low-cost countries was as low as 34 percent, which included outsourced production of hull. This is an indication that the supplier industry in Møre og Romsdal is significant for shipyards, and there are some consequential effects of these industries on the total supply chain management of the shipyards.

According to Aslesen (2006), Norwegian shipbuilding is characterized by a sequential processing of products leading to a complete ship. During this sequential processing, several actors work simultaneously while the product is stationary for the outfitting phase. More and more of the work is outsourced to suppliers as work packages. As the variations among the suppliers and the personnel can be high, shipbuilding in Norway is project-based where each new ship gets a project number and an own project organization to control the project. Each project usually has unique technical solutions and a system of actors that are temporarily put together to do the building, and has similarities to the construction industry (Aslesen 2006). Naturally, these project-based activities have limitations on time and cost, creating a necessity to streamline suppliers' activities in terms of company strategy.

Therefore, as per the requirements of this thesis, there was focus on compressing the total cycle time of Ulstein Shipyard's production networks by integrating the value stream of a key supplier, WestCoat, into Ulstein Shipyard's value stream. One actor from the shipbuilding industry, one shipyard and one supplier will be used for an analysis in this case study. Some background information about the companies will be presented in the following sections.

1.2 Ulstein Shipyard AS

The companies in the group are gathered under the holding company, Ulstein Group ASA, whose primary objective is business development across the organization. The company was originally founded in 1917 as Ulstein mek. Verksted. The group has around 800 employees in seven countries and is headquartered in Ulsteinvik, Norway. The Ulstein Group is the parent company of a maritime group (see Figure 1) of operating companies within design and solutions, shipbuilding, power and control, sales and aftermarket services, property, ownership of buildings and plants, shipping, ship ownership and investments (Ugland and Gjerstad, 2010) .

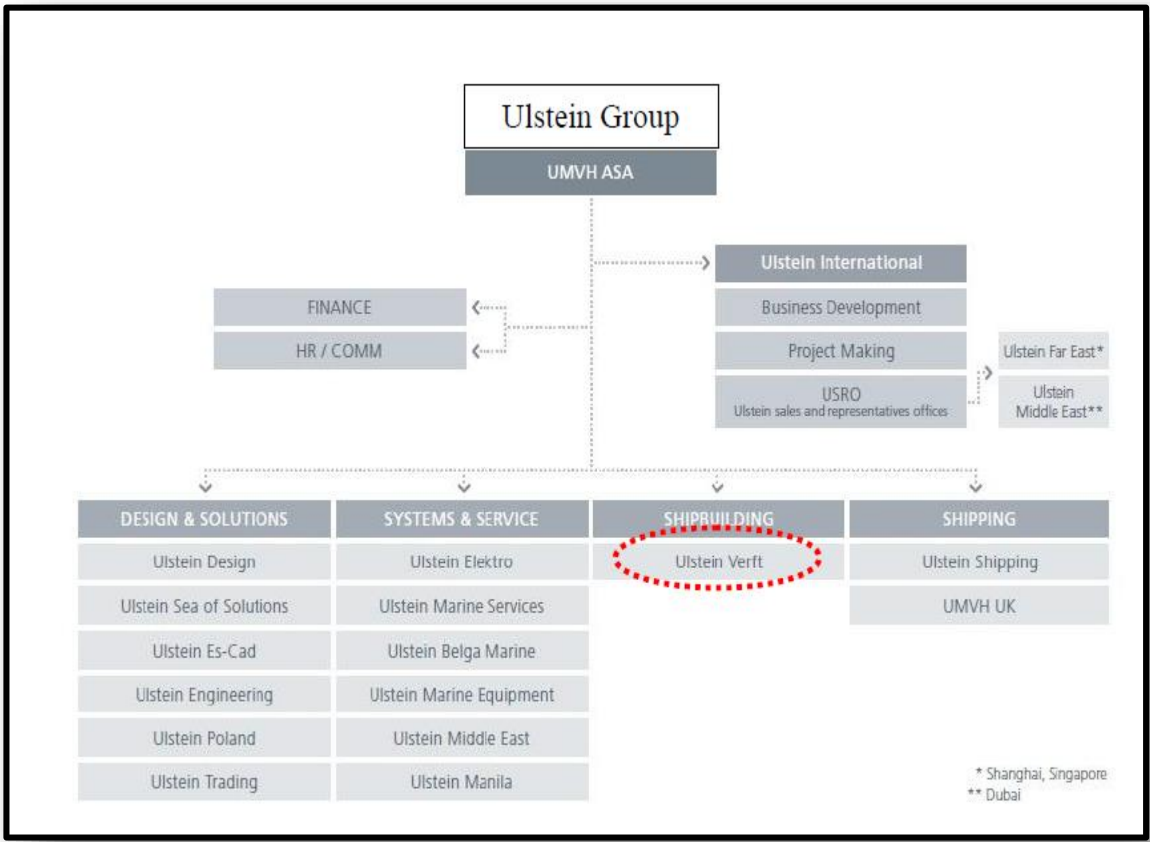


Figure 1: Ulstein Group organization chart.

Source: Ugland and Gjerstad (2010).

Ulstein Shipyard builds a wide range of highly effective and sustainably efficient vessels that include offshore support, offshore construction, and seismic and research vessels. Ulstein Shipyard mainly produces "prototypes" of ships and usually only one or two ships with the same design are produced by it. The design is often sold to other shipyards after production at Ulstein Shipyard is completed. According to Ulstein (2015), it has a strong focus on innovative technological solutions and methods. It also has strong expertise within project management, effective logistics and pre-outfitting techniques. It uses a collaborative approach and has streamlined production processes, achieving a high level of flexibility and quality in the process.

The main yard is based in Ulsteinvik, Norway. In addition, the shipyard has a department in Vanylven, Norway, where steel sections for the main yard are built (Ulstein, 2015). Ulstein's vision is "to create tomorrow's solutions for sustainable marine operations". It has three key areas they focus on—innovation, expertise and quality. These three together create added value for customers (Ulstein, 2015).

1.3 WestCoat AS

WestCoat AS (WestCoat) is a Norwegian company located in Ulsteinvik, Norway. Its main competence is in surface treatment of ships. The company was founded in 2008 and merged with NorCoat AS, a peer which had been in the industry since 2002, in 2010. WestCoat has two employees in administration and 80 in operations.

Today, the company's only customer is Ulstein Shipyard, and it is a full-service supplier of the following services: sandblasting, painting, metallization and scaffolding. WestCoat delivers manpower and equipment for these services included in both new builds and repairs at the shipyard (WestCoat, 2015). As Ulstein Shipyard does not have its own painting department, WestCoat is included in the planning phase, and much more involved in the early stages of planning and execution of the outfitting phase.

1.4 Relevance of the Study

This study seeks to find a way for compressing time in Ulstein Shipyard's production networks as well as a way forward to integrate suppliers' value stream into the shipyard's value stream. As there was prior research done on Ulstein Shipyard's supplier integration, this work is a step-ahead research to investigate the streamlining of the value stream of suppliers into that of the shipyard. SMARTProd had Lean Shipbuilding II (2011–13), an innovative project supported by the Regional Research Fund for Central Norway focused on methods for developing the flow in critical processes within the internal supply chain, testing a principle for creating more reliable material flows, identifying bottlenecks associated with external production to enhance the capability of the organization, and fostering collaboration and learning within the organization. In a nutshell, therefore, this is a continuation of the research under the SMARTprod project in Ulstein Shipyard and in collaboration with the Molde Research Centre.

1.5 Research problem and Research Questions

1.5.1 Research Problem

In this section, the research problem for this thesis is outlined. This includes the background for this thesis, and the problems and challenges that Ulstein Shipyard is currently facing. This will be summed up by two research questions.

This thesis is part of a project between Ulstein Shipyard, the Molde Research Centre, (Møreforskning Molde) and Molde University College and WestCoat. The project is called SMART prod, and the idea behind it is to industrialize the shipbuilding process. The project will span over three years, and the main goal is to create an industrial shipbuilding strategy within a value creating supplier network. Within this main goal, there are some secondary goals.

1. *Develop a strategic concept of time compression in engineer to order (ETO) shipbuilding in Ulstein Shipyard.*
2. *Develop a joint integration model with the suppliers to stimulate innovation in material and production technology, working methods and product improvements.*

In line with this strategic goal, another thesis was conducted under SMARTprod project. It was primarily based on buyer-supplier relationships in an ETO environment. That thesis also sought a way to handle shorter production time by suppliers in the ETO environment (Rød, 2014).

Rød (2014) summarized this by developing an industrialized shipbuilding method where modules are equipped in parallel; through a closer integration with suppliers, the following things are expected to be achieved. First, a 10 percent reduction in internal production cost. Second, an increase in production from 3.2 to 5.2 ships a year. If this is achieved, there is a calculated potential to reduce costs by 57.6 million NOK and increase revenues by 36 million NOK per year.

The current thesis works under SMARTprod project is continued with the same greater goal of industrialization of shipbuilding. However, this thesis only investigates the value stream integration of a single supplier, WestCoat.

Therefore, this thesis is one of the deliveries—the second—from this project. Its focus will stay within the secondary goals of SMARTprod project, and seeks to explore the issues that cause waste and delays in the integration process of one of the supplier’s value stream into that of Ulstein Shipyard.

The thesis have been conducted on WestCoat. It is one of the key suppliers and works on the sandblasting and painting tasks for Ulstein Shipyard projects. When discussing about Ulstein Shipyard’s suppliers, this can be equaled to subcontractors that come to the shipyard, deliver and install their products on a ship. This means that they are part of actual production and do not only deliver goods or materials, but also perform the actual work of preparing and installing their products on the ship.

This way, they are more service suppliers compared than goods suppliers. However, WestCoat only delivers sandblasting and painting services through its workforce. Ulstein Shipyard supplies the sand and paints for the tasks.

Ship manufacturing is always a sequential job and done by several different actors (Aslesen, 2006). At Ulstein Shipyard, suppliers have to carry out their tasks and activities in the following way: each of the suppliers gets a time slot in the project plan to finish its work in a specific block or area of the ship. When a supplier is finished with one area, another supplier takes over, and often there are several suppliers working simultaneously in the same area. This way of coordinating the work flow creates many challenges, bottlenecks dependencies and reworks in the shipbuilding process. According to Aslesen (2006), this demands a high degree of coordination and planning of the outfitting, partly because several actors are involved and partly because the outfitting happens inside the ship in a limited physical space or in areas where several tasks are simultaneously performed. Some of these problems are raised and communicated in a kickoff meeting for this project with Ulstein Shipyard.

If suppliers cannot start their tasks at the planned time or tasks are not finished within their time slots, those tasks in a particular area of the ship would be delayed. Although not all delays are critical for the completion of the ship, there are problems that can arise if delays occur. An example of this is that if one supplier is delayed, it also creates problems for the other suppliers who are ready to begin the subsequent jobs but cannot until the previous supplier has finished.

The suppliers next in queue have their workers ready to take over but cannot start until the previous work has been completed. The result of this can be that they will need to wait or they can sometimes start working on other parts of the ship. In both instances, these create inefficiencies such as waiting, moving people and material around, and changes in the plans. Thus, by following the Toyota Production System (TPS), there is a scope of research as Liker (2004) stated that the heart of the TPS is delivering value by eliminating waste and ensuring an undisturbed workflow.

There is an overall scope of research on process, tasks and sub tasks of ship construction within the light of the TPS and lean production as it has been observed wastes of time and associated resources in different phases. Conversely, research has been conducted on

WestCoat's tasks of sandblasting, treating and painting in the Ulstein Shipyard outfitting phase.

1.5.2 Research Questions

To solve a research problem, it is important to define interesting research questions that should be answered through empirical investigations. According to Yin (2009), the process of defining the research questions is probably the most important step to be taken in a research study.

By observing the findings from empirical investigations, exploration was conducted on how to compress total cycle time (TCT) in the Ulstein Shipyard ETO production networks with a focus on a single supplier integration. This leads to the title of the thesis.

Time compression in ETO production- A Case study of Ulstein Shipyard.

While elaborating the first part of the title, the first research question is found:

Research question 1: *How to compress the TCT in Ulstein Shipyard*'s *ETO production networks?*

The first question is the general question on TCT compression in Ulstein Shipyard's ETO environment. To make it more specific, a second question is necessary. As discussed, there is focus on value stream integration of a supplier into Ulstein Shipyard's value stream. Therefore, the second research question is:

Research question 2: *How to integrate a supplier*'s *value stream into that of Ulstein Shipyard? What are the obstacles and benefits?*

This second question is quite specific. It narrows down the capacity of research into the domain of a single supplier namely, WestCoat. While trying to find the answers of these "how" questions, some relevant "what" questions also surfaced in research question 2. While investigating the second research question the probable obstacles in expected value stream integration of the buyer and the supplier will be sought. Subsequent consequential obstacles and benefits will also be discussed in same research question.

1.6 Structure of the paper

The thesis is divided into several parts. In Chapter 1, there is a short description along with a brief picture of the shipbuilding industry in Møre og Romsdal, Ulstein Shipyard and WestCoat. This chapter also represents the relevance, limitations of the study along with a description of the research problem and questions. The second chapter discusses the literature review—TCT, ETO, buyer-supplier relationships, supplier integration, lean construction and value stream mapping (VSM). The third chapter represents the research methodology. This chapter discusses the details of how this research is conducted to reach its goal along with its strengths and weaknesses. In Chapter 4, the case study findings are analyzed, where the real scenario as observed is depicted. Chapter 5 represents a discussion and analysis to draw the outcome of the research to see whether the study goal could be achieved .Chapter 6 describes conclusion and Chapter 7 represents limitations and further research. At the end, there are references and appendices.

2.0 Literature Review

This section discusses the literature review for the research. The review is formulated in a way that as much as possible of the relevant literature from different sources can be covered. Literature review can be categorized into two parts: where the subject matter of this thesis is represented and where the subject matter is not represented or if there is any scope for value addition in existing theories. In fact, value addition in existing theories is one of the prime interest points of the research. Therefore, through this work, there will be an attempt to fill the research gap by adding some new value to existing research.

The literature review starts with the concept of the Total Cycle Time (TCT) and its different perspectives. Later on, the TCT is connected with the concept of ETO to explore whether time compression is possible in ETO. Then, ETO is integrated with the supply chain process where there is a presence of a buyer-supplier relationship, relationship norms and dependence, assertiveness and cooperativeness in managerial decision-making, and complexity of trust in a buyer-supplier relationship. After that, lean construction principles, and lean manufacturing tools are discussed followed by an analysis on VSM.

2.1 Total Cycle Time (TCT)

The TCT is defined as "the elapsed time between customer enquiry and customer need being met is shown to be a fundamental driver in achieving enhanced business performance" (Mason-Jones and Towill, 1999). Especially in the agile supply chain, time compression has become an important key enabler. The approach of time compression has become so powerful that it is now known as a paradigm.

Towill (2008) also argued, in a construction supply chain and TCT handbook, that the TCT compression paradigm can be simply expressed as "the principle of reducing the time taken to execute a business process from perception of customer need to the satisfying of the need". The author said that industrialists in the UK, such as Jack Burbidge (1983) and John Parnaby (1995), were early advocates of the paradigm. Likewise, management consultants, such as Stalk and Hout (1990), widely publicized the approach.

Later, there was further contribution from Thomas (1990) and a consultant to the work of Stalk and Hout (1990). From their research, it was found that subject to proper reengineering, all normal performance criteria are bettered (Mason-Jones and Towill 1999). They stated that the TCT compression paradigm is now widespread and, because of its universal appeal and strategic advantage, is sometimes alternatively known as time-based management (TBM), as coined by the Boston Consulting Group.

The leverage exerted may well be sector-dependent and a powerful reason for ongoing research in construction. Thus, it is assumed that this paradigm has a very important relevance to construction in the shipbuilding industry. An increase in productivity, an improvement in quality, a reduction in cycle time and an expedition of innovative products to market have been the primary objectives of time compression (Hui, 2004).

Meanwhile, Thomas (1990) established two very important key points associated with TCT compression programs. First, the only worthwhile goal is to reduce the TCT from a customer need right through to the satisfaction of that need. Second, a TCT compression program not only reduces the expected cycle time, but achievement on target also has to be guaranteed.

This argument expresses the particular notion of the relevance and necessity of discussing on-time compression in this thesis on Ulstein Shipyard, as ETO time compression by satisfying diversified customized needs, are embedded in a necessity for a deeper look at the expected cycle time of both Ulstein Shipyard and the supplier company.

The importance of a discussion on the TCT is manifold. To find out these important reasons, there were some detailed industrial case studies despite the reluctance of companies to release the information or give executives time to write up a meaningful account of the change program (Towill, 2008). One aerospace industrial result is shown in Table 1. They confirm that good reengineering of the product delivery process (PDP) is rewarded by an improved performance measured by every business metric, that is, no tradeoff or engineering compromise is required.

Table 1: Manufacturing industry case study perspective.

Source: Typical results quoted by (Parnaby, 1995) on-time compression paradigm applied to aerospace actuator company.

Benchmark	Improvement
Lead time	Down 75%
Manufacturing costs	Down 75%
Material movements	Down 90%
Inventories	Down 75%
Work in progress	Down 75%
Adherence to schedule	Up to 30%
Product ownership	Much improved

For further evidence, another example of a survey can be mentioned. Schmenner (1988) summarized the results obtained in a large-scale experiment (several 100 companies) by surveying three different market sectors, and testing the results for correlation between cause and effect. Of the various 10 factors tested for statistical significance, only TCT reduction was found to have a significant impact on productivity (Towill, 2008).

Subsequently, he also added that any change program which links customer needs to customer satisfaction must take either an end-to-end or a systems approach. Time as an explicit target is self-explanatory as it is a performance metric that travels unambiguously across company and national boundaries. In addition, the focus on learning is a necessary prelude to continuous improvement in performance (Thomas, 1990).

At this level, the importance of business process mapping needs to be discussed. Researchers tried to find out available time compression possibility. Due to this background, a small brief on business process is required. Business process means a range of activities between a customer need and that need being satisfied (Towill, 2008). He gave an example of a single, integrated design and described a construction business process known as T_{40}, and explained that TCT compression takes a holistic view of the organization. This reengineering is preceded by the creation of a total systems model, usually called the process map of the business, he added.

Towill (as cited in Evans, Naim and Towill, 1997) agreed that a detailed, highly structured mapping approach has been given in a construction example of the reengineering process or *how* things are done with the highest possible standard (a procedure usually associated only with what we do) using the TCT as an explicit performance metric against which an alternative design may be compared. Towill (2008) regrettably described that many executives want to skip the mapping part of reengineering wrongly believing that the business process is clear. The same executives then became curious about why reengineering programs fail to deliver the predicted benefits. The truth of the matter is that one fact is worth a dozen opinions and one process flow chart contains a dozen facts.

Therefore, a flow chart is an essential and major step in reliable business process modeling (Towill, 1997). He also argued that an erroneous model of a business process is potentially every bit as damaging to a company as an erroneous model of an artifact.

Towill (2008) also explained further about time compression and stated that if a reliable flow chart of the business process is available, various practical reengineering ideas to reduce the TCT may be explored. Some process charts are indeed laid out such that the activity may be immediately recognized as either essential or otherwise (Scott and Westbrook, 1991).

While trying to measure the TCT, the T_{40} concept can be a useful project. To illustrate this, there was a case study devised to enable a new industry-wide process for construction. As shown in the figure below, the newly engineered process is capable of reducing time to complete construction by 40 percent resulting in consequential cost savings of 25 percent of the capital value (Ireland, 1996). An important outcome of T_{40} was the substantive evidence that the TCT compression paradigm applies to project-based companies and value streams (Towill, 2008).

Towill (2008) also argued that the starting point of the T_{40} project was the knowledge that managing the process of producing a building, a civil engineering structure—such as a road or a bridge—or an oil refinery involves a similar set of processes. However, while there are similarities between projects, essentially every project is different and a prototype because the site is different and, hence, so is the design. Nevertheless, the T_{40} project is aimed at exploiting the practical similarities between projects as the basis for innovation in construction. Figure 2 depicts the T_{40}.

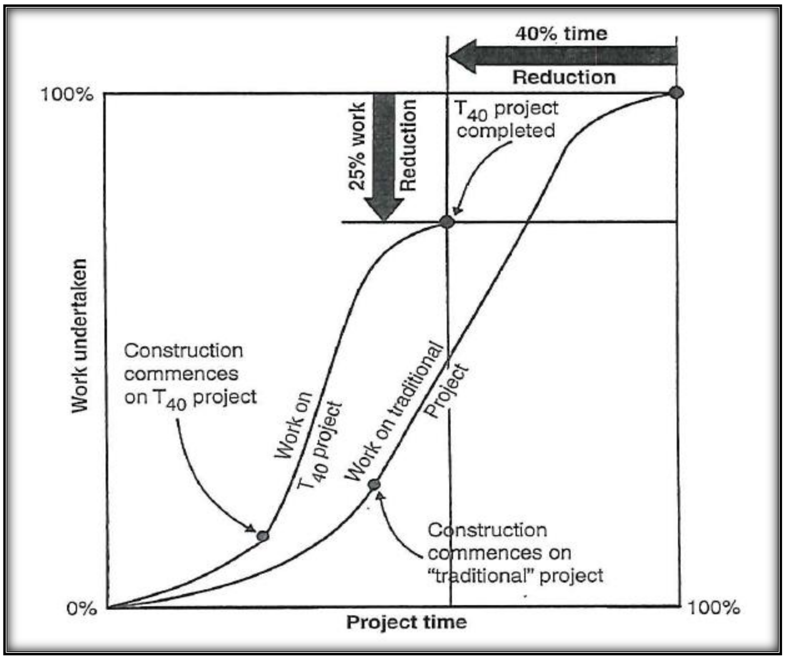


Figure 2: Work-time relationship.

Source: Retrieved from Ireland V. (1996).

According to Ireland (1996), the final integrated design and construction process requires the "whole solutions team" to be involved from the point of determining customer needs to those needs being satisfied. It requires some resolution like a clear specification of the customer's needs, preferably in performance terms, he also added. This also needs the acceptance of responsibility by the whole team for the design and construction phases, significant changes from the current practice. The negotiated cost of a particular project, including reference to a third-party audit, can also be considered if necessary.

2.2 Engineer-to-Order Production

A widely used phenomenon in the field of industrial engineering is ETO. ETO manufacturers produce customer-specific products that require unique engineering or design work, or significant customization activities. Typically, small production quantities, including different versions and a huge variety of parts, must be managed (Camelot ITLab, 2014). Camelot ITLab (2014) also said that since a significant proportion of the total cost and lead time is incurred in the early phases, competitive planning processes must set in at the very beginning of the lifecycle and manage the complete lifecycle on an ongoing basis.
Generally, the ETO supply chain is regarded as a supply chain where the "decoupling point" is located at the design stage, so the customer order comes in at the design phase of a product. The decoupling point is often called the customer order decoupling point (CODP). Primarily, ETO production is associated with large, complex project environments in sectors such as construction and capital goods (Gosling and Naim, 2009).

Therefore, while discussing ETO, a comprehensive discussion on the decoupling point has also been covered simultaneously in the light of the product process matrix. Hayes and Wheelwright (1984) explained the different job nature in terms of the unique unit size in their product-process matrix. They also explained that shipbuilding is a low volume and high variety project-based task. This project-based task is highly technical and complicated, and involves different skilled traders, contractors and suppliers.

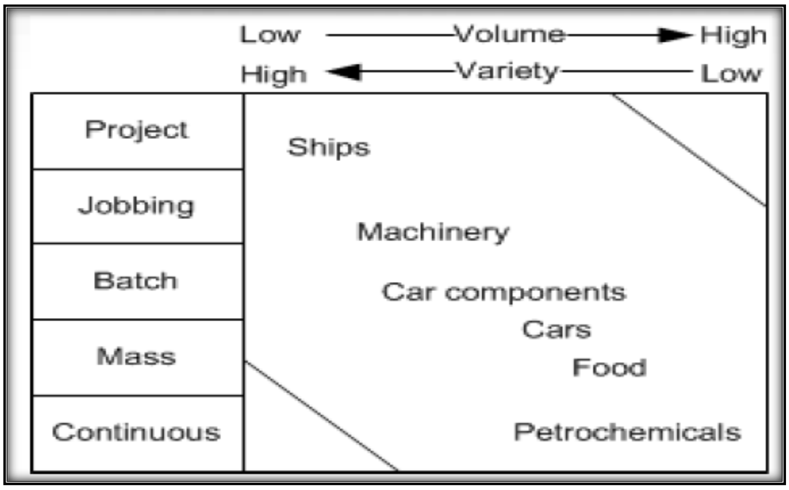


Figure 3: ETO and customer order decoupling point.

Source: Hayes and Wheelwright (1979).

Olhager (2012) has discussed elaborately on the CODP. He argued that the CODP has been traditionally defined as the point in the value chain of a product. Sharman (1984) and Olhager (2003) stated that sometimes the CODP is called the order penetration point. Olhager (2003) also said that different manufacturing situations—such as make to stock (MTS), assemble to order (ATO), make to order (MTO) and ETO—all relate to different positions of the CODP (Figure 3).

Olhager (2003) continued by saying that the CODP, thus, divides the operations stages that are forecast-driven (upstream of the CODP) from those that are customer order-driven (the CODP and downstream). Sharman (1984) argued that the CODP is also the last point at which the inventory is held.

Thus, the inventory at the CODP is a strategic stock point since delivery promises are based on the stock availability at the CODP and the lead times and capacity availability for the customer order-driven activities downstream the CODP (Olhager, 2003). Olhager (2012) stated that there is a strong consensus in the literature on CODP on the fact that the operations upstream are significantly different than those downstream, based on the fact that the upstream material flow is forecast-driven whereas real customer orders dominate downstream. Figure 4 depicts the different CODPs.

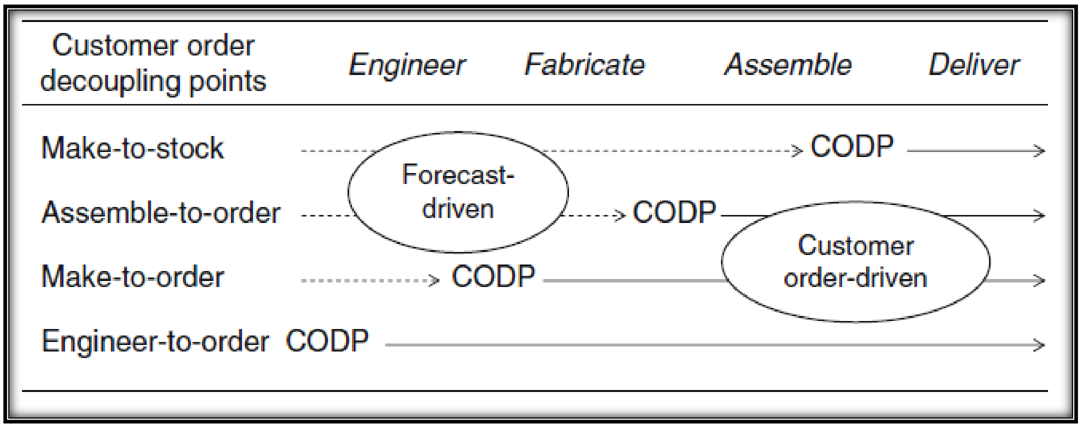


Figure 4: Different customer order decoupling points.

Source: Sharman (1984).

Olhager (2012) said that this has implications for many aspects of the manufacturing value chain. Areas that have been treated in the literature include operations strategy (Olhager and Ostlund, 1990; Olhager, 2003), logistics systems (Hoekstra and Romme, 1992), manufacturing planning and production control (Giesberts and van der Tang, 1992; van der Vlist et al., 1997; Olhager and Wikner, 1998, 2000), manufacturing focus (Hallgren and Olhager, 2006), and supply chain planning (Olhager, 2010). Other papers have treated the CODP more generally for a certain area of application, such as the Finnish paper and pulp industry (Lehtonen, 1999) and the Dutch food industry (van Donk, 2001).

According to Christopher (2000), it is important to recognize that there are actually two decoupling points. He said that the first is the material decoupling point, and should ideally lie as far downstream as possible in the supply chain and as close to the final market place as possible. Christopher (2000) also stated that the second decoupling point is the information decoupling point.

Ideally, this should lie as far upstream as possible in the supply chain as this is the furthest point in which information on real, final demand reaches. The challenge is to develop "lean" strategies up to the decoupling point, but "agile" strategies beyond that point. By managing these two decoupling points, a powerful opportunity for an agile response can be created (Christopher, 2000).

Hicks, McGovern and Earl (2000) stated that there are three stages of interaction between ETO companies and their customers. The first stage is marketing, which provides an opportunity for the companies to identify market trends, technical and non-technical customer requirements, and customer criteria for assessing competing offers.

The second stage is tendering that involves the preliminary development of a conceptual design and a definition of major components and systems. A technical specification, delivery schedule, price and commercial terms are agreed upon. They also explained that 75–80 percent of costs are committed at this stage.

The third stage takes place after a contract has been awarded and includes non-physical processes—such as design and planning—and physical processes associated with manufacturing, assembly and commissioning.

Supply chain management in ETO companies involves the coordination of internal processes across these three stages. Tendering, design and contract management are considered to be core capabilities in these companies. These often lead to more attention being paid to product capability and features than to design for manufacture or assembly. This results in increased costs and excessive variety (Hicks, McGovern and Earl, 2000).

Hicks, McGovern and Earl (2000) also described that a key competitive factor in ETO markets is delivery performance. Improving performance has two components: reducing lead time and increasing the reliability of lead time estimates. Lead time reduction has been achieved by shortening the duration of individual processes and by increasing the overlapping of previously sequential activities. Improvements in technology, such as the application of large, multifunctional machine tools, can reduce process time and improve dimensional accuracy. This, in turn, reduces assembly time and variability.

Hicks, McGovern and Earl (2000) stated that the research undertaken has shown that ETO companies can be classified according to the level of vertical integration. Two types of design and contract business can be identified. In the first type, all items from suppliers are delivered to the site and the ETO company carries out the construction and commissioning phase of the work. In the second type, either suppliers or subcontractors undertake all physical activities with only marketing, design, procurement and project management being performed internally.

Hicks, McGovern and Earl (2000) also stated that in considering the appropriate level of vertical integration, ETO companies seek an optimum response to a number of factors. These include reconciling customer delivery times with available capacity, reducing costs, the availability of capital for investment in equipment, the potential utilization of a plant, internal and external capabilities, and flexibility. These factors vary from firm to firm, giving rise to differing levels of vertical integration. This variability makes it difficult to prescribe best practices for supply chain management in ETO companies.

Hicks, McGovern and Earl's (2000) observations on ETO companies suggest that there has been a trend towards vertical disintegration driven by financial pressures and the need for cost reduction. Vertical disintegration can increase flexibility by making alternative product configurations possible, but it can also reduce the scope of concurrent engineering and flexibility to deal with design changes.

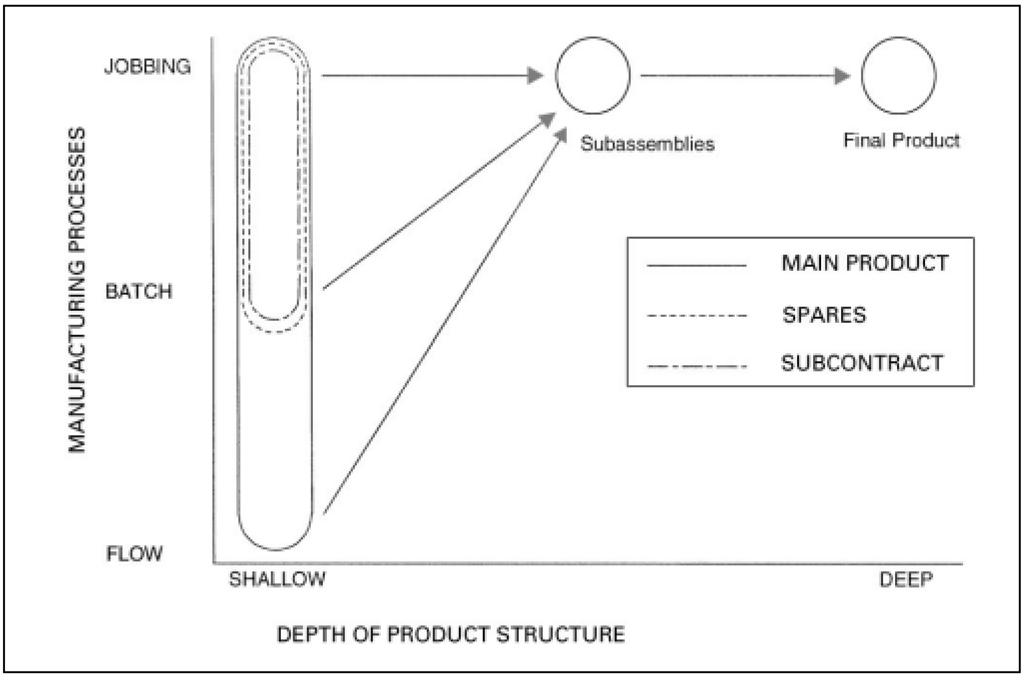


Figure 5: Vertically integrated ETO Company.

Source: Hicks, McGovern and Earl (2000).

To illustrate Figure 5, Hicks, McGovern and Earl (2000) stated that the approach to the outsourcing of manufacturing activities varies from firm to firm. A common approach has been to concentrate on assembly processes as these are considered to result in high levels of added value. Some companies have also retained jobbing processes when manufacturing technologies or other capabilities provide a competitive advantage.

In some cases, such as the production of large, heavy components, in-house manufacturing capability is necessary due to a lack of potential suppliers. At the other extreme, some ETO companies have outsourced all manufacturing, assembly, construction and commissioning activities as a mechanism for minimizing overhead costs. The company produces, in low volumes, the main product that has a deep product structure.

This typically consists of a number of major subassemblies that have medium levels of product structure that are delivered to the customer's site for final assembly. These

subassemblies are produced from a range of components that are manufactured using jobbing, batch and flow processes. An example would be a large steam turbine generator.
According to Naslund and Willamson (2000), Stock and Boyer (2009) defined supply chain based on a synthesis of a wide range of suggestions provided by a variety of practitioners, academics and hybrid sources. They deconstructed the commonalities in all the reviewed suggestions in order to develop their definition of Supply Chain Management (SCM) as “the management of a network of relationships within a firm and between inter-dependent organizations and business units consisting of material suppliers, purchasing, production facilities, logistics, marketing, and related systems that facilitate the forward and reverse flow of materials, services, finances and information from the original producer to final customer with the benefits of adding value, maximizing profitability through efficiencies, and achieving customer satisfaction” (Stock and Boyer, 2009, p.706).
Naslund and Willamson (2000) stated that to some extent, the SCM definitions seem to indicate a move away from the chain analogy to a network analogy. Hertz (2001) also discusses the supply chain network as “the network that supplies a specific product or product group following the chain from raw material to the final consumer”. Lambert et al. (2005, p.25) write that “given that a supply chain is a network of companies, or independent business units, from original supplier to end-customers, management of this network is a broad and challenging task”.

2.3 Supply Chain Integration and Collaboration

According to Angerhofer and Angelides (2006), the objective of a collaborative supply chain is to gain a competitive advantage by improving the chain’s overall performance through a holistic approach rather than by improving each link independently. The belief is that increased collaboration will lead to a seamless, synchronized supply chain which, in turn, will lead to improved customer service, lower costs and higher profits (Holweg et al., 2005). Other potential benefits of supply chain collaboration include improved flexibility, better utilization of resources, shortened as well as improved control of delays, and increased quality and development of competency, each of which will lead to lower costs and higher profits (Gruat La Forme et al., 2007). A more general benefit of increased collaboration is the positive effect that supply chain collaboration has on key performance indicators, thus leading to increased profits (Angerhofer and Angelides, 2006). Supply chain collaboration has emerged as one of several phrases used to describe efforts for creating long-term competitiveness.

2.3.1 Supply Chain Integration

Naslund and Willamson (2000) claimed that although the topic of supply chain integration may not be formally defined, Lambert et al. (1998) mean that the goal of supply chain integration is to enhance total process efficiency and effectiveness across members of the chain. Many authors emphasize both the strategic and operational importance of integration of supply chains (Frohlich and Westbrook, 2001; Zailani and Rajagopal, 2005).

From a strategic perspective, Ajmera and Cook (2009) discussed supply chain integration as partners with joint authority, which will share resources, benefits and risks. Similarly, supply chain integration is sometimes interpreted as a high level collaboration in which the involved parties act as one entity within an extended enterprise (Wen et al., 2007). Newman et al. (2009) stated that supply chain integration has a broader and longer-term perspective compared to supply chain collaboration.

One stated benefit of integration is the network's ability to design products faster, with higher quality and lower costs, as compared to a single company (Ajmera and Cook, 2009). Sharing a similar philosophy, Ragatz et al. (2002) listed a number of potential benefits from supply chain integration. Integration can add expertise and information regarding new ideas and technologies into each partner's system. Integration can help identify problems as well as solutions ahead of time, facilitate outsourcing and reduce the internal complexity of various projects. In addition, integration can improve communication and information exchange between companies. Finally, the researchers claimed that integration can reduce rework and overall project costs.

Cousins and Menguc (2006) presented two different types of integration. They focused on internal integration, found within an organization, and external integration, observed across organizational boundaries and between firms within a supply chain. The basic level of supply chain integration, intra-organizational process management emphasizes that the different functional areas within a company should act as a part of an integrated and coordinated process rather than as functional "silos" within the company (Morash and Clinton, 1998).

The second level of supply chain integration refers to inter-organizational collaborative integration (Bowersox, 1990). Close, interactive, long-term relationships with customers and suppliers are the main characteristics of collaborative integration. The focus is on the behavioral, communicational and interactive flows of the supply chain.

Therefore, the inter-organizational relationship among Ulstein Shipyard and its suppliers play a vital role in its supply chain integration.

2.3.2 Buyer-Supplier Relationship

Developing the right sourcing strategy in managing the firm's supplies is critical for today's managers. They realize the long-term impact of their sourcing strategies (make or buy, supply-base structure, and the nature of the buyer-supplier relationship) on the profits and the efficient functioning of the organization (Park et al., 2012).

Terms like outsourcing, downsizing, streamlining suppliers and forming strategic partnerships with suppliers have become part of today's business jargon. They reflect changes in business practices. Streamlining suppliers and forming strategic partnerships with suppliers means a prime manufacturer and its suppliers are involved in relational exchanges rather than spot market exchanges (Park et al., 2012).

Park et al. (2012) said that since sourcing has a significant effect on the bottom line of a company, it has become a major strategic option. The strategic aspects of sourcing can be analyzed from many different dimensions. Gadde and Hakansson (1994) categorized them into three strategic choices: (1) the question of make or buy, (2) the supply-base structure and (3) the nature of the buyer-supplier relationship.

However, due to the relevance of the research problem of this thesis, discussions will be focused on the buyer-supply chain relationship.

Parties involved in a transaction need to safeguard against the hazards of opportunism and harness the high powered incentives of markets. Kreps (1990) introduced reputation as a self-enforcing device of the trust-honor arrangement, using the well-known prisoner's dilemma to prove the value of cooperation in repeated transactions. Partnerships emerge as a means of reducing the hazards of opportunism and utilizing market incentives. Such relational exchanges between buyers and sellers are not new.

Macaulay (1963) observed that two norms are widely accepted: "(1) Commitments are to be widely accepted in almost all situations; one does not welsh on a deal. (2) One ought to produce a good product and stand behind it" (1963, p. 63). McNeil (1980) distinguished between discrete and relational contracts and identified relational norms—role integrity, preservation of the relationship and harmonization of relational conflict and supra contract norms. Transaction costs may be reduced when parties involved in transactions honor those relational norms.

2.3.3 Relational Norms and Dependence

Relational norms may be described as the values shared among exchange partners regarding what is deemed appropriate behavior in a relationship (for example, Heide and John, 1992). When buyer-supplier relationships are characterized by high relational norms, exchange parties are more committed (Gundlach et al., 1995) and exhibit a long-term orientation (Ganesan, 1994), thus lowering future negotiation costs (Artz and Norman, 2002).

Over the last two decades, closer supply chain relationships exhibited by high relational norms—such as trust, collaboration, long-term relationship and increased information sharing—have evolved in many industries to help firms respond to changes (Droge and Germain, 2000; Hoetker et al., 2007; Monczka et al., 1998; Sengün and Wasti, 2007; Whipple and Frankel, 2000). Relationships with low relational norms are characterized by distributive (Walton and McKersie, 1965) or aggressive (Ganesan, 1993) bargaining behavior.

Chanchai and Young (2009) summarized that the use of legal contracts governs these relationships and aggressive bargaining tactics are used to resolve disagreements. In short, high relational norm relationships may be characterized as partnerial or cooperative, while low relational norm relationships tend to be "arm's length" or competitive.

2.3.4 Relationship Continuance

Chanchai and Young (2009) quoted that research has shown that expectations of continuance in buyer-supplier relationships are strong when there are shared values between the exchange partners regarding what constitutes appropriate behavior in the relationship (Morgan and Hunt, 1994). It has been argued that the presence of relational norms increases the expectancy of relationship continuity (Joshi and Arnold, 1998).

These norms can take on relevant dimensions such as flexibility, information exchange and solidarity, to name a few (Heide and John, 1992). Under conditions of high relational norms, buying firms have a high expectation of relationship continuity and low expectations under low relational norms (Joshi and Arnold, 1998). Besides, evidence has shown that in some buyer-supplier relationships, the effect of trust is a deterrent to relationship dissolution and facilitates relationship continuance (Gassenheimer and Manolis, 2001; Helper and Sako, 1995).

If firm relationships are characterized by thin relational networks, mutual lack of knowledge and weak inter-dependence, the relationships tend to be fragile and dissolvable when exposed to changes in supply and demand (Hallen and Johanson, 2004).

2.3.4 Assertiveness and Cooperativeness in Managerial Decision-making

Wilmot and Hocker (2001) base negotiation, or conflict management, strategies on a two-dimensional framework: assertiveness and cooperativeness. They base this framework on the five different negotiation strategies provided by Kilmann and Thomas (1975)—avoidance, accommodation, collaboration, competition and compromise.

According to Wilmot and Hocker (2001), assertiveness is required when a tendency of concern for oneself exists, and cooperativeness is required in the presence of concern for others. The greater the concern for self, the greater an individual's assertiveness tendency, whereas the greater the concern for others, the greater an individual's cooperativeness tendency.

Using Kilmann and Thomas' (1975) negotiation strategies, a high level of assertiveness would be exhibited by an individual engaged in competition and collaboration strategies, and a low level of assertiveness would be exhibited by an individual engaged in accommodation and avoidance strategies.

Chanchai and Young (2009) added that a high level of cooperativeness would be exhibited by an individual engaged in collaboration and accommodation strategies, and a low level of cooperativeness would be exhibited by an individual engaged in competition and avoidance strategies.

2.3.5 Buyer-Supplier Relationship—Complexity of Trust

Buyer-supplier relationships focus on established inter-organizational "transactions, flows, and linkages" between the vendor of a product or service and the purchaser of that service (Oliver, 1990). Koulikoff-Sourviron and Harrison (2006, p. 77) identified seven dimensions of the buyer-supplier relationship with their accompanying characteristics, briefly explained in Table 2.

Table 2: Dimensions and characteristics of buyer-supplier relationship.

Source: Koulikoff-Sourviron and Harrison (2006).

Dimensions and characteristics of the buyer–supplier relationship

Dimensions	Characteristics
Goals	Goals are shared, explicit, and clear at strategic and operational levels
Information sharing	Open and prompt two-way information sharing
Relationship structure	Multiple levels and functions are in contact. Clear communication channels. Inter-personal relationships
Coordination mechanisms	Formal as well as informal mechanisms govern the relationship
Locus of decision making	Clear decision-making process. Mandate from top management
Top management commitment	Top managers jointly support the relationship
Compatibility	Compatibility of organizational structure and management philosophy

Since buyers and suppliers may have divergent interests, with the supplier wanting to obtain the highest reasonable price and the buyer seeking the lowest possible cost, the management of the relationship between a buyer and a supplier is inherently subject to conflicts and pressures (Moeller et al., 2006). Mukherji and Francis (2008) noted that it requires constant mutual adaptation, inter-dependence and joint action to create a relationship in which both parties have a high level of trust in each other. Sengün and Wasti (2007) noted that the relationship between the parties balances trust, control and risk as the buyer and supplier pursue their distinct but syncretic agendas.

2.3.5 Complexity of Trust and Distrust

According to Josh et al. (2009), scholars consistently defined trust as a key “aspect of relationships” that is “varied within person and across relationships” (Schoorman et al., 2007, p. 344), but perspectives about the exact nature of trust have varied widely. The relationship between trust and vulnerability associated with risk is common to many discussions of trust (cf. Donaldson and Dunfee, 1999; Kjaernes, 2006; Mayer et al., 1995; Searle and Ball, 2004).

About the overlap of trust and distrust, Lewick et al. (1998, p. 439) explained that “speed, quality, and global reach, which require trust, also have precipitated distrust through corporate restructuring, downsizing, and fundamental violations of psychological contracts”. Baruch and Lambert (2007) explained that distrust produces organizational anxiety in addition to individual anxiety. Thompson and Bunderson (2003) noted that violation of the perceived psychological contract that exists between parties is interpreted as both a serious ethical breach and destroyer of trust.

Josh et al. (2009) pointed that Caldwell and Clapham (2003, p. 358) identified six factors that measured organizational-level trustworthiness—including honest communication, task competence, quality assurance, interactional courtesy, legal compliance and financial balance. In assessing the decision to trust another person, each party evaluates the other party's behavior about the perceived psychological contract and duties owed through a subjective mediating lens, and makes the decision of whether or not to trust (Caldwell and Clapham, 2003). Adapting the Caldwell and Clapham (2003) framework to the buyer-supplier relationship, Josh et al. (2009) proposed a diagram indicated in Figure 6 as a model for understanding the decision to trust that exists in this relationship.

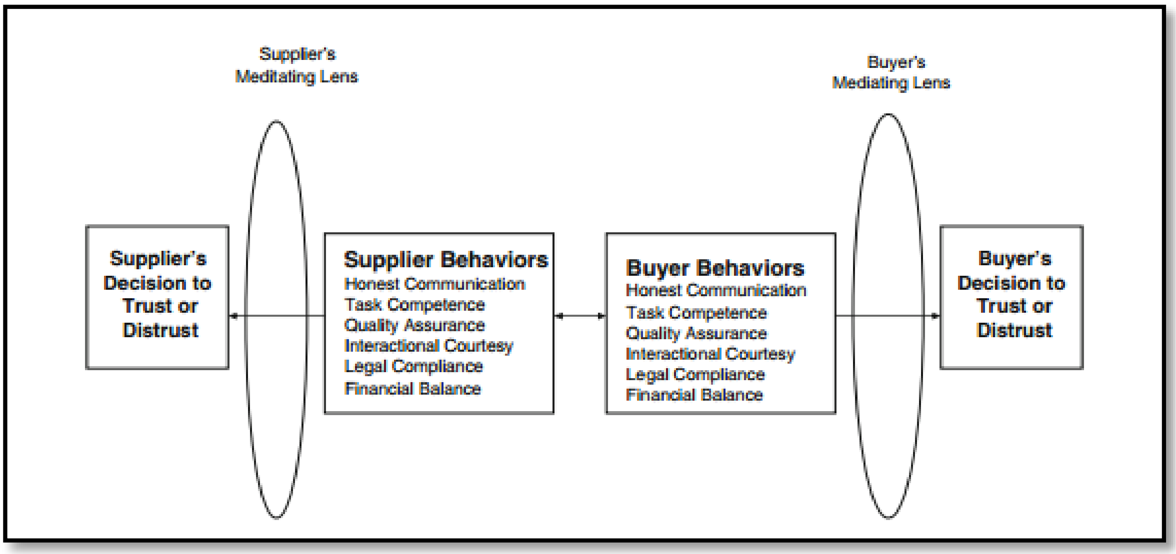


Figure 6: Model for buyer-supplier decision to trust or distrust.

Source: Josh et al. (2009).

Josh et al. (2009) also added that each of the six factors of organizational trustworthiness identified by Caldwell and Clapham (2003) may play a key role in the personal calculus through which the buyer or supplier ascertains whether the other party's behavior is ethical and trustworthy. Table 3 defines each of those six factors and provides an example of how each factor may be interpreted in the buyer-supplier relationship (Caldwell and Clapham, 2003, pp. 353–359).

Table 3: Six factors of trustworthiness and their practical applications.

Source: Caldwell and Clapham (2003).

Factor	Factor definition	Practical application
Honest communication	The degree to which communications are honest, truthful, and complete – including whether commitments are honored	Either party may interpret what is communicated based upon personal assumptions and history. Expectations are dependent upon the interpretation of the psychological contract thought to apply
Task competence	The ability to perform key tasks competently, including both technical and relational tasks	A buyer may expect a supplier to deliver a product at an agreed upon time, but circumstances may arise that the supplier fails to anticipate. The competence of the other party may be called into question
Quality assurance	The degree to which products or services meet quality expectations and the degree to which processes comply with quality standards	Parties may differ regarding the distinction between "conformance with specifications" and "fitness for the expected use required." Operational definitions about quality may differ substantially
Interactional courtesy	Being treated as a valued "end" rather than as a "means." Treatment that is courteous, respectful, and committed to the welfare, growth, and wholeness of the other	The buyer–supplier relationship is inherently an instrumental or outcome-based relationship, and the tendency may be for one party to view the relationship as merely transactional and short term
Legal compliance	Conformance with the spirit of the law, in addition to the letter of the law	Acknowledging that what was intended and relied on in a formal agreement may not be precisely reflected by the contract's actual verbiage
Financial balance	Providing the resources to realistically accomplish what is expected from the other party	Recognizing that an unanticipated change in market conditions needs to be accommodated in the buyer–supplier relationship

Finally, Josh et al. (2009) said that building trust at the organizational level is dependent on the ability of the parties involved to communicate that they are trustworthy and to demonstrate that trustworthiness by consistent behavior (Schoorman et al., 2007). However, trust building also requires recognizing that the other party may have a separate agenda, a different set of values and a unique perspective about the goals and objectives to be accomplished in the potential partnership (Hosmer, 2008).

The buyer-supplier relationship provides an opportunity for the parties to build a relationship that is mutually beneficial, but the implicit nature of that relationship can be challenging and difficult to negotiate (Mukherji and Francis, 2008; Saccani and Perona, 2007). Josh et al. (2009) added that by understanding and honoring the expectations of the other party, both the buyer and the supplier can build mutual trust and can make meaningful headway in pursuing the opportunity for a shared benefit. Communicating about mutual expectations, honoring commitments and working in a partnership can allow both parties to build trust while maintaining a reputation as ethical and committed partners.

2.4 Outsourcing

An important part of Ulstein Shipyard is the outsourcing of different tasks to many suppliers. Therefore, this section will be covering outsourcing.

Brandes et al. (2012) stated that the standard recipe for outsourcing, in literature and in practice, is to keep core activities and resources in-house. For complementary resources and capabilities, partnership relationships are recommended and for standard solutions to buy "at arm's length" (Cox, 1996). However, what is considered core is changing over time.

Porter (1980a, 1980 b) stated that outsourcing can also be seen as a radical contrast to the conventional wisdom of competitive strategy since it is a way to achieve a combination of two strategies—cost leadership and differentiation— at the same time.

2.4.1 Five Different Logics of Outsourcing

Brandes et al. (2012) described five different logics for outsourcing: cost cutting, core competence focus, control, flexibility and access to external resources.

Brandes et al. (1997), and Lonsdale and Cox (1997) described that the first logic is cost cutting or the lowest cost. Cost is often considered the most important criterion for an outsourcing decision. A comparison has been made between the cost for in-house production and external sourcing.

Williamson (1979) divided costs into production and transaction costs. From a transaction cost perspective, the company is primarily considered a governance structure. Transaction costs include a number of ex ante costs—such as drafting and negotiations—and ex post costs—such as monitoring and enforcing agreements (Rindfleich and Heide, 1997).

Brandes et al. (2012) argued that a trade-off exists between transaction and production costs. In-house control will typically involve lower transaction costs, but, at the same time, will sacrifice the potential for economies of scale and the collective pooling of resources found in an outsourcing/market solution.

Brandes et al. (2012) summarized from Prahalad et al. (1990), Grant (1991) and Javidan (1998) that the second logic is based on long-term competitiveness rooted in the corporation's core competence. By definition, the core competence has complex and systemic properties with tacit knowledge and competences embedded in organizational and cultural contexts. Organizational learning is important for the development of core competence.

Brandes et al. (2012) also pointed out the following strategic implications of this perspective:

1. Core competence should be kept in-house.
2. The availability of important complementary resources in partnership relationships should be secured.
3. The supply of commodities should be done via the market mechanism (Brandes et al., 1997; Lonsdale and Cox, 1997).
4. Outsourcing decisions might require upgrading of competence (Quinn and Hilmer, 1994; Harrison and Kelly, 1993).

Brandes et al. (2012) explained that the concept of core competence has many aspects in common with Williamson's concept of transaction costs. Hamel and Hene (1994) stated that core competence is not a simple skill or asset and can range from "what one does best" to "what the customers value the highest" (Nordigarden, 2007). Some researchers argued that the application of a resource-based view to outsourcing has been the most vital development during the last decade (Espino-Rodriguez and Padron-Robaina, 2006).

The third logic, control, is based on the assumption that outsourcing should be avoided in cases where there is a high risk of supplier opportunism. A dominant supplier with unique resources (high asset specificity) and an information advantage (information asymmetry) might behave opportunistically (Londsale, 2001). Andersson et al. (2008) argued that a supplier's high prices are not only a cost problem, but the buyer could also lose control of lead times (time-to-market and time-to-customer), quality and product development.

Brandes et al. (2012) summarized from Greaver (1999), Abrahamsson et al. (2003) and Carlson (2005) that the fourth logic, flexibility, is important in its own right in a highly dynamic environment. It is tempting to try to transform fixed costs into variable costs by outsourcing, especially when companies face a need for investments in new machinery, factories or IT systems.

Nordigarden (2007) claimed that this situation can trigger outsourcing decisions. A combination of in-house production and outsourcing can also be a viable solution. Brandes et al. (2012) added that a high degree of uncertainty regarding new technology could lead to outsourcing as a firm seeks to maintain flexibility and reduce costs at the same time.

About the fifth logic, access to superior external resource, Deavers (1997) mentioned access to world-class competence as one of the top five reasons for outsourcing. Harrison and Kelly (1993), Fine and Whitney (1999), and Quinn (2000) also claimed that the ability to exploit external resources puts the management of supplier relationships into focus.

2.5 Toyota Production System and Lean Production

2.5.1 Toyota Production System

TPS was devised by Eiji Toyoda and Taiichi Ohno for the Toyota Motor Company in 1977. TPS is the next major evolution in efficient business processes after the mass production system invented by Henry Ford, and it has been documented, analyzed and exported to companies across diverse industries throughout the world. Outside of Toyota, TPS is often known as "lean" or "lean production" (Liker, 2004).

The cornerstones of the TPS (lean production) are the pull system and built-in quality; their sustainability is ensured by *kaizen* activities on a daily basis. Meeting and exceeding customers' requirements is the task of everyone within the organization. The heart of the TPS is delivering value by eliminating waste and ensuring an undisturbed workflow (Liker, 2004). It is also necessary to emphasize that lean is about developing and customizing principles that are right to a specific organization (for example, a shipyard) and diligently practicing them to achieve high performance that continues to add value to customers and society. This, of course, means being competitive and profitable (Liker, 2004).

2.5.2 Lean Manufacturing

The story of lean begins with the TPS, developed after the Second World War by Eiji Toyoda and Taiichi Ohno for Toyota. At that time, Toyota was a small company and needed a production system capable of rapid changes in kinds and models (Liker and Lamb, 2000). TPS was the next major evolution in efficient business processes after the mass production system invented by Henry Ford, and it has been documented, analyzed and exported to companies across diverse industries throughout the world (Liker, 2004). James Womack's book, entitled *The Machine That Changed the World* (1990), is a straightforward account of the history of automobile manufacturing combined with a study of Japanese, American and European automotive assembly plants. What is new is the phrase "lean manufacturing" (Womack and Jones, 1990).

2.5.3 Basics of Lean Manufacturing

The heart of the TPS is delivering value by eliminating waste and ensuring an undisturbed workflow. Outside of Toyota, TPS is often known as “Lean”, “Lean Production” or “Lean Manufacturing” (Liker, 2004). Lean manufacturing caught the imagination of manufacturing in many countries and implementations are now commonplace. The knowledge and experience base are expanding rapidly (Diekmann et al., 2004).

To put it simply, the main idea behind lean is to maximize customer value while minimizing waste. The ultimate goal, which is very hard and almost impossible to achieve, is to provide perfect value to the customer. This can be achieved by having a perfect value creation process with zero waste (Lean Enterprise Institute, 2009). This section presents the concepts of value and waste.

2.5.4 Lean Manufacturing Tools

One goal of our thesis is to integrate WestCoat into Ulstein Shipyard’s ETO production networks**.** Our proposition to reach this goal is to implement an efficient lean tool. Using this lean tool will help us identify the activities where waste occurs, understand the characteristics of waste occurrences, and remove those wastes from the internal manufacturing and external supplier contexts. This will help create opportunities for greater integration of the supplier into the shipyard’s ETO production networks and to mitigate the dependencies and bottlenecks that arose between WestCoat and the production networks. Moreover, implementing those lean tools is highly relevant to answer the second question in our thesis of how to integrate the supplier’s value stream into Ulstein Shipyard’s value stream.

According to Monden (1993), there are three types of operations in an internal manufacturing context that people engage in as they relate to the customer:

1) Value adding operations involve the conversion or processing of raw materials or semi-finished products through the use of manual labor. These activities include subassembly of parts, forging raw materials and painting body work.
2) Non-value added operations are a pure waste and involve unnecessary activities, such as waiting time, stacking intermediate products and double handling, which should be eliminated completely.
3) Necessary but non-value adding operations seem wasteful, but are necessary under current operating procedures. Examples include unpacking deliveries and transferring a tool from one hand to another. It is necessary to make major changes to the operating

system, such as creating a new layout or arranging for suppliers to deliver unpacked goods, in order to eliminate these types of operation.

Womack and Jones (2003) stressed that lean mainly depends on one critical starting point called value. According to S. Tyagi et al. (2014), value can be defined only by the customer, and it can measure the manufacturer's efficiency when the product is delivered at a reasonable price at an appropriate time in the right amount.

Singh and Singh (2013) stated that one of the major challenges for the manufacturing industry is to make different products with a minimum lead time, reduced inventory and world class quality. There is a need to help manufacturing companies to improve their competitiveness.

In recent times, many organizations have either attempted to implement or have already implemented lean manufacturing. Some companies have implemented a few tools, techniques, practices and procedures of lean manufacturing, while others have implemented a whole spectrum of lean manufacturing elements (Gurumurthy and Kodali, 2009).

The objective of lean manufacturing is to reduce waste in every part—such as human effort, inventory, time to market and manufacturing space—to become more responsive to customer demand while producing quality products in the most efficient and economical manner (Womack et al., 1990).

Lean manufacturing encompasses many different strategies and activities that are familiar to almost all industrial engineers (Braglia et al., 2006; Chitturi et al., 2007; Mahapatra and Mohanty, 2007). In many such cases, firms have reported some benefits by applying lean principles; however, it is apparent that there is a need to understand the entire system in order to gain maximum benefits (Singh et al., 2010). VSM acts as an enterprise improvement tool in lean manufacturing to assist in visualizing the entire production process, representing both material and information flow. Many managers and researchers such as Hines et al. (1998), Hines (1999), Abdulmalek and Rajagopal (2007), Serrano et al. (2008) and Singh et al. (2009) applied VSM for identification and elimination of waste in production industry.

2.5 Value Stream Mapping (VSM)

Rother and Shook (1999) explained that a value stream is comprised of all activities (both value added and non-value added required to bring a product or a group of products from the raw material stage to the customer. According to Hines and Rich (1997), value stream refers only to the specific parts of the firms that actually add value to a specific product or service under consideration.

According to Brown et al. (2014), VSM is an important tool used in lean manufacturing to identify and visualize waste. Gurumurthy and Kodali (2010) mentioned that VSM is a pencil-and-paper visualization tool that shows the flow of material and information as a product makes its way through the stream.

Rother and Shook (1999) said that the ultimate goal of VSM is to identify all types of waste in the value stream and to take steps to eliminate them by implementing a future-state value stream that can become a reality within a short period of time. Womack and Jones (2003) proposed five lean management principles forming the backbone of VSM:

1) Specify value for the product from the customer's point of view.
2) Identify the value stream and eliminate waste.
3) Make the value flow.
4) Let the customer pull (value) rather than push to customers.
5) Pursue to reach the level of perfection.

Similarly, Rother and Shook (1999) stated that four steps are involved in VSM in order to design and introduce a lean value stream (Figure 7):

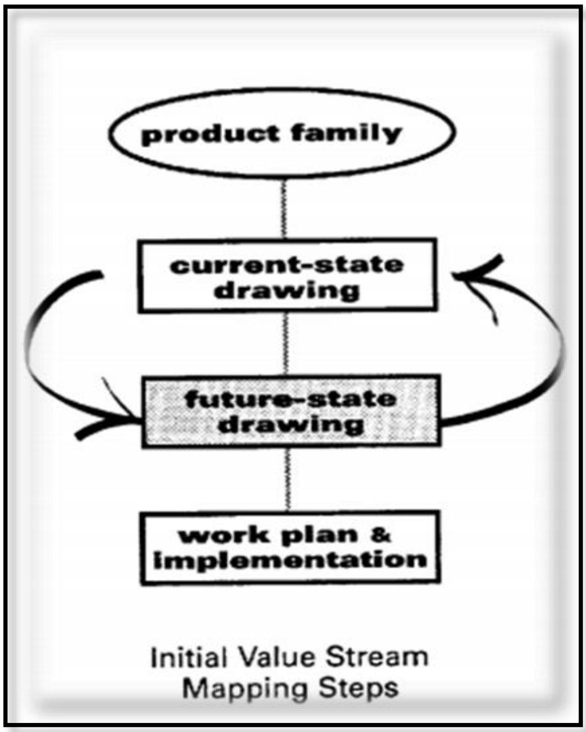


Figure 7: Value stream mapping steps.

Source: Rother and Shook (1999).

1) Selecting a product family by focusing on one product family from the customer end of the value stream as the target for improvement instead of drawing all product flows considered too complicated (Rother and Shook, 1999).
2) Drawing a current state map by using measurements such as cycle time, setup time and lead time in order to examine the production floor and to analyze the complete path a product takes through the plant according to the major processing steps, wherever material or information flows occur (Rosentrater and Balamuralikrishna, 2006). A current state map serves as the basis for developing the future state map.
3) Developing a future state map which demonstrates the output of the proposed changes based on the gaps identified in the current state map (Tyagi et al., 2014). A future state map is a picture of how the system should look after the inefficiencies in it have been removed. Drawing a future state map is done by answering a set of questions on issues related to efficiency and on technical implementation related to the use of lean tools (Abdulmalek and Rajagopal, 2008).
4) Conducting a work plan to implement the future state map based on the differences between the current and future state maps (Arbulu and Tommelein, 2002). Rother and Shook (1999) explained that this work plan shows what plan to draw and by when, measurable goals and clear checkpoints with real deadlines, and named reviewers (Figure 8).

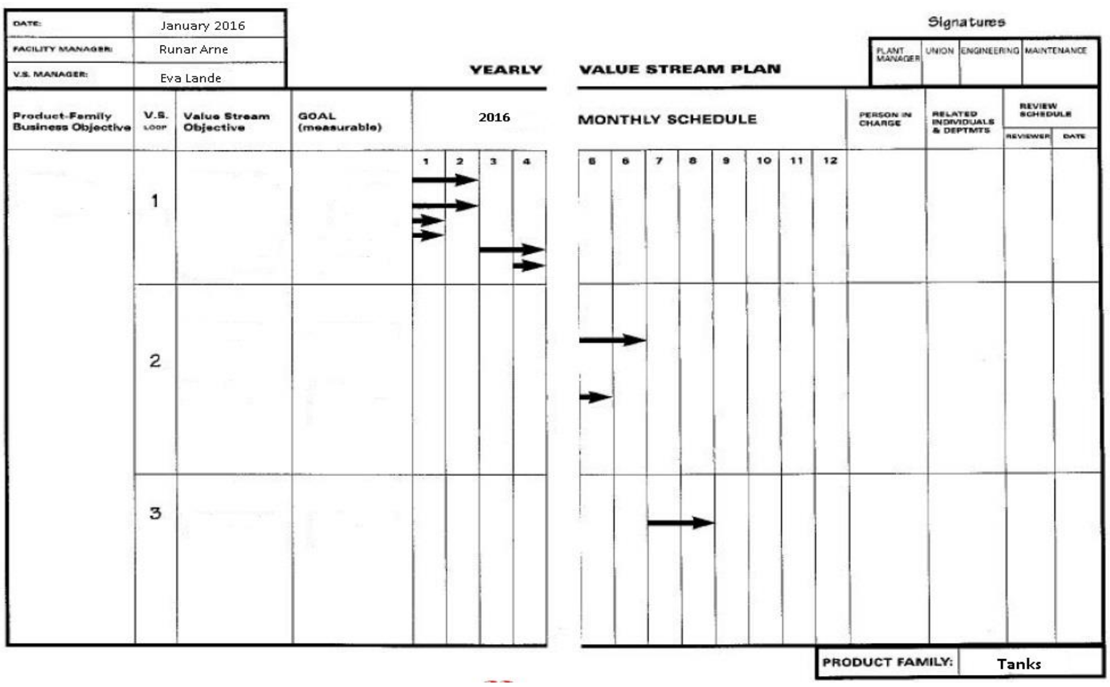


Figure 8: Yearly value stream plan.

Source: Rother and Shook (1999).

Before implementing the developed future state map, company has to engage a person who will be the manager of the value stream to execute the future state map. Value stream managers' job is to lead the people who will operate the process in all business functions and to be responsible for the cost, quality and delivery of the product in the current state while mapping and leading the implementation of the future state. First, the value stream manager has to do the following tasks:

1) Breaking implementation of the developed future state into steps:

It is not possible to implement the entire future state concept at once, as it looks at the entire flow through the company's facility. Therefore, they suggested dividing the company's future state value stream map into segments or loops.

2) Create a value stream plan:

Company's future state map shows where to go. Rother and Shock (1999) stated that once the value stream manager have a sense for the basic order in which he or she want to implement the elements of expected future state vision, the value stream manager needs to write them down as the yearly value stream plan. Additionally, the value stream manager needs to create a yearly value stream plan that shows:

- What plan to do and when to do it?
- Set measurable goals.
- Set checkpoints with real deadlines and named reviewers.

The value stream manager can start the plan implementation by focusing on achieving continuous improvements in loops of the developed future state value stream. Loops improvements include: develop a continuous flow, establish a pull system and eliminate wastes in the value stream. Figure 8 display a yearly value stream plan where the value stream manager can set objectives, measurable goals and keep tracking of the execution of the value stream plan. Yearly value stream plan used also as a performance indicator to evaluate the manufacturing performance quarterly or monthly. Moreover, continuous improvements in the process achieved through focusing on the unsuccessful objectives and goals in the yearly value stream plan instead of focusing on the accomplished objectives and goals.

3) Management responsibility:

Rother and Shock (1999) stated that value stream improvement is primarily a management responsibility. Management has to understand that its role is to see the overall flow, develop a vision of an improved, lean flow for the future, and lead its implementation. One cannot delegate it. He or she can ask the front lines to work on eliminating waste, but only management has the perspective to see the total flow as it cuts across department and functional boundaries.

Rother and Shock (1999) also stated that from the combined experience with many companies in range of industries over the past fifteen years the following are needed:

-Constant efforts to eliminate overproduction. If one eliminates over production the system will have great flow.

-A firm conviction that lean principles can be adapted to work in given setting, coupled with a willingness to try, fail and learn.

In other note Rother and Shock (1999) stated that many errors simply occurred with the territory when implementing change in long established mass production practices. If one does it right, each approach will be nearer to the target and will add to the understanding level. Such reiteration is a normal part of any lean implementation effort and success will be achieved those who have the determination to personally work through the obstacles.

They also added that management needs to dedicate time and to really learn this stuff for themselves- learn it to the point that the can actually teach it. Then they need to teach it. Not primarily in the classroom (although there is a place for that), but in their daily interactions with their staff. At whatever level, from CEO to plant floor supervisor, the words and deeds of managers must be pushing the creation of a lean value stream. It simply will not work if it is relegated to a few minutes at the weekly staff meeting. It is got to be part and parcel of every day’s activities. Practice the mapping concept presented here to the point that it becomes an instinctive means of communication.

Rother and Shock (1999) also added that one will need a way to get people to follow his or her lead, without always waiting for ones to lead them. Begin by focusing ones organization on a relatively small number of specific target (e.g. manage by value stream maps). One may recognize this as policy deployment. They also added that eventually, one should evolve to policy management, which is much more dynamic process where lower levels of the organization take part in formulating policy as well as carrying it out. As you learn organization matures, you will find the policy begins to emerge from interactions between levels of the organization, rather than simply emanating from above to be deployed by below.

Rother and Shock (1999) urged executioners that lean promotion group has to be actually on the plant floor. This team has to be involved in leading the changes, embracing a “hands on" approach to problem solving, while paying attention to the actual needs of the organization and customers. They added that the only way to learn lean methods is to apply the techniques hands on with a bit of coaching.

Finally, they added that lean value stream must be developed with respect for people. However, respect for people should not be confused with respect for old habits. Developing lean value streams can be hard work, often with one-step back for every two forward. Developing a lean value stream exposes sources of waste, which means that people in all business may have to change habits. They believed that every management and employee has a role to play in lean implementation, and that everyone should feel a benefit from it. These benefits can come in many forms: increased competitiveness of the company, a better working environment, greater trust between management and employees and not least a sense of accomplishment in serving customer.

2.6.1Value Stream Mapping Tools

According to Hines and Rich (1997), several authors—like New (1993), and Jessop and Jones (1995)—have developed individual tools to understand the value stream. Hines and Rich (1997) argued that those authors viewed their creations as the answer rather than as a part of a jigsaw. Moreover, Hines and Rich (1997) claimed that the tools developed by those authors do not fit well with the more cross-functional toolbox required by today's best companies. Therefore, Hines and Rich (1997) constructed a typology of seven new tools in terms of the seven wastes in the TPS—over production, waiting, transport, inappropriate processing, unnecessary inventory, unnecessary motion and defects—to allow for an effective application of subsets of the complete suite of tools.

The value stream tools are:

1. Process activity mapping.
2. A supply chain response matrix.
3. Production variety funnel.
4. Quality filter mapping.
5. Demand amplification mapping.
6. A decision point analysis.
7. A physical structure.

Hines and Rich (1997) highlighted the importance of the mapping process, saying a researcher will be able to utilize the benefits associated with each tool in order to conduct a more detailed analysis of the value stream with a view to its improvement. They drew a table from a variety of origins where the tools are correlated with the seven types of wastes and they suggested that, in order to make improvements in the supply chain, an outline understanding of the particular wastes to be reduced must be gained before any mapping activity takes place. This is depicted in Table 4.

Table 4: Seven value stream mapping tools.

Source: "The seven value stream mapping tools" (Hines and Rich, 1997).

Wastes / Structure	Mapping Tools						
	Process Activity Mapping	Supply Chain Response Matrix	Production Variety Funnel	Quality Filter Mapping	Demand Amplification Mapping	Decision Point Analysis	Physical Structure (a) Volume (b) Value
Overproduction	L	M		L	M	M	
Time Waiting	H	H	L		M	M	
Transport	H						L
Inappropriate Processing	H		M	L		L	
Unnecessary Inventory	M	H	M		H	M	L
Unnecessary Motion	H	L					
Product Defects	L			H			
Overall Structure	**L**	**L**	**M**	**L**	**H**	**M**	**H**
Origin of Tool	Industrial Engineering	Time compression/ Logistics	Operations Management	New Tool	Systems Dynamics	Efficient Consumer Response / Logistics	New Tool
Notes: H = High correlation and usefulness M = Medium correlation and usefulness L = Low correlation and usefulness							

Hines and Rich (1997) suggested using a process activity mapping tool drawn from the industrial engineering origin in order to map the value stream. Process activity mapping originates from industrial engineering, which adjusts several techniques in order to eliminate wastes at the work place, inconsistencies and irrationalities. Furthermore, industrial engineering techniques provide high quality goods and accelerated cheap services.

According to Hines and Rich (1997), there are five stages for the process activity mapping approach:

1) Studying the flow of processes.
2) Identifying the wastes.
3) A more efficient sequence for the rearrangement of the process to be considered.
4) A better flow manner, including the varied flow layout or transport routing to be considered.

5) Ensure that everything that is being done in each stage is necessary and understanding the consequences of removing the superfluous tasks to be considered.

Simply, according to Hines and Rich (1997), the process activity mapping tool includes the following steps:

1) Conducting a preliminary analysis of the undertaken process.
2) Recording the details of all the required items in each process.

The result of conducting those steps is explained in a map for the process under consideration in Table 5.

Table 5: Process activity mapping.

Source: Hines and Rich (1997).

#	STEP	FLOW	MACHINE	DIST (M)	TIME (MIN)	PEOPLE	OPERATION	TRANSPORT	INSPECT	STORE	DELAY	COMMENTS
1	RAW MATERIAL	S	RESERVOIR				O	T	I	S	D	RESERVOIR/ ADDITIVES
2	KITTING	O	WAREHOUSE	10	5	1	O	T	I	S	D	
3	DELIVERY TO LIFT	T		120		1	O	T	I	S	D	
4	OFFLOAD FROM LIFT	T			0.5	1/2	O	T	I	S	D	
5	WAIT FOR MIX	D	MIX AREA		20		O	T	I	S	D	
6	PUT IN CRADLE	T		20	2	1/2	O	T	I	S	D	
7	PIERCE/POUR	O	MIX AREA 12		0.5	1	O	T	I	S	D	
8	MIX (BLOWERS)	O			20	1/2	O	T	I	S	D	BASE MATERIAL, BLOW & ADDITIVES
9	TEST #1	I			30	1+1	O	T	I	S	D	SAMPLE/TEST
10	PUMP TO STORAGE TANK	T	STORE TANK	100		1	O	T	I	S	D	DEDICATED RESERVOIR
11	MIX IN STORAGE TANK	O	STORE TANK		10	1	O	T	I	S	D	
12	I.R. REST	I			10	1+1	O	T	I	S	D	STAMP & APPROVE
13	AWAIT FILLING	D			15		O	T	I	S	D	LONGER IF SCREEN LATE
14	TO FILLER HEAD	T		20	0.1	1	O	T	I	S	D	
15	FILL/TOP/TIGHTEN	O	FILLER HEAD		1	1+1	O	T	I	S	D	1 UNIT
16	STACK	T	PALLET	3	0.1	1	O	T	I	S	D	1 UNIT
17	DELAY TO FILL 1 PALLET	D			30		O	T	I	S	D	
18	STRAP PALLET	O			2	1	O	T	I	S	D	
19	TRANSFER TO STORE	T		80	2	1	O	T	I	S	D	
20	AWAIT TRUCK	D	STORE		540		O	T	I	S	D	BATCH 360/ QUEUE 180
21	PICK/MOVE BY FORK LIFT	T		90	3	1	O	T	I	S	D	FORK LIFT
22	WAIT TO FILL FULL LOAD	D	LORRY		30	1+1	O	T	I	S	D	1 OPERATOR, 1 HAULIER
23	AWAIT SHIPMENT	D	LORRY		60	1	O	T	I	S	D	1 HAULIER
	TOTAL		23 STEPS	443	781.2	25	6	8	2	1	6	
	OPERATORS				38.5	8						
	% VALUE ADDING				4.93%	32%						

The basis of this approach is, therefore, to try and eliminate activities that are unnecessary, simplify others, combine yet others and seek sequence changes that will reduce waste. Afterwards, a calculation and recording can be done for the total distance moved, the time taken and the involved people.

The completed diagram (Table 5) could be used as a basis to conduct further analyses and subsequent improvements by using the 5W1H technique. The 5W1H technique asks questions such as:

1) What is the activity to be executed?
2) Who is responsible to execute this activity?
3) How the activity will be executed?
4) Where the activity should be executed?
5) When should the activity be executed?

According to Shingo (1988), *why* an element does not comprise a specific phenomenon is a question that must be asked about the other five elements in pursuit of the purposes. Moreover, he stated that one must ask, "Why is *what* being selected as the problem?" and "Why is *who* doing it?" When a problem arises, it should be viewed in terms of its five components: *what*, *who*, *how*, *where* and *when*. The question *why* should then be asked about each of the components.

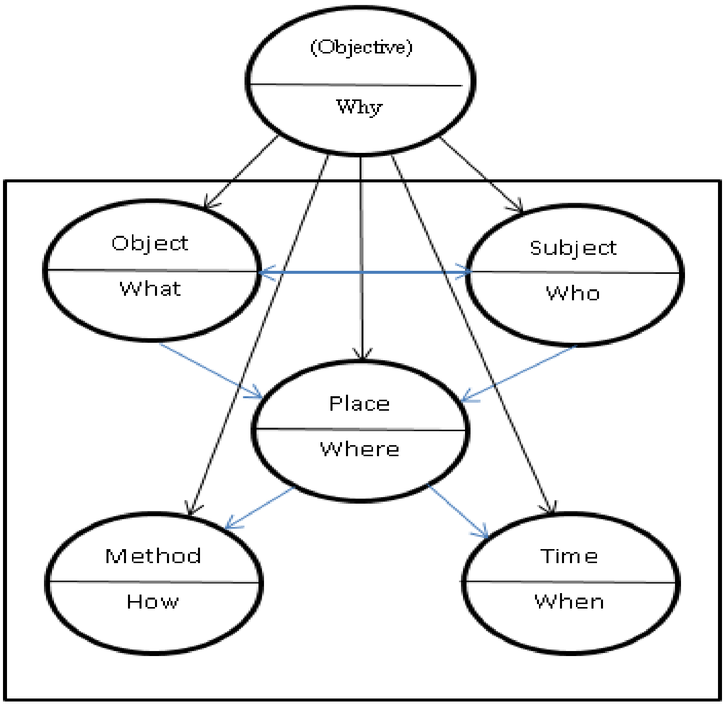


Figure 9: Five elements of production 5W1H.

Source: Retrieved from Shingo (1988).

2.7 Lean Construction

Even though lean production was highly successful in the car manufacturing industry, many believed that it would not be applicable to the construction industry. The construction industry is compared to the car industry which is highly dynamic and complex. The construction industry operates in a highly uncertain environment. Furthermore, the industry has substantial schedule and time pressures which makes it fundamentally different from the car industry (Dugnas and Oterhals, 2008).

2.7.1 Lean Construction Principles

In various subfields of the new production philosophy, a number of heuristic principles for flow process design, control and improvement have evolved. There is ample evidence that the efficiency of flow processes in production activities can be considerably and rapidly improved through those principles (Koskela, 1992). The principles are believed to be crucial to lean construction. However, most of them also apply to lean manufacturing (Koskela, 2000). Koskela added that in general, the principles are applicable to both the total flow process and its sub-processes. In addition, the principles implicitly define flow process problems, such as complexity, in either transparency or segmented control. The principles are presented below.

1. Meeting the requirements of the customer.
2. Reducing non-value adding activities.
3. Reducing cycle time.
4. Reducing variability.
5. Increasing flexibility.
6. Increasing transparency.

It is also necessary to emphasize that lean is about developing and customizing principles that are right for each specific organization and diligently practicing them to achieve a high performance that continues to add value to customers and society (J.K. Liker, 2004).

2.8 Lean Shipbuilding

Dugnas and Oterhals (2008) said that the worldwide research in this area is limited. First, such limitation is due to the fact that lean shipbuilding is actually quite similar to lean construction. Second, the term itself has yet to become a concept with a solid theoretical base. They primarily discussed Norwegian shipyards.

The shipbuilding industry in Norway bases its production on different phases due to specific competition conditions. The key trend now is to outsource the hull fabrication and primary outfitting to low-cost countries. The remaining work is done at outfitting yards in Norway. Hence, there are usually four key production phases (Dugnas and Oterhals, 2008):

1. Hull fabrication.
2. Primary outfitting.

3. Final outfitting.
4. Testing.

Within the lean shipbuilding program, the concept of project logistics is understood as the flow of parts and components within a shipyard facility. The focus is on the optimization of internal logistics by analyzing and modeling transportation time and equipment, prefabrication and assembly time, facility layout, and storage of parts and components. Simplification, visualization and information flow are the key words here (Dugnas and Oterhals, 2008).

Dugnas and Oterhals (2008) also said that while project logistics is dealing with internal issues, phase-based project management has a wider scope and mainly addresses the project (construction) activities carried out in later project phases than initially planned. Keeping in mind the complexity of such one-of-a-kind projects that contain thousands of work packages, the lack of control of phases and their transition pose a significant threat. In the Norwegian shipbuilding context, this means project cost, disruption of workflow and planned work sequence, and overburdening of the workforce, which, ultimately, can result in the delayed delivery of the final product. Global supply chains make the situation even more complex.

2.9 Lean Shipbuilding in Ulstein Shipyard

According to Oterhals and Guvåg (2014), Ulstein Shipyard is developing a new concept for shipbuilding, i.e., project-based production. The concept is intended to reduce the throughput time for vessels under construction by focusing on everything which is not conducive to creating value, production and adjacent features.

The concept has the following four basic elements:

1. A systematic analysis and measurements of the main processes (and in relation to production).
2. Continuous improvements.
3. Involvement of employees.
4. Organizational learning.

The aim of the project has been to raise productivity and lower production costs by developing and adopting methods that contribute to increasing the reliability and predictability of construction projects.

It is focused on two overarching issues:

2.9.1 Project Logistics

The term project logistics has been introduced as part of the concept. Project-based production has its own logistics requiring specific adaptations that relate to purely physical conditions and organizational conditions seen from a value chain perspective.

2.9.2 Social Logistics

The term social logistics has been used actively in the change process to focus on the social interaction within this type of production—prim0arily, the inter-dependence that exists between activities, disciplines and functions (both directly related to production and adjacent features).

2.10 Summary of the Literature Review

This chapter was started with the discussion on the concept of the Total Cycle Time (TCT) and its different perspectives. Afterwards, the TCT was connected with the concept of ETO to explore whether time compression is possible in ETO. Subsequently, ETO is integrated with the supply chain process where there is a presence of a buyer-supplier relationship, relationship norms and dependence, assertiveness and cooperativeness in managerial decision-making, and complexity of trust in a buyer-supplier relationship. Finally, lean construction principles, and lean manufacturing tools are discussed followed by an analysis on VSM.

3.0 Research Methodology

This chapter will elaborate the research methodology and research design. Initially, the research design will be explained. After that a brief discussion will be presented on case study research method, case study type and action research. Finally, different types of relevant data collection methods and the types of data that were collected for this thesis will be discussed.

3.1 Research design

Research design can be defined as "a logical plan for getting from here to there, where here may be designed as the initial set of questions to be answered, and there is some set of conclusions (answers) about these questions" (Yin, 2009, p. 26). The purpose of using research design is to avoid a situation where the evidences do not address the initial research questions. According to Yin (2009) there are five main components of research design:

3.1.1 Study questions:

Study questions indicate what type of research should be used in the study. The main objective is to describe the study questions and their purpose. Relevant research strategy questions starts with, who, what, and where query. Similarly, the typical case study questions start with how and why query.

3.1.2 Study propositions:

A study proposition gives the direction from where the research should be started on top of its general study questions. However, Baxter and Jack (2008) argued that because of researchers lack of experience, knowledge or information, proposition cannot be presented in an exploratory case study. According to Yin (2009) some studies may have a legitimate reason for not having any propositions.

3.1.3 Unit of analysis:

An important feature of research design is choosing the unit of analysis. The unit of analysis can be a company, an individual person, an event or an entity (Yin, 2009). Similarly, case studies have also been done about decisions, programs, the implementation process, and organizational change. Therefore, in this study, unit of analysis is total cycle time compression.

According to Voss et al., (2002), there is no clear definition of what is a single case or unit of analysis. Single case sometimes involve to the study of several contexts within the case

(Mukherjee et al., 2000). This is indicated in the research questions in which identifying the root cause of time waste and integrating the VSM of the buyer and the supplier are the key factors.

3.1.4 Linking data to propositions:

There are different ways of data interpretations. One way of interpreting the findings is using statistical data. It can also be done comparing other explanations of previous research in similar studies. However, sometimes these techniques might not support current explanation for the desired result.

3.1.5 Criteria for interpreting a study's findings:

This can be statistical criteria, but it can also be about identifying and discussing other explanations that do not support explanation for the results. According to Ellram (1996), research methodologies can be classified as, "according to the type of data used and the type of analysis performed on the data". The type of data can be divided into two categories, either empirical or modelled. Empirical data is often gathered for analysis from the real world, often via case studies and surveys. The data can also be modelled, where either hypothetical or real world data is manipulated by a model (Ellram, 1996). The following figure 10 shows classification of research methodologies based on the type of data and type of analysis:

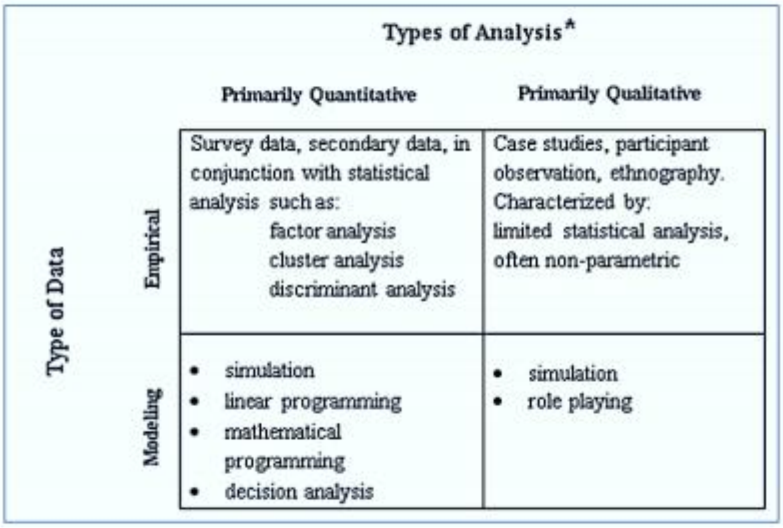


Figure 10: Basic research design.

Source: Ellram (1996).

The research design in this study can be classified as empirical, since the study is of a real life company. The empirical study uses primarily qualitative analysis through a case study of the company. According to Ellram (1996) qualitative results are often presented verbally to create an understanding of relationships or complex interactions.

3.2 Case study as a research method

Using case studies as a research method remains one of the most challenging social science endeavors (Yin, 2009). However, the choice of making case study or not depends on the research questions at a great extent. The more the research questions seek to explain the contemporary circumstances; how and why this particular social phenomenon works; the more the case study method is relevant. Similarly, this particular study is a case study. The choice of the research questions seek to explain some contemporary circumstances of an empirical problem.

There are many different aspects of research based case studies. Case study research has several advantages. Voss et al. (2002), argued that unrestrained by the rigid limits of questionnaires and models, a case study can lead to new and creative insights. They suggested that this insights can help to build new theory with valid and strong background. In a case study some different aspects can be studied.

Moreover, the 'why' kind question gives better understandings of the nature and complexity of the complete aspect (Meredith, 1998). Yin (2009), argued that the examination of a case research data is most often conducted within the context of its use. It means within the situation in which the activity takes place (Zaidah, 2007).

On the contrary, there are several challenges in conducting a case study research. According to Voss et al. (2002), case study research is time consuming, it needs skilled interviewers. It was believed that there may have fair skills, if not very good skill to conduct an interview. Moreover, intensive care is needed to draw generalizable conclusion in ensuring rigorous research. There are chances of making mistakes or drawing erroneous conclusion.

Additionally, direct observations are used to conduct case research. Direct observations need access to the phenomenon being studied which is time consuming.

3.3 Case study type and case selection

There are several categories of case studies existing in different literatures. Yin (2009) mentioned three categories of case studies. These are exploratory, descriptive and explanatory. Yin (2009) further distinguished among single, holistic and multiple-case studies. Stake (1995) categorized case studies as intrinsic, instrumental, or collective. McDonough and McDonough (1997) categorized case study as interpretive and evaluative. This case study is an exploratory case study.

3.3.1 Exploratory case study

An exploratory case study explores a phenomenon through the data, which serves as a point of interest of the researcher (Zaidah, 2007). According to Yin (2009) exploratory case study is conducted to those situation where the phenomenon is evaluated has no clear, single set of outcomes. One of the advantages of exploratory case study is it narrows down the scope of investigation.

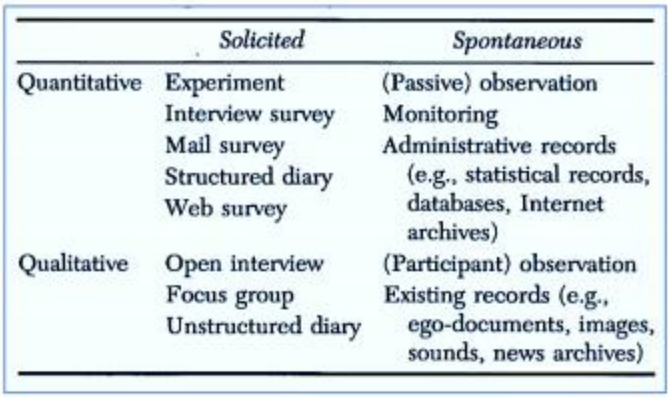
An exploratory case study should be preceded by statements about what is to be explored, the purpose of the exploration, and the criteria by which the exploration will be judged successfully. The SMARTprod project is conducted with the greater goal of bringing efficiency in Ulstein shipbuilding. This case study explored the tactics to compress the total cycle time. The purpose of the exploration is to compress total cycle time and integrate the value stream of a key supplier into Usltein shipyard value stream. The criteria to be judged for these case study have been discussed in literature review.

3.4 Action Research

In this thesis a real-life situation has been discussed, and an appropriate research methodology for this case has been described. Action research is an integration of research and action in several cycles of data collection, analysis and interpretation, planning and introduction of action strategies, and evaluation of these strategies through further data collection. The process continues in the same way into another cycle, and the series of cycles is stopped when someone decides to stop it, and then the final results may be seen and presented (Somekh, 2005). As more such action cycles are determined, new information will be discovered and new constraints will emerge (Coghlan and Brannick, 2010). One main aspect of action research is the close co-operation between the researchers and the practitioners in a company who seek to solve a problem. According to Denscombe (2007), this gives a greater appreciation and respect for the knowledge possessed by the practitioners. The relationship between researchers and practitioners may also provide the project with valuable knowledge about understanding the situation and the workplace. This is the information that normally could be difficult to obtain with traditional researchers from outside (Somekh, 2005). This study has been conducted with close co-operation with company personnel of both the buyer and a key supplier. Both of the authors of this thesis were attached in Ulstein Shipyard for one week. The research has been evolved continuously through discussions and co-operation with key personnel of both Ulstein Shipyard and the key supplier company. As action research applies the existing knowledge to the situation which is being studied, the aim is both to solve a practical problem and to build upon the existing knowledge through using data from the real-life situation in a particular field of study (Coghlan and Brannick, 2010 and Somekh, 2005). This is also the goal in this case as works have been done with shipyard company and supplier company to come up with solutions of practical problems as well as writing a thesis based on a theoretical framework. One of the advantages of action research as a method, as described by Denscombe (2007), is that one solves a practical problem where the results of the research are transferred into practice. Also, the participation of practitioners in the research can "democratize the research process" (Denscombe, 2007, p. 131). However, there are also some disadvantages. Using action research means that there will be some extra work for the practitioners, as they are to take part in the research. Further, the research is constrained by what is allowed and ethical in the workplace setting being studied. It is also more difficult to be impartial for the researcher in the approach to research (Denscombe, 2007).

3.5 Data collection

Data collection can be divided into two categories. The data can either be primary or secondary. Hox and Boeije (2005, p. 593) define primary data as "data that are collected for a specific research problem at hand, using procedures that fit the research problem best." They define secondary data as "data originally collected for a different purpose and reused for another research question". Primary data can be classified as qualitative or quantitative data. Qualitative data involve understanding of the complexity and context of the research problem. The qualitative data often consist of text, while quantitative data are described numerically (Hox and Boeije, 2005). Figure 11 presents a list of methods to collect both quantitative and qualitative primary data.



	Solicited	*Spontaneous*
Quantitative	Experiment Interview survey Mail survey Structured diary Web survey	(Passive) observation Monitoring Administrative records (e.g., statistical records, databases, Internet archives)
Qualitative	Open interview Focus group Unstructured diary	(Participant) observation Existing records (e.g., ego-documents, images, sounds, news archives)

Figure 11: Primary data.

Source: Hox and Boeije (2005).

Yin (2009) identifies six sources of evidence that are most commonly used in case studies. None of the six sources have a complete advantage over the other sources. The six sources of evidence are:

1. Documentation.
2. Archival records.
3. Interviews.
4. Direct observations.
5. Participant observation.
6. Physical artefacts.

In this case study, several of the six sources were used to gather information. The sources of evidence that are used in this case will be presented briefly in following section preceded by a brief discussion on interview and direct observations.

3.5.1 Interview

Interview is a useful method for data collection. Interviews used in case studies are normally more guided conversations than structured queries. It is vital to ask questions in a manner that provides the needed information, but the questions should at the same time be reasonable and easy to answer for the interviewee. Different types of interviews are in-depth-, focused-, and survey (more structured) interviews (Yin, 2009).

In an in-depth interview the interviewer can ask about facts as well as the interviewee's opinion on a subject. The interviewee may also be encouraged to come up with propositions that may be basis for further exploration. From such an interview the interviewer may also get suggestions on other sources of information.

Sometimes the interviewee will have the role of an informant rather than a respondent, which is important to have in a case study. An in-depth interview may take place over several meetings within a time period. The interview may still contain open ended questions and be more like a conversation, but it follows more strictly a predefined set of questions. Survey interviews follow more structured and survey-like questions. This type of interview is mainly used to collect quantitative data in a case study and are analyzed as a regular survey (Yin, 2009).

Ellram (1996) separates the interview technique into unstructured, semi-structured and structured interviews. Unstructured interviews are conversational, while structured interviews may be in the form of a questionnaire.

Using interviews when collecting data can have several strengths and weaknesses. Interviews can be targeted and the interviewer can focus his or her questions according to what he or she wants to find out. Also interviews can be insightful and give the interviewer information and explanations from the interviewee (Yin, 2009).

Several weaknesses can also be mentioned about interviews as a data collection method. If the questions are not well formulated, the resulting information will not be as good as it could have been. Also the person being interviewed may provide inaccurate information due to poor recall. Another weakness is that the person being interviewed may be affected by the interviewer and answer what the interviewer wants to hear (Yin, 2009).

3.5.2 Direct observations

Direct observations may be useful to provide additional information about the topic. Direct observations can be both formal and casual data collection activities. Formal observations can be conducted to observe meetings, factory work and so on. Observations are made throughout the field visit, for example in connection with an interview or other data collection methods. These kinds of observations are more casual. The reliability of the observations increases with the number of observers (Yin, 2009).

3.5.3 Primary data collection through observations and interviews

The primary data collection in this case study has been done in several ways. First, it has been started with participants' observations. However, direct observations needs a longer time compared with secondary data. Moreover, Yin (2009) argued that the situation might also be affected by the fact that it is being observed, and it may therefore proceed differently. Correspondingly, in this study direct observations were followed to some extent.

To gather primary data, interviews have been done with some Ulstein and WestCoat managements. Hartley (2004) suggested that the first strategy in collecting data should be to get a general overview of the structure and functioning of the organization. In the interviews the authors learnt something of the history and present functioning of the organizations.

Another valuable aspect in this was to walk around the organization observing the work flow and the work being undertaken. In the initial phase of the research an interview was held with shipyard's planning management department guided by thesis supervisor. These interviews were helpful to gain an insight into the history and the current state of the Norwegian ship industry and how the shipbuilding process is.

After developing an initial theoretical framework for which the interview guide was based on, a second interview round was done where a guided tour was taken in piping department followed by interview with shipyard's planning management team and coordinator. The reason for this interview round was to get a clear and better idea of work processes are, and the continuing relationship.

In the third round, the authors were attached in shipyard for five days. They interviewed ship planners, ship planning head, last planning coordinator, supplier head and supplier supervisor. In addition, a guided tour led by Ulstein coordinator gave an extensive idea about how the activities are being taken place. All these interviews and guided tour were recorded as formal interviews. These interviews were based on complete theoretical framework of this thesis, and to get more information around the relationships in regards to the theoretical framework.

Additionally, it was also intended to dig deeper to explore the interesting points discovered in the previous round. The last round of interviews were more in-depth than the previous ones and went more into the specifics of the relationship to see what works well, what does not work and what could have been better.

3.5.4 Secondary data

Hox and Boeije (2005, p. 593) defined secondary data as the "data originally collected for a different purpose and reused for another research question". Similarly, there are some strengths and weaknesses associated with secondary data collection. Secondary data can be less time consuming and mostly less expensive compared with primary data.

However, associating with a particular research area might be difficult as it had been done targeting other research objectives. Additionally, Hox and Boeije (2005) argued that it is important to be able to evaluate the quality of the retrieved data. Similarly, in the case of the qualitative data for this study, several sources were used to obtain information. These sources included the websites of Ulstein Shipyard, WestCoat and other maritime-related entities. Additional secondary material was gathered from different interviews.

These were information on internal presentations of the company, job descriptions and visual images from selected pages in different information systems. Moreover, the quantitative data collected from the company was fully based on the data given by its management. These were the actual and planned timelines of activities and the deviations from them of the shipyard and its supplier. In addition to this, a large part of the secondary data was collected and obtained by searching in relevant literature and recent academic journals, PhD, master thesis and different websites.

3.6 Research methodology summary

This research methodology chapter has given a direction on the methodology of conducting this thesis. The discussion has been started with a brief description on research design and its components. Thereafter the main frame of this study has been discussed.

This research is an explorative case study conducted on a shipyard and its key supplier. This case study has analyzed a real life situation where researchers worked with close cooperation of company personnel and tried to come up solution with existing problem. Therefore, this research has been conducted in the frame of action research. Finally a brief discussion on different data collection method were discussed.

4.0 Case Study Findings

Based on the findings from the interviews, this chapter illustrates the involvement of one key supplier named WestCoat into Ulstein project phases alongside with focusing on the problems that occurred in the project outfitting phase. Project problems in the outfitting phase were observed and investigated from two perspectives. The first perspective was from Ulstein Shipyard and the next one is WestCoat perspective. Then an explanation has been provided about the information flow in the project outfitting phase accompanied with clarification of the causes of information flow gap in the outfitting phase. Afterwards, this chapter sums up with mentioning the process flow of WestCoat alongside with detailed explanation for their tasks in the project. Finally, case study findings from this chapter have been summarized and gathered in figure 12 and figure 13 which shows the findings from Ulstein Shipyard and WestCoat.

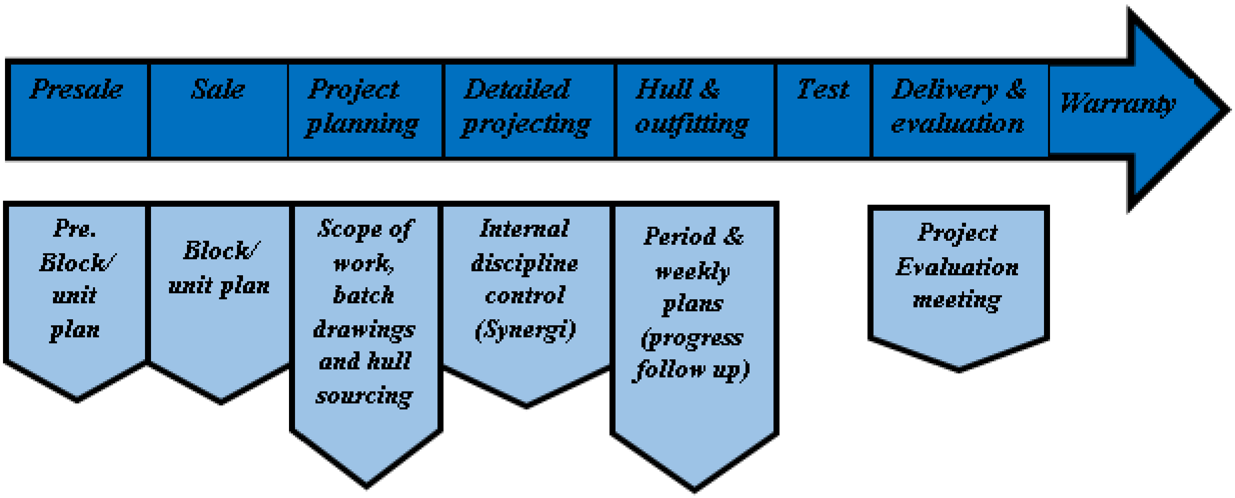


Figure 12: Project phases of ULSTEIN SX 121 subsea ship.

Source: Retrieved from Ulstein Synergi system (2015).

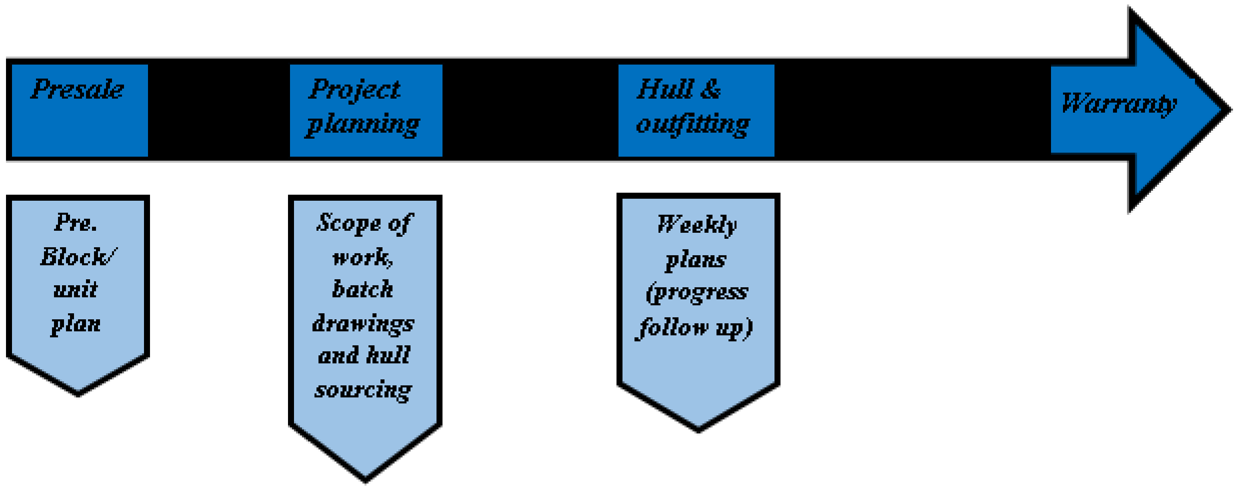


Figure 13: Involvement of WestCoat into the project phases of ULSTEIN SX 12.

Source: Retrieved from Ulstein Synergi system (2015).

4.1 Presale and project planning phases:

According to the WestCoat management (personal communication, March 24, 2015)[1] WestCoat was involved in the Ulstein project from the presale phase, when the prices for a new ship were calculated. Moreover, they mentioned that WestCoat was included in the planning phase of the project because the shipyard did not have its own painting department. The information decoupling point in the project is located at this phase as it is the furthest point in which information on real, final demand reaches.

WestCoat had a framework agreement for three years with fixed prices including a square meter price for finished work and an hourly price for reworks caused by other suppliers, they stated. Based on the fixed per-square-meter prices, WestCoat and Ulstein Shipyard discussed and confirmed the area (in square meters) required to work on Ulstein project based on its design sketches. The shipyard's relevant departments such as planning and operations, later discussed the project plan of the ship with WestCoat.

Figure 14 illustrates the tasks for the participants involved in planning, coordinating, supervising and performing WestCoat tasks in Ulstein project. The project planners at Ulstein Shipyard set up a proposal plan for the painting work followed by verifying and setting dates for the plans proposed by the leading coordinator at the shipyard. Subsequently, the project planners distributed the plan to all the production coordinators at the shipyard and asked them for their feedback on the proposal in order to either confirm or modify it.

[1] An interview and personal communication with the WestCoat management, March 25, 2015.

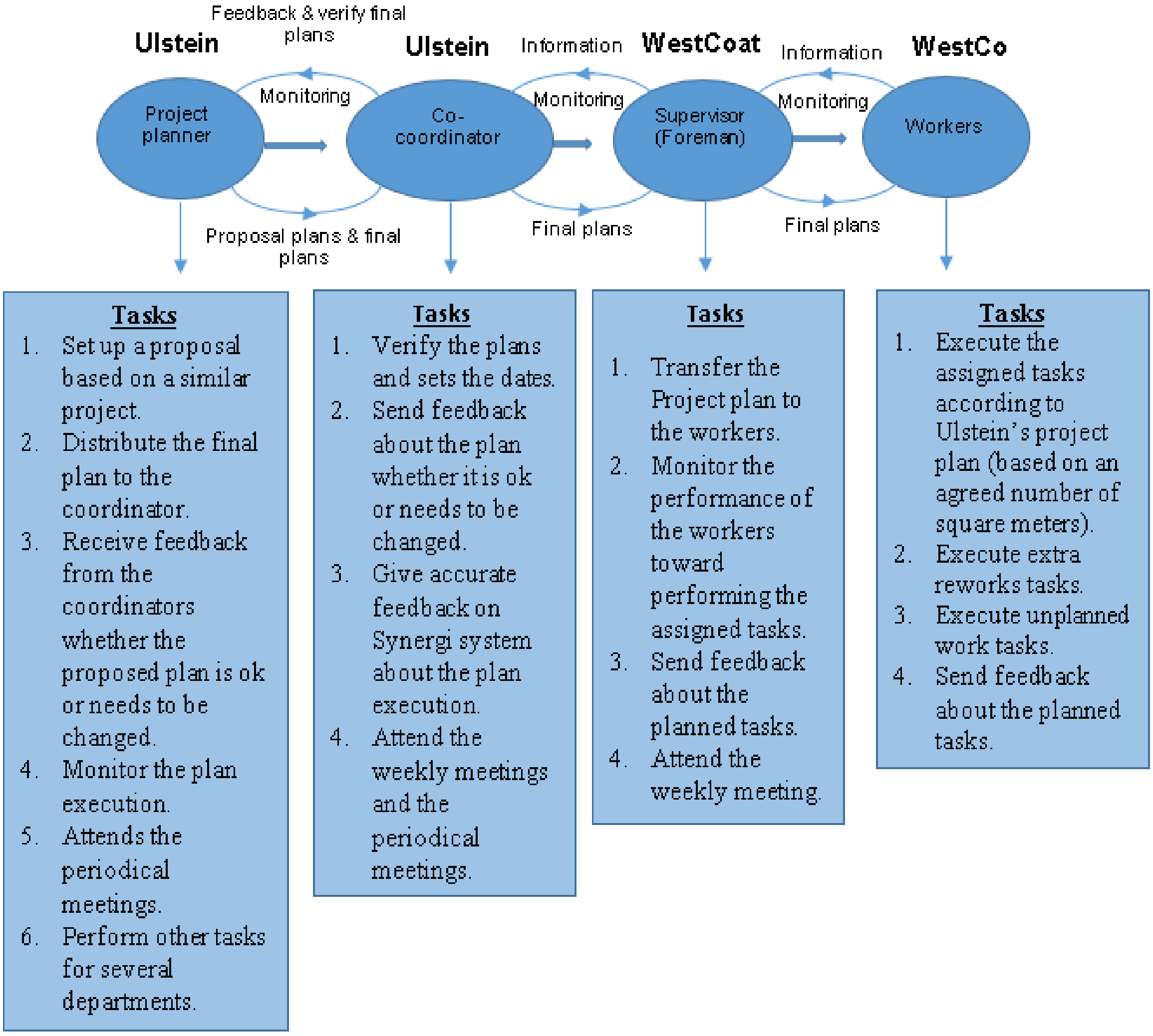


Figure 14: Current tasks & information flow between Ulstein Shipyard and WestCoat.

Source: Retrieved from Ulstein Shipyard planning department (Personal communication, March 25, 2015).[2]

This stage is followed by setting up of an internal discipline control through the help of a Synergi system. Ulstein Shipyard used the Synergi system to monitor WestCoat deviations between the settled plan tasks and the actual execution of those tasks. Alongside, it used a key performance indicator, called the "healthy seven", in the outfitting phase. This key performance indicator covered several elements such as: tools, documentation, resources, areas, previous work, material and causes.

The function of the "healthy seven" was to track and understand which of its elements caused the project plan deviations. Ulstein Shipyard controlled WestCoat's tasks in the ship by using the Synergi system and the key performance indicator.

[2] An interview and personal communication with the Ulstein Shipyard planning department, March 24, 2015.

According to respondent from Ulstein planning department (personal communication, March 25, 2015) [3] each work discipline in the shipyard had a production coordinator responsible for verifying the proposed plans from the project planners, giving the planners feedback about the plans before confirming them and managing the plan tasks with the corresponding supplier.

4.2 Outfitting phase:

After the project plans for sandblasting, treating and painting had been settled, WestCoat was not involved in remaining project phases until the aft-ship had arrived at the Ulstein hull yard. Then, WestCoat came in again in the outfitting phase. In this phase, WestCoat was largely involved and participated in the weekly meetings with other work disciplines.
According to Ulstein planning department (Personal communication, March 25, 2015) [4] all weekly meeting participants such as: the shipyard's project planner and the leading/project coordinator, WestCoat project supervisors (or foreman in Ulstein Shipyard's terms) from different disciplines and other subcontractors- gathered with one perspective in the Synergi system, and the participants came up with an agreement about weekly dates and activities. Moreover, it has been stated that the suppliers attended weekly meetings with their own supervisor (foreman) in the outfitting phase. They went through the previous week's plan to check if they followed the schedule from the previous week's meeting, and modified the current plan in case of delays from the previous week. Additionally, the project coordinators from Ulstein Shipyard attended weekly meetings without being prepared about the issues they were supposed to discuss during the meeting with adequate preparations. On the contrary, WestCoat management (personal communication, March 24, 2015)[5] stated that the last planner tool which used during the weekly meeting to control and monitor the execution of the project plan tasks was not utilized efficiently, primarily because of lack of the project plan commitments and giving inaccurate feedback from Ulstein planning department.
After this weekly meeting, the project plan for WestCoat tasks was preliminary settled and the project plan considered "alive". On the contrary, there was another periodical meeting for the whole project (mentioned in figure 14), including all the concerned departments and staff from Ulstein Shipyard. Generally, this periodical meeting takes place every 6/8 weeks, where Ulstein's project manager, project planners, leading coordinator, all the production

[3] An interview and personal communication with Ulstein planning department, March 25, 2015.
[4] An interview and personal communication with Ulstein planning department, March 25, 2015.
[5] An interview and personal communications with WestCoat management, March 24, 2015.

coordinator and technical departments attends. Meanwhile, Ulstein's suppliers were not attending on this periodical meeting as showed in figure 15, but their coordinators from Ulstein Shipyard attends.

In the periodical project meeting, they discuss and make plans for the next six or eight weeks accompanied by the weekly plans. The material de-coupling point comes at this phase where Ulstein Shipyard supplies WestCoat with the required material to conduct their tasks. Each task in the outfitting phase took place according to the shipyard's project plan; WestCoat started its tasks of sandblasting, treating and painting several steel blocks, units, tanks, areas and rooms once the aft-ship had arrived at the hull yard. After WestCoat finished one task, other suppliers started their assigned tasks in the outfitting phase. For instance, the WestCoat task of painting the engine room was followed by another supplier installing pipes and pipes supporters. One respondent from Ulstein Shipyard (personal communication, March 25, 2015) [6] stated that the causes of the problems in the outfitting phase occurred for several reasons. First and second reasons occurred within Ulstein Shipyard (the shipyard could control it), the other reasons occurred externally (the shipyard could not control it).

4.2.1 Problems in the project outfitting phase:

Reasons for the problems in the project outfitting phase have been observed and investigated from two perspectives, namely Ulstein Shipyard and WestCoat. The following section shows those perspectives respectively:

4.2.1.1 Ulstein Shipyard perspective

4.2.1.1.1 First reason

The first was a lack of vision on the part of the Ulstein Shipyard project planner about the inter-dependencies between its suppliers when they executed their project plan tasks. The planners did not take into account the inter-dependencies when creating the project plan. Those inter-dependencies caused deviations and delays.

Ulstein's respondent described the situation through different examples. First, when WestCoat finished its assigned tasks in the engine room, another supplier installed the pipes and the supporters to hold up the pipes in the engine room. Installing the supporters required welding them to the floor of the engine room which caused burning marks that damaged the painting of the tanks that located under the engine room. Therefore, the finished work on those tanks had to be repeated. Subsequently, the project plan time to finish this task

[6] An interview and personal communication with Ulstein Shipyard respondent, March 25, 2015.

increased significantly, additionally causing a monitoring problem in the Synergi system. In the feedback, the project coordinator said that the tasks were complete but they weren't.

4.2.1.1.2 Second reason

After WestCoat finished its tasks in the cargo room, it found out that it had yet to install steel parts on the walls of some areas in the cargo room for use as equipment holders (fire extinguishers). These necessary steel works damaged the painting of the cargo room, and, therefore, WestCoat had to partially repeat its tasks in the cargo room. Those real examples of inter-dependencies, between the suppliers while they were performing their tasks, gave an exploratory notion about the nature of wastes that occurred during the outfitting phase. Those wastes were:

1) *Waste of time*: Waste of time created a deviation in the project plan tasks and extended the lead-time to finish the assigned tasks.
2) *Waste of material:* Repeating the assigned tasks and using additional material in the tasks already done.
3) *Another kind of waste:* This caused by extra cleaning services carried out due to the repetition of the assigned tasks done before.

Additionally, the inter-dependencies negatively influenced the execution of the next assigned tasks in the project plan.

4.2.1.1.3 Third reason

The execution of the project plan tasks stopped due to unfavorable weather conditions. Weather conditions affected the execution of some tasks in the project plan (i.e. the painting task) causing deviations and delays.

The workers stopped their painting task when it was raining and when the humidity was higher than 85 degree. One respondent from Ulstein Shipyard claimed that the planning department was not successful to consider these unfavorable weather conditions although it was the unit's responsibility to do so during the creation of the plan.

4.2.1.1.4 Forth reason

The overall pipes and other ship installments became more complicated in the current times compared to five years ago.

4.2.1.1.5 Fifth reason

There was a serious communication gap as a result of language barriers (i.e. Romanians and Polish workers), causing misunderstandings and delays in the execution of the assigned tasks. This communication gap took place when the shipyard's project coordinator asked WestCoat workers to perform certain tasks according to the project plan. Later, when the coordinator carried out an inspection for WestCoat's workers to check if they had finished their tasks, he found out that they were incomplete due to misunderstandings and language barriers.

Therefore, Ulstein Shipyard and WestCoat conducted weekly meetings to monitor and solve the problems and deficiencies arising from such inter-dependencies. They then modified the plan for the following week to shift the delays that could affect other assigned tasks in the project plan.

4.2.1.2 WestCoat perspective

WestCoat as mentioned, was paid a fixed per-square-meter price for the finished work along with an hourly price for the rework resulting from other suppliers. In case of the delays caused by other suppliers, that prevented WestCoat to start its planned task in one area, WestCoat shifted its workers to execute another task in a different area until the other suppliers had finished their work.

It has been claimed by WestCoat's respondent that the supplier did not profit when it had to re-execute tasks as a result of other suppliers. On the contrary, one respondent from Ulstein planning department (Personal communication, January 21, 2015)[7] mentioned that it was profitable for the suppliers to re-execute tasks. Therefore, WestCoat claims about non-profitability contradicted with Ulstein Shipyard's perception.

Moreover, it has been stated by one respondent from WestCoat management (personal communication, March 24, 2015)[8] that its performance level in tasks such as sandblasting, treating and painting was not the same compared to the level five years ago for the following reasons:

4.2.1.2.1 First reason

The project plan from the shipyard regarding WestCoat's painting tasks was not transparent and mismatched with contract agreements in certain circumstances.

4.2.1.2.2 Second reason

Controlling and monitoring WestCoat's tasks by the shipyard were not precise or accurate due to the lack of information flow integration between both sides.

[7] An interview and personal communication with Ulstein planning department, March 25, 2015.
[8] An interview and personal communications with WestCoat management, March 24, 2015.

4.2.1.2.3 Third reason

Ulstein Shipyard's assigned unplanned tasks to WestCoat were not included in their contract.

4.2.1.2.4 Forth reason

WestCoat was considered neither an internal nor an external part of the shipyard.

4.2.1.2.5 Fifth reason

WestCoat used 15 percent additional workforce to cover the deviations from the project plan. Consequently, the total cost of workers increased by 5-10percent. In addition, the extra workers were not highly skilled and efficient enough compared to the original workers. Therefore, there were variations in both the number of workers and their performance in the assigned tasks, and their efficiency in using the material to perform those tasks.

4.2.2 Information flow in the outfitting phase:

It has been demonstrated by one respondent from Ulstein Shipyard that the information flow regarding the requirements of WestCoat's tasks started from WestCoat workers and went through its supervisors (foremen in Ulstein's terms) to the Ulstein Shipyard project coordinator and was finally delivered to the Ulstein Shipyard project planner (figure 15).
It was thought by Ulstein Shipyard respondent that it was not an efficient way to transfer the information regarding the project plan task requirements. Ulstein Shipyard's respondent recommended that it would be more efficient if the planners physically observed the work site (outfitting phase) to understand the inter-dependencies between the suppliers regarding performing their tasks, the requirements of the supplier's tasks and the chronological arrangement of the suppliers tasks in the project plan.

4.2.2.1 Causes of information flow gap in the outfitting phase

Ulstein Shipyard uses the Synergi system to plan, execute, and monitor the project plan tasks, while WestCoat doesn't use the same system to handle its work tasks. Therefore, there was an information flow gap, which caused misunderstandings, wrong orders and a lack of transparency. One respondent from Ulstein Shipyard's planning department clarified that WestCoat was not using the same operating system as the shipyard. The main reason was the high investment costs involved in purchasing and installing Synergi system into WestCoat. Ulstein planning department demonstrated how giving WestCoat access to Ulstein Shipyard's Synergi system would facilitate a smooth information flow between them, but the opportunity was not used owing to confidentiality issues and the fact that no one from WestCoat requested permission to access the shipyard's Synergi system.

It was believed by Ulstein management that there was no need to give WestCoat this accessibility to Synergi system because the shipyard had other suppliers carrying out painting alongside WestCoat. Ulstein management believed that by granting WestCoat the accessibility, it would make the relationship between the supplier and the shipyard more fundamental and tied. Eventually, this would contradict with the shipyard's policy of depending on many suppliers to perform the painting tasks instead of being tied to one. Ulstein Shipyard used several suppliers to perform the painting tasks in its projects in order to maintain competition between the suppliers. Figure 15 explains the information flow between Ulstein Shipyard and WestCoat systems.

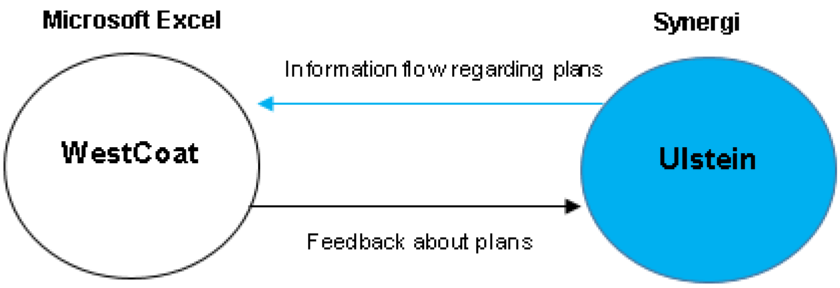


Figure 15: Current information flow between Ulstein Shipyard & WestCoat systems

Source: Retrieved from Ulstein Shipyard & WestCoat managements (2015).

One respondent from WestCoat management (personal communication, March 24, 2015)[9] stated that the current information flow between Ulstein Shipyard and the supplier created a communication gap and lack of transparency regarding the efficient execution and monitoring of the project plan.

On the other side, respondent from Ulstein Shipyard's planning department (Personal communication, March 25, 2015)[10] clarified that Ulstein Shipyard were not fully committed to fulfilling WestCoat's project plan tasks on time. Ulstein Shipyard gave inaccurate feedback on the Synergi monitoring system about the completion of WestCoat's tasks in the project plan. Moreover, they justified giving inaccurate feedback on Synergi monitoring

[9] An interview and personal communication with WestCoat management, March 25, 2015.
[10] An interview and personal communication with Ulstein Shipyard planning department, March 25, 2015.

system that the tasks required flexibility and needed to be adjusted often due to unexpected delays arising from other tasks in the plan.

4.3 Testing phase:

The testing phase that follows the outfitting phase, as Figure 12 showed, is where all the project plan tasks on the project have to be complete and ready to be tested. One respondent from Ulstein Shipyard's planning department (Personal communication, March 25, 2015)[11] stated that the plan tasks on the ship were completed on schedule due to the rework. Besides, there were many delays in starting the testing phase because of the unexpected task delays as a result of the weather conditions.

4.4 Project evaluation phase:

After the required tests were conducted on the ship, it returned to the shipyard so that any observed malfunctions could be fixed or any unfinished tasks could be completed by the suppliers. The ship was then delivered to the customer followed by the next phase—as explained in figure 14— the project evaluation phase. In this phase, Ulstein Shipyard invited all the involved disciplines in the project to discuss about their performance in the project and to figure out how cooperation between the different disciplines took place. It has been mentioned by one respondent from Ulstein Shipyard planning department that WestCoat was not involved in the project evaluation phase but its coordinator from the shipyard attended.

4.5 The warranty and aftermarket services phase:

In the final, warranty and aftermarket services phase, WestCoat provided the necessary repairs and maintenance works for the ship. WestCoat checked the tasks' capacity before offering the warranty and aftermarket services in order to avoid any overcapacity or overlapping while performing the current tasks.

4.6 WestCoat Process flow:

The process flow of WestCoat started with the sandblasting and painting of different steel blocks and units once the aft-ship arrived at Ulstein's hull yard. Later, when the aft-ship arrived at the inner dock in the shipyard, the supplier continued its process flow by sandblasting and painting several tanks, areas and rooms.

[11] An interview and personal communication with Ulstein Shipyard planning department, March 25, 2015.

Painting tanks was the most expensive work for WestCoat. Additionally, it sandblasted and painted the remaining steel blocks and units that were not done at the hull yard. WestCoat's process flow is summarized, as explained in Figure 16, based on the consecutive tasks in the project plan.

The painting tasks in the project plan were controlled by Ulstein Shipyard, followed by the inclusion of WestCoat and the customer in the control process.

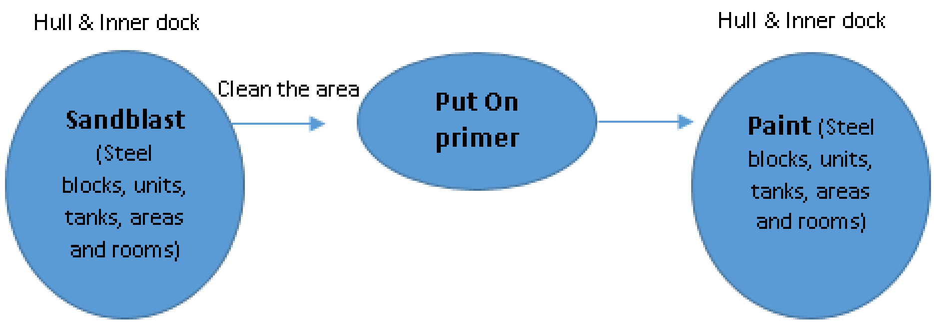


Figure 16: WestCoat process flow.

Source: Retrieved from Ulstein Shipyard Synergi system (2015).

4.7 Surface treatment by WestCoat:

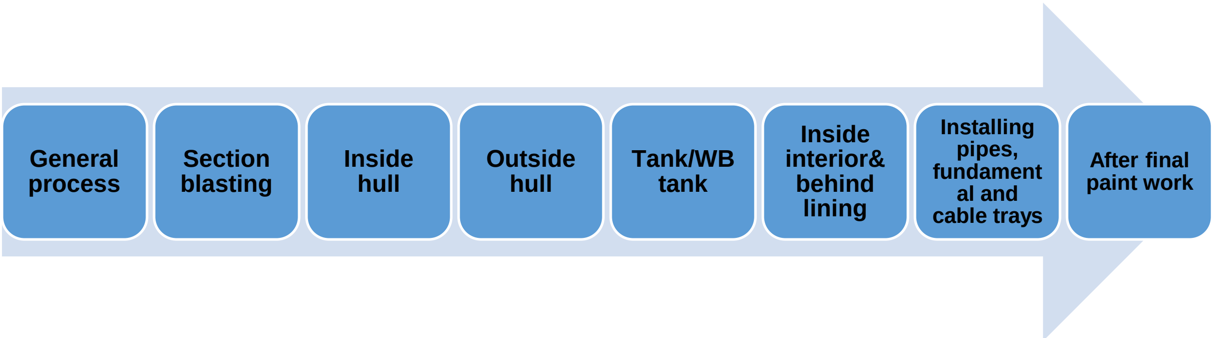


Figure 17: Surface treatment by WestCoat.

Source: Retrieved from Ulstein Synergi system(2015).

WestCoat's activities in the ship took place according to the following consecutive tasks:

1) *Installing pipes, fundamentals and cable trays:* When Ulstein Shipyard checked the quality of the delivered pipes, WestCoat continued its blasting tasks and applied the primer. Later, other operators performed the mounting and welding tasks. Then, WestCoat performed the required grinding task before Ulstein Shipyard conducted its inspection. Finally, WestCoat performed the painting task.

2) *Section blasting*: When the approval of the steel inspection by Ulstein Shipyard was done, WestCoat sandblasted and performed a salt test on the steel blocks and units. Then, it cleaned the blast and applied the primer before painting the first layer.
3) *Tank/WB tank:* After, the approval of the steel inspection by Ulstein Shipyard, WestCoat washed, dried, performed a salt test and cleaned the blast before Ulstein Shipyard conducted an inspection. Afterwards, there were probable rework by Ulstein Shipyard and WestCoat concerning re-blasting and cleaning before the shipyard conducted another inspection.

   Then, WestCoat painted and dried the first layer, and applied and dried two layers of stripe coating. It then painted a second layer and may have painted a third layer also on the MIS tank before performing quality control. Ulstein Shipyard performed the final paint inspection to check if it needed any rework before conducting the final inspection of the tank. This final inspection was performed before closing.

4) *Hull outside:* Consequently, after the approval of the steel inspection by Ulstein Shipyard, WestCoat ground, washed and performed a salt test, and cleaned the hull outside before Ulstein Shipyard inspected it. WestCoat then applied the first layer of stripe coating and covered it with plastic. It then painted the first layer and applied a second layer of stripe coating and painted it. Subsequently, it conducted quality control before Ulstein Shipyard performed the final paint inspection. Generally, a rework is possible before the shipyard's final paint inspection of the vessel.
5) *Inside interior & behind lining:* After the approval of steel inspection by Ulstein Shipyard, WestCoat applied a single-coat primer and cleaned it. It then painted the goods in the cold zone and dried it after finishing. Finally, the shipyard performed its inspection before insulation.
6) *Hull inside:* After the approval of steel inspection by Ulstein Shipyard, WestCoat repaired the grindings from the stripe coating. It covered, washed and removed the covers inside the hull. Later, WestCoat redid certain works (i.e., washing, cleaning and covering of equipment) to fulfill Ulstein Shipyard's inspection criteria.
   Subsequently, WestCoat applied and dried a layer of stripe coating, a primer and another layer of stripe coating. It removed the covers and cleaned before conducting quality control. Eventually, Ulstein Shipyard conducted a final paint inspection to figure out if there was any possibility of rework inside the hull.

7) *After final paint work:* WestCoat checked for burn marks. In case it found any, it ground, washed, cleaned and painted the areas according to the specifications of thickness and dry time. Afterwards, Ulstein Shipyard conducted the final paint inspection for the ship.

4.8 Case findings Summary

The following tables 6&7 summarized the case study findings in this chapter. Table 6 summarized the case findings from Ulstein Shipyard across the project phases followed by table 7 which summarized the findings from WestCoat across the project phases.

Table 6: *Summary of the case findings from Ulstein Shipyard.*

Case findings					
Project phases	**Presale phase**	**Planning phase**	**Outfitting phase**	**Testing phase**	**Project evaluation phase**
Ulstein Shipyard	**1-** Calculating prices for new ships based on the required number of square meters (fixed price) and reworks (hourly price).	**1-** Project plan verified by other department rather than the planning department. **2-** Planning department became supportive function rather than core function. **3-** Mismatches between the projects planned tasks and the requirements to conduct those tasks. **4-** Project planners were not attached physically on site to observe the realities and requirements of the project tasks.	**1-** Supplies WestCoat with the required material to conduct their tasks. **2-**Inefficient information flow from WestCoat's workers until reaching Ulstein's planning department. **3-**Giving inaccurate feedback regarding the execution of the project tasks. **4-** Assigning extra working tasks which were not mentioned in the contract agreement with WestCoat. **5-**Inefficient monitoring of the project tasks. **6-**Communication gap with WestCoat's workers due to language barriers. **7-** Ship installments became more complicated in current days. **8-** Last planner tool to control and monitor the execution of the project plan tasks was not utilized efficiently.	**1-**Project plan tasks were deviated from the planned times. **2-** Delays to start the testing phase due to reworks on certain rooms, areas and tanks.	**1-** All project disciplines from Ulstein involved in the project evaluation phase. **2-** Suppliers were not involved in the project evaluation phase.

Table 7: Summary of the case findings from WestCoat.

Case findings					
Project phases	**Presale phase**	**Planning phase**	**Outfitting phase**	**Testing and project evaluation phases**	**Warranty phase**
WestCoat	**1-** A framework agreement for three years with fixed prices including a square meter price for the finished work and an hourly price for the reworks which caused by other suppliers.	**1-** Confirmed the number of square meters that were required to work on Ulstein project according to the design sketches.	**1-** Lack of transparency regarding Ulstein project plan. **2-** Gap of information flow due to using different operating systems. **3-** Conducting tasks that were not exist in the contract agreement with Ulstein Shipyard. **4-** Conducting reworks due to inter-dependencies with other suppliers during executing the project tasks. **5-** Hiring extra workforce to cover the time deviations on the project plan.	**1-** WestCoat was not involved in the testing and project evaluation phases.	**1-** Provides the necessary repairs and maintenance services for the project after checking the work capacity.

5.0 Discussion and Analysis

Chapter 5 discusses the relevant theory presented in chapter 3 and the associated findings from the case study in the previous chapter.

SMART prod is running the project on the basis of finding the scope for compressing the TCT of ship manufacturing.

Towill (2008) argued in the Construction Supply Chain and Time Compression Paradigm handbook that the TCT compression paradigm can be simply expressed as “the principle of reducing the time taken to execute a business process from perception of customer need to the satisfying of the need.

With this scope and based on its findings, the broader or general objective of the SMARTProd project is to compress the TCT through different tasks and activities under the ETO environment. A part of this task is to integrate the supplier value stream.

In the previous chapter it is described about the TCT of ship building where the task is started from the presale phase and finishes with the delivery to the customer, briefly with warranty services if requires. As the focused research questions deal with compressing the TCT in the production networks in Ulstein Shipyard, the scope of the research is narrowed by focusing on the outfitting phase as it is the main phase in which value is added. In this phase, the focus was mainly on the aft-ship part of the Ulstein project as it was the most time consuming, labor-dependent and complex part of total ship manufacturing. Most of the installations of the manufacturing process take place were in this part of the ship. Here, the further focus was on a key supplier called WestCoat who performed the sandblasting, treating and painting tasks.

Based on Chapter 2, the first research question follows:

5.1 Research Question 1

How to compress the TCT in Ulstein Shipyard’s ETO production networks?

According to Hui (2004), the reduction of cycle times is considered one of the primary objectives of time compression. Based on the case study findings from Chapter 4, it was clear that there were many deviations on the project plan across the whole production networks (project phases) of the shipyard.

5.1.1 Analysis for the production networks in Ulstein project

The following Figure 18 displays the main schedule across several production networks in the shipyard during the manufacturing of the ship.

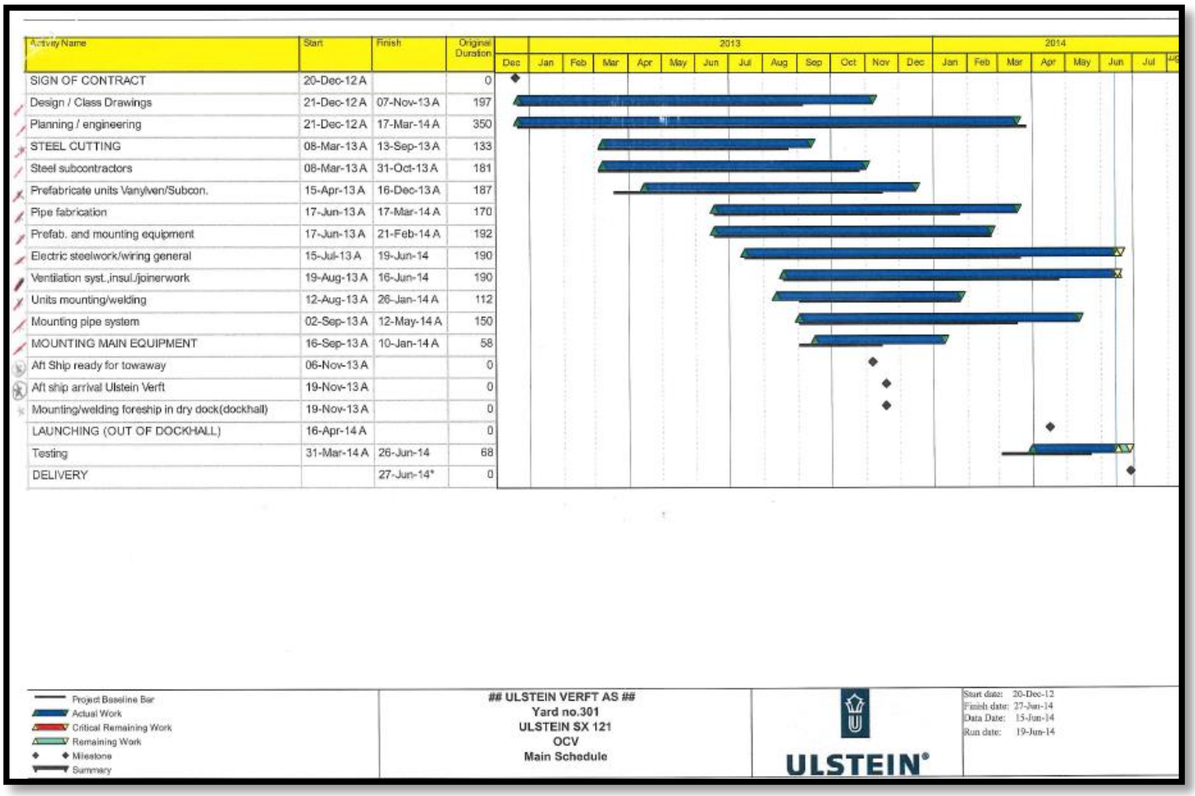


Figure 18: Main schedule across several production networks in Ulstein Shipyard.

Source: Retrieved from Ulstein Shipyard's Synergi system (2015).

Based on figure 18, significant deviations have been found between planned and actual duration of different activities that took place in shipyard's production networks. This ended up with table 8 and figure 19. These show significant deviations along with potential areas where time reduction improvements could have been achieved.

Table 8: Deviations analysis on main schedule in ULSTEIN SX 121.

Source: Retrieved from Ulstein Shipyard's Synergi system (2015).

	Design/Class drawings	Planning/ engineering	Steel cutting	Steel subcontractors	Prefabricate units	Pipe fabrication	Prefab and Mounting eqipm	Electric steelwork/ wiring general	Ventilation syst/ joinwork	Units mounting/ welding	Mounting pipe system	Mounting main equipment	Testing
Planned days	197	350	133	181	187	170	192	190	190	112	150	58	68
days	322	452	190	238	246	274	250	340	302	168	253	117	88
Deviation	125	102	57	57	59	104	58	150	112	56	103	59	20

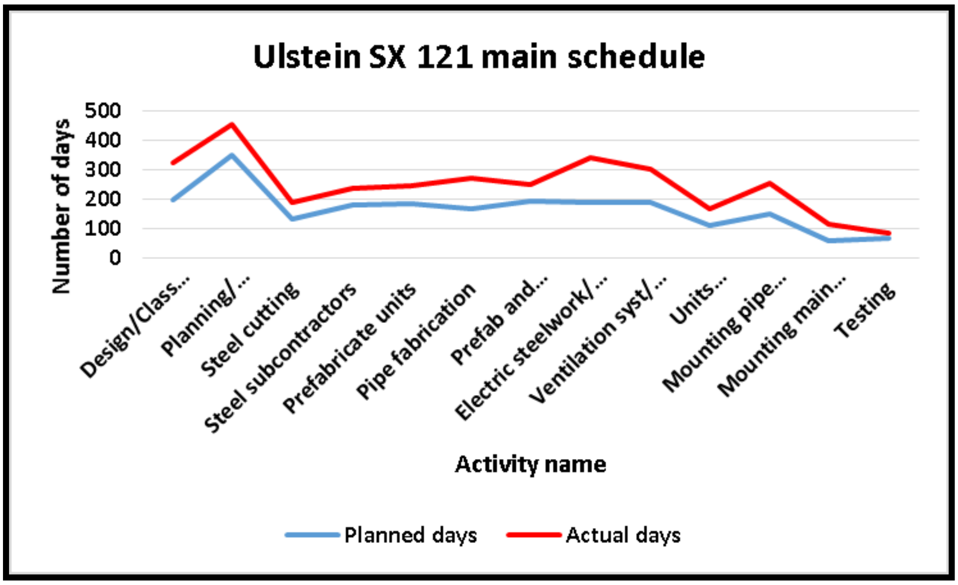


Figure 19: Deviation analysis on main schedule in ULSTEIN SX 121.

Source: Retrieved from Ulstein's shipyard Synergi system (2015).

The previous figures 18 & 19 show deviations across the production networks in Ulstein Shipyard during the manufacturing of the Ulstein SX 121 subsea ship. Associated deviations from the whole production networks were found alongside with delivering Ulstein SX 121 subsea ship on time to the customer. This indicates that Ulstein Shipyard was successful to deliver the project on time through hiring extra workers by suppliers to recover the wastes of reworks and repairs by paying extra cost to execute the project tasks. Meanwhile, Ulstein Shipyard was not successful to fulfil the planned time across the project production networks.

Therefore, it was believed that time reduction in TCT is possible by removing those associated deviations from the production networks in Ulstein Shipyard. The criteria to remove the time deviations across all production networks are vast, too broad and require intensive research with longer time frame than the current master's thesis duration.

Therefore, decisions were made among authors, Ulstein Shipyard and Molde Research Centre to narrow down the scope of the time compression analysis in the given scope of this thesis. Thus the scope of the analysis has been narrowed down to the outfitting phase as it is the main phase in which value was added.

5.1.2 Outfitting phase analysis

Subsequently, there was focus on answering the first research question of *how to compress the TCT in Ulstein Shipyard's ETO production networks*.

The research analysis was carried out on several tasks of the phase. Figures 20 and 21 show deviations of tasks taken place in the outfitting phase in terms of start and end dates. Naturally, these deviations indicate a weak execution of project planning with the subsequent waste of time along with flawed or misappropriate tasks done by the suppliers before WestCoat. This waste of time due to the inter-dependencies deviates the Ulstein Shipyard project from the principles of lean construction. The principles, according to Koskela (2000), are presented below.

1. Meeting the requirements of the customer
2. Reducing non-value adding activities
3. Reducing cycle time
4. Reducing variability
5. Increasing flexibility
6. Increasing transparency.

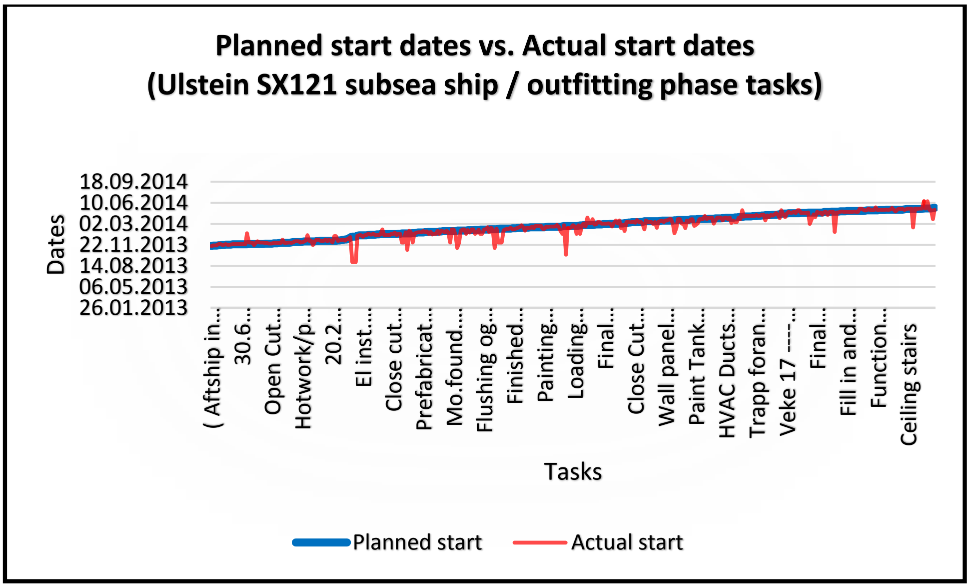


Figure 20: Planned start dates versus actual start dates for outfitting phase tasks.

Source: Retrieved from Ulstein Shipyard's Synergi system (2015).

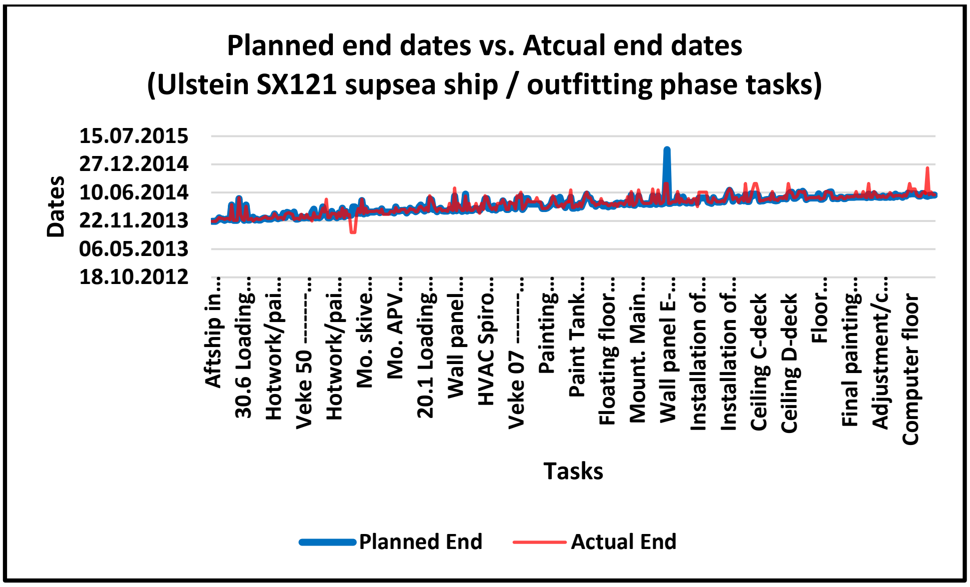


Figure 21: Planned end dates versus actual end dates for outfitting phase tasks.

Source: Retrieved from Ulstein Shipyard's Synergi system (2015).

From the case study findings in chapter 4 and the previous outfitting phase analysis in Figures 20 and 21, it has been found that Ulstein Shipyard prioritized the first principle of the lean construction principles, which is meeting the requirements of the customer by delivering the project on time. The other principles of lean construction, such as reducing non-value added activities and reducing the cycle time, were not properly achieved. Figures 20 and 21 have an evidential base that the waste of time and deviations occurred, causing obstacles in the production process flow. Therefore, those inter-dependencies create a chain of subsequent delays, affecting the primary objective of reducing the outfitting phase cycle time.

Koskela (2000) states that in general, the lean construction principles apply both to the total flow process and to its sub-processes. In addition, the principles implicitly define flow process problems, such as complexity, lack of transparency or segmented control.

It is also necessary to emphasize that lean is about developing and customizing principles that are right for each specific organization and diligently practicing them to achieve high performance that continues to add value to customers and society (Liker, 2004).

However, investigating all these outfitting tasks were also a vast job. Therefore, with the alignment of Molde Research Centre and Ulstein Shipyard, it has been decided to focus the analysis on the outfitting tasks provided by key supplier WestCoat.

5.1.3 Analysis of WestCoat tasks in the project outfitting phase

As mentioned before in the case study findings in chapter 4, each task in the outfitting phase took place according to the shipyard project plan. WestCoat began its tasks from sandblasting, treating and painting several steel blocks, units, tanks, areas and rooms once the aft-ship arrived at the Ulstein hull yard. After WestCoat finished its work on one task, another supplier started its assigned tasks in the outfitting phase.

Based on data and general expectations retrieved from Ulstein Shipyard's Synergi system and WestCoat excel sheets for the painting task, staffing plans and working hours, there were obvious deviations between WestCoat planned tasks and actual execution of those tasks in the outfitting phase. Table 9 displays WestCoat extra working hours that occurred due to painting plan deviations in the outfitting phase.

Table 9: Extra hours occurring due to painting plan deviations.

Source: Retrieved from Ulstein Synergi system performance report (2015).

Activity test	Hours
Repairs of pre-painted areas	854
Tank repairs	331
Errors and reworks	1136
Total	2321

Afterwards, table 10 shows that the project profitability was five percent of the selling price which range between 750million NOK and 1.2 billion NOK. This means, the project profitability was 37.5 million-60 million NOK.

Alongside these findings, the total number and rate of extra working hours were obtained from Ulstein Shipyard Synergi system. The extra working hours were 2,321 and the rate for each extra working hour was 340 NOK. Therefore, the cost of the total extra hours at Ulstein Shipyard was 789,140 NOK which corresponds to 1.5-2 percent of the project profitability.

Table 10: ULSTEIN SX 121 project profitability.

Source: Retrieved from general expectations of Ulstein Shipyard management and Synergi system.

Selling price	750-1200 million NOK
Profitability %	5% of the selling price
Profitability in NOKs	37.5-60 million NOK
Number of extra hours	2321hours
Rate of extra hour	340 NOK/hour
Total cost of extra hours	789140 NOK
Extra hours cost % (based on the profitability)	1.5-2%

A further analysis of WestCoat's painting plan deviations have been provided. Those deviations were as follows:

5.1.3.1 Units painting:

Table 11: Units painting task (planned and actual time required).

Source: Retrieved from Ulstein Shipyard's Synergi system (2015).

Task/activity	Discipline	Start	End	Planned time required	Actual Start	Actual End	Actual time required	Deviation
SBL/MAL S 841	221	11.12.2013	13.12.2013	2	11.12.2013	17.12.2013	6	4
SBL/MAL S 844	221	10.12.2013	20.12.2013	10	17.12.2013	20.12.2013	3	-7
Total	-	-	-	12	-	-	9	-3

The planned time to conduct the units' painting task for the aft-ship in the inner dock was 12 days while the actual required time was nine days. As displayed in Table 11, there was no delay in painting the units, but the logs shows that the painting of the unit's task was completed three days ahead of schedule.

5.1.3.2 Painting tanks

The tank painting task was the most intensive task done by WestCoat. Based on the case study findings from chapter 4, there were inter-dependencies while performing the task in several rooms and tanks. Those inter-dependencies caused delays that deviated the execution of the project plan. Figure 22 and 23 display those deviations.

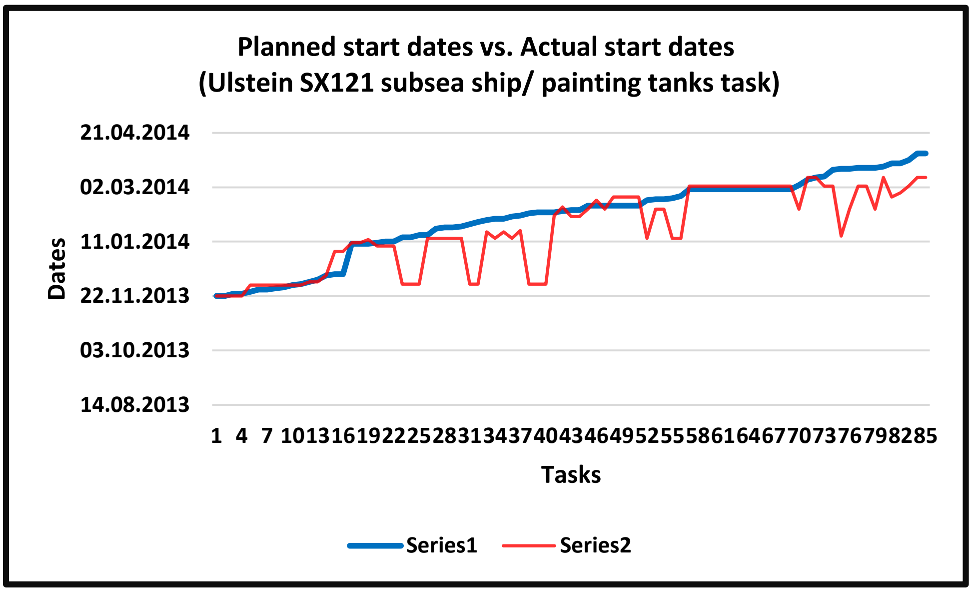


Figure 22: Planned start dates versus actual start dates for tank painting task.

Source: Retrieved from Ulstein Shipyard's Synergi system (2015).

Figure 22 displays the deviations of the planned start dates from the actual start dates for painting the tanks.

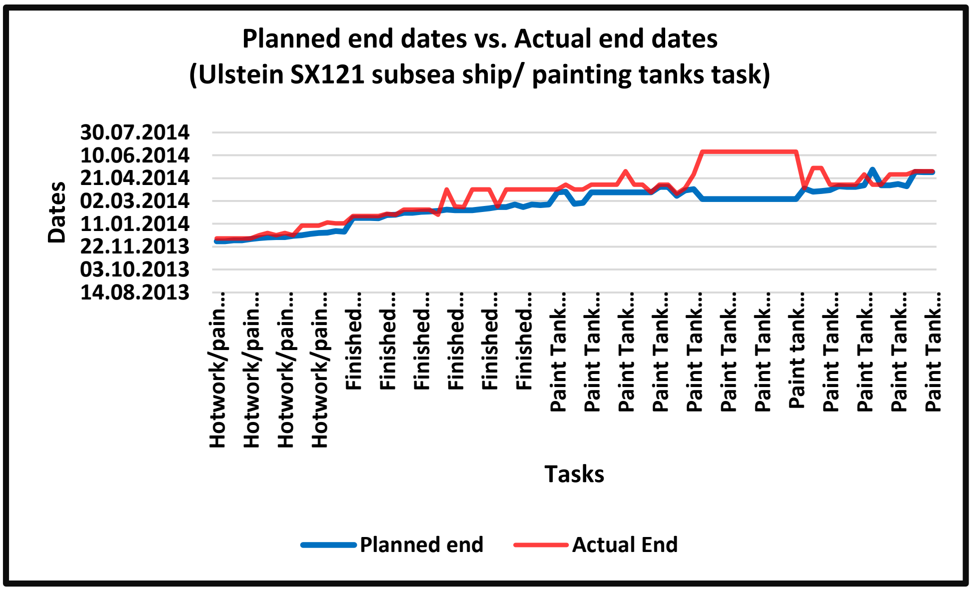


Figure 23: Planned end dates versus actual end dates for tank painting task.

Source: Retrieved from Ulstein Shipyard's Synergi system (2015).

Meanwhile, figure 23 displays the deviations of the planned end dates from the actual end dates for the same task.

Accordingly, in figures 22 and 23, a similar evidence base of waste of time and deviations occurring in the painting tasks of WestCoat activities were found. This hindered the flow of the production process in the same manner as in the outfitting phase. Therefore, these inter-dependencies by different suppliers working in the outfitting phase create accumulated redundancies in overall project plan execution in the outfitting phase.

5.1.3.3 Painting rooms and areas:

According to Figures 24 and 25, the project plan deviations in painting rooms and areas were not as much as the project plan deviations in painting tanks. Based on the case study findings from chapter 4, there were inter-dependencies in preforming the painting tasks in the rooms and areas from one side and painting the tanks from the other side. Performing the painting task alongside with necessary installments in the areas and rooms causes more damage to the painted tanks. Consequently, there were more rework requirements in repainting the tanks. Therefore, there were fewer deviations while painting the areas and rooms than painting the tanks. Figures 24 and 25 displays those deviations that took place due to the inter-dependencies that arising in performing the rooms and areas painting task.

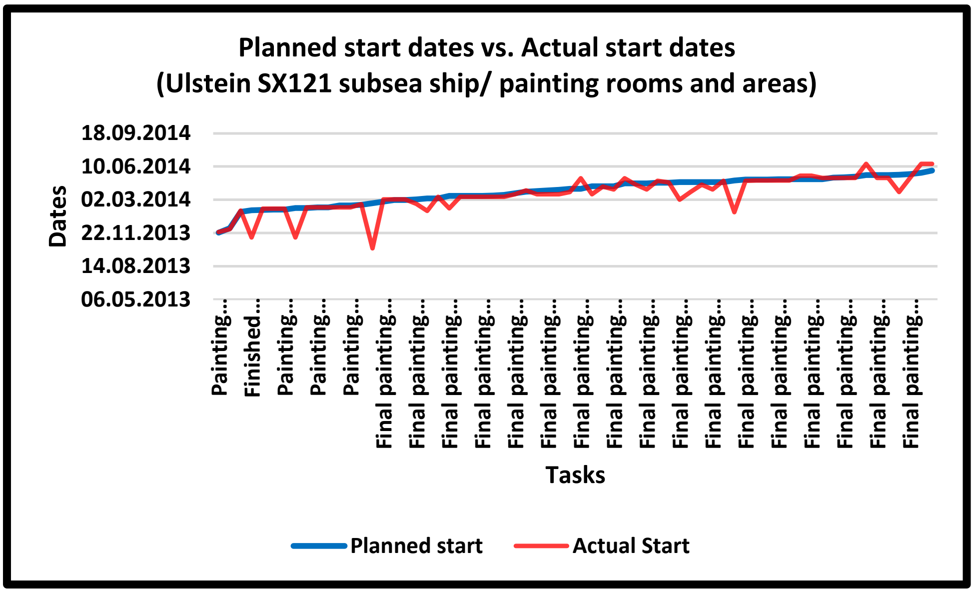


Figure 24: Planned start dates versus actual start dates for rooms and areas painting task.

Source: Retrieved from Ulstein Shipyard’s Synergi system (2015).

Figure 24 displays the deviations of the planned start dates from the actual start dates for the same task.

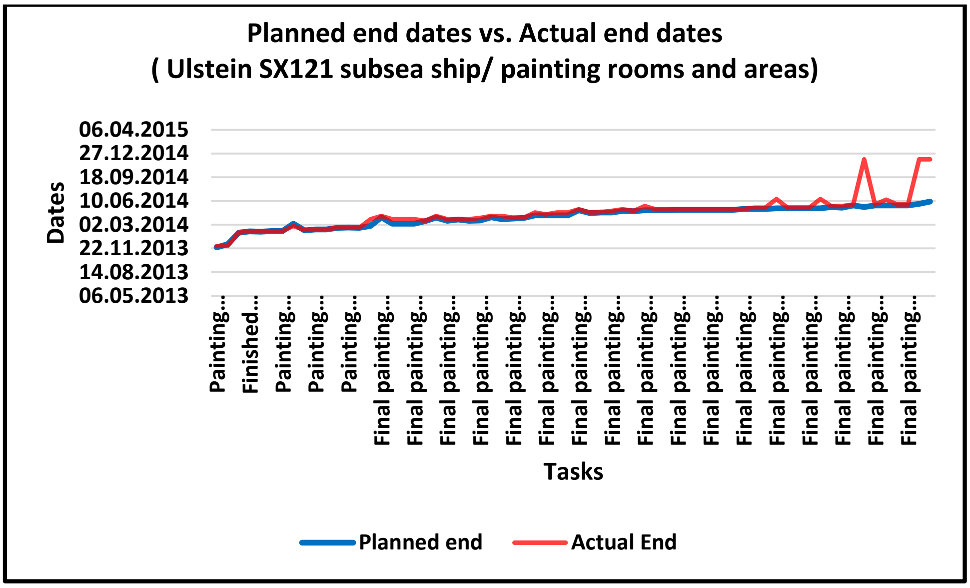


Figure 25: Planned end dates versus actual end dates for rooms and areas painting task.

Source: Retrieved from Ulstein Shipyard's Synergi system (2015).

Meanwhile, figure 25 displays the deviations of the planned end dates from the actual end dates for the same task.

5.1.3.4 WestCoat staffing plan and Working Hours:

Variations in the staffing plan and working hours in WestCoat to execute the project plan tasks were influenced by the deviations in the project plan on the Ulstein Shipyard Synergi system.

Figures 26 and 27, and Tables 12 and13 show the variations in the seven-month staffing and working hour plans for WestCoat on Ulstein project (Ulstein SX121 subsea ship). WestCoat started to execute its tasks in the outfitting phase in November 2013 and finished its final task in December 2014.

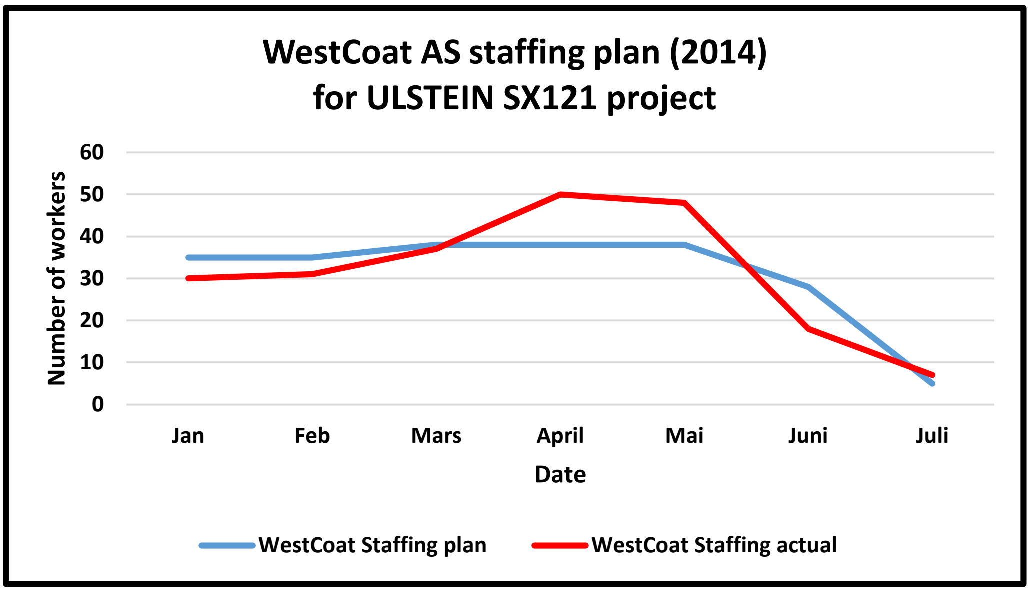


Figure 26: WestCoat staffing plan (2014) for ULSTEIN SX 121 project.

Source: Retrieved from WestCoat staffing plan Excel sheets for ULSTEIN SX 121 project (2014).

Table 12: WestCoat staffing plan (2014) for ULSTEIN SX 121 project.

Source: Retrieved from WestCoat staffing plan Excel sheets for ULSTEIN SX 121 project (2014).

	Jan. 2014	Feb. 2014	Mars. 2014	April. 2014	Mai. 2014	Juni. 2014	Juli. 2014
WestCoat Staffing plan	35	35	38	38	38	28	5
WestCoat Staffing actual	30	31	37	50	48	18	7

As displayed in figure 26 and table 12, a significant variations have been observed in WestCoat's staffing plan in the months of April and May, in which the final painting task in the outfitting phase was executed. WestCoat's staffing plan in those months included 38 workers for each month, while the actual staffing required was 50 workers for April and 48 for May.

Moreover, in Figure 27 and Table 13, a significant variations have been observed in WestCoat's working hours plan in the months of April and May, in which the task of conducting the final painting in the outfitting phase was executed. WestCoat's working hours plan -based on the Ulstein Shipyard plan- in the two months were 8,050 hours for each month, while the actual working hours required were 10,776 for April and 9,684 for May.

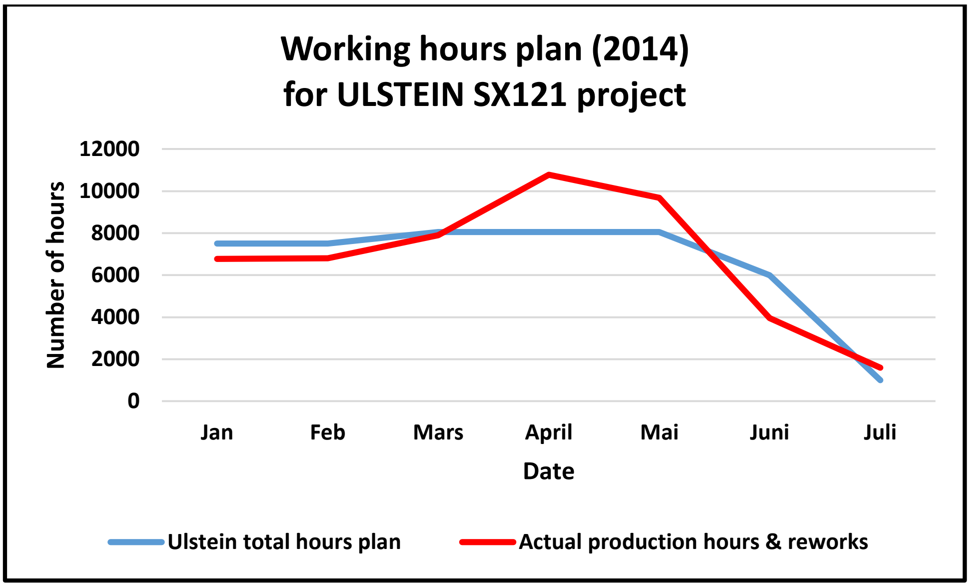


Figure 27: Working hours plan (2014) for ULSTEIN SX 121 project.

Source: Retrieved from WestCoat staffing plan Excel sheets for ULSTEIN SX 121 project (2014).

Table 13: Working hours plan (2014) for ULSTEIN SX121 project.

Source: Retrieved from WestCoat staffing plan Excel sheets for ULSTEIN SX 121 project (2014).

	Jan. 2014	Feb. 2014	Mar. 2014	Apri. 2014	May. 2014	Jun. 2014	Jul. 2014
Ulstein total hours plan	7500	7500	8050	8050	8050	6000	1000
Actual production hours & reworks	6767	6798	7895	10776	9684	3958	1596

Based on the previous analysis of WestCoat's painting tasks in the outfitting phase, it is believed that there are potential opportunities for Ulstein Shipyard to compress the TCT and increase its project profitability across the project phases.

The evidential base for this belief was emanated from the case study findings regarding the project plan deviations. Moreover, it has been found that the deviations were taking place in all the project phases as mentioned in table 8 and figure 19. Therefore, generalizing the findings from the outfitting phase to the other project phases, the scope for compressing the TCT will be created alongside robust opportunities to increase its project profitability.

In summary, the analysis for the first research question follows.

Generally, Ulstein Shipyard needs to compress the TCT of the overall project phases. The example of one supplier, WestCoat, can be taken as a model example to generalize with other supplier tasks. While thinking of ways to compress the TCT, the underlying primary causes of the time deviation problem were tried to be understood. The first cause lay in the nature of the relationship between Ulstein Shipyard as a buyer and WestCoat as a supplier. The shipyard keeps an arm's length relationship with the supplier. Moreover, Ulstein Shipyard adopts a competitive policy towards its suppliers. The second cause was inefficient planning of the project that did not correspond with the realities and requirements of the working tasks across the project phases. Consequently, it was found that this cause was embedded in the project planning process. The process of planning the project was changed recently. Five years ago, project planners used to visit the shipyard frequently and meticulously observed the activities, realities and requirements to perform the working tasks. By being present in person, project planners used to pinpoint the crucial realities and requirements.

Currently, the situation has changed significantly. Nowadays, planners are asked to propose project plans based on previous plans instead of having more on-the-job experience in the realities and requirements. Additionally, planning department tasks were partially shifted to the project coordinator responsible for conducting the planning tasks alongside with his specific tasks.

In other words, the project planners believe that planning has become a support function instead of being the main contributing function in the shipyard. Moreover, the planners think that they are just doers of the plans but not responsible to take decisions or being responsible for deciding either how the plans should be executed and how long each task in the project plan should take.

All these factors create obstacles in efforts to compressing the TCT of the project.

The first question of *how to compress the TCT in Ulstein Shipyard*'s *ETO production networks?"* leads to the need to integrate WestCoat's value stream with that of Ulstein Shipyard. The integrated value stream will include only the value adding activities. Consequently, it was believed that there would be scope for TCT compression by removing waste and non-value adding activities from the integrated stream. Therefore, a second research question was needed to understand how this value stream integration could be achieved.

5.2 Research Question 2

How to integrate a supplier's value stream into that of Ulstein Shipyard? What are the obstacles and benefits?

One of the most significant parts of this thesis is the integration of the supplier into the buyer's production networks. However, integration is a broad terminology. Thus, the integration of WestCoat's value stream into that of Ulstein Shipyard has been focused. While integrating, a general discussion on supply chain integration and buyer-supplier relationship based on Ulstein Shipyard and WestCoat is required.

5.2.1 Supply Chain Integration

According to Lambert et al. (1998) the goal of supply chain integration is to enhance total process efficiency and effectiveness across members of the supply chain. From a strategic perspective, Ajmera and Cook (2009) described supply chain integration as partners with joint authority that will share resources, benefits and risks. Similarly, supply chain integration is sometimes interpreted as high-level collaboration, where the involved parties act as one entity within an extended enterprise (Wen et al. 2007).

Based on the case study findings from chapter 4, it has been found that Ulstein Shipyard shared resources, benefits and risks with WestCoat, but the goal of supply chain integration was not achieved due to unwillingness on the part of the Ulstein Shipyard management to integrate WestCoat. The shipyard's management strategy is to maintain the competitiveness between the suppliers that perform the painting tasks instead of being dependent on one supplier.

Therefore, Ulstein Shipyard avoids a complete integration of WestCoat into its supply chain. Consequently, the total process efficiency and effectiveness across members of the supply chain could not be achieved. Moreover, the lack of integration deprives the companies of its potential benefits such as adding expertise, identifying problems as well as solutions ahead of time, and improving communication and information exchange regarding new ideas and technologies into each partner's system. The evidence of not achieving these potential benefits was found in the dissimilarities of the systems (i.e., Synergi and Microsoft Excel) used by Ulstein Shipyard and WestCoat. The dissimilarities of using different systems create obstacles in integrating the information flow, and hinder an increase in transparency among the members of the supply chain.

5.2.2 Buyer Supplier relationship

Park et al., (2012) mentioned that the terms such as outsourcing, downsizing, streamlining suppliers, and forming strategic partnerships with suppliers have become part of today's business jargon. They reflect changes in shipbuilding practices. Streamlining suppliers and forming strategic partnerships with suppliers means that Ulstein Shipyard and WestCoat are involved in relational exchanges rather than spot market exchanges.

Based on the case study findings, it has been observed that Ulstein Shipyard is taking an advantage of its post-contract bargaining power over WestCoat by assigning different number of workers and working hours to execute the project plan tasks. Ulstein Shipyard keeps an arm's length relationship with WestCoat rather than making them an integral part of its production networks.

While they are involved in transactions, Ulstein Shipyard safeguards itself against the hazards of opportunism from its suppliers by keeping an arm's length relationship with them to avoid any risk of copying its know-how in shipbuilding and delivers ships on time. Thus, the repeated transactions between Ulstein Shipyard and WestCoat for years did not help increase inter-organizational trust.

5.2.3 Relational Norms and Dependence

Relational norms may be described as the values shared among exchange partners regarding what is deemed appropriate behavior in a relationship (for example, Heide and John, 1992). Over the last two decades, closer supply chain relationships exhibited by high relational norms — such as trust, collaboration, long-term relationship, and increased information sharing—have evolved in many industries to help firms respond to changes (Droge and Germain, 2000; Hoetker et al, 2007; Monczka et al, 1998; Sengün and Wasti, 2007; Whipple and Frankel, 2000).

Based on the case study findings and observations about the relationship between Ulstein Shipyard and WestCoat, it was found that there were low relational norms characterized by distributive or aggressive bargaining behaviors as a part of which tactics where used to resolve disagreements. The evidential base for the low relational norm between Ulstein Shipyard and WestCoat was stated by one respondent from shipyard. Low relational norms tend to be arm's length or competitive, he added.

5.2.4 Governance forms:

One method to analyze suppliers and finding strategies to govern them is to use the Kraljic matrix (1983). This was developed to find strategies for suppliers based on two dimensions—profit impact and supply risk.

The profit impact of a given supply item can be defined in terms of the volume purchased, the percentage of total purchase cost, or impact on product quality or business growth. Supply risk is assessed in terms of availability of the supply item, the number of suppliers, competitive demand, make-or-buy opportunities, storage risks and substitution possibilities (Kraljic, 1983). However, Guvåg et al., (2012) analyzed this on the light of a STX OSV shipyard more elaborately.

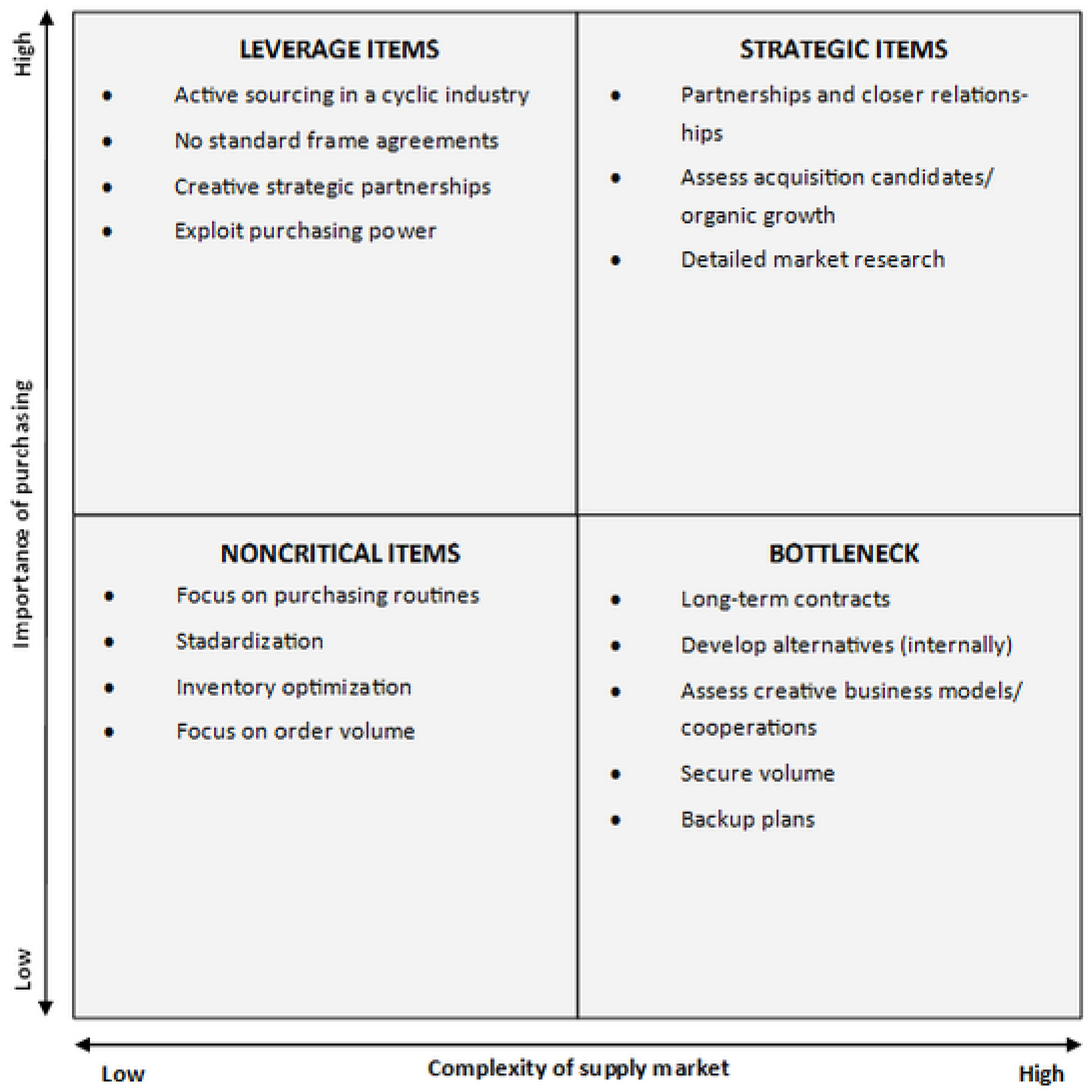


Figure 28: Recommended positioning and supplier strategies for STX OSV.

Source: Guvåg et al., (2012).

In Figure 28 depicting the Kraljic matrix, a buyer can categorize its supplier in four ways: first, a leverage items supplier with which buyer have no standard frame agreements, and can have strategic partnerships and exploit purchasing power; second, a non-critical items supplier which the buyer can utilize for standardization, inventory optimization, and order volumes; third, a bottleneck items supplier that the buyer can utilize to develop alternatives, secure volumes and retain for back-up plans; fourth, a strategic items supplier that may play a critical role for the buyer. The buyer should develop partnerships and close relationships with its suppliers, conduct a detailed market research on them and can, possibly, mull over a potential acquisition of a supplier. In a nutshell, WestCoat is in a strategic position with respect to Ulstein Shipyard, making it constantly assess the business model of the supplier and strategic decisions to either develop it through integration or create an internal or external alternatives.

While putting in place the recommended positioning and supplier strategies based on the matrix, it has been found that WestCoat is a mixture of strategic and bottleneck items supplier. Thus, it was found that a long-term, three-year contract along with a partnership and closer relationship exist between them.

However, as discussed, the relationship is, to some extent, assertive. Therefore, Ulstein Shipyard can think about acquiring the whole business of WestCoat. Thus, on the one hand, Ulstein Shipyard shares a good relationship with WestCoat, and on the other hand it has the option of developing alternatives.

Naturally, the complexity of supply market is high as there can be other suppliers available. Finding an efficient supplier can be a challenge for Ulstein Shipyard considering the extensive services provided by WestCoat over the past 10 years. The importance of purchasing market is also high as Ulstein Shipyard purchases a significant amount of services from WestCoat.

5.2.5 Relationship Continuance

According to Chanchai and Young (2009), research has shown that expectations of continuance in buyer-supplier relationships are high when there are shared values between the exchange partners regarding what constitutes appropriate behavior in the relationship (Morgan and Hunt, 1994). As the relational norms between Ulstein Shipyard and WestCoat are low, the continuance expectancy decreased. Consequently, flexibility, information exchange and solidarity will be influenced by the low relational norms.

5.2.6 Assertiveness and cooperativeness in managerial decision-making

Wilmot and Hocker (2001) based negotiation, or conflict management, strategies on a two-dimensional framework: assertiveness and cooperativeness. They based this framework on the five different negotiation strategies provided by Kilmann and Thomas (1975) — avoidance, accommodation, collaboration, competition, and compromise. Based on the case study findings and observations, it has been found that the assertiveness strategy of Ulstein Shipyard toward managerial decision-making was practiced with a tendency of concern for oneself. The greater the concern for self, the greater the individual's assertiveness tendency.

5.2.7 Lean Manufacturing tool (Value stream mapping)

VSM is a lean manufacturing tool that acts as an enterprise improvement tool to assist in visualizing the entire production process, representing both material and information flow (Singh & Singh, 2013). Visualizing the entire production process in the outfitting phase in Ulstein Shipyard is considered to be too complicated.

According to Rother and Shock (1999) the ultimate goal of VSM is to identify all types of waste in the value stream and to take steps to eliminate them by implementing a future-state value stream that can be accomplished within a short period of time. Therefore, Rother and Shock's four steps of VSM has been implemented as shown in Figure29:

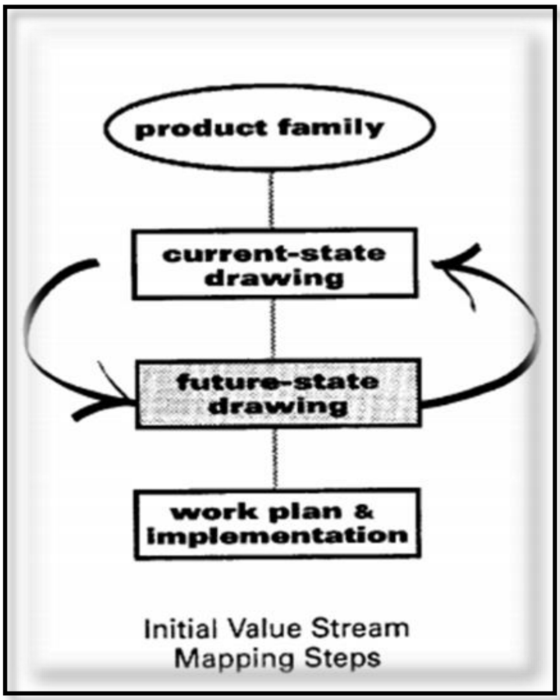


Figure 29: Value stream mapping steps.

Source: "Value Stream Mapping to Add Value and Eliminate Muda" (Rother and Shook, 1999).

5.2.7.1 Selecting a product family

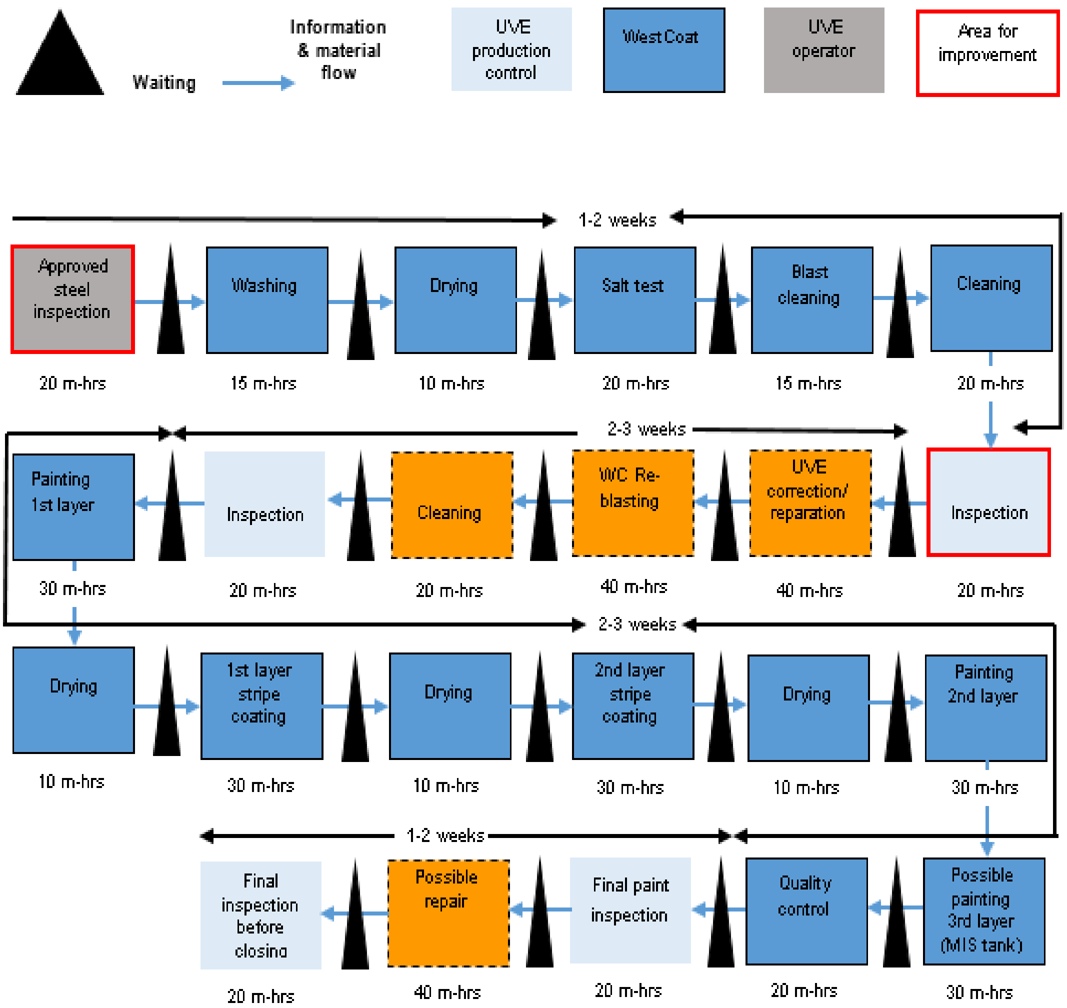
The focus was on one product family from the customer end of the value stream as the target for improvement. Based on a discussion with Ulstein Shipyard, a decision was made to work on the tank in the outfitting phase of the Ulstein project SX 121. There were other phases of the ship, but the decision to focus on the outfitting phase was made because it was the main value addition phase. Moreover, the tank was selected because tanks were the most expensive work of WestCoat.

5.2.7.2 Drawing a current state map

As the case study findings, observations and analysis indicated, there were deviations time regarding executing the project tasks by WestCoat. The VSM tool was used in order to visualize the elements of a specific production process from door to door where WestCoat conducted its tasks on the tank to remove the non-value added activities of the process. The process of drawing the current state map requires the following:

1. Collecting information on the current state while walking through the actual material and information flows.
2. Conducting a quick walk along the entire door-to-door value stream in order to understand the flow and sequence of the production process.
3. Calculating the cycle and value added time for each task performed by WestCoat by using a stopwatch.

There were several limitations to follow these criteria as the project had already been completed and ship had been delivered to the final customer. Therefore the current state map had been drawn based on the flow and sequence of the production process from Ulstein Shipyard Synergi system. This contained the necessary elements of the map, such as processing activities and non-value added activities from the customer's point of view. Moreover, the time duration for each task in the current value stream was assumed by the project leading coordinator who was responsible for allocating time slots for each task in the project plan.



Total duration = 6-8 weeks

Hours per week = 100 hrs.

Total lead time = 630-780 hrs.

Notes:

1) Total duration have been assumed based on Synergi system average duration of conducting the tank tasks.
2) All durations are per unit of man hour (m-hr).
3) Time values for each activity have been assumed by the project coordinator.
4) The processing time doesn't reflect the exact value added time.

		Duration (hrs)	%
Waiting time	=	110-260	17.5-33%
Total processing time	=	280	44.5-36%
Reworks or repair	=	140	22-18.5%
Inspection	=	80	13-10%
Steel inspection	=	20	3-2.5%
Total lead time	=	630-780	100%

Figure 30: WestCoat current state map for tank production process.

Source: Ulstein Shipyard Synergi system (2015).

5.2.7.2.1 Current state map analysis:

The analysis of the current state map for WestCoat value stream to carry its tasks on tanks focuses on the appraisal of the value added and non-value added activities. Figure 30 displays WestCoat value stream for its tank tasks. The elements of the supplier's value stream in the flow of information and raw materials into products consists of inspection, processing time, waiting time and reworks or repairs. The tasks in the current state map were linked together through arrows indicating the information and material flow alongside triangles represented the time a tank has to wait until it processed by the following task. Regarding the duration, specific number of man hours for each task in the current state was allocated at the bottom of each task based on the project coordinator's assumptions. The lead time for tank tasks was displayed in arrows at the top of each task. Consequently, the total non-value added times or waste was calculated by subtracting the total processing time from the total lead time for the tank production process. Processing times in the current state map was considered to be the value added time and specified based on an assumptions of the project coordinator who was responsible for allocating time slots for each task in the project plan. It was one of the case study limitations to obtain the exact value added time from the processing time for each task. Therefore, the value added time was considered as the processing time. Moreover, the unit of time for each task is a man-hour and the unit of time for the current state map is a week, with each week representing 100 working hours.

5.2.7.2.2 Current state map analysis results

In the process of mapping the current state of the tanks, total duration average was around six- eight weeks to flow through the production process. According to the project plan, this process should have taken 3 weeks on an average. So, there was a time deviation from the plan. This deviation took place as a result of conducting several non-value added activities such as inspection, waiting time, reworks and repairs. Moreover, as mentioned by a respondent from WestCoat, the tank tasks were considered to be the most complex works it performed.

WestCoat's value added activities in the current state map represented as the processing time (44.5-36 percent of the total time in the production process) where value was added from the customer's perspective alongside non-added value activities—such as reworks or repairs (22-18.5 percent) conducted by WestCoat, required inspections (16-12.5 percent) conducted by Ulstein Shipyard's production control and waiting time (17.5-33 percent) where no inspection, processing or reworks occurs. In other words, this means that only 47-36 hours of a 100 hours per week add value to the tank as a final product, while the remaining 53-64 hours were non-value added time.

5.2.7.2.3 Causes of non-value added activities (obstacles or bottlenecks)

Non-value added activities or waste refer to the total efforts of WestCoat that do not add value to the tanks as a final product from the perspective of the customer. There are several reasons for this:

1. *Inspection:* Ulstein Shipyard conducted a crucial steel inspection to ensure that the quality of the steel met the quality standards. Therefore, non-value added time was consumed for this activity. In case the steel did not meet quality norms, additional non-value added time was consumed to repair and reform the defects.
2. *Repairs or reworks:* WestCoat primarily, alongside Ulstein Shipyard, conducts rework or repairs. According to a respondents from Ulstein Shipyard, those activities occurred due to defects in the quality of steel and inter-dependencies between the suppliers in conducting their tasks that caused delays and, in certain circumstances, damaged the work. In addition, details on reality and the requirements of work tasks by the planning department were missing.
3. *Waiting time:* Waiting time refers to the idle time in which no inspection, processing or reworks occurs. Waiting time hinders the smooth flow of the production process. It had been stated by a respondent from Ulstein Shipyard that waiting time occurred for several reasons such as unfavorable weather conditions with high humidity. Consequently, WestCoat workers had to suspend the painting tasks until conditions were proper to restart work. Moreover, he added that delays in delivering the necessary material and information contributed significantly to the waiting time, and WestCoat workers had to sit idle until they had received the required material and information to conduct their tasks. Meanwhile, from the guided tour of the dock yard and several interviews with the participants of the production process, it had been observed that multitasking affected the waiting time in the production process. In general, it had been observed that when WestCoat had to start its work in one task, it found that another

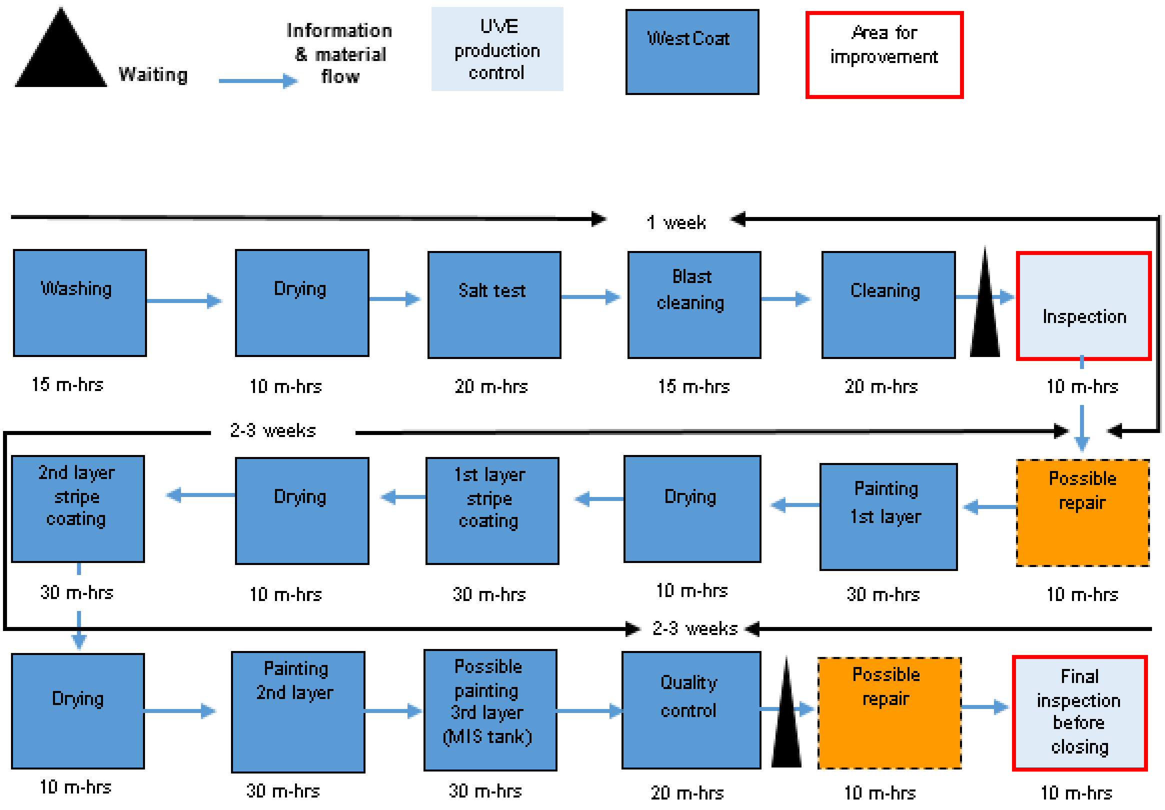
supplier had not completed its task yet. Therefore, WestCoat workers were shifted to begin another task rather than sitting idle until the other supplier had completed his work on the first task. Consequently, at that time WestCoat was not done with the other task whereas the supplier had finished with the first task but was delayed. Thus, a dilemma for WestCoat began as it needed more time to complete the second task and then come back to the first. This was another reason cause of the waiting time.

It was believed that there would be scope for compressing the TCT and integrating the value stream of WestCoat into Ulstein Shipyard's value stream by removing and mitigating the non-value added activities such as inspections, waiting times, repairs and reworks from the current state map.

Later, a future state map was developed based on the current state map where the non-value added activities were removed from the value stream. This future state map let the value flow, the customer pull the value instead of push and offer suggestions on how to implement this future state map.

5.2.7.3 Developing Future State Map

An analysis of the current state map of the tank production process found that waiting time alongside rework and repairs were consuming more time than other activities. On the project plan, an average lead time of three weeks was required for WestCoat to finish its tank tasks. While the average for the actual lead time to finish their tasks on tank was 8 weeks. It means that in the project's actual lead time, the waiting time consumed around one to two-and-half weeks, reworks or repairs consumed almost one-and-half weeks and inspection consumed 1 week. In total, five weeks were consumed for non-value added activities from the customer's point of view. Therefore, a future state map (figure 31) was developed where non-value added activities had been mitigated and removed from the current state map.



Total duration = 3-4 weeks

Hours per week = 100 hrs.

Total lead time = 360-380 hrs.

Notes:

1) Total duration have been assumed based on Synergi system average duration of conducting the tank tasks.
2) All durations are per unit of man hour (m-hr).
3) Time values for each activity have been assumed by the project coordinator.
4) The processing time doesn't reflect the exact value added time.

		Duration (hrs)	**%**
Waiting time	=	40-60	11-16%
Total processing time	=	280	78-74%
Reworks or repair	=	20	5.5-5%
Inspection	=	20	5.5-5%
Total lead time	=	360-380	100%

Figure 31: WestCoat future state map for tank production process.

Source: Ulstein Shipyard Synergi system (2015).

5.2.7.3.1 Future state map analysis:

Future state map for tank production process was developed through following three steps. The first step is to remove the steel inspection activity from the current state map by shifting that activity backwards to take place in the source of the steel production, specifically in Poland. The actual lead time (630–780 man hours) for the tank tasks will be reduced by 2.5-3 percent (20 man hours), and the likelihood of finding defects in the steel quality will decrease and influence the time consumed for repairs and rework. The second step is to improve the project plan for the tank tasks by taking into consideration the inter-dependencies between the suppliers while they conduct their tasks. This will significantly reduce the time consumed to conduct repairs or rework by 15-19 percent (120 man hours) from the actual lead time (630–780 man hours). Repairs or rework can also be avoided by greater involvement of the project planners with the inner dock site. The third step is to mitigate and reduce the waiting time in the tank tasks by understanding clearly the realities and the requirements of the project plan tasks, integrating the information flow regarding the project plan tasks between WestCoat and Ulstein Shipyard by using the same Synergi operating system and prioritizing the plan tasks to avoid multitasking influences on the waiting time. Thus, it will help in mitigating and reducing the waiting time by 17.5–33 percent (70–200 man hours) from the total lead time (630–780 man hours).

5.2.7.3.2 Future state map analysis results

In a nutshell, the project's actual lead time in the developed future state map fell to 360–380 man hours from 630–780 man hours, the waiting time decreased to 40-60 man hours from 110-260 man hours, the time on rework or repairs fell to 20 man hours from 140 man hours and that on inspections (including steel inspection) dropped to 20 man hours from 100 man hours.

5.2.7.4 Implementing future state map

Implementing the developed future state map alongside obtaining the actual results requires long time scale to be processed and executed. Such a time scale was not available and has been considered to be one of the case study limitations. Therefore, guidelines and scenario on how the future state implementation step should take place had been developed based on Rother and Shock (1999).

Before implementing the developed future state map, Ulstein Shipyard has to engage a person to manage the value stream to execute the future state map. The value stream manager's job is to lead the team that will operate the process in all business functions and be responsible for the cost, quality and delivery of the product in the current state while mapping and leading the implementation of the future state. First, the manager has to do the following tasks:

5.2.7.4.1 Splitting Implementation into Steps

The crucial point about implementing the future state map is to visualize it as a process of constructing chains of connected flows for different activities. This can be possible by dividing the developed future state map into loops and objectives as described below:

- **Ulstein Shipyard loop:** This encompasses the flow of material and information between the customer and the performer (WestCoat) of the tank production process. Managing this loop will impact all the activities in the integrated value stream.
- **Ulstein Shipyard loop objectives:**

1. Develop a continuous flow from the first activity until the last activity in the value stream.
2. Reduce the total lead time of the tank production process.
3. Remove the steel inspection activity from the production process activities.
4. Develop a pull system.

- **Extra loops:** There are material and information flow loops between different activities (pulls). Each activity (pull system) in the value stream corresponds with the end of another loop.
- **Extra loops objectives:**

1. Reduce the waiting time between the production process activities.
2. Improve the transparency and accuracy of the project plan tasks.
3. Mitigate the influence of multitasking in the production process.
4. Reduce the repairs and reworks activities in the production process.

All these loops will help divide the implementation of the developed future state map into manageable pieces.

5.2.7.4.2 Create Value Stream Plan

The developed future state map gives an idea of where to go. Therefore, the value stream manager needs to create a yearly value stream plan that shows:

1. What he is planning to do and when he will do it.
2. Set measurable goals.

3. Set checkpoints with real deadlines and named reviewers to give feedback on the execution of his plan.

The value stream manager can start the plan implementation by focusing on achieving continuous improvements in the loops of the developed future state value stream. The loop improvements includes: developing a continuous flow, establishing a pull system and eliminating waste in the value stream. Figure 32 displays a yearly value stream plan in which the value stream manager can set objectives and measurable goals, and keep tracking the execution of the plan.

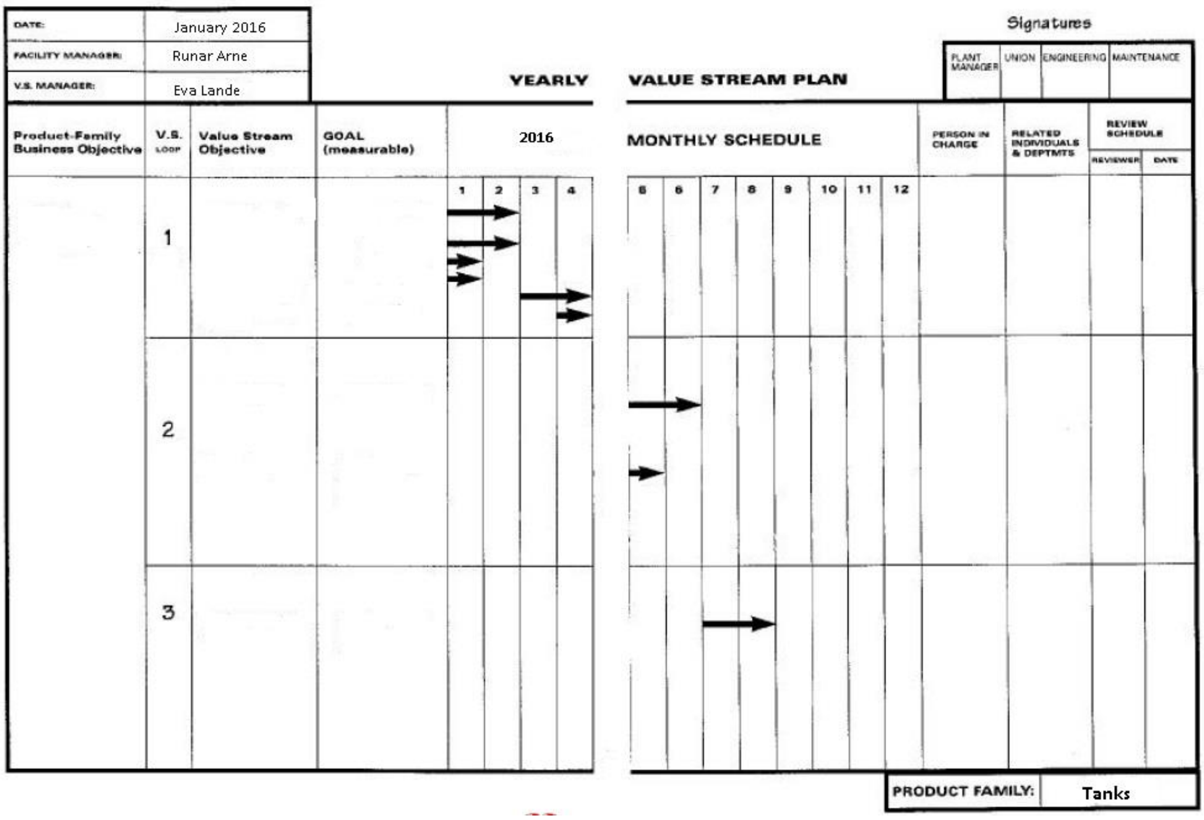


Figure 32: Yearly value stream plan.

Source: Rother and Shook (1999).

Once the value stream manager has understood what elements to implement in the developed future state, he needs to write them in a yearly value stream plan. This yearly plan can be used as a key performance indicator also to evaluate the performance of the production processes every quarter or month. Moreover, continuous improvements in the production process can be achieved by focusing on the unsuccessful objectives and goals in the yearly value stream plan instead of focusing on the accomplished objectives and goals.

5.2.7.4.3 Management responsibility:

The responsibility for bringing about improvements in the value stream mainly belongs to Ulstein Shipyard management. It has to understand its role in visualizing the whole flow, improve the future lean flow and take the lead to implement the program. The shipyard's management cannot delegate the implementation of the developed future lean flow to someone else (the front lines or consultants) as it is the only involved party that can visualize the total flow that cuts across departmental and functional boundaries. Implementing the developed future lean flow has to be a part of everyday activities in Ulstein Shipyard. Alongside the Ulstein Shipyard's management responsibility, a shipyard as a whole has to have the conviction that lean construction principles—such as meeting the requirements of the customer, reducing non-value added activities, reducing the cycle time and variability and increasing flexibility and transparency—can be adapted successfully accompanied by a robust desire to learn from trials and unsuccessful practices.

The Ulstein Shipyard management has to follow these steps to achieve improvements in the value stream:

1) Dedicate time and learn the lean principles for itself.
2) Creation of the lean value stream has to be a part of Ulstein Shipyard's activities.
3) Focus on a small number of a specific goals managed by the value stream maps.
4) Evolve a policy management by involving the lower levels in Ulstein Shipyard into formulating a policy and implementing it. When a lean shipyard matures, the policy will start to emerge from the interaction between the several levels of the organization instead of being generated from the top layers to prevail below.
5) Develop a lean value stream has to be done with respect for people and with "respect for old habits".

6.0 Conclusion

The purpose of this thesis is to compress the TCT of Ulstein Shipyard's ETO production networks by focusing on the activities performed by a key supplier. It was believed that a compression is possible by integrating the value stream of supplier WestCoat into that of Ulstein Shipyard. In the light of this purpose, two research questions were asked to reach the thesis goals.

The first research question was about investigating how to compress the TCT. It was found that there were several time deviations across the ETO production networks (project phases). In order to understand the underlying causes, the reasons for those deviations were tracked and analyzed. The research and analysis were conducted on only the production network of the tanks.

Time deviations occurred due to two reasons. The first of these was the nature of the relationship between Ulstein Shipyard as a buyer and WestCoat as a supplier. Ulstein Shipyard has an arm's length relationship with WestCoat, which means it does not plan to fully integrate WestCoat into its production network. This is because it follows a policy of maintaining competitiveness among its suppliers. The nature of the relationship between the two influenced the communication and information flow with WestCoat claiming that information sharing during the outfitting phase was inefficient and delays occurred several times because of the lack of information required to conduct the tasks. This indicates that attention must be paid to making crucial efforts at information sharing alongside facilitating access to the operating system and use. These steps will help manage the buyer–supplier relationship efficiently.

Second, time deviations in the ETO production networks occurred due to inefficient planning of the project which did not reflect the realities or the requirements of the working tasks across the networks. Examples of problems occurring due to inefficient planning are inter-dependencies between the suppliers while performing their tasks.

Corresponding to those causes of time deviations, solutions have been suggested to counter those causes. Suggestions on enhancing the efficiency of the planning tasks by reshuffling them across members that are involved in executing Ulstein SX 121 project are given.

The second research question was about investigating how to integrate a supplier (WestCoat) value stream into that of Ulstein Shipyard as well as explaining the obstacles and benefits of this integration.

Therefore, one of the lean manufacturing tools –the VSM tool– has been suggested to use. This tool was used to integrate the value stream of the supplier (WestCoat) into that of the buyer (Ulstein Shipyard).

Moreover, VSM differentiates the activities in the current value stream into value added and non-value added activities, which showed potential areas of time reduction improvements. Thus, it serves as a base to develop a future state map for the integrated value stream, where non-value added activities were mitigated and removed from the value stream. Besides, suggestions were offered on how to remove those non-value added activities from the value stream.

An analysis with regards to the developed future state map showed that actual lead time to execute the tanks production network could be reduced significantly and the production network flow (material and information flow) could be improved.

Generally, the findings showed that compressing the TCT is possible by making improvements in the planning process, integrating the value stream of the supplier into the buyer's value stream and removing the non-value added activities from the production network.

7.0 Limitations of Study and Further Research

The purpose of this thesis was to compress the TCT in Ulstein Shipyard's ETO production networks. Prior to this thesis, not much research had been done in this area.

Therefore, the authors of this thesis analyzed the current TCT in one of Ulstein Shipyard's projects (Ulstein SX 121), and compared it with theories in order to understand how to achieve the compression. The analysis scope of the project was limited to only one production network, i.e. the production network of the tanks in the shipyard. This scope limitation occurred because analyzing all the production networks required a very long time, and expansive work and analysis. Therefore, this is considered to be one of the study limitations.

Apart from the scope limitation, there were time limitations in:

1) Calculating activities' exact cycle times and value added time in the value stream because the authors were not able to be present when the activities took place.
2) Implementing the developed future state as it required a longer period than the available time for the authors.

Moreover, the case analysis was done in only five months whereas more time was required for an in-depth analysis. There were also other limitations when the study was conducted. Since the study was done only on a single ship, the project and all secondary and primary data were based on this ship. This had a subtle weakness in terms of generalizing the case findings and analysis. In addition, interviews were conducted only with the personnel related to a single ship. Therefore, there is scope for a bias in information sharing. Finally, this study only investigated a single supplier. Thus, all decisive outcomes were based on the data of that single supplier.

This master thesis is the second delivery from the SMARTprod project that will continue the research until the end of 2016. Many findings analyzed and discussed in this thesis serve as the basis for further research in this project.

Further research on the application of the concepts of continuous improvements on Ulstein Shipyard's projects, the adoption of best practices to tie and integrate the relationship between the buyer and its suppliers, motion studies and the implementation of the developed future state map are recommended.

8.0 References

Abdulmalek, F. A., & Rajagopal, J. (2007). Application of VSM to process industry. International Journal of Production Economics, 107(1), 223–236.

Abrahamsson, M., Andersson, D., & Brege, S. (2003). Outsourcing–Från mode och trend till balanserat strategibeslut (Outsourcing–from fashion and trend to a balanced strategy). Manage Magazine, 5, 18–29.

Ajmera, A., & Cook, J. (2009). A multi-phase framework for supply chain integration. S.A.M. Advanced Management Journal, 74(1), 37–47.

Angerhofer, B. & Angelides, M. (2006). A model and a performance measurement system for collaborative supply chains. Decision Support Systems, 42(1), 283–292.

Andersson, D., Brege, S., Nordigarden, D., & Rehme, J. (2008). Outsourcing of wood-based component manufacturing: Driving forces found in Scandinavian companies. J. Forest Prod. Bus. Res., 4(7), 78–94.

Arbulu, R. J., & Tommelein, I. D. (2002). Proceedings of the Tenth Annual Conference on the International Group for Lean Construction (IGLC-10): Value Stream Analysis of Construction Supply Chains: Case Study on Pipe Support Used in Power Plants (pp. 183–195). Gramado, Brazil.

Artz, K. W., & Norman, P. M. (2002). Buyer-supplier contracting: Contract choice and ex post negotiation costs. Journal of Managerial Issues, 14(4), 399–417.

Aslesen, S., & Bertelsen, S. (2006). Ulstein Verft AS–Lean shipbuilding, Internet notate, Modnet.

Baruch, Y., & Lambert, R. (2007). Organizational anxiety: Applying psychological concepts into organizational theory. Journal of Managerial Psychology, 22(1), 84–99.

Baxter. P., & Jack, S. (2008). Qualitative case study methodology: Study design and implementation for novice researchers. The Qualitative Report, 13(4), 544–559.

Bjørn G., Jagjit, S., Dugnas, K., & Oddmund, O. (2014). A high value production network. Molde, Norway: Molde Research Institute.

Bowersox, D. J., Closs, D. J., & Stank, T. P. (1999). 21st century logistics: Making supply chain integration a reality. Chicago, IL, USA: Council of Logistics Management (CLM).

Braglia, M., Carmignani, G., & Zammori, F. (2006). A new value stream mapping approach for complex production systems. International Journal of Production Research, 44(18), 3929–3952.

Brandes, H., Lilliecreutz, J., & Brege, S. (1997). Outsourcing–success or failure? Findings from five case studies. Eur. J. Pur. Supply Manag., 3(2), 63–75.

Brandes, O., Brege, S., & Brehmer, P. (2012). The strategic importance of supplier relationships in the automotive industry. Retrieved from http://cdn.intechopen.com/pdfs-wm/45361.pdf.

Brown, A., Amundson, J., & Badurdeen, F. (2014). Sustainable value stream mapping (sus-VSM) in different manufacturing system configurations: Application case studies. Journal of Cleaner Production, 85, 164–179. doi:10.1016/j.jclepro.2014.05.101.

Caldwell, C., & Clapham, S. (2003). Organizational trustworthiness: An international perspective. *Journal of Business Ethics*, *47(4)*, 349–364.

Camelot ITLab (2014). *Managing complexity and bringing order processing to excellence*. Retrieved from http://www.camelot-itlab.com/fileadmin/user_upload/Flyer/Camelot_ITLab_ETO_en.pdf.

Carlson, M., & and Lind, J. (2005). Management control: An alternative to outsourcing. In L. Bengtsson, C. Berggren, & J. Lind (Eds.), *Alternativ till outsourcing*. Malmo, Sweden: Liber.

Chanchai, T., & Young, R. (2009). The role of agent negotiation behaviors in buyer-supplier relationships. Journal of Managerial Issue 21. Retrieved from http://search.proquest.com/docview/194167425/2F1E1F8235EE4078PQ/2?accountid=40814.

Chitturi, R. M., Glew, D. J., & Paulls, A. (2007). International Conference on Agile Manufacturing 9–11 July: *Value Stream Mapping in a Jobshop* (pp. 142–147).Durham, UK: Durham University.

Christine, B. M. (2001). A case in case study methodology, *Field Methods, 13(4),* 329–352.

Christopher, M. (2000). The agile supply chain: Competing in volatile markets. *Industrial Marketing Management, 29(1),* 37–44.

Coghlan, David and Theresa Brannick (2010) Doing Action Research in your own Organization, 3rd Edition. Sage publications.

Cousins, P., & Bulent Menguc, B. (2006). The implications of socialization and integration in supply chain management. *Journal of Operations Management*, *24 (5)*, 604–615.

Cox, A. (1996). Relational competence and strategic procurement management—towards an entrepreneurial and contractual theory of the firm. *Eur. J. Pur. Supply Manag.*, *2(1)*, 57–70.

Deavers, K. L. (1997). Outsourcing: A corporate competitiveness strategy, not a search for low wages. *J. Labor Res.*, *18(4),* 503–519.

Denscombe, Martyn (2007) The Good Research Guide: For Small-Scale Social Research Projects, Third Edition. Open University Press

Donaldson, T., & Dunfee, T. W. (1999). *Ties that bind: A social contracts approach to business ethics*. Boston, MA, USA: Harvard Business School Press.

Droge, C., & Germain, R. (2000). The relationship of electronic data interchange with inventory and financial performance. *Journal of Business Logistics*, *21*, 209–230.

Dugnas, K., and Oddmund O. (2008). State-of-the-Art Shipbuilding: Towards Unique and Integrated Lean Production Systems: *Systems 16th Annual Conference of the International Group for Lean Construction: People, Culture and Change*. Molde, Norway.

Ellram, L. M. (1996). The use of the case study method in logistics research. *Journal of Business Logistics*, *17(2)*, 93–138.

Espino-Rodriguez, T. F., & Padron-Robaina, V. (2006). A review of outsourcing from the resource-based view of the firm. Int. J. Manag. Rev., 8(1), 49–70.

Evans, G. N., Naim, M. M., & Towill, D. R. (1997). Proceedings of the Mouchel Centenary Conference: *Process Costing—The Route to Construction Re-engineering* (pp. 153–162). Edinburgh, UK: Civil Comp Press.

Fine, C. H., & Whitney, D. E. (1999). Is the make-buy decision process a core competence? Working paper from MIT Center for Technology, Policy and Industrial Development. Cambridge, MA, USA: MIT.

Frohlich, M., & Roy Westbrook, R. (2001). Arcs of integration: An international study of supply chain strategies. *Journal of Operations Management*, *19(2)*, 185–200.

Gadde, L. E., & and Hakansson, H. (1994). The changing role of purchasing: Reconsidering three strategic issues. *European Journal of Purchasing and Supply Management*, *1(1)*, 27–35.

Ganesan, S. (1994). Determinants of long-term orientation in buyer-seller relationships. *Journal of Marketing*, *58(April)*, 1–19.

Gassenheimer, J. B., & Manolis, C. (2001). The influence of product customization and supplier selection on future intentions: The mediating effects of salesperson and organizational trust. *Journal of Managerial Issues*, *13(4)*, 418–435.

Giesberts, P. M. J., & Van der Tang, L. (1992). Dynamics of the customer order decoupling point: Impact on information systems for production control. *Production Planning and Control*, *3(3)*, 300–313.

Golafshani, N. (2003). Understanding reliability and validity in qualitative research. *The Qualitative Report*, *8(4)*, 597–604. Retrieved from http://www.nova.edu/ssss/QR/QR8-4/golafshani.pdf.

Gosling, J., & Mohamed M. N. (2009). Engineer-to-order supply chain management: A literature review and research agenda. *International Journal of Production Economics*, *122 (2)*, 741–754.

Grant, R. M. (1991). The resource-based theory of competitive advantage: Implications for strategy formulation. *Calif. Manage. Rev., (spring)*, 114–135.

Greaver, M. F. (1999). *Strategic outsourcing: A structured approach to outsourcing decisions and initiatives*. New York, NY, USA: AMACOM.

Gruat La Forme, F. A., Botta Genoulaz, V., & Campagne, J. P. (2007). A framework to analyse collaborative performance. *Computers in Industry*, *58 (7)*, 687.

Gundlach, G. T., Achrol, R. S., & Mentzer J. T. (1995). The structure of commitment in exchange. *Journal of Marketing*, *59*(*January*), 78–92.

Gurumurthy, A., & Kodali, R. (2009), Application of benchmarking for assessing the lean manufacturing implementation. *Benchmarking: An International Journal*, *16(2)*, 274–308.

Hallen, X., & Johanson, X. (2004). Sudden death: Dissolution of relationships in the Russian transition economy. *Journal of Marketing Management*, *20*, 941–957.

Harrison, B., & Kelly, M. R. (1993). Outsourcing and the search for flexibility. *Work, Employ. Soc.*, *7(2)*, 213–235.

Hartley, J. (2004). Case study research. In C. Cassell & G. Symon (Eds.), *Essential guide to qualitative methods in organizational research* (pp. 323–333). London, UK: Sage Publications.

Hayes, R. H., & Wheelwright, S. C. (1979). Link manufacturing process and product life cycles. *Harvard Business Review, 57(1),* 133–265.

Heide, J. B., & John, G. (1992). Do norms matter in marketing relationships? *Journal of Marketing, 56(April),* 32–44.

Helper, S. R., & Sako, M. (1995). Supplier relations in Japan and the United States: Are they converging? *Shan Management Review, 3,* 77–84.

Hertz, S. (2001). Dynamics of alliances in highly integrated supply chain networks. *International Journal of Logistics: Research Applications, 4(2),* 237–256.

Hervik, A., Oddmund, O., Bjørn, G. B., & Gøran, J. (2012). *NCE Maritime klyngeanalyse 2012: Status for maritime næringer i Møre og Romsdal*. Molde, Norway: Molde Research Institute.

Hicks, C., McGovern, T., & Earl, C. F. (2000). Supply chain management: A strategic issue in engineer to order manufacturing. *International Journal of Production Economics, 65(2),* 179–190.

Hines, P., Rich, N., Bicheno, J., Brunt, D., Taylor, D., Butterworth, C., & Sullivan, J. (1998). Value stream management. *The International Journal of Logistics Management, 9(1),* 25–42.

Hines, P. (1999). Value stream management: Next frontier in supply chain. *Logistics Focus, 1(3),* 36–39.

Hines, P., & Rich. N. (1997). The seven value stream mapping tools. *International Journal of Operations & Production Management, 17(1),* 46–64.

Hoekstra, S., & Romme, J. (1992). *Integrated logistics structures: Developing customer oriented goods flow*. London, UK: McGraw-Hill.

Hoetker, G., Swaminathan, A., & Mitchell, W. (2007). Modularity and the impact of buyer-supplier relationships on the survival of suppliers. *Management Science, 53(2),* 178–191.

Holweg, M., Disney, S., Holmström, J., & Småros, J. (2005). Supply chain collaboration: Making sense of the strategy continuum. *European Management Journal, 23 (2),* 170–181.

Hosmer, L. T. (2008), *The ethics of management* (6th ed.). New York, NY, USA: McGraw-Hill.

Hox, J.J. & Boeije, H.R. (2005). Data collection, primary versus secondary. Pp. 593-599 in K. Kempf-Leonard (Ed.). Encyclopedia of Social Measurement. San Diego, CA: Academic Press.

Hui, L.T. (2004) "Business timeliness: the intersections of strategy and operations management", International Journal of Operations & production Management, 24:6, 605-624.

Ireland, V. (1996). Case study: T40 radical time production in construction projects. *Business Change and Re-engineering, 3(1),* 28–38.

Javidan, M. (1998). Core competence: What does it mean in practice. *Long Range Plann., 31(1),* 60–71.

Jessop, D., & Jones, O. (1995). Proceedings of the 4th Annual IPSERA Conference: *Value Stream Process Modelling: A Methodology for Creating Competitive Advantage*. Birmingham, UK: University of Birmingham.

Josh, G., Loc , D., Carranco, C., Mark, B., Shundricka, T., et al. (2009). The buyer-supplier relationship: An integrative model of ethics and trust. *Journal of Business Ethics (supplement), 3(90),* 329–341. Retrieved from http://search.proquest.com/docview/733013935/C27FDA9A1CEF47F6PQ/11?accountid=40814.

Joshi, A. W., & Arnold, S. J. (1998). How relational norms affect compliance in industrial buying. *Journal of Business Research, 41,* 105–114.

Kreps, D. M. (1990). *Corporate culture and economic theory. Perspectives on positive political economy,* 90–143. Cambridge, UK: Cambridge University Press.

Kilmann, R. H., & Thomas, K. W. (1977). Developing a forced choice measure of conflict handling behavior: The 'MODE' instrument. *Educational and Psychological Measurement, 37,* 309–325.

Kjaernes, U. (2006). Trust and distrust: Cognitive decisions or social relations. *Journal of Risk Research 9(8),* 911–932

Koskela, L. (1992). *Application of the new production philosophy in construction*. CIFE technical report 72, Stanford University.

Koskela, L. (2000). "Unpublished PhD thesis". An exploration towards a production theory and its application to construction Espoo, Finland: VTT Building Technology.

Koulikoff-Sourviron, M., & Harrison, A. (2006). Buyer–supplier relationships in inter- and intra-organisational supply contexts: The unobtrusive yet pervasive human resource picture. *International Journal of Logistics: Research & Applications, 9(1),* 75–94.

Lambert, D. M., Cooper, M. C., & Pagh, J. D. (1998). Supply chain management implementation issues and research opportunities. *The International Journal of Logistics Management, 11(1),* 1–17.

Lambert, D., García-Dastugue, S. & Croxton, K. (2005). An evaluation of process-oriented supply chain management frameworks. *Journal of Business Logistics, 26(1)*, 25–51.

Lehtonen, J. -M. (1999). Choice of order penetration point in the Nordic paper industry environment. *Paper and Timber, 81(3)*, 196–199.

Lewick, R. J., McAllister, D. J., & Bies, R. J. (1998). Trust and distrust: New relationships and realities. *Academy of Management Review 23(3),* 438–458.

Liker, J. K. (2004). *The Toyota way—14 management principles from the world's greatest manufacturer* (1st ed.). McGraw-Hill Companies.

Liker, J. K., & Lamb, T. (2000) *A guide to lean shipbuilding*. Ann Arbor, MI, USA: University of Michigan.

Lonsdale, C. (2001). Locked-in to supplier dominance: On the dangers of asset specificity for the outsourcing decision. *Supply Chain Manage., 4(4)*, 176–183.

Lonsdale, C., & Cox, A. (1997). Outsourcing: Risk and rewards. *Supply Manage, 3*, 32–34.

Macaulay, T. (1963). Non-contractual relations in business: A preliminary study. *American Sociological Review, 28(1)*, 55–69.

Mahapatra, S. S., & Mohanty, S. R. (2007). Lean manufacturing in continuous process industry: An empirical study. *Journal of Scientific and Industrial Research, 66(1)*, 19–27.

Mason-Jones, R., & Towill, D. R. (1999). Total cycle time compression and the agile supply chain. *International Journal of Production Economics, 62,* 61–73.

Mayer, R. C., Davis, J. H., & Schoorman, F. D. (1995). An integration model of organizational trust. *Academy of Management Review, 20(3)*, 709–729.

McNeil, I. (1980). *The New Social Contract 65*. New Haven, CT, USA: Yale University.

McDonough, J., & McDonough, S. (1997). Research methods for English language teachers. London, UK: Arnold.

Meredith, J. (1998). Building operations management theory through case and field research. *Journal of Operations Management, 16*, 441–454.

Moeller, S., Fassnacht, M., & Klose, S. (2006). A framework for supplier relationship management (SRM). *Journal of Business-to-Business Marketing, 13(4)*, 69–94

Monczka, R. M., Petersen, K. J., Handfield, R. B., & Ragatz, G. I. (1998). Success factors in strategic supplier alliances: The buying company perspective. *Decision Sciences, 29,* 533–578.

Monden, Y. (1993). *Toyota production system: An integrated approach to just-in-time* (2nd ed.). Norcross, GA, USA: Industrial Engineering and Management Press.

Morash, E. A., & Clinton, S. R. (1998). Supply chain integration: Customer value through collaborative closeness versus operational excellence. *Journal of Marketing Theory and Practice, 6(4)*, 104–121.

Morgan, R. M. & Hunt, S. D. (1994). The commitment-trust theory of relationship marketing. *Journal of Marketing, 58(July)*, 20–38.

Mukherjee, A., Mitchell, W., and Talbot, F. B. (2000), The impact of new manufacturing technologies and strategically flexible production, *Journal of Operations Management, 18*, 139–68.

Mukherji, A., & Francis, J. D. (2008). Mutual adaption in buyer–supplier relationships. *Journal of Business Research, 61(2)*, 154–161.

Naslund, D., & Williamson, S. (2000). What is management in supply chain management? A critical review of definitions, frameworks and terminology.

New, C. (1993). The use of throughput efficiency as a key performance measure for the new manufacturing era. *The International Journal of Logistics Management*, 4(2), 95–104.

Newman, R., Hanna, M., Gattiker, T., & Huang, X. (2009). Charting supply chain management integration and initiatives: A framework to guide implementation. *American Journal of Business, 24(1)*, 19–31.

Nordigarden, D (2007). *Outsourcing in the wood product manufacturing sector: A combined customer and supplier perspective* (Unpublished doctoral dissertation). Linkoping University, Linkoping, Sweden

Olhager, J., & O¨stlund, B. (1990). An integrated push-pull manufacturing strategy. *European Journal of Operational Research, 45(2–3)*, 135–142.

Olhager, J., & Wikner, J. (1998). A framework for integrated material and capacity based master scheduling. In A. Drexl & A. Kimms (Eds.), *Beyond manufacturing resource planning (MRPII)—advanced models and methods for production planning* (pp. 3–20). Berlin, Germany: Springe

Olhager, J., & Wikner, J. (2000). Production planning and control tools. *Production Planning and Control, 11(3)*, 210–222

Olhager, J. (2003). Strategic positioning of the order penetration point. *International Journal of Production Economics, 85(3)*, 319–329.

Olhager, J. (2012). The role of decoupling points in value chain management. Modelling value: Selected Papers of the 1st International Conference on Value Chain Management (2012), pp. 37‑47.

Oliver, C. (1990). Determinants of interorganisational relationships: Integration and future directions. *Academy of Management Review, 15*, 241–265

Oterhals, O., & Guvåg, B. (2014). Rapport 1401, Lean Shipbuilding II: Sluttrapport (In Norwegian).

Park, Y. O., Reddy, C., & Jurn, I. (2012). Sourcing strategies of manufacturing firms: Transaction cost implications. Mid-American Journal Business. Retrieved from http://search.proquest.com/docview/214180611/27A825902364B24PQ/2?accountid=40814.

Parnaby, J. (1995). Systems engineering for better engineering. *IEE Management Journal, 5(6)*, 256–266.

Porter, M. E. (1980a). *Competitive strategy. Techniques for analysing industries and competitors*. New York, NY, USA: Free Press.

Porter, M. E. (1980b). *Competitive advantage*. New York, NY, USA: Free Press.

Prahalad, C. K., & Hamel, G. (1990). The core competence of the corporation. *Harvard Bus. Rev., May–June*, 2–15.

Quinn, J. B., & Hilmer, F. (1994). Strategic outsourcing. *Sloan Manage. Rev. 18(Summer)* 43–55.

Quinn, J. B. (2000). Outsourcing innovation: The new engine of growth. *Sloan Manage. Rev., 41(4)*, 13–28.

Ragatz, G., Handfield, R. & Petersen, K. (2002). Benefits associated with supplier integration into new product development under conditions of technology uncertainty. *Journal of Business Research, 55(5)*, 389–400.

Rindfleich, A., & Heide, J. B. (1997). Transaction cost analysis: Past, present and future applications. *J. Marketing, 61(October)*, 30–54.

Rosentrater, K. A., & Balamuralikrishna, R. (2006). Value stream mapping—a tool for engineering and technology education and practice: *Proceedings to the 2006 ASEE IL/IN Conference,* Fort Wayne, IN, USA, March 31–April 1.

Rother, M., & Shook, J. (1999). Learning to see: Value stream mapping to create value and eliminate MUDA. Cambridge, MA, USA: Lean Enterprise Institute.

Saccani, N., & Perona, M. (2007). Shaping buyer–supplier relationships in manufacturing contexts: Design and test of a contingency model. *Journal of Purchasing & Supply Management 13*, 26–41

Schmenner, R. W. (1988). The merit of making things fast. *Sloan Management Review*, Vol.30, no, 7, pp 27-36.

Schoorman, F. D., Mayer, R. C., & Davis, J. H. (2007). An integrative model of organizational trust: Past, present, and future. *Academy of Management Review, 32(2)*, 344–354.

Scott, C., & Westbrook, R. (1991). New strategic tools for strategic management. *International Journal of Physical Distribution and Logistics Management.* 20, no. 1, 23-33

Searle, R. H., & Ball, K. S. (2004). The development of trust and distrust in a merger. *Journal of Managerial Psychology 19(7)*, 708–721.

Sengün, A. E., & Wasti, S. N. (2007). Trust, control, and risk: A test of Das and Teng's conceptual framework for pharmaceutical buyer-supplier relationships. *Group & Organization Management, 32(4)*, 430–464.

Sengün, A. E., & Wasti, S. N. (2008). Buyer–supplier relationships: Derived value over two decades. *Journal of Supply Chain Management: A Global Review of Purchasing & Supply, 36(4)*, 600–608

Serrano, I., Ochoa, C., & de Castro, R. (2008). Evaluation of value stream mapping in manufacturing system redesign. *International Journal of Production Research*, *46(16)*, 4409–4430

Sharman, G. (1984). The rediscovery of logistics. *Harvard Business Review*, *62(5)*, 71–80.

Shingo, S. (1988). *Non-stock production: The Shingo system for continuous improvement*. Cambridge, MA, USA: Productivity Press.

Singh, B., Garg, S. K., & Sharma, S. K. (2009). Lean can be a survival strategy during recessionary times. *International Journal of Productivity and Performance Measurement*, *58(8)*, 803–808.

Singh, B., Garg, S. K., Sharma, S. K., & Grewal, C. (2010), Lean implementation and its benefits to production industry. *International Journal of Lean Six Sigma*, *1(2)*, 157–168.

Singh, H., & Singh, A. (2013). Application of lean manufacturing using value stream mapping in an auto-parts manufacturing unit. *Journal of Advances in Management Research, 10*(1), 72–84. doi:http://dx.doi.org/10.1108/09727981311327776.

Somekh, Bridget (2005) Action Research: A Methodology for Change and Development. McGraw-Hill Education

Stake, R. E. (1980). The case study method in social inquiry. In H. Simons (Ed.), Towards a science of the singular, 7(2), 5–8. Retrieved from http://www.fivehokies.com/Evaluation/Evaluation%20and%20Analysis%20Designs/Case%20Studies/The%20Case%20Study%20Method%20in%20Social%20Inquiry.pdf.

Stake, R. E. (1995). *The art of case study research*. Thousand Oaks, CA, USA: Sage Publications.

Stalk, G., & Hout, T. (1990). *Competing Against Time*. London, UK: Free Press.

Stock, J., & Boyer, S. (2009). Developing a consensus definition of supply chain management: A qualitative study. *International Journal of Physical Distribution & Logistics Management, 39(8)*, 690–711.

Thomas, P. R. (1990). *Competitiveness though total cycle time*. New York, NY, USA: McGraw-Hill.

Thompson, J. A., & Bunderson, J. S. (2003). Violations of principle: Ideological currency in the psychological contract. *Academy of Management Review, 284(4)*, 571–586.

Towill, D. R. (1997). Successful business system engineering. *IEE Engineering Management journal, 7(1, 2)*, 55–64, 89–96.

Towill, D. R. (2008). *Construction supply chain and the time compression paradigm handbook*. 11–10.

Tyagi, S. K., Choudhary, A., Cai, X., & Yang, K. (2014). Value stream mapping to reduce lead-time of a product development process. *International Journal of Production Economics*. doi:10.1016/j.ijpe.2014.11.002.

Ugland. S., & Gjerstad. T. (2010). *A study of work-time utilization and root causes hindering workflow at Ulstein Verft AS*. Molde, Sweden: Molde University College

Van der Vlist, P., Hoppenbrouwers, J. E. M., & Hegge, H. M. H. (1997). Extending the enterprise through multi-level supply control. *International Journal of Production Economics, 53(1)*, 35–42.

Van Donk, D. P. (2001). Make to stock or make to order: The decoupling point in the food processing industries. *International Journal of Production Economics, 69(2)*, 297–306.

Voss, C., Tsikriktsis, N., & Frohlich, M. (2002). Case research in operations management. *International Journal of Operations & Production Management, 22(2)*, 195–219.

Walton, R. E., & McKersie, R. B. (1965). *A behavioral theory of labor negotiations: An analysis of a social interaction system*. New York, NY, USA: McGraw-Hill.

Wen, C., Li, X., & Bai, Y. (2007). Research on dynamic supply chain integration network model based on collaboration theory and non-linear Polya processes: *2007 International Conference on Wireless Communications, Networking and Mobile Computing* (pp. 6085–6088). http://www.ulstein.com/kunder/ulstein/cms66.nsf.

WestCoat 2015. http://www.westcoat.no/.

Whipple, J. M., & Frankel, R. (2000). Strategic alliance success factors. *The Journal of Supply Chain Management, (summer)*, 21–28

Wilmot, W. W., & Hocker, J. L. (2001). *Interpersonal conflict* (6th ed.). New York, NY, USA: McGraw-Hill.

Williamson, O. E. (1979). Transaction-cost economics: The governance of contract relations. *J. Law Econ. 22*, 3–61

Womack, J. P., & Jones, D. T. (1990). *The machine that changed the world*. New York, NY, USA: Rawson.

Womack, J. P., & Jones, D. T. (2003). *Lean thinking: Banish waste and create wealth in your corporation.* London, UK: Simon & Schuster.

Womack, J. P., & Jones, D. T. (2003). *Lean thinking: Banish waste and create wealth in your corporation*. New York, NY, USA: Free Press.

Yin, R. (2009), Case study research: Design and methods (4th ed.). London, UK: Sage Publications.

Zaidah, Z. (2007). Case study as a research method, *Journal Kemanusiaan*, 9. Retrieved from http://eprints.utm.my/8221/1/ZZainal2007-Case_study_as_a_Research.pdf.

9.0 Appendices

Appendix 1: Interview Guides

Interview guide 1

Introduction:

Interviewee was thanked for his acceptance to be interviewed, give his time, share his experience and keep patience. Then he was asked politely for a permission to record the interview. Later, interviewee was informed about the master thesis, researchers objective and their reason for working on this case. Finally, he was asked about his position and work responsibilities in the company.

Shipbuilding industry

1) Can you explain the history and the current state of the Norwegian ship industry in Møre og Romsdal?
2) What are the recent projects of Ulstein Shipyard?
3) Which production networks executed in Ulstein Shipyard?
4) Which suppliers are involving in Ulstein's production networks?
5) Who considered as key suppliers for Ulstein Shipyard?
6) What are the main conditions of the contract between Ulstein Shipyard and the key suppliers?
7) What are the main problems that faced the key suppliers?
8) How these problems affect Ulstein's projects?
9) Where and when those problems occurred?
10) Are there any reports or data that clarify those problems?
11) Why those problems occurred?

Interview guide 2

Introduction:
Interviewee was thanked for his acceptance to be interviewed, give his time, share his experience and keep patience. Then he was asked politely for a permission to record the interview. Later, interviewee was informed about the master thesis, researchers objective and their reason for working on this case. Finally, he was asked about his position and work responsibilities in the company.

Questions regarding the relationship between Ulstein Shipyard and the key supplier

1) Which project selected to investigate the production processes?
2) What are the production processes of this project?
3) Who is the key supplier in this project?
4) Where and when this key supplier starts his tasks?
5) Which problems faced this supplier during executing his project tasks?
6) Are there any performance reports or data that clarify those problems?
7) What are the main causes of those problems?
8) Who is responsible to track the execution and performance of the key supplier tasks?
9) How the performance of the key supplier is measured?
10) Which system used to communicate with the key supplier?
11) How is the communication with the key supplier taking place?
12) Are there any problems regarding the communication with the key supplier?
13) What is the nature of the relationship with the key supplier?
14) Does Ulstein Shipyard use only one key supplier to perform specific tasks?
15) Why the key supplier not invited to 6/8 weeks evaluation meeting?

Interview guide 3

Introduction:
Interviewee was thanked for his acceptance to be interviewed, give his time, share his experience and keep patience. Then he was asked politely for a permission to record the interview. Later, interviewee was informed about the master thesis, researchers objective and their reason for working on this case. Finally, he was asked about his position and work responsibilities in the company.

Questions to explore the root causes of the problems in Ulstein production networks

1) What are the main problems during executing tasks in the project production networks?
2) Are there any potential areas for improvements in the project production networks?
3) Are there any performance reports or data that clarify those problems?
4) Who are responsible to execute this production networks?
5) How the project production networks executed?
6) Where the production networks executed?
7) When the production networks executed?
8) What are the solutions to solve problems in the project production networks?
9) Who should be involved to execute those solutions?

Questions concerned project planning, coordinating and inter-dependencies between the suppliers during executing the project tasks.

1) How the project planning process take place?
2) Who is responsible from Ulstein Shipyard to create the project plan?
3) How the plan transferred from Ulstein Shipyard to the key supplier?
4) What are the tasks of each participant who involved in Ulstein project?
5) How the information transferred between the involved participants in Ulstein project?
6) Are there any examples of problems that occurred during executing the project tasks?

7) In case, there are inter-dependencies between suppliers to conduct their project tasks, who is responsible for those inter-dependencies?

8) Why those inter-dependencies occurred?

9) Are there any examples for such inter-dependencies between the suppliers?

10) How the inter-dependencies between the suppliers been handled in the project?

Questions concerned the contract agreements between Ulstein Shipyard and the key supplier

1) What are the main contract agreements between Ulstein Shipyard and the key supplier?

2) Does the contract covers all the necessary information and descriptions about the assigned working tasks?

3) When the key supplier start his working tasks?

4) How the key supplier respond to changing orders?

5) Are there any extra working tasks assigned by Ulstein Shipyard to the key supplier?

6) How the key supplier paid for conducting extra working tasks?

Appendix 2: Yard No. 301. Unit Painting

10301 Con	Date: 25.03.2015 11:47:47							
External	ID	Task/activity	Status	Discipline	Start	End	Actual Start	Actual End
		SBL/MAL S 841		221	11.12.2013	13.12.2013	11.12.2013	17.12.2013
		SBL/MAL S 844		221	10.12.2013	20.12.2013	17.12.2013	20.12.2013
		SBL/MAL SS-40		221	12.09.2013	15.09.2013	14.09.2013	18.09.2013
		SBL/MAL Unit 412 og 413		221	14.10.2013	17.10.2013	14.10.2013	20.10.2013
		SBL/MAL Unit 422 og 423		221	17.10.2013	23.10.2013	14.10.2013	29.10.2013
		SBL/MAL Unit 513 A/B		221	11.10.2013	14.10.2013	14.10.2013	14.10.2013
		SBL/MAL Unit 521		221	21.10.2013	31.10.2013	29.10.2013	03.11.2013

Appendix 3: WestCoat Staffing Plan

Staffing plan WestCoat AS 2014 B.301

	2014 Jan	2014 Feb	2014 Mars	2014 April	2014 Mai	2014 Juni	2014 Juli
B.301 plan from Ulstein	**7500**	**7500**	**8050**	**8050**	**8050**	**6000**	**1000**
B.301 Actual Result	**6389**	**6578**	**7433**	**10493**	**9404**	**3620**	**890**
Working Hour	**378**	**220**	**462**	**283**	**280**	**338**	**706**
Total Hour production	6767	6798	7895	10776	9684	3958	1596
Total Hour Plan	**7500**	**7500**	**8050**	**8050**	**8050**	**6000**	**1000**
Staffing plan	35	35	38	38	38	28	5
Staffing Actual	30	31	37	50	48	18	7
Difference	***5***	***4***	***1***	***-12***	***-10***	***-10***	***2***

Printed from Planned and actual task B.301 Ulstein Verft AS

Eldar Knotten
01.08.2014

Appendix 4: Yard No. 301. Painting Areas and Rooms

10301 Cor	Date: 25.03.2015 11:49:44							
External	ID	Task/activ	Status	Discipline	Start	End	Actual Start	Actual End
		Painting behind lining Bridge deck & Part of E-deck (Vanylven)		221	23.11.2013	27.11.2013	25.11.2013	02.12.2013
		Painting behind lining SWBD room		221	06.12.2013	10.12.2013	03.12.2013	03.12.2013
		Painting behind lining Main stairs		221	24.01.2014	27.01.2014	28.01.2014	28.01.2014
		Finished Hotwork/ final painting Instrument room 1 PS		221	29.01.2014	02.02.2014	08.11.2013	02.02.2014
		Painting behind lining Life boat area PS&SB		221	30.01.2014	01.02.2014	03.02.2014	03.02.2014
		Painting behind lining A-deck		221	31.01.2014	03.02.2014	03.02.2014	03.02.2014
		Painting behind lining Main deck		221	31.01.2014	03.02.2014	03.02.2014	03.02.2014
		Finished Hotwork/final painting Instrument room 2		221	05.02.2014	07.03.2014	08.11.2013	25.02.2014
		Painting Heisesjakt		221	05.02.2014	06.02.2014	07.02.2014	07.02.2014
		Painting behind lining B-deck		221	07.02.2014	10.02.2014	07.02.2014	11.02.2014
		Painting behind lining C-deck		221	07.02.2014	10.02.2014	07.02.2014	11.02.2014
		Painting behind lining D-deck		221	13.02.2014	17.02.2014	07.02.2014	17.02.2014
		Painting behind lining E-deck		221	13.02.2014	18.02.2014	07.02.2014	17.02.2014
		Painting behind lining FWD stairs		221	15.02.2014	17.02.2014	17.02.2014	17.02.2014
		Hotwork/final painting AC-room 3 A deck		221	19.02.2014	25.02.2014	07.10.2013	25.03.2014
		Final painting HPU-room #162-#165		221	24.02.2014	03.04.2014	03.03.2014	08.04.2014
		Final painting Life boat area PS		221	01.03.2014	07.03.2014	03.03.2014	25.03.2014
		Final painting Life boat area SB		221	01.03.2014	07.03.2014	03.03.2014	25.03.2014
		Final painting Topside PS/SB #-11-#100		221	03.03.2014	07.03.2014	18.02.2014	25.03.2014
		Final painting Mooring deck		221	06.03.2014	17.03.2014	27.01.2014	18.03.2014
		Final painting Outside Main deck #-11-#44		221	06.03.2014	01.04.2014	11.03.2014	08.04.2014
		Final painting AC-rom Bridge deck		221	14.03.2014	19.03.2014	04.02.2014	25.03.2014
		Final painting Bow thr. room 2		221	14.03.2014	24.03.2014	11.03.2014	25.03.2014
		Final painting Emerg.gen.room		221	14.03.2014	19.03.2014	11.03.2014	25.03.2014
		Final painting Vertical bottom PS/SB		221	14.03.2014	20.03.2014	11.03.2014	31.03.2014
		Final painting Topside PS/SB #100-175		221	15.03.2014	02.04.2014	11.03.2014	08.04.2014
		Final painting Flat bottom		221	17.03.2014	25.03.2014	11.03.2014	08.04.2014
	WP09008-	Final painting Upper Engine room SB & Caising SB/PS		221	21.03.2014	28.03.2014	18.03.2014	01.04.2014
		Final painting AC-rom E deck		221	26.03.2014	31.03.2014	30.03.2014	01.04.2014
		Final painting Pump room SB		221	28.03.2014	10.04.2014	18.03.2014	22.04.2014

	WP09008	Final painting Upper Engine room SB & Caising SB/PS	221	21.03.2014	28.03.2014	18.03.2014	01.04.2014
		Final painting AC-rom E deck	221	26.03.2014	31.03.2014	30.03.2014	01.04.2014
		Final painting Pump room SB	221	28.03.2014	10.04.2014	18.03.2014	22.04.2014
	WP09008	Final painting Lower Engine room SB	221	30.03.2014	11.04.2014	18.03.2014	15.04.2014
		Final painting Outside Bridge deck/E-deck	221	01.04.2014	11.04.2014	18.03.2014	22.04.2014
		Final painting Outside A-deck	221	04.04.2014	11.04.2014	25.03.2014	22.04.2014
		Final painting Workshop A-deck SB	221	04.04.2014	02.05.2014	06.05.2014	06.05.2014
		Final painting Pump room PS	221	12.04.2014	20.04.2014	18.03.2014	22.04.2014
		Final painting Upper & Lower engine room PS	221	12.04.2014	23.04.2014	11.04.2014	24.04.2014
		Final painting Winch room	221	12.04.2014	22.04.2014	02.04.2014	29.04.2014
		Final painting Basket corridor & Stores Room SB #23-#75 (SB)	221	20.04.2014	29.04.2014	06.05.2014	06.05.2014
		Final painting Crane pedestal	221	20.04.2014	28.04.2014	16.04.2014	29.04.2014
		Final painting Stores main deck	221	20.04.2014	02.05.2014	02.04.2014	20.05.2014
		Final painting Incinerator/garbage room	221	22.04.2014	02.05.2014	28.04.2014	06.05.2014
		Final painting Propulsion room PS	221	22.04.2014	02.05.2014	23.04.2014	06.05.2014
		Final painting Lower prop. room PS	221	24.04.2014	03.05.2014	02.03.2014	06.05.2014
		Final painting Lower prop. room SB	221	24.04.2014	03.05.2014	25.03.2014	06.05.2014
		Final painting Lower winch room	221	24.04.2014	03.05.2014	16.04.2014	06.05.2014
		Final painting Propulsion room Center	221	24.04.2014	03.05.2014	02.04.2014	06.05.2014
		Final painting Propulsion room SB	221	24.04.2014	03.05.2014	28.04.2014	06.05.2014
		Final painting HPR FWD SB	221	29.04.2014	04.05.2014	23.01.2014	06.05.2014
		Final painting Deck workshop/store Main-deck PS	221	02.05.2014	08.05.2014	28.04.2014	08.05.2014
		Final painting El.workshop stores	221	02.05.2014	08.05.2014	29.04.2014	13.05.2014
		Final painting Fire, chem.,paint, gas room	221	02.05.2014	08.05.2014	29.04.2014	13.05.2014
		Final painting Bunker station PS	221	03.05.2014	10.05.2014	29.04.2014	18.06.2014
		Final painting Bunker station SB	221	03.05.2014	10.05.2014	29.04.2014	13.05.2014
		Final painting Deck Store SB #55 - #65	221	03.05.2014	10.05.2014	13.05.2014	13.05.2014
		Final painting Deck workshop SB #65 - #75	221	03.05.2014	10.05.2014	13.05.2014	13.05.2014
		Final painting Hydraulikk room PS #65 - #75	221	03.05.2014	10.05.2014	07.05.2014	18.06.2014
		Final painting Equipment room PS	221	08.05.2014	15.05.2014	07.05.2014	20.05.2014
		Final painting Basket Room / Carousel area	221	09.05.2014	13.05.2014	07.05.2014	20.05.2014
		Final painting ROV-Hangar #102-#113	221	10.05.2014	22.05.2014	07.05.2014	27.05.2014
		Final painting Deck Store SB #44 - #55	221	15.05.2014	15.05.2014	18.06.2014	03.12.2014
		Final painting Equipment room FWD	221	15.05.2014	22.05.2014	07.05.2014	27.05.2014
		Final painting Equipment room SB	221	15.05.2014	22.05.2014	07.05.2014	16.06.2014
		Final painting Outside Main deck #44-#99	221	16.05.2014	23.05.2014	25.03.2014	27.05.2014
		Final painting Mission room PS #55 - #65	221	18.05.2014	23.05.2014	07.05.2014	27.05.2014
		Final painting Main deck #75-#99	221	22.05.2014	29.05.2014	18.06.2014	03.12.2014
		Final painting Main deck inside #44 - #75	221	29.05.2014	07.06.2014	18.06.2014	03.12.2014

Appendix 5: Yard No. 301: Painting Task

10301 Co	Date: 25.03.2015 11:55:03							
External	ID	Task/acti	Status	Discipline	Start	End	Actual Start	Actual End
		Hotwork/paint Tank no.022 DB WB/DW tank PS		221	22.11.2013	04.12.2013	22.11.2013	10.12.2013
		Hotwork/paint Tank no.024 Wing WB/DW anti-heeling tank PS		221	22.11.2013	04.12.2013	22.11.2013	10.12.2013
		Hotwork/paint Tank no.023 DB WB/DW tank SB		221	24.11.2013	06.12.2013	22.11.2013	10.12.2013
		Hotwork/paint Tank no.025 Wing WB/DW anti-heeling tank SB		221	24.11.2013	06.12.2013	22.11.2013	10.12.2013
		Hotwork/paint Tank no.021 Wing WB/DW anti-heeling tank SB		221	26.11.2013	09.12.2013	02.12.2013	10.12.2013
		Hotwork/paint Tank no.029 Wing WB/DW tank SB		221	28.11.2013	11.12.2013	02.12.2013	17.12.2013
		Hotwork/paint Tank no.033 Wing WB/DW tank SB		221	28.11.2013	12.12.2013	02.12.2013	22.12.2013
		Hotwork/paint Tank no.028 Wing WB/DW tank PS		221	29.11.2013	13.12.2013	02.12.2013	17.12.2013
		Hotwork/paint Tank no.032 Wing WB/DW tank PS		221	30.11.2013	13.12.2013	02.12.2013	22.12.2013
		Hotwork/paint Tank no.020 Wing WB/DW anti-heeling tank PS		221	02.12.2013	16.12.2013	02.12.2013	17.12.2013
		Hotwork/paint Tank no.036 Wing WB/DW tank PS		221	03.12.2013	17.12.2013	02.12.2013	07.01.2014
		Hotwork/paint Tank no.026 DB WB/DW tank PS		221	05.12.2013	20.12.2013	05.12.2013	07.01.2014
		Hotwork/paint Tank no.027 DB WB/DW tank SB		221	07.12.2013	22.12.2013	05.12.2013	07.01.2014
		Hotwork/paint Tank no.037 Wing WB/DW tank SB		221	11.12.2013	23.12.2013	11.12.2013	14.01.2014
		Hotwork/paint Tank no.030 DB WB/DW tank PS		221	12.12.2013	26.12.2013	02.01.2014	12.01.2014
		Hotwork/paint Tank no.031 DB WB/DW tank SB		221	12.12.2013	25.12.2013	02.01.2014	12.01.2014
		Finished Hotwork/paint Tank no.018 DB WB/DW tank PS		221	09.01.2014	24.01.2014	10.01.2014	28.01.2014
		Finished Hotwork/paint Tank no.044 Wing WB/DW tank PS		221	09.01.2014	24.01.2014	10.01.2014	28.01.2014
		Finished Hotwork/paint Tank no.045 Wing WB/DW tank SB		221	09.01.2014	24.01.2014	13.01.2014	28.01.2014
		Finished Hotwork/paint Tank no.041 DB WB/DW tank CE		221	10.01.2014	23.01.2014	07.01.2014	28.01.2014
		Finished Hotwork/paint Tank no.054 WB/DW roll red.tank CE		221	11.01.2014	30.01.2014	07.01.2014	02.02.2014
		Finished Hotwork/paint Tank no.055 WB/DW roll red.tank CE		221	11.01.2014	31.01.2014	07.01.2014	31.01.2014
		Finished Hotwork/paint Tank no.014 DB WB/DW tank PS		221	15.01.2014	04.02.2014	03.12.2013	11.02.2014
		Finished Hotwork/paint Tank no.016 Wing WB/DW anti-heeling tank PS		221	15.01.2014	04.02.2014	03.12.2013	11.02.2014
		Finished Hotwork/paint Tank no.015 DB WB/DW tank SB		221	17.01.2014	06.02.2014	03.12.2013	11.02.2014
		Finished Hotwork/paint Tank no.017 Wing WB/DW anti-heeling tank SB		221	17.01.2014	07.02.2014	14.01.2014	11.02.2014
		Finished Hotwork/paint Tank no.046 Wing WB/DW tank PS		221	23.01.2014	08.02.2014	14.01.2014	31.01.2014
		Finished Hotwork/paint Tank no.019 DB WB/DW tank SB		221	24.01.2014	11.02.2014	14.01.2014	27.03.2014
		Finished Hotwork/paint Tank no.047 Wing WB/DW tank SB		221	24.01.2014	10.02.2014	14.01.2014	18.02.2014
		Finished Hotwork/paint Tank no.049 Wing WB/DW tank PS		221	25.01.2014	10.02.2014	14.01.2014	17.02.2014
		Finished Hotwork/paint Tank no.034 DB WB/DW tank PS		221	27.01.2014	10.02.2014	03.12.2013	27.03.2014
		Finished Hotwork/paint Tank no.035 DB WB/DW tank SB		221	29.01.2014	12.02.2014	03.12.2013	27.03.2014
		Finished Hotwork/paint Tank no.052 Aftpeak tank SB		221	31.01.2014	14.02.2014	20.01.2014	27.03.2014
		Finished Hotwork/paint Tank no.050 Wing WB/DW tank SB		221	01.02.2014	17.02.2014	14.01.2014	18.02.2014
		Finished Hotwork/paint Tank no.051 Aftpeak tank PS		221	01.02.2014	17.02.2014	20.01.2014	27.03.2014
		Finished Hotwork/paint Tank no.012 Wing WB/DW tank PS		221	03.02.2014	22.02.2014	14.01.2014	27.03.2014
		Finished Hotwork/paint Tank no.008 Wing WB/DW tank PS		221	04.02.2014	17.02.2014	21.01.2014	27.03.2014
		Finished Hotwork/paint Tank no.042 Wing FW tank SB		221	06.02.2014	22.02.2014	03.12.2013	27.03.2014
		Finished Hotwork/paint Tank no.040 Wing FW tank PS		221	07.02.2014	21.02.2014	03.12.2013	27.03.2014
		Finished Hotwork/paint Tank no.043 Wing FW tank SB		221	07.02.2014	22.02.2014	03.12.2013	27.03.2014
		Paint Tank no.053 WB/DW roll red.tank CE		221	07.02.2014	21.03.2014	04.02.2014	27.03.2014
		Paint Tank no.311 Chain locker SB		221	08.02.2014	22.03.2014	12.02.2014	07.04.2014
		Finished Hotwork/paint Tank no.038 DB WB/DW tank PS		221	09.02.2014	24.02.2014	03.02.2014	27.03.2014
		Finished Hotwork/paint Tank no.039 DB WB/DW tank SB		221	09.02.2014	26.02.2014	03.02.2014	27.03.2014

		Finished Hotwork/paint Tank no.039 DB WB/DW tank SB	221	09.02.2014	26.02.2014	03.02.2014	27.03.2014
		Paint Tank no.252 Sewage tank	221	13.02.2014	21.03.2014	10.02.2014	07.04.2014
		Paint Tank no.275 FO drain tank	221	13.02.2014	21.03.2014	18.02.2014	07.04.2014
		Paint Tank no.280 Bilge water tank	221	13.02.2014	21.03.2014	10.02.2014	07.04.2014
		Paint Tank no.281 Bilge water settling tank	221	13.02.2014	21.03.2014	21.02.2014	07.04.2014
		Paint Tank no.282 Clean bilge water tank	221	13.02.2014	21.03.2014	21.02.2014	06.05.2014
		Paint Tank no.284 Sludge tank	221	13.02.2014	21.03.2014	21.02.2014	07.04.2014
		Paint Tank no.288 Sludge settling tank	221	13.02.2014	21.03.2014	21.02.2014	07.04.2014
		Paint Tank no.004 DB/Wing WB/DW tank PS	221	18.02.2014	21.03.2014	14.01.2014	21.03.2014
		Paint Tank no.255 Urea tank	221	19.02.2014	02.04.2014	10.02.2014	07.04.2014
		Paint Tank no.256 Urea tank	221	19.02.2014	02.04.2014	10.02.2014	07.04.2014
		Paint Tank no.048 WB/DW tank CE	221	20.02.2014	13.03.2014	14.01.2014	18.03.2014
		Paint Tank no.005 DB/Wing WB/DW tank SB	221	22.02.2014	25.03.2014	14.01.2014	30.03.2014
		Paint Tank no.069 Liquid cargo tank PS	221	28.02.2014	28.03.2014	03.03.2014	29.04.2014
		Paint Tank no.263 HP Hydr.oil store tank	221	28.02.2014	06.03.2014	03.03.2014	18.06.2014
		Paint Tank no.271 FO settling tank no.1	221	28.02.2014	06.03.2014	03.03.2014	18.06.2014
		Paint Tank no.274 FO service tank no.2	221	28.02.2014	06.03.2014	03.03.2014	18.06.2014
		Paint Tank no.290 LO store tank main eng. PS	221	28.02.2014	06.03.2014	03.03.2014	18.06.2014
		Paint Tank no.291 LO store tank main eng. SB	221	28.02.2014	06.03.2014	03.03.2014	18.06.2014
		Paint Tank no.292 LO store tank aux.eng.	221	28.02.2014	06.03.2014	03.03.2014	18.06.2014
		Paint Tank no.293 LO store tank thruster	221	28.02.2014	06.03.2014	03.03.2014	18.06.2014
		Paint Tank no.295 LO store tank main azimuth	221	28.02.2014	06.03.2014	03.03.2014	18.06.2014
		Paint Tank no.298 Dirty LO tank	221	28.02.2014	06.03.2014	03.03.2014	18.06.2014
		Paint Tank no.299 LO Drop tank	221	28.02.2014	06.03.2014	03.03.2014	18.06.2014
		Paint tank Tank no.272 FO settling tank no.2	221	28.02.2014	06.03.2014	03.03.2014	18.06.2014
		Paint tank Tank no.273 FO service tank no.1	221	28.02.2014	06.03.2014	03.03.2014	18.06.2014
		Paint Tank no.006 DB WB/DW tank CE	221	04.03.2014	29.03.2014	10.02.2014	30.03.2014
		Paint Tank no.070 Liquid cargo tank SB	221	09.03.2014	22.03.2014	11.03.2014	13.05.2014
		Paint Tank no.071 Liquid cargo tank PS	221	11.03.2014	24.03.2014	11.03.2014	13.05.2014
		Paint Tank no.003 Wing FW tank SB	221	12.03.2014	26.03.2014	03.03.2014	07.04.2014
		Paint Tank no.314 Void	221	18.03.2014	03.04.2014	03.03.2014	07.04.2014
		Paint Tank no.010 DB WB/DW tank PS	221	19.03.2014	02.04.2014	16.01.2014	07.04.2014
		Paint Tank no.013 Wing WB/DW tank SB	221	19.03.2014	02.04.2014	10.02.2014	07.04.2014
		Paint Tank no.001 Forpeak tank	221	20.03.2014	05.04.2014	03.03.2014	29.04.2014
		Paint Tank no.002 Wing FW tank PS	221	20.03.2014	10.05.2014	03.03.2014	07.04.2014
		Paint Tank no.011 DB WB/DW tank SB	221	20.03.2014	05.04.2014	10.02.2014	07.04.2014
		Paint Tank no.009 Wing WB/DW tank SB	221	21.03.2014	05.04.2014	11.03.2014	29.04.2014
		Paint Tank no.007 Wing WB/DW tank SB	221	24.03.2014	08.04.2014	21.02.2014	29.04.2014
		Paint Tank no.310 Chain locker PS	221	24.03.2014	03.04.2014	25.02.2014	29.04.2014
		Paint Tank no.321 Cofferdam PS	221	27.03.2014	05.05.2014	03.03.2014	06.05.2014
		Paint Tank no.318 Void	221	02.04.2014	04.05.2014	11.03.2014	06.05.2014
		Paint Tank no.319 Void	221	02.04.2014	04.05.2014	11.03.2014	06.05.2014

Appendix 6: General Overall Working Task

10301 Construction Sched	Date: 27.03.2015 10:52:58									
ID	Task/activity	Statu:	Op	Discipline	Start	End	Man-hr:	Used MI	Actual Sta	Actual End
283200200	Ship unit plan			283	07.03.2013	18.03.2013	5 (4)	23	21.01.2013	25.11.2013
	Veke 26 ----------------------				23.06.2013	30.06.2013	0	0	23.06.2013	30.06.2013
	Veke 27 ---------------------				30.06.2013	07.07.2013	0	0	30.06.2013	07.07.2013
	Veke 28 --------------------				07.07.2013	14.07.2013	0	0	07.07.2013	14.07.2013
	Arrival SS-51 del 1 - 431, 511			SALT	12.07.2013	12.07.2013	0	0	11.07.2013	11.07.2013
	Outfitting Block SS51				13.07.2013	01.12.2013	0	0	15.07.2013	03.12.2013
	Veke 29 --------------------				14.07.2013	21.07.2013	0	0	14.07.2013	21.07.2013
	Veke 30 --------------------				21.07.2013	28.07.2013	0	0	21.07.2013	28.07.2013
	Veke 31 --------------------				28.07.2013	04.08.2013	0	0	28.07.2013	04.08.2013
	Veke 32 --------------------				04.08.2013	11.08.2013	0	0	04.08.2013	11.08.2013
54030	Sammenstilling 411 til 421 (van)			233	05.08.2013	09.09.2013	162	0	19.09.2013	19.09.2013
	Veke 33 --------------------				11.08.2013	18.08.2013	0	0	11.08.2013	18.08.2013
55020	Montering 511&431 til SS51			233	12.08.2013	25.10.2013	270	129	16.08.2013	25.09.2013
	Veke 34 --------------------				18.08.2013	25.08.2013	0	0	18.08.2013	25.08.2013
	Veke 35 --------------------				25.08.2013	01.09.2013	0	0	25.08.2013	01.09.2013
86100	Maskinmodul nr. 1			241	26.08.2013	01.10.2013	500	415	03.09.2013	06.10.2013
86200	Maskinmodul nr. 2			241	26.08.2013	01.10.2013	500	429	03.09.2013	06.10.2013
	Veke 36 --------------------				01.09.2013	08.09.2013	0	0	01.09.2013	08.09.2013
	Veke 37 --------------------				08.09.2013	15.09.2013	0	0	08.09.2013	15.09.2013
	Arrival SS-40 - 411,421 (Uve Vanylven)			632	11.09.2013	11.09.2013	0	0	11.09.2013	11.09.2013
	Outfitting block SS40			Alle	12.09.2013	22.11.2013	0	0	12.09.2013	26.11.2013
	SBL/MAL SS-40			221	12.09.2013	15.09.2013	0	0	14.09.2013	18.09.2013
	Veke 38 --------------------				15.09.2013	22.09.2013	0	0	15.09.2013	22.09.2013
84000	Mounting Main Engines			241	16.09.2013	01.11.2013	600	601	23.09.2013	03.11.2013
	Veke 39 --------------------				22.09.2013	29.09.2013	0	0	22.09.2013	29.09.2013
	Loading Evaporator (FW generator)			241	23.09.2013	26.10.2013	0	0	03.10.2013	03.10.2013
	Loading Pump module (maskinromsmodul)			241	23.09.2013	24.09.2013	0	0	30.09.2013	06.10.2013
	Mounting of EQ SS51			Alle	23.09.2013	22.11.2013	0	0	14.10.2013	26.11.2013
	Veke 40 --------------------				29.09.2013	06.10.2013	0	0	29.09.2013	06.10.2013
	Loading Catalysators			243	30.09.2013	08.11.2013	0	0	07.10.2013	19.11.2013
	Veke 41 --------------------				06.10.2013	13.10.2013	0	0	06.10.2013	13.10.2013
	Arrival SS-51 del 2- 432, 433,512			Crist	07.10.2013	07.10.2013	0	0	08.10.2013	07.10.2013
	Arrival SS-60 -514,825,611,612,613,826			Crist	07.10.2013	07.10.2013	0	0	08.10.2013	07.10.2013
	Arrival SS-71 -701,702			Crist	07.10.2013	07.10.2013	0	0	08.10.2013	07.10.2013
	Arrival SS-81 - 811, 812, 831			Crist	07.10.2013	07.10.2013	0	0	08.10.2013	07.10.2013
	Arrival SS-82- 821,822,823,833,824,832			Crist	07.10.2013	07.10.2013	0	0	08.10.2013	07.10.2013
	Outfitting block SS60			Alle	07.10.2013	05.01.2014	0	0	14.10.2013	03.12.2013
	Outfitting block SS81			Alle	07.10.2013	29.11.2013	0	0	14.10.2013	03.12.2013
	Outfitting block SS82			Alle	07.10.2013	08.12.2013	0	0	14.10.2013	03.12.2013
	Steel Outfitting block SS60			UEI	07.10.2013	09.01.2014	0	0	09.10.2013	03.12.2013
	Steel Outfitting block SS81			UEI	07.10.2013	29.11.2013	0	0	08.10.2013	03.12.2013
	Steel Outfitting block SS82			UEI	07.10.2013	04.12.2013	0	0	08.10.2013	10.12.2013
	Outfitting block SS71			Alle	08.10.2013	28.11.2013	0	0	15.10.2013	03.12.2013
55040	Montering unit 432 til SS51			233	09.10.2013	18.11.2013	320	587	11.10.2013	19.11.2013
	Arrival SS-41 - 412, 413 og 422,423 (Uve Vanylven)			632	10.10.2013	10.10.2013	0	0	10.10.2013	10.10.2013
	Arrival SS-52 -513			SALT	11.10.2013	11.10.2013	0	0	11.10.2013	11.10.2013
	SBL/MAL Unit 513 A/B			221	11.10.2013	14.10.2013	0	0	14.10.2013	14.10.2013
	Veke 42 --------------------				13.10.2013	20.10.2013	0	0	13.10.2013	20.10.2013
	HVAC Hotwork SS81			HVAC	14.10.2013	26.10.2013	0	0	16.10.2013	21.10.2013
	Open Cut out 82.1 - SS82, AC room 3			233	14.10.2013	16.10.2013	0	0	21.10.2013	21.10.2013
	Open Cut out 82.2 - SS82, AC room 3			233	14.10.2013	16.10.2013	0	0	21.10.2013	21.10.2013
	SBL/MAL Unit 412 og 413			221	14.10.2013	17.10.2013	0	0	14.10.2013	20.10.2013
	Arrival SS-52 -521			SALT	15.10.2013	15.10.2013	0	0	14.10.2013	14.10.2013
	SBL/MAL Unit 422 og 423			221	17.10.2013	23.10.2013	0	0	14.10.2013	29.10.2013
55070	Montering unit 512 til SS51			233	18.10.2013	22.11.2013	250	357	17.10.2013	26.11.2013
	Veke 43 --------------------				20.10.2013	27.10.2013	0	0	20.10.2013	27.10.2013
[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

		SBL/MAL Unit 422 og 423	221	17.10.2013	23.10.2013	0	0	14.10.2013	29.10.2013
	55070	Montering unit 512 til SS51	233	18.10.2013	22.11.2013	250	357	17.10.2013	26.11.2013
		Veke 43 --------------------		20.10.2013	27.10.2013	0	0	20.10.2013	27.10.2013
	74140	Eksosrør m. oppheng Sone 41	243	21.10.2013	06.01.2014	0	0	12.11.2013	21.11.2013
		Feste for kabelgater SS89	UEI	21.10.2013	23.11.2013	0	0	12.11.2013	26.11.2013
		Gjennomføringer SS89 elektro	UEI	21.10.2013	23.11.2013	0	0	21.10.2013	26.11.2013
		HVAC Hotwork SS60	HVAC	21.10.2013	09.11.2013	0	0	22.10.2013	24.10.2013
		Outfitting block SS89		21.10.2013	03.12.2013	0	0	21.10.2013	03.12.2013
		SBL/MAL Unit 521	221	21.10.2013	31.10.2013	0	0	29.10.2013	03.11.2013
		Steel Outfitting block SS41 NB!!	UEI	21.10.2013	06.01.2014	0	0	21.10.2013	07.01.2014
	58600	Windows in wheelhouse	233	21.10.2013	18.01.2014	180	58	23.10.2013	27.10.2013
		Close Cut out 82.1 - SS82, AC room 3	234	23.10.2013	23.10.2013	0	0	29.10.2013	29.10.2013
	54040	Sammenstilling 412,413 & 422,423	233	24.10.2013	18.11.2013	364	100	20.09.2013	20.11.2013
		Loading Swing up motor	241	25.10.2013	25.10.2013	0	0	28.10.2013	28.10.2013
		Veke 44 --------------------		27.10.2013	03.11.2013	0	0	27.10.2013	27.10.2013
		Arrival Unit 593	632	28.10.2013	11.11.2013	0	0	05.11.2013	05.11.2013
	39120	Forpigging	223	28.10.2013	30.04.2014	400	1339	03.09.2013	25.04.2014
		Laoding MCC	UEI	28.10.2013	08.11.2013	0	0	29.10.2013	11.11.2013
		Loading Boiler	241	28.10.2013	08.11.2013	0	0	29.10.2013	29.10.2013
		Loading Chiller units	241	28.10.2013	28.10.2013	0	0	29.10.2013	29.10.2013
		Loading El equipment	UEI	28.10.2013	29.11.2013	0	0	11.11.2013	03.12.2013
		Loading Freq. converters for thrusters	UEI	28.10.2013	08.11.2013	0	0	28.10.2013	11.11.2013
		Loading Provision cooling system	241	28.10.2013	31.10.2013	0	0	29.10.2013	29.10.2013
		Loading Sewage unit	241	28.10.2013	31.10.2013	0	0	29.10.2013	29.10.2013
		Loading Transformator	UEI	28.10.2013	29.10.2013	0	0	28.10.2013	03.11.2013
		Loading Transformators	UEI	28.10.2013	29.11.2013	0	0	06.11.2013	03.12.2013
		Loading Workshop equipment Drilling machine	243	28.10.2013	31.10.2013	0	0	28.10.2013	03.11.2013
		Loading Workshop equipment Lathe.	243	28.10.2013	31.10.2013	0	0	28.10.2013	03.11.2013
	55090	Montering unit 521 til 513&514 (SS52)	233	28.10.2013	20.11.2013	0	0	04.11.2013	20.11.2013
		Open Cut out 42.1 - Upper engine room	233	28.10.2013	31.10.2013	0	0	28.10.2013	03.11.2013
		Open Cut out 81.1- Bathroom modules M dk	233	28.10.2013	01.11.2013	0	0	04.11.2013	04.11.2013
		Open Cut out 82.3 - Bathroom modules A dk	233	28.10.2013	01.11.2013	0	0	29.10.2013	04.11.2013
		Open Cut out 83.1 - Bathroom modules B dk	233	28.10.2013	01.11.2013	0	0	04.11.2013	04.11.2013
		Open Cut out 84.1 - Bathroom modules C dk	233	28.10.2013	01.11.2013	0	0	29.10.2013	04.11.2013
		Open Cut out 85.1 - Bathroom modules D dk	233	28.10.2013	01.11.2013	0	0	29.10.2013	04.11.2013
	55010	Montering av Vros (Unit 593)	233	29.10.2013	22.11.2013	315	315	05.07.2013	26.11.2013
	55050	Montering unit 433 (SS51)	233	29.10.2013	22.11.2013	0	384	04.11.2013	20.11.2013
		Veke 45 ******************************		03.11.2013	10.11.2013	0	0	03.11.2013	10.11.2013
		HVAC Hotwork Bridge deck	HVAC	04.11.2013	22.11.2013	0	0	30.09.2013	30.09.2013
		HVAC hotwork E-deck	HVAC	04.11.2013	22.11.2013	0	0	30.09.2013	30.09.2013
		Open Cut out 43.1 - Switchboard room	233	04.11.2013	07.11.2013	0	0	04.11.2013	04.11.2013
		Open Cut out 43.2 - Switchboard room	233	04.11.2013	07.11.2013	0	0	04.11.2013	04.11.2013
WP09010-07		Aftship ready for towaway from Hullyard	290	05.11.2013	05.11.2013	0	0	06.11.2013	06.11.2013
		Insulation Lower Tweendeck	RMI	05.11.2013	25.01.2014	225	0	10.11.2013	28.01.2014
	77010	ROV porter	243	06.11.2013	20.04.2014	500	704	12.11.2013	25.04.2014
		Loading Water mist unit	241	08.11.2013	08.11.2013	0	0	10.11.2013	10.11.2013
		HVAC Hotwork SS82	HVAC	09.11.2013	23.11.2013	0	0	24.10.2013	25.11.2013
		Veke 46 ******************************		10.11.2013	17.11.2013	0	0	10.11.2013	17.11.2013
		Close Cut out 82.2 - SS82, AC room 3	234	11.11.2013	15.11.2013	0	0	12.11.2013	19.11.2013
		Loading Starting air compressor	241	11.11.2013	19.11.2013	0	0	29.10.2013	20.11.2013
	77190	ROV Moonpool luke	243	11.11.2013	20.04.2014	800	663	20.01.2014	06.07.2014
		43.1 Loading El equipment	UEI	14.11.2013	06.12.2013	0	0	29.10.2013	10.12.2013
		43.1 Loading HVAC equipment	243	14.11.2013	22.11.2013	0	0	05.11.2013	26.11.2013
		43.1 Loading Main switch board	UEI	15.11.2013	20.11.2013	0	0	26.11.2013	26.11.2013
		Veke 47 --------------------		17.11.2013	24.11.2013	0	0	17.11.2013	24.11.2013
WP09008-10		Aftship in Inner Dock	222	19.11.2013	19.11.2013	0	0	19.11.2013	19.11.2013
WP09010-07		Arrival of Aftship	290	19.11.2013	19.11.2013	0	0	19.11.2013	19.11.2013
		Loading Working air compressor	241	19.11.2013	20.11.2013	0	0	19.11.2013	20.11.2013
		Open Cut out 20.1 - Main deck to Winch room	233	20.11.2013	29.11.2013	0	0	26.11.2013	03.12.2013
	54010	Montering SS40 til skrog	233	21.11.2013	13.12.2013	360	564	25.11.2013	17.12.2013
		Hotwork/paint Tank no.022 DB WB/DW tank PS	221	22.11.2013	04.12.2013	0	0	22.11.2013	10.12.2013

		Finished Hotwork/paint Tank no.047 Wing WB/DW tank SB	221	24.01.2014	10.02.2014	0	0	14.01.2014	18.02.2014
		Painting behind lining Main stairs	221	24.01.2014	27.01.2014	0	0	28.01.2014	28.01.2014
		Finished Hotwork/paint Tank no.049 Wing WB/DW tank PS	221	25.01.2014	10.02.2014	0	0	14.01.2014	17.02.2014
WP09008-05		Mount. LARS	243	25.01.2014	20.02.2014	0	0	27.01.2014	17.02.2014
		Veke 05 -------------------		26.01.2014	02.02.2014	0	0	26.01.2014	02.02.2014
		Alignment spole arr. og skive (kranplan)	241	27.01.2014	31.01.2014	0	0	21.01.2014	04.02.2014
		Alignment winch (kranplan)	241	27.01.2014	31.01.2014	0	0	28.01.2014	04.02.2014
		Close Cut out 20.2 - Upper Winch room to Lower Winch room	234	27.01.2014	31.01.2014	0	0	21.01.2014	28.01.2014
		Finished Hotwork/paint Tank no.034 DB WB/DW tank PS	221	27.01.2014	10.02.2014	0	0	03.12.2013	27.03.2014
	11.jan	Installation of APV rack and AHC cylinder	241	27.01.2014	08.02.2014	0	0	04.02.2014	11.02.2014
		Mo.found. in Galley	223	27.01.2014	30.01.2014	0	0	03.02.2014	03.02.2014
	38960	Wall panel Bridge deck	223	27.01.2014	16.05.2014	1500	1047	07.01.2014	13.07.2014
		Finished Hotwork/ final painting Instrument room 1 PS	221	29.01.2014	02.02.2014	0	0	08.11.2013	02.02.2014
		Finished Hotwork/paint Tank no.035 DB WB/DW tank SB	221	29.01.2014	12.02.2014	0	0	03.12.2013	27.03.2014
	nov.19	Install cable and pipe penetrations in ADeck for MHT.	243	29.01.2014	27.02.2014	0	0	28.01.2014	24.02.2014
		Mo. HPU (kranplan)	241	29.01.2014	29.01.2014	0	0	04.02.2014	04.02.2014
		Painting behind lining Life boat area PS&SB	221	30.01.2014	01.02.2014	0	0	03.02.2014	03.02.2014
	38910	Wooden floor Bridge deck	223	30.01.2014	30.05.2014	200	322	14.01.2014	18.05.2014
		20.1 Loading Main HPU for crane	241	31.01.2014	31.01.2014	0	0	31.01.2014	04.02.2014
		Finished Hotwork/paint Tank no.052 Aftpeak tank SB	221	31.01.2014	14.02.2014	0	0	20.01.2014	27.03.2014
		Painting behind lining A-deck	221	31.01.2014	03.02.2014	0	0	03.02.2014	03.02.2014
		Painting behind lining Main deck	221	31.01.2014	03.02.2014	0	0	03.02.2014	03.02.2014
		Finished Hotwork/paint Tank no.050 Wing WB/DW tank SB	221	01.02.2014	17.02.2014	0	0	14.01.2014	18.02.2014
		Finished Hotwork/paint Tank no.051 Aftpeak tank PS	221	01.02.2014	17.02.2014	0	0	20.01.2014	27.03.2014
		Veke 06 -------------------		02.02.2014	09.02.2014	0	0	02.02.2014	09.02.2014
		Alignment kontroll av fundament (kranplan)	241	03.02.2014	04.02.2014	0	0	14.01.2014	14.01.2014
		Finished Hotwork/paint Tank no.012 Wing WB/DW tank PS	221	03.02.2014	22.02.2014	0	0	14.01.2014	27.03.2014
		Flushing og hydr. syst. Rør,(kranplan)	241	03.02.2014	06.03.2014	0	0	04.02.2014	11.02.2014
		HVAC Spiro acc.B-deck	HVAC	03.02.2014	26.04.2014	0	0	04.02.2014	20.05.2014
		Piping (kranplan)	241	03.02.2014	30.04.2014	0	0	14.02.2014	06.05.2014
		Finished Hotwork/paint Tank no.008 Wing WB/DW tank PS	221	04.02.2014	17.02.2014	0	0	21.01.2014	27.03.2014
		Floating floor MD	223	04.02.2014	21.02.2014	0	0	11.02.2014	25.02.2014
		Mo. Hydrostat cylinder (kranplan)	241	04.02.2014	08.02.2014	0	0	04.02.2014	11.02.2014
		Finished Hotwork/final painting Instrument room 2	221	05.02.2014	07.03.2014	0	0	08.11.2013	25.02.2014
		Painting Heisesjakt	221	05.02.2014	06.02.2014	0	0	07.02.2014	07.02.2014
		Finished Hotwork/paint Tank no.042 Wing FW tank SB	221	06.02.2014	22.02.2014	0	0	03.12.2013	27.03.2014
		Finished Hotwork/paint Tank no.040 Wing FW tank PS	221	07.02.2014	21.02.2014	0	0	03.12.2013	27.03.2014
		Finished Hotwork/paint Tank no.043 Wing FW tank SB	221	07.02.2014	22.02.2014	0	0	03.12.2013	27.03.2014
	38150	Insulation MD	223	07.02.2014	14.04.2014	250	642	30.01.2014	23.04.2014
		Paint Tank no.053 WB/DW roll red.tank CE	221	07.02.2014	21.03.2014	0	0	04.02.2014	27.03.2014
		Painting behind lining B-deck	221	07.02.2014	10.02.2014	0	0	07.02.2014	11.02.2014
		Painting behind lining C-deck	221	07.02.2014	10.02.2014	0	0	07.02.2014	11.02.2014
		Paint Tank no.311 Chain locker SB	221	08.02.2014	22.03.2014	0	0	12.02.2014	07.04.2014
		Finished Hotwork/paint Tank no.038 DB WB/DW tank PS	221	09.02.2014	24.02.2014	0	0	03.02.2014	27.03.2014
		Finished Hotwork/paint Tank no.039 DB WB/DW tank SB	221	09.02.2014	26.02.2014	0	0	03.02.2014	27.03.2014
		Veke 07 -------------------		09.02.2014	16.02.2014	0	0	09.02.2014	16.02.2014
		HVAC Spiro acc.C-deck	HVAC	10.02.2014	26.04.2014	0	0	11.02.2014	20.05.2014
		Hydr. piping (kranplan)	241	10.02.2014	30.04.2014	0	0	14.02.2014	06.05.2014
	nov.22	Installation of cooling water piping	241	10.02.2014	16.05.2014	0	0	24.02.2014	13.06.2014
		20.2 Loading Main valve block for crane	241	12.02.2014	12.02.2014	0	0	14.02.2014	14.02.2014
		Close Cut out 20.1 - Main deck to Winch room	234	12.02.2014	28.02.2014	0	0	28.01.2014	28.02.2014
	38340	Insulation B-deck	223	12.02.2014	30.04.2014	380	366	11.02.2014	23.03.2014
	38440	Insulation C-deck	223	12.02.2014	30.04.2014	480	450	11.02.2014	25.04.2014
		Paint Tank no.252 Sewage tank	221	13.02.2014	21.03.2014	0	0	10.02.2014	07.04.2014
		Paint Tank no.275 FO drain tank	221	13.02.2014	21.03.2014	0	0	18.02.2014	07.04.2014
		Paint Tank no.280 Bilge water tank	221	13.02.2014	21.03.2014	0	0	10.02.2014	07.04.2014
		Paint Tank no.281 Bilge water settling tank	221	13.02.2014	21.03.2014	0	0	21.02.2014	07.04.2014
		Paint Tank no.282 Clean bilge water tank	221	13.02.2014	21.03.2014	0	0	21.02.2014	06.05.2014
		Paint Tank no.284 Sludge tank	221	13.02.2014	21.03.2014	0	0	21.02.2014	07.04.2014
		Paint Tank no.288 Sludge settling tank	221	13.02.2014	21.03.2014	0	0	21.02.2014	07.04.2014
		Painting behind lining D-deck	221	13.02.2014	17.02.2014	0	0	07.02.2014	17.02.2014

		Painting behind lining D-deck	221	13.02.2014	17.02.2014	0	0	07.02.2014	17.02.2014
		Painting behind lining E-deck	221	13.02.2014	18.02.2014	0	0	07.02.2014	17.02.2014
		Painting behind lining FWD stairs	221	15.02.2014	17.02.2014	0	0	17.02.2014	17.02.2014
		Veke 08------------------		16.02.2014	23.02.2014	0	0	16.02.2014	23.02.2014
		Floating floor B-deck	223	17.02.2014	05.03.2014	0	0	18.02.2014	10.03.2014
		Floating floor C-deck	223	17.02.2014	18.03.2014	0	0	18.02.2014	25.03.2014
		HVAC Spiro acc.Bridge deck	HVAC	17.02.2014	26.04.2014	0	0	18.02.2014	20.05.2014
	38240	Insulation A-deck	223	17.02.2014	30.04.2014	450	1005	18.02.2014	25.04.2014
		Insulation E-deck	RMI	17.02.2014	14.03.2014	600	0	25.02.2014	17.03.2014
	38190	Insulation prov.rooms	223	17.02.2014	19.03.2014	150	216	18.02.2014	02.03.2014
		Montering av Stahl Heis	243	17.02.2014	07.05.2014	0	0	27.01.2014	06.03.2014
		Paint Tank no.004 DB/Wing WB/DW tank PS	221	18.02.2014	21.03.2014	0	0	14.01.2014	21.03.2014
		Cut out for GWW drive rom	233	19.02.2014	20.03.2014	0	0	24.02.2014	24.02.2014
		Hotwork/final painting AC-room 3 A deck	221	19.02.2014	25.02.2014	0	0	07.10.2013	25.03.2014
		Paint Tank no.255 Urea tank	221	19.02.2014	02.04.2014	0	0	10.02.2014	07.04.2014
		Paint Tank no.256 Urea tank	221	19.02.2014	02.04.2014	0	0	10.02.2014	07.04.2014
	38180	Wall panel MD	223	19.02.2014	09.05.2014	775	974	13.02.2014	29.06.2014
		Alignment kontroll av pidestal (kranplan)	241	20.02.2014	20.02.2014	0	0	24.02.2014	24.02.2014
		Loading PDU og trafo	UEI	20.02.2014	20.02.2014	0	0	18.02.2014	25.02.2014
		Paint Tank no.048 WB/DW tank CE	221	20.02.2014	13.03.2014	0	0	14.01.2014	18.03.2014
	11.jul	Install Main Winch	241	21.02.2014	22.02.2014	0	0	24.02.2014	04.03.2014
		Paint Tank no.005 DB/Wing WB/DW tank SB	221	22.02.2014	25.03.2014	0	0	14.01.2014	30.03.2014
		Veke 09 ------------------		23.02.2014	02.03.2014	0	0	23.02.2014	02.03.2014
		Final painting HPU-room #162-#165	221	24.02.2014	03.04.2014	0	0	03.03.2014	08.04.2014
		HVAC Spiro acc.D-deck	HVAC	24.02.2014	26.04.2014	0	0	18.02.2014	20.05.2014
	11.mar	Install power cabling from Offshore Eq.	UEI	25.02.2014	30.05.2014	0	0	01.04.2014	13.06.2014
	11.aug	Installation of GWW drives (2 pcs) and brake resistors (2 pcs)	UEI	25.02.2014	03.05.2014	0	0	04.03.2014	06.05.2014
	11.okt	Installation of GWW drives (2 pcs) and brake resistors (2 pcs)	UEI	25.02.2014	03.05.2014	0	0	04.03.2014	06.05.2014
		Mounting of scaffolding work	222	25.02.2014	22.03.2014	0	0	25.03.2014	01.04.2014
		Insulation D-deck	RMI	26.02.2014	28.03.2014	555	0	26.02.2014	01.04.2014
		Heis sjakt, lukk utkapp i toppen	243	28.02.2014	06.03.2014	0	0	28.02.2014	11.03.2014
		Mo. knukle boom (kranplan)	241	28.02.2014	19.03.2014	0	0	11.03.2014	20.03.2014
		Mo. main boom (kranplan)	241	28.02.2014	19.03.2014	0	0	11.03.2014	20.03.2014
		Paint Tank no.069 Liquid cargo tank PS	221	28.02.2014	28.03.2014	0	0	03.03.2014	29.04.2014
		Final painting Life boat area PS	221	01.03.2014	07.03.2014	0	0	03.03.2014	25.03.2014
		Final painting Life boat area SB	221	01.03.2014	07.03.2014	0	0	03.03.2014	25.03.2014
		Floating floor D-deck	223	01.03.2014	18.03.2014	0	0	03.03.2014	25.03.2014
11.18.1		Installation of MHT on ADeck, Part 1	222	01.03.2014	02.03.2014	0	0	04.03.2014	09.03.2014
		Veke 10 ----------------		02.03.2014	09.03.2014	0	0	02.03.2014	09.03.2014
		Final painting Topside PS/SB #-11-#100	221	03.03.2014	07.03.2014	0	0	18.02.2014	25.03.2014
		Mo. konge (kranplan)	241	03.03.2014	05.03.2014	0	0	06.03.2014	11.03.2014
WP09008-05		Mount. Offshore Crane above deck	241	03.03.2014	22.03.2014	0	0	18.03.2014	25.03.2014
		Wall panel Lower Tweendeck	RMI	03.03.2014	28.03.2014	400	0	04.03.2014	04.03.2014
	nov.20	Build to fit entrance to MHT stair tower on A-Deck port side.	243	04.03.2014	19.03.2014	0	0	18.03.2014	25.03.2014
		Paint Tank no.006 DB WB/DW tank CE	221	04.03.2014	29.03.2014	0	0	10.02.2014	30.03.2014
	11.feb	Re-build to fit and install HPU for Main Winch	241	04.03.2014	25.03.2014	0	0	25.02.2014	25.03.2014
		Final painting Mooring deck	221	06.03.2014	17.03.2014	0	0	27.01.2014	18.03.2014
		Final painting Outside Main deck #-11-#44	221	06.03.2014	01.04.2014	0	0	11.03.2014	08.04.2014
		Paint Tank no.070 Liquid cargo tank SB	221	09.03.2014	22.03.2014	0	0	11.03.2014	13.05.2014
		Veke 11 ----------------		09.03.2014	16.03.2014	0	0	09.03.2014	16.03.2014
		Ceiling/Walls kjøl/frys/tørrproviant	223	10.03.2014	23.05.2014	0	0	11.03.2014	18.06.2014
		Close Cut out 42.1 - Upper engine room	234	10.03.2014	14.03.2014	0	0	10.03.2014	10.03.2014
		Close Cut out for GWW drive rom	234	10.03.2014	13.03.2014	0	0	08.03.2014	17.03.2014
WP09008-05		Mount. Main Azimuth Thrusters, outer part	241	10.03.2014	02.04.2014	0	0	20.03.2014	08.04.2014
	38350	Wall panel B-deck	223	10.03.2014	16.05.2014	1000	915	11.03.2014	29.06.2014
		Paint Tank no.071 Liquid cargo tank PS	221	11.03.2014	24.03.2014	0	0	11.03.2014	13.05.2014
		Paint Tank no.003 Wing FW tank SB	221	12.03.2014	26.03.2014	0	0	03.03.2014	07.04.2014
		Final painting AC-rom Bridge deck	221	14.03.2014	19.03.2014	0	0	04.02.2014	25.03.2014
		Final painting Bow thr. room 1	221	14.03.2014	24.03.2014	0	0	18.03.2014	25.03.2014
		Final painting Bow thr. room 2	221	14.03.2014	24.03.2014	0	0	11.03.2014	25.03.2014
		Final painting Emerg.gen.room	221	14.03.2014	19.03.2014	0	0	11.03.2014	25.03.2014

	Hotwork/paint Tank no.022 DB WB/DW tank PS	221	22.11.2013	04.12.2013	0	0	22.11.2013	10.12.2013
	Hotwork/paint Tank no.024 Wing WB/DW anti-heeling tank PS	221	22.11.2013	04.12.2013	0	0	22.11.2013	10.12.2013
	Painting behind lining Bridge deck & Part of E-deck (Vanylven	221	23.11.2013	27.11.2013	0	0	25.11.2013	02.12.2013
	Hotwork/paint Tank no.023 DB WB/DW tank SB	221	24.11.2013	06.12.2013	0	0	22.11.2013	10.12.2013
	Hotwork/paint Tank no.025 Wing WB/DW anti-heeling tank SB	221	24.11.2013	06.12.2013	0	0	22.11.2013	10.12.2013
	Veke 48 --------------------		24.11.2013	01.12.2013	0	0	24.11.2013	01.12.2013
	20.1 Loading Pipes and valves	241	25.11.2013	15.03.2014	0	0	25.11.2013	18.03.2014
	20.2 Loading Pumps and coolers for lower prop room	241	25.11.2013	25.11.2013	0	0	25.11.2013	26.11.2013
	30.6 Loading Ballast water treatment unit	241	25.11.2013	25.11.2013	0	0	25.11.2013	26.11.2013
	30.6 Loading FO transfer pump	241	25.11.2013	25.11.2013	0	0	25.11.2013	26.11.2013
	30.6 Loading Pipes and valves	241	25.11.2013	30.04.2014	0	0	25.11.2013	06.05.2014
	30.6 Loading Pumps	241	25.11.2013	20.12.2013	0	0	25.11.2013	06.01.2014
	30.6 Loading Valve chests	241	25.11.2013	20.12.2013	0	0	25.11.2013	02.12.2013
	Loading Separators	241	25.11.2013	25.11.2013	0	0	26.11.2013	26.11.2013
nov.16	Move crane on ADeck port side	243	25.11.2013	14.03.2014	0	0	17.01.2014	06.03.2014
	Close Cut out 43.1 - Switchboard room	233	26.11.2013	28.11.2013	0	0	03.12.2013	03.12.2013
	Close Cut out 43.2 - Switchboard room	233	26.11.2013	28.11.2013	0	0	03.12.2013	03.12.2013
	Hotwork/paint Tank no.021 Wing WB/DW anti-heeling tank SB	221	26.11.2013	09.12.2013	0	0	02.12.2013	10.12.2013
54020	Montering SS41 til skrog	ScanCor	26.11.2013	19.12.2013	0	8	21.11.2013	21.11.2013
	Open Cut out 30.2 - Main deck to equipment room	233	27.11.2013	29.11.2013	0	0	03.12.2013	03.12.2013
	Open Cut out 30.3 - Equipment room to Pump room	233	27.11.2013	05.12.2013	0	0	10.12.2013	10.12.2013
	Open Cut out 30.4 - Equipment room to Pump room	233	27.11.2013	29.11.2013	0	0	03.12.2013	03.12.2013
	Open cut out 30.5 - A deck to Equipment room	233	27.11.2013	29.11.2013	0	0	03.12.2013	03.12.2013
	Open cut out 30.6 - Main deck to equipment room	233	27.11.2013	05.12.2013	0	0	03.12.2013	10.12.2013
	Hotwork/paint Tank no.029 Wing WB/DW tank SB	221	28.11.2013	11.12.2013	0	0	02.12.2013	17.12.2013
	Hotwork/paint Tank no.033 Wing WB/DW tank SB	221	28.11.2013	12.12.2013	0	0	02.12.2013	22.12.2013
	Open Cut out 10.1 - Main deck to Prop.room	233	28.11.2013	06.12.2013	0	0	29.11.2013	10.12.2013
	Open Cut out 10.2 - Main deck to Prop.room	233	28.11.2013	06.12.2013	0	0	29.11.2013	10.12.2013
	Open Cut out 10.3 - Main deck to Prop.room	233	28.11.2013	06.12.2013	0	0	29.11.2013	10.12.2013
	Hotwork/paint Tank no.028 Wing WB/DW tank PS	221	29.11.2013	13.12.2013	0	0	02.12.2013	17.12.2013
57000	Montering SS71 til skrog	233	29.11.2013	10.01.2014	405	573	02.12.2013	12.01.2014
	Hotwork/paint Tank no.032 Wing WB/DW tank PS	221	30.11.2013	13.12.2013	0	0	02.12.2013	22.12.2013
	Veke 49 --------------------		01.12.2013	08.12.2013	0	0	01.12.2013	08.12.2013
	Hotwork/paint Tank no.020 Wing WB/DW anti-heeling tank PS	221	02.12.2013	16.12.2013	0	0	02.12.2013	17.12.2013
	Loading Transformators/drives	UEI	02.12.2013	13.12.2013	0	0	17.12.2013	17.12.2013
58000	Montering SS81 til skrog	McP	02.12.2013	15.01.2014	0	0	02.12.2013	02.12.2013
	Hotwork/paint Tank no.036 Wing WB/DW tank PS	221	03.12.2013	17.12.2013	0	0	02.12.2013	07.01.2014
	HVAC hotwork Main deck	HVAC	03.12.2013	21.01.2014	0	0	03.12.2013	14.01.2014
	Montering Unit 513 tank top	ScanCor	03.12.2013	17.01.2014	0	0	03.12.2013	19.01.2014
55060	Montering SS51 til skrog	ScanCor	04.12.2013	09.01.2014	0	0	02.12.2013	12.01.2014
	Hotwork/paint Tank no.026 DB WB/DW tank PS	221	05.12.2013	20.12.2013	0	0	05.12.2013	07.01.2014
58010	Montering SS82 til skrog	McP	05.12.2013	24.01.2014	0	0	09.12.2013	02.12.2013
	Arrival SS-89 - 842,843,891 (Uve Vanylven)	632	06.12.2013	06.12.2013	0	0	09.12.2013	09.12.2013
	Arrival Units : 844,841 (Uve Vanylven)?	632	06.12.2013	06.12.2013	0	0	09.12.2013	09.12.2013
	Painting behind lining SWBD room	221	06.12.2013	10.12.2013	0	0	03.12.2013	03.12.2013
	Hotwork/paint Tank no.027 DB WB/DW tank SB	221	07.12.2013	22.12.2013	0	0	05.12.2013	07.01.2014
	Veke 50 --------------------		08.12.2013	15.12.2013	0	0	08.12.2013	15.12.2013
	10.1 Loading Main el prop motor	241	09.12.2013	13.12.2013	0	0	12.12.2013	12.12.2013
	10.3 Loading Lub oil/servo unit	241	09.12.2013	20.12.2013	0	0	07.01.2014	07.01.2014
	Loading Exp. tank for thrusters	241	09.12.2013	13.12.2013	0	0	11.12.2013	11.12.2013
	Loading Servo pumps for thrusters	241	09.12.2013	13.12.2013	0	0	11.12.2013	11.12.2013
55080	Montering SS52 til skrog	ScanCor	09.12.2013	22.01.2014	0	0	21.11.2013	21.11.2013
51000	Mounting Azimuth	233	09.12.2013	14.02.2014	450	883	09.12.2013	19.01.2014
	Loading Osmose system	241	10.12.2013	13.12.2013	0	0	17.12.2013	17.12.2013
	SBL/MAL S 844	221	10.12.2013	20.12.2013	0	0	17.12.2013	20.12.2013
	10.2 Loading Main el prop motor	241	11.12.2013	14.12.2013	0	0	13.12.2013	13.12.2013
	Hotwork/paint Tank no.037 Wing WB/DW tank SB	221	11.12.2013	23.12.2013	0	0	11.12.2013	14.01.2014
38940	Insulation Bridge deck	223	11.12.2013	28.02.2014	400	642	11.12.2013	20.02.2014
	Montering av heis	222	11.12.2013	10.01.2014	0	0	17.12.2013	24.01.2014
85020	Montering EL. motor silent thruster	241	11.12.2013	10.01.2014	50	28	09.12.2013	25.04.2014
	Open Cut out 20.2 - Upper Winch room to Lower Winch room	233	11.12.2013	13.12.2013	0	0	17.12.2013	17.12.2013

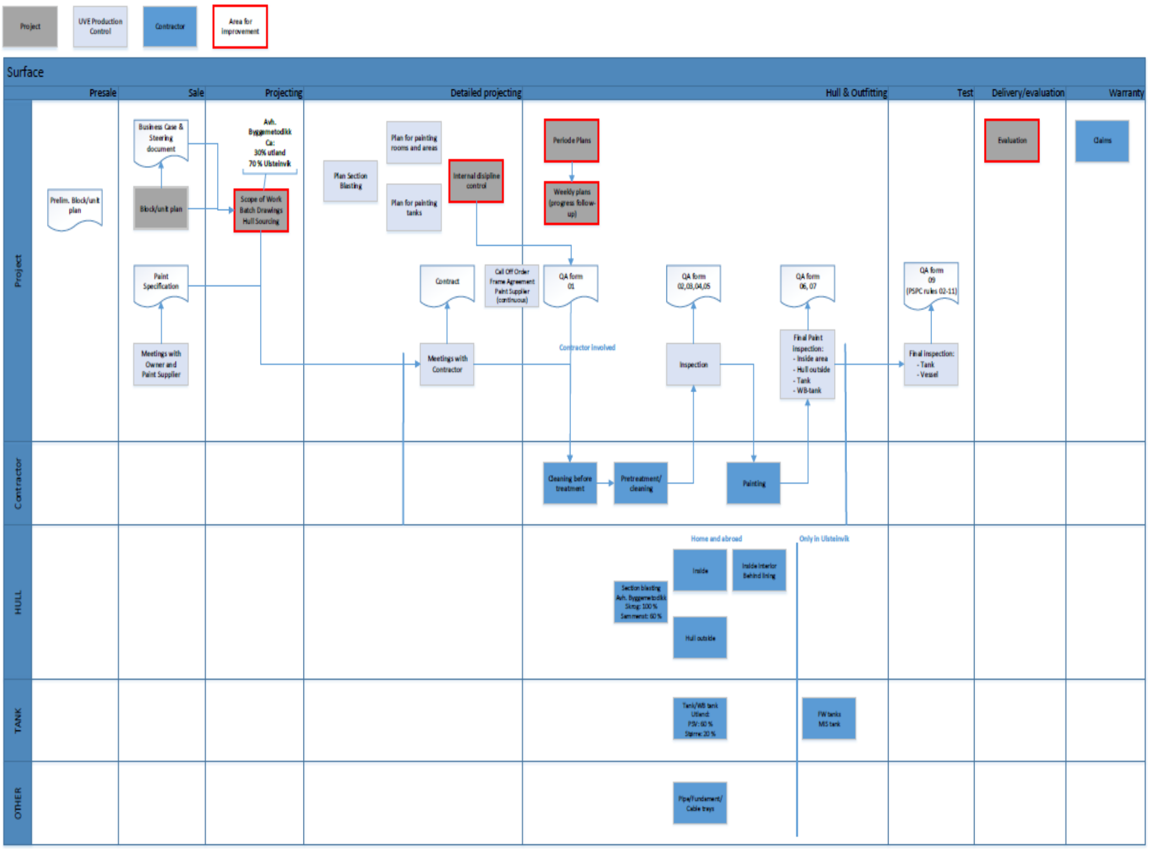
	Open Cut out 20.2 - Upper Winch room to Lower Winch room	233	11.12.2013	13.12.2013	0	0	17.12.2013	17.12.2013
	SBL/MAL S 841	221	11.12.2013	13.12.2013	0	0	11.12.2013	17.12.2013
	20.2 Loading FW pumps and coolers	241	12.12.2013	28.01.2014	0	0	03.12.2013	14.01.2014
	Hotwork/paint Tank no.030 DB WB/DW tank PS	221	12.12.2013	26.12.2013	0	0	02.01.2014	12.01.2014
	Hotwork/paint Tank no.031 DB WB/DW tank SB	221	12.12.2013	25.12.2013	0	0	02.01.2014	12.01.2014
	Loading Thruster motor 1 & 2	241	13.12.2013	14.12.2013	0	0	11.12.2013	11.12.2013
58630	Montering unit 841 til skrog	233	13.12.2013	17.01.2014	225	231	14.12.2013	19.01.2014
	Veke 51 --------------------		15.12.2013	22.12.2013	0	0	15.12.2013	22.12.2013
	30.6 Loading ROV equipment	241	16.12.2013	20.02.2014	0	0	17.12.2013	21.02.2014
	10.3 Loading Main el prop motor	241	18.12.2013	20.12.2013	0	0	13.12.2013	13.12.2013
58610	Montering SS89 til skrog, kl 0600	233	18.12.2013	29.01.2014	297	439	18.12.2013	03.02.2014
	Veke 52 -------------------		22.12.2013	29.12.2013	0	0	22.12.2013	29.12.2013
	Veke 01 -------------------		29.12.2013	05.01.2014	0	0	29.12.2013	05.01.2014
	HVAC hotwork A deck	HVAC	01.01.2014	02.01.2014	0	0	02.09.2013	02.09.2013
	HVAC hotwork B-deck	HVAC	01.01.2014	01.03.2014	0	0	02.09.2013	02.09.2013
	HVAC hotwork D-deck	HVAC	01.01.2014	01.03.2014	0	0	02.09.2013	02.09.2013
	Veke 02 --------------------		05.01.2014	12.01.2014	0	0	05.01.2014	12.01.2014
	20.2 Loading El equipment	UEI	06.01.2014	17.02.2014	0	0	07.01.2014	18.02.2014
	20.2 Loading Spooling devise for crane(Cut Out)	233	06.01.2014	14.01.2014	0	0	07.01.2014	20.01.2014
	El inst. (kranplan)	UEI	06.01.2014	16.04.2014	0	0	30.12.2013	25.04.2014
	Mo. skive (kranplan)	243	06.01.2014	10.01.2014	0	0	07.01.2014	12.01.2014
56020	Montering SS60 til skrog	233	06.01.2014	21.02.2014	540	1800	07.01.2014	20.02.2014
	20.2 Loading APV for crane	241	08.01.2014	15.01.2014	0	0	15.01.2014	20.01.2014
	Finished Hotwork/paint Tank no.018 DB WB/DW tank PS	221	09.01.2014	24.01.2014	0	0	10.01.2014	28.01.2014
	Finished Hotwork/paint Tank no.044 Wing WB/DW tank PS	221	09.01.2014	24.01.2014	0	0	10.01.2014	28.01.2014
	Finished Hotwork/paint Tank no.045 Wing WB/DW tank SB	221	09.01.2014	24.01.2014	0	0	13.01.2014	28.01.2014
	Finished Hotwork/paint Tank no.041 DB WB/DW tank CE	221	10.01.2014	23.01.2014	0	0	07.01.2014	28.01.2014
	Finished Hotwork/paint Tank no.054 WB/DW roll red.tank CE	221	11.01.2014	30.01.2014	0	0	07.01.2014	02.02.2014
	Finished Hotwork/paint Tank no.055 WB/DW roll red.tank CE	221	11.01.2014	31.01.2014	0	0	07.01.2014	31.01.2014
	Veke 03 --------------------		12.01.2014	19.01.2014	0	0	12.01.2014	19.01.2014
	Alignment winch og spole arr. (kranplan)	241	13.01.2014	15.02.2014	0	0	04.02.2014	14.02.2014
	Close Cut out 30.1 - Main deck to ROV equip.room	234	13.01.2014	24.01.2014	0	0	07.01.2014	07.01.2014
	Close Cut out 30.2 - Main deck to equipment room	234	13.01.2014	24.01.2014	0	0	07.01.2014	07.01.2014
	Close Cut out 30.3 - Equipment room to Pump room	234	13.01.2014	24.01.2014	0	0	07.01.2014	07.01.2014
	Close Cut out 30.4 - Equipment room to Pump room	234	13.01.2014	24.01.2014	0	0	07.01.2014	07.01.2014
	Close cut out 30.5 - A deck to Equipment room	234	13.01.2014	24.01.2014	0	0	14.01.2014	28.01.2014
	Close cut out 30.6 - Main deck to equipment room	234	13.01.2014	24.01.2014	0	0	14.01.2014	28.01.2014
	Mo. APV (kranplan)	243	13.01.2014	16.01.2014	0	0	20.01.2014	20.01.2014
	Mo. spole arr. (kranplan)	241	13.01.2014	28.02.2014	0	0	07.01.2014	25.02.2014
	Close Cut out 10.1 - Main Deck to Prop.room	234	14.01.2014	30.01.2014	0	0	14.01.2014	28.01.2014
	Close Cut out 10.2 - Main deck to Prop.room	234	14.01.2014	30.01.2014	0	0	14.01.2014	28.01.2014
	Finished Hotwork/paint Tank no.014 DB WB/DW tank PS	221	15.01.2014	04.02.2014	0	0	03.12.2013	11.02.2014
	Finished Hotwork/paint Tank no.016 Wing WB/DW anti-heelin	221	15.01.2014	04.02.2014	0	0	03.12.2013	11.02.2014
58620	Montering unit 844 til skrog	233	15.01.2014	06.02.2014	180	307	21.01.2014	11.02.2014
	Open Cut out 86.1 - Bathroom modules E dk	233	15.01.2014	16.01.2014	0	0	29.10.2013	19.01.2014
	Close Cut out 10.3- Main deck to Prop.room	234	16.01.2014	30.01.2014	0	0	28.01.2014	28.01.2014
	Mounting unit 892 to skrog	233	16.01.2014	19.02.2014	0	0	21.01.2014	18.02.2014
	Finished Hotwork/paint Tank no.015 DB WB/DW tank SB	221	17.01.2014	06.02.2014	0	0	03.12.2013	11.02.2014
	Finished Hotwork/paint Tank no.017 Wing WB/DW anti-heelin	221	17.01.2014	07.02.2014	0	0	14.01.2014	11.02.2014
	Veke 04 --------------------		19.01.2014	26.01.2014	0	0	19.01.2014	26.01.2014
	HVAC hotwork Tank top/tween deck	HVAC	20.01.2014	01.02.2014	0	0	21.01.2014	27.01.2014
	Mo. winch (kranplan)	241	20.01.2014	28.02.2014	0	0	21.01.2014	25.02.2014
	Mounting guide rails	243	20.01.2014	14.03.2014	0	0	21.01.2014	06.03.2014
nov.17	Prefabricate 4 pcs foundations for MHT	243	20.01.2014	12.02.2014	0	0	27.01.2014	17.02.2014
	20.1 Loading Main winch for crane	241	21.01.2014	31.01.2014	0	0	21.01.2014	04.02.2014
	Montering moonpool luke	243	21.01.2014	28.02.2014	0	0	25.01.2014	25.02.2014
	Finished Hotwork/paint Tank no.046 Wing WB/DW tank PS	221	23.01.2014	08.02.2014	0	0	14.01.2014	31.01.2014
	HVAC Spiro acc. Main deck	HVAC	23.01.2014	26.04.2014	0	0	23.01.2014	20.05.2014
77140	Pidestall og platform, kranmon	243	23.01.2014	20.04.2014	200	286	10.01.2014	25.04.2014
	Finished Hotwork/paint Tank no.019 DB WB/DW tank SB	221	24.01.2014	11.02.2014	0	0	14.01.2014	27.03.2014
	Finished Hotwork/paint Tank no.047 Wing WB/DW tank SB	221	24.01.2014	10.02.2014	0	0	14.01.2014	18.02.2014

	Final painting Bunker station SB	221	03.05.2014	10.05.2014	0	0	29.04.2014	13.05.2014
	Final painting Deck Store SB #55 - #65	221	03.05.2014	10.05.2014	0	0	13.05.2014	13.05.2014
	Final painting Deck workshop SB #65 - #75	221	03.05.2014	10.05.2014	0	0	13.05.2014	13.05.2014
	Final painting Hydraulikk room PS #65 - #75	221	03.05.2014	10.05.2014	0	0	07.05.2014	18.06.2014
	Veke 19 ------------------		04.05.2014	11.05.2014	0	0	04.05.2014	11.05.2014
	Bunkring of Diesel oil on Day tanks PS&SB	241	05.05.2014	06.05.2014	0	0	06.05.2014	06.05.2014
	Ceiling Tweendeck	RMI	05.05.2014	30.05.2014	275	0	13.05.2014	13.08.2014
	Commissioning/test of Life-boat Davit	243	05.05.2014	09.05.2014	0	0	06.05.2014	07.05.2014
	Commissioning/test of Mob-boat Davit	243	05.05.2014	08.05.2014	0	0	06.05.2014	09.05.2014
	Floor covering D-deck	223	05.05.2014	02.06.2014	0	0	06.05.2014	18.06.2014
	Internal test HVAC	HVAC	05.05.2014	12.05.2014	0	0	20.05.2014	02.06.2014
	Function test Hydrophore system (Shore line)	UEI	06.05.2014	10.05.2014	0	0	06.05.2014	08.05.2014
	Adjustment/check of Generator protection. Equip.	UEI	07.05.2014	09.05.2014	0	0	09.05.2014	20.05.2014
	Commissioning/test of Provision Hatch	243	07.05.2014	09.05.2014	0	0	07.05.2014	08.05.2014
	Start-up and test of Main Engines PS&SB	241	07.05.2014	16.05.2014	0	0	08.05.2014	20.05.2014
	Test of Liferaft	243	07.05.2014	08.05.2014	0	0	07.05.2014	09.05.2014
	Commissioning/test of ROV roller gate (TTS)	243	08.05.2014	09.05.2014	0	0	09.05.2014	09.05.2014
	Final painting Equipment room PS	221	08.05.2014	15.05.2014	0	0	07.05.2014	20.05.2014
	Start-up of Ballast pumps/valves	241	08.05.2014	09.05.2014	0	0	09.05.2014	11.06.2014
	Start-up/Function test of Bilge pumps	241	08.05.2014	20.05.2014	0	0	16.05.2014	26.05.2014
	Fill in and function test of Boiler	241	09.05.2014	09.05.2014	0	0	09.05.2014	12.05.2014
	Fill in and test of SW/FW-central Cooling system. Aft ship	241	09.05.2014	31.05.2014	0	0	30.04.2014	21.05.2014
	Final painting Basket Room / Carousel area	221	09.05.2014	13.05.2014	0	0	07.05.2014	20.05.2014
	Flushing/fill up Chillwater system	241	09.05.2014	20.05.2014	0	0	13.05.2014	21.05.2014
	Start-up HPU (Ulmatec leveranse)	241	09.05.2014	16.05.2014	0	0	12.05.2014	19.05.2014
	Test of Boiler	241	09.05.2014	09.05.2014	0	0	12.05.2014	12.05.2014
	Final painting ROV-Hangar #102-#113	221	10.05.2014	22.05.2014	0	0	07.05.2014	27.05.2014
	Veke 20 ------------------		11.05.2014	18.05.2014	0	0	11.05.2014	18.05.2014
	Ceiling stairs	223	12.05.2014	06.06.2014	0	0	13.05.2014	18.06.2014
	Computer floor	RMI	12.05.2014	30.05.2014	115	0	13.05.2014	13.08.2014
	Floor covering E-deck	223	12.05.2014	02.06.2014	0	0	13.05.2014	18.06.2014
38330	Furnitures B-deck	223	12.05.2014	02.06.2014	870	417	13.02.2014	06.07.2014
38430	Furnitures C-deck	223	12.05.2014	02.06.2014	900	453	13.05.2014	06.07.2014
	Start-up/Commissioning of PMS	UEI	12.05.2014	31.05.2014	0	0	12.05.2014	28.05.2014
	Start-up/function and final test of LO/FO Separators PS	241	12.05.2014	16.05.2014	0	0	13.05.2014	15.05.2014
	Start-up/function and final test of LO/FO Separators SB	241	12.05.2014	16.05.2014	0	0	13.05.2014	15.05.2014
	Start-up/function test of Fire/Emerg.fire pump	UEI	13.05.2014	05.06.2014	0	0	13.05.2014	06.06.2014
	Floor covering Bridge deck	223	14.05.2014	30.05.2014	0	0	18.06.2014	18.06.2014
	Comm. of Jets vacuum toilets and Sewage system	241	15.05.2014	20.05.2014	0	0	13.05.2014	05.06.2014
	Final painting Deck Store SB #44 - #55	221	15.05.2014	15.05.2014	0	0	18.06.2014	03.12.2014
	Final painting Equipment room FWD	221	15.05.2014	22.05.2014	0	0	07.05.2014	27.05.2014
	Final painting Equipment room SB	221	15.05.2014	22.05.2014	0	0	07.05.2014	16.06.2014
	Final painting Outside Main deck #44-#99	221	16.05.2014	23.05.2014	0	0	25.03.2014	27.05.2014
	Final painting Mission room PS #55 - #65	221	18.05.2014	23.05.2014	0	0	07.05.2014	27.05.2014
	Veke 21 ------------------		18.05.2014	25.05.2014	0	0	18.05.2014	25.05.2014
	Bottom inspection with diver	222	19.05.2014	19.05.2014	0	0	16.05.2014	16.05.2014
	Comm. and main test HVAC	HVAC	19.05.2014	26.06.2014	0	0	19.05.2014	04.07.2014
	Commissioning ROV Equipment (Ulmatec)	243	19.05.2014	12.06.2014	0	0	19.05.2014	18.06.2014
38230	Furniture A-deck	223	19.05.2014	20.06.2014	800	568	21.05.2014	06.07.2014
38140	Furniture MD	223	19.05.2014	20.06.2014	560	270	22.05.2014	06.07.2014
	Furnitures D-deck	RMI	19.05.2014	20.06.2014	1275	0	13.08.2014	13.08.2014
	Furnitures E-deck	RMI	19.05.2014	20.06.2014	600	0	13.08.2014	13.08.2014
	Main test of HVAC	241	19.05.2014	05.06.2014	0	0	18.06.2014	18.06.2014
	Tightness test of Hatches, doors and windows	243	19.05.2014	12.06.2014	0	0	13.05.2014	18.06.2014
	Loadtest of Main Generator sets	UEI	20.05.2014	23.05.2014	0	0	20.05.2014	21.05.2014
	Bilge test and Level alarms	UEI	21.05.2014	23.05.2014	0	0	22.05.2014	22.05.2014
	Commissioning of DP/Joystick system	UEI	21.05.2014	19.06.2014	0	0	22.05.2014	19.06.2014
	Spooling of wire on Main,aux and tugger winches	241	21.05.2014	24.05.2014	0	0	22.05.2014	26.05.2014
	Start-up and test of HPU w/Capstans and Tuggers	241	21.05.2014	03.06.2014	0	0	20.05.2014	04.06.2014
	Bilge test system	UEI	22.05.2014	23.05.2014	0	0	22.05.2014	19.06.2014
	Final painting Main deck #75-#99	221	22.05.2014	29.05.2014	0	0	18.06.2014	03.12.2014

		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
		Bilge test system	UEI	22.05.2014	23.05.2014	0	0	22.05.2014	19.06.2014
		Final painting Main deck #75-#99	221	22.05.2014	29.05.2014	0	0	18.06.2014	03.12.2014
		Mo.Galley equipment	223	22.05.2014	04.06.2014	0	0	18.06.2014	18.06.2014
		Spoling av vaier (kranplan)	243	22.05.2014	22.05.2014	0	0	18.06.2014	18.06.2014
		Veke 22 ------------------		25.05.2014	01.06.2014	0	0	25.05.2014	01.06.2014
	39060	Brann/redningsutstyr	223	26.05.2014	02.06.2014	120	110	02.06.2014	06.07.2014
		Commissioning of Telephone and PA system	UEI	26.05.2014	20.06.2014	0	0	27.05.2014	30.06.2014
		Start-up / Comm. Chill water compressors	HVAC	26.05.2014	12.06.2014	0	0	26.05.2014	09.07.2014
		Start-up Chillwater compressors	241	26.05.2014	26.06.2014	0	0	27.05.2014	25.06.2014
		Start-up of Bow Thrusters	UEI	26.05.2014	03.06.2014	0	0	28.05.2014	12.06.2014
		Start-up of Heeling system	241	26.05.2014	30.05.2014	0	0	27.05.2014	02.06.2014
		Start-up of Main prop.	UEI	26.05.2014	29.05.2014	0	0	28.05.2014	05.06.2014
		Start-up of work air Compressor	241	26.05.2014	26.05.2014	0	0	30.05.2014	04.06.2014
		Comm. and test of Bilge water separator	241	27.05.2014	30.05.2014	0	0	28.05.2014	30.05.2014
		Commissioning / Test of water tight doors, Hydr	243	27.05.2014	05.06.2014	0	0	27.05.2014	06.06.2014
		Test Fuel Oil Solas valves	241	27.05.2014	27.05.2014	0	0	28.05.2014	28.05.2014
		Test of safety release valves on Starting Air Pressure sys.	241	27.05.2014	27.05.2014	0	0	22.05.2014	28.05.2014
		Test SW inlet valves	241	27.05.2014	27.05.2014	0	0	28.05.2014	28.05.2014
		Test of Navigation lights	UEI	28.05.2014	28.05.2014	0	0	30.05.2014	30.05.2014
		Final painting Main deck inside #44 - #75	221	29.05.2014	07.06.2014	0	0	18.06.2014	03.12.2014
WP09008-10		Inclining test	243	29.05.2014	29.05.2014	0	0	30.05.2014	30.05.2014
		Veke 23 ------------------		01.06.2014	08.06.2014	0	0	01.06.2014	08.06.2014
		Commissioning of Provision refr. plant	241	02.06.2014	26.06.2014	0	0	28.05.2014	30.06.2014
		Commissioning of Watermist system	241	02.06.2014	05.06.2014	0	0	04.06.2014	12.06.2014
		Internal test of Fire Alarm System	UEI	02.06.2014	04.06.2014	0	0	04.06.2014	30.06.2014
		Start-up / Test of Deck and Hangar cranes (Aukra)	243	02.06.2014	23.06.2014	0	0	04.06.2014	01.07.2014
		Test Personell Elevator	243	02.06.2014	06.06.2014	0	0	04.06.2014	04.06.2014
		Test Provision Elevator	243	02.06.2014	06.06.2014	0	0	04.06.2014	04.06.2014
		Commissioning/test of Aerial plant/SAT-TV antenna	UEI	03.06.2014	09.06.2014	0	0	05.06.2014	11.06.2014
		Start-up/test of Helideck monitoring sys	UEI	03.06.2014	03.06.2014	0	0	05.06.2014	30.06.2014
		HAT drives/test of steering gear	UEI	04.06.2014	05.06.2014	0	0	06.06.2014	10.06.2014
		Radio test	UEI	04.06.2014	05.06.2014	0	0	06.06.2014	06.06.2014
		Test of Fire / Emerg.Fire pump	241	04.06.2014	05.06.2014	0	0	06.06.2014	10.06.2014
		Commission and test of CCTV system	UEI	05.06.2014	05.06.2014	0	0	19.06.2014	02.07.2014
		Filling of nitrogen (kranplan)	241	05.06.2014	05.06.2014	0	0	05.06.2014	06.06.2014
		Test of Galley calling system	UEI	05.06.2014	05.06.2014	0	0	19.06.2014	01.07.2014
		Test of WH Air Horn (Typhon)	UEI	05.06.2014	05.06.2014	0	0	11.06.2014	30.06.2014
		Test of Window Wiper Plant and flushing	UEI	05.06.2014	05.06.2014	0	0	10.06.2014	30.06.2014
		Wash and cleaning of Accomodation	223	05.06.2014	26.06.2014	0	0	06.06.2014	30.06.2014
		Bunkring FO	241	06.06.2014	06.06.2014	0	0	06.06.2014	10.06.2014
		Commissioning/test of Helideck	243	06.06.2014	06.06.2014	0	0	10.06.2014	10.06.2014
		Veke 24 ------------------		08.06.2014	15.06.2014	0	0	08.06.2014	15.06.2014
		Commissioning / Test of Incinerator	241	10.06.2014	11.06.2014	0	0	11.06.2014	12.06.2014
		Commissioning of SevSat antenna	UEI	10.06.2014	12.06.2014	0	0	11.06.2014	19.06.2014
		Commissioning/test of Gangway	243	10.06.2014	12.06.2014	0	0	18.06.2014	18.06.2014
		HAT - A-Frame LARS SB (Winch, LARS, Solid Hatch, HPU, S	243	10.06.2014	12.06.2014	0	0	18.06.2014	18.06.2014
		HAT - Main Moon Pool Hatch	243	10.06.2014	12.06.2014	0	0	18.06.2014	18.06.2014
		HAT - MP LARS (Winch, LARS, MP hatch, HPU, Sheaves, Sl	243	10.06.2014	12.06.2014	0	0	18.06.2014	18.06.2014
		LARS overload test Moon Pool	243	10.06.2014	11.06.2014	0	0	12.06.2014	12.06.2014
		LARS Overload test SB A-frame	243	10.06.2014	11.06.2014	0	0	12.06.2014	12.06.2014
		Start-up / Function test of Fuel oil Transfere pumps	241	10.06.2014	11.06.2014	0	0	11.06.2014	18.06.2014
		Test of Fire alarm system	UEI	10.06.2014	12.06.2014	0	0	10.06.2014	03.07.2014
		Test of PC-nettwork (measuring of network cabeling)	UEI	10.06.2014	13.06.2014	0	0	19.06.2014	07.07.2014
		Test of Watermist system Galley	241	10.06.2014	10.06.2014	0	0	18.06.2014	30.06.2014
		Test Offshore Crane	241	10.06.2014	11.06.2014	0	0	10.06.2014	18.06.2014
		Fire and Safety Plan, inspection	243	11.06.2014	11.06.2014	0	0	11.06.2014	12.06.2014
		Load Calculator Installation / Test	UEI	11.06.2014	13.06.2014	0	0	30.06.2014	07.07.2014
		Test of E0 Alarm system at Quay	UEI	11.06.2014	11.06.2014	0	0	05.06.2014	19.06.2014
		Test of Emerg. Lights (in lunch break 11:-12:10)	UEI	11.06.2014	12.06.2014	0	0	12.06.2014	02.07.2014

	Test of EU Alarm system at Quay	UEI	11.06.2014	11.06.2014	0	0	05.06.2014	19.06.2014
	Test of Emerg. Lights (in lunch break 11:-12:10)	UEI	11.06.2014	12.06.2014	0	0	12.06.2014	02.07.2014
	Test of emergency stop system	UEI	11.06.2014	11.06.2014	0	0	12.06.2014	03.07.2014
	Test of Telephone and PA System.	UEI	11.06.2014	11.06.2014	0	0	12.06.2014	04.07.2014
	Internal Redundancy test of power system	UEI	12.06.2014	12.06.2014	0	0	12.06.2014	19.06.2014
	Manouvre test	UEI	12.06.2014	12.06.2014	0	0	12.06.2014	19.06.2014
	Naut-AW survey	UEI	13.06.2014	14.06.2014	0	0	12.06.2014	19.06.2014
WP07005-09	Yard Seatrial	290	13.06.2014	14.06.2014	0	0	13.06.2014	19.06.2014
WP07005-09	Technical Seatrial	290	14.06.2014	15.06.2014	0	0	19.06.2014	19.06.2014
WP07005-09	DP Seatrial	290	15.06.2014	18.06.2014	0	0	19.06.2014	19.06.2014
	Veke 25 -----------------		15.06.2014	22.06.2014	0	0	15.06.2014	22.06.2014
	Comm/Test Ballast water Treatment	241	16.06.2014	17.06.2014	0	0	18.06.2014	04.07.2014
	Test of foamsystem Helideck	241	16.06.2014	16.06.2014	0	0	18.06.2014	01.07.2014
	Test of Osmose system	241	16.06.2014	16.06.2014	0	0	18.06.2014	26.06.2014
	Megger test of Distribution Systems	UEI	20.06.2014	20.06.2014	0	0	03.07.2014	07.07.2014
	Start-up dead ship	UEI	20.06.2014	20.06.2014	0	0	26.06.2014	26.06.2014
	Veke 26 -----------------		22.06.2014	29.06.2014	0	0	22.06.2014	29.06.2014
	Commissioning and test of Imp.current system on Hull/Sea C	UEI	23.06.2014	23.06.2014	0	0	30.06.2014	30.06.2014
	Preparation for delivery	223	23.06.2014	25.06.2014	0	0	23.06.2014	30.06.2014
	Test of Catalysators	UEI	23.06.2014	25.06.2014	0	0	23.06.2014	25.06.2014
	Test of Galley Equipment	223	23.06.2014	23.06.2014	0	0	03.07.2014	04.07.2014
BP07003	Delivery	290	27.06.2014	27.06.2014	0	0	08.07.2014	08.07.2014
	Naming ceremony	290	27.06.2014	27.06.2014	0	0	27.06.2014	27.06.2014
	Test Starting Air capasity	241	30.06.2014	30.06.2014	0	0	18.06.2014	01.07.2014

Appendix 7: Ulstein Surface Process Diagram



Appendix 8: Ulstein Surface Specified Diagram