Master's degree thesis

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A Descriptive study of the development of the supply chain of shipyards in Møre and Romsdal since the 90s'

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Preface

As with all master thesis you never end up with what you thought you would end up with when you started. In my case it took two years longer than planned, but in way I think that it improved the end result because of the fact that through my job as a purchaser in the offshore industry in Møre and Romsdal I have gained maturity and a deeper understanding of the topic. The offshore industry in Møre and Romsdal, can in many ways, be seen as the "related cousin" of the maritime industry in Møre and Romsdal with many of the same trademarks and characteristics.

I would like to thank everyone that has helped me with for the patience they have showed me and particularly my supervisor Arild Hervik for not giving up on me. Special thanks also go to Mark Sabatino for invaluable support.

Kjetil Trangerud 26.05.2014

Summary

The purpose of this thesis as stated earlier is to describe the developments of the supply chain for the shipyards i Møre and Romsdal since the 90's. The chosen method has been case study due to the ability of this method to capture contextual condition to describe the phenomena that is being researched and the ability to track development over time, (Yin 2003). According to (Hervik et al. 2011) the maritime industry in Møre and Romsdal is very tightly connected and this makes a strong argument for the fact that the use of case study methodology is a suitable research design for this research.

The following research question was formulated based on the defined research problem previously stated. What are the main developments in the organization of the supply chain for the shipyards in Møre and Romsdal since the 90's? When collecting evidence about the development of the supply chain since the 90s'' for the shipyards in Møre and Romsdal this thesis identified developments in terms of form of governance as well as the underlying drivers for the organization of the supply chain transaction. This thesis will argue that there has been developments were on try to balance the control that can be achieved through vertical integration of the supply chain transaction and the efficiency of the market governance for some transaction. At the same time there has been a tendency for other transactions that one seeks to increase control of the transaction. An example of the first can be the hull fabrication transaction and an example of the last can be the design transaction.

For the underlying drivers for the supply chain transaction this thesis will argue that importance of delivery time has influenced the temporal specific assets and the frequency of the transaction while the importance of customer demands has influenced complexity, demand uncertainty and human specific assets of the design transaction. Mobility has influenced physical assets for shipbuilding equipment and human asset specificity of the hull fabrication transaction while production cost has been the drives for physical specific assets in production technology.

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1. Introduction

Norway has had a long and proud tradition for shipping, ship designing, shipbuilding and equipping of ships. For its' time the Viking ships for instance were known for their superb sea keeping ability, stability and speed compared to contemporary vessels, (Stensvold 2010b). These skills were something that was known along most of the Norwegian coast line, (Stensvold 2010b). Møre and Romsdal has been a part of this proud maritime tradition. There has also been a tradition in Møre and Romsdal of investing in technology and according to (Bukve, Løseth, and Gammelsæter 2004) Møre and Romsdal was in the forefront when it came to implementing new technology like the steam engine and also the motor in the late 19th and 20th century. Currently, the maritime industry is heavily geared towards advanced offshore service vessels, (Hervik et al. 2011). There has also been a trademark in the maritime industry that there are close relations and cooperation between the actors in the maritime industry in Møre and Romsdal, (Bukve, Løseth, and Gammelsæter 2004) and (Hervik et al. 2011). The maritime industry in Møre and Romsdal has built on the traditions of being in the forefront of technological development and close cooperation from the past and this has shaped the way the industry looks today.

The shipyards have traditionally had a strong position in the maritime industry in Møre and Romsdal, (Dedekam jr. and Hervik 1989) and (Bukve, Løseth, and Gammelsæter 2004). According to (Kanerva, Lietepohja, and Hakulinen 2002) and (Dedekam jr. and Hervik 1989) many European shipyards got in trouble because of the oil crises in the 70's and 80's and this also included the Norwegian shipyards that was strongly focused on building big oil tankers (Dedekam jr. and Hervik 1989). According to (Kanerva, Lietepohja, and Hakulinen 2002) the shipyards that survived started to outsource activities that they later used to do themselves in the early parts of the 80's as well as an increase in the use of subcontractors on their own yards. According to (Kanerva, Lietepohja, and Hakulinen 2002) and (Sergio and Senada 2009) this is also something that has influenced to the way that supply chain is organized. (Hervik 2003) and (Hervik, Aslesen, and Oterhals 2005) have found outsourcing and subcontracting is also something that has taken place in Møre and Romsdal and Norway.

This thesis is interested in describing the major happenings that have taken place since the 90's with focus on the shipyards concerning changes that has happened with their supply chain. The purpose of this is to gain new knowledge about the development of the supply chain and how it is organized in order to better understand the present situation. Such an understanding is also a necessary pre-requisite in order to prepare for the future.

The structure of this thesis will be to first present the methodical foundation for this thesis before a review of the theory that will be used when this thesis is presented. The empirical data of this thesis will be split into three parts. The first part will cover general data about shipbuilding and background information. The second part will focus on the development of the maritime industry in Møre and Romsdal since the 90's by describing main developments for the 4 main actors as identified by (Dedekam jr. and Hervik 1989), (Hervik, Nesset, and Opdal 1998) and (Hervik et al. 2011). The third and last part will focus on presenting empirical data about the change in the governance arrangements for the shipyards based on findings in the previous section about the development of the maritime industry in Møre and Romsdal since the 90's. Then a discussion section will follow where empirical findings are discussed in relation to the research problem before a conclusion to the thesis is presented. After that limitations of the research and recommendations for future research will follow.

2. Method

1.1 Research method and Research design

According to (Bryman and Bell 2011) two very important decisions to make regarding how to conduct research are decisions regarding research method and research design. (Bryman and Bell 2011) provide a distinction between these two often confusing terms by defining **research method** as a way of collecting data, while **research design** is *"...a structure that guides the execution of research method and the analysis of the subsequent data"* (Bryman and Bell 2011, page 41).

1.1.1 Research design

(Bryman and Bell 2011) provide an overview over several different research designs that provide a structure for collecting and analysing data. One of these research designs are case studies. For (Bryman and Bell 2011) a case study is recognized by *"...the focus on a bounded situation or a system, an entity with a purpose and functioning parts",* (Bryman and Bell 2011, page 60). According to (Yin 2003) a case study is an appropriate research design in order to

> *"... investigate a contemporary phenomenon within its real-life context, especially when the boundaries between phenomenon and context is not clearly evident",* (Yin 2003, page 13).

In this thesis the phenomenon that this thesis is interested in looking at is the supply chain for the shipyards and the development of its' organization since the 90's. The real life context of this thesis is to be understood as the maritime industry of Møre and Romsdal.

For (Yin 2003) the ability to trace change over time is a strong feature of a case study. Because this thesis aims to describe what has happened in the maritime industry in Møre and Romsdal over a period of time, from the early 90's until today, this is another reason why the use of case studies is suitable as a research design for this thesis.

(Yin 2003) states that case studies can be advantageous when one believes that contextual condition can give valuable insight into the phenomena the case is investigating.

According to (Bukve, Løseth, and Gammelsæter 2004) and (Hervik et al. 2011) there are and have been close relations and also dependence between the actors in the maritime industry in Møre and Romsdal. This makes a case study very suitable as research design for this thesis because of the ability of a case study to capture contextual conditions that can give valuable insight to the phenomena one wishes to study. Further (Yin 2003) contrasts the use of a case study against an experiment in which one takes the phenomena one wants to investigate out of its context into a controlled environment where it is possible to focus on a few variables at a time.

Further (Yin 2003) breaks down the structure of collection and analysis of data for a case study into the following 5 components:

- Research questions
- Research prepositions
- Unit of analysis
- The logical link between prepositions and data
- The criteria for interpreting the findings

1.1.1.1 Research question:

(Bryman and Bell 2011) state that research questions are important in order to provide guidance in conducting the different tasks involved in the research process.

The purpose of this thesis as stated earlier is to describe the developments of the supply chain for the shipyards i Møre and Romsdal since the 90's.

By describing the development of the supply chain and its' organization for the shipyards in Møre and Romsdal since the 90's one can hopefully get an overview of what has happened and thereby gain a more thorough understanding of the current situation today. Such knowledge and understanding is useful for making predictions and choices for the future.

According to (Collis and Hussey 2003) descriptive research is defined as:

> *"...research which describes a phenomena as they exist. It is used to identify and obtain information on the characteristics of a particular problem or issue"(Collis and Hussey 2003, page 11)* .

Further (Yin 2003) states that case studies can be used in descriptive research and that the research questions of a descriptive study are characterized by a "what", "who", "where" and "how many"/"how much".

In order to help guide the research process the following research question has been stated.

What are the main developments in the organization of the supply chain for the shipyards in Møre and Romsdal since the 90's?

1.1.1.2 Research prepositions:

According to (Yin 2003) research prepositions have the purpose of directing attentions towards something that should be studied within the scope of the study.

With the chosen formulation of the research problem and research question it would be interesting to see if there has been any change in the organization of the supply chain for the shipyards in Møre and Romsdal since the 90's until today.

(Lambert, Cooper, and Pagh 1998) describes a supply chain as a chain of key activities and processes that goes from customer to supplier in order to deliver products, services and information that has value for the customer. According to (van Weele 2010) there are two predominate theories that try to answer which type of activities that should be performed outside the boundaries of the firm. The first theory that (van Weele 2010) present is the Transaction Cost Economic approach that aims at finding the governance structure that minimize the cost of every transaction conducted by looking at both cost of making the good as well as cost of conducting the actual transaction, (Riordan and Williamson 1985). The second theoretical framework is the approach focusing on Core competence that according to (van Weele 2010) state that in order to sustain a competitive advantage one should locate core competences where one should focus resources in order to provide superior value to the customer.
According to (Rindfleisch and Heide 1997) Transaction Cost Economics can trace its' roots from (Coase 1937) to (Williamson 1975) and (Williamson 1985) and is a recognized field of research with a rich empirical support in the field of make vs. buy decisions.

Because of the recognition of the TCE framework this thesis will use it as a framework in order to investigate if there have been any changes in governance arrangements of the supply chain of the shipyards in Møre and Romsdal since the 90's. Also with the implications of (Kanerva, Lietepohja, and Hakulinen 2002), (Dedekam jr. and Hervik 1989), (Hervik 2003) and (Hervik, Aslesen, and Oterhals 2005) it seems very likely that there has been a change in the form of governance for the shipyards in Møre and Romsdal.

Based on this the following preposition is stated:

There has been a change in the organization of the supply chain of the shipyards in Møre and Romsdal since 1990.

With a problem formulation that are looking at the organization of the supply chain for the shipyards in Møre and Romsdal since the 90's it would also be interesting to look at the drivers behind choices of governance. TCE is a recognized framework that present several underlying attributes of a given transaction that determines the transaction cost of a given transaction, (Douma and Schreuder 2008). Because of the rich empirical support of the TCE framework (Rindfleisch and Heide 1997) the drivers behind the governance arrangements for the shipyards in Møre and Romsdal should also be mentioned in the TCE framework.

Based on this the following preposition is stated:

For the shipyards in Møre and Romsdal there have been changes in the Transaction Cost Economic drivers for the organization of the supply chain since the 90s''

1.1.1.3 Unit of analysis:

(Yin 2003) raises the importance of defining what is the case one wants to investigate and states that this can be achieved through defining the proper unit of analysis. According to (Yin 2003) units of analysis can be units such as individuals, groups, trade flow between countries and calls for slightly different research design and method. In the view (Yin 2003) when the primary research questions have been specified sufficiently the unit of analysis should come as a natural extension of the primary research questions. In this thesis the primary research question previously stated was

What are the main developments in the organization of the supply chain for the shipyards in Møre and Romsdal since the 90's?

Based on the formulation of the research questions of this thesis the natural unit of analysis is the development of the organization of the supply chain for the shipyards in Møre and Romsdal since the 90's.

1.1.1.4 The logical link between prepositions and data and criteria for interpreting the findings

According to (Yin 2003) creating a logical link between the stated prepositions in a case study and data as well as criteria for interpreting the findings is some of the most problematic and least developed part of the case study research design.

The preferred general method to do this is according to (Yin 2003) to rely on the initial theoretical argumentation that lead to the use of case studies in the first place in order to structure collection of data and use of analytical strategies. An alternative way of doing so is according to (Yin 2003) to define and test rival explanations in order to drive the case study forward. The third general sort of analytical strategy mentioned by (Yin 2003) is to develop a descriptive framework in which a case study is organized and this is not a preferred option, but can work for descriptive case studies.

One variation of the general analytical strategy according to (Yin 2003) is to rely on comparing a empirically observed pattern with a predicted one. According to (Yin 2003) for descriptive studies it is very important that the predicted pattern is determined before the study was started.

In this thesis the research question has been formulated with the purpose of describing the main developments in the organization of the supply chain for the shipyards in Møre and Romsdal since the 90's. The stated prepositions that follow the primary research question is that there has been a change in the organization of the supply chain since the 90's and that main drivers for this change are described in the TCE framework.

According to (Douma and Schreuder 2008) Transaction economic theory there are 3 main forms of governance for an economic transaction market, hybrid and hierarchy and that there are 3 main dimensions within the transaction: asset specificity, uncertainty/complexity and frequency. These forms of governance and dimensions within the transaction influence the transaction costs. The governance form that is chosen for a particular economic transaction is chosen in order to minimize both the cost of producing the good as well as the cost of conducting the transaction (Riordan and Williamson 1985).

In order to answer the first preposition this thesis will gather empirical data about the organization of the supply chain of the shipyards in Møre and Romsdal around 1990 and compare them with the present day organization of the supply chain using the TCE forms of governance as a theoretical foundation.

In order to answer the second preposition this thesis will gather empirical data about changes in the underlying drivers for the organization of the supply chain mentioned in the TCE framework for the shipyards in Møre and Romsdal since the 90s''.

1.1.1.5 Judge quality of Research design

According to (Yin 2003) there are four criteria for judging the quality of the research design in a case study. Construct validity, which is the degree to which the concepts of the study are being measured correctly, internal validity, the degree to which casual relationships are built in the study, external validity, the degree to which the study can be generalized, and reliability, the degree to which the study can be replicated.
Since this thesis is of a descriptive nature internal validity is not of much relevance for this thesis.

The unit of analysis in this case study has been defined to be the development in the organization of the supply chain since the 90's. Due to the choice of research design and unit of analysis this thesis is making no attempt to generalize these findings beyond the shipyards of Møre and Romsdal. This thesis will focus on the major shipyard and shipyard constellations in terms of turnover, number of ships delivered annually and those that have most of their central activities located in Møre and Romsdal. In order to ensure construct validity multiple sources of evidence have been used as recommended by (Yin 2003).

During this thesis evidence has been collected from unstructured interviews with experts within the maritime industry in Møre and Romsdal and practitioners as well. Also documentation was used from research reports, academic articles, official history books of shipyards, technical magazines and webpages of shipyards. The information from these interviews was triangulated with written sources in order to ensure construct validity of the information obtained. Similarly information obtained from written sources related to specific shipyards were at the best of abilities compared with information obtained from unstructured interviews with representatives from different shipyards in Møre and Romsdal.

1.1.2 Research method

According to (Yin 2003) a case study can rely on both quantitative and qualitative data. This research relies mostly on qualitative data, but also has some quantitative data as well. (Collis and Hussey 2003) differ between qualitative and quantitative by explaining that quantitative data are numerical data that are quantitative in nature while qualitative data are non-numerical and more related to data in text or verbal form.

(Yin 2003) presents six sources of evidence for collecting data for a case study. They are documentation, archival records, interviews, direct observations, participant observations and physical artefacts. This thesis will rely on interviews as primary data and documentations as secondary sources of evidence due to the nature of this research.

1.1.2.1 Interviews

Interviews are according to (Yin 2003) one of the most important sources of information in a case study. According to (Bryman and Bell 2011) the aim of the interview is to elicit information from the interviewee for information related to, among other things, behaviour of the interviewee or others as well as attitudes, norms, beliefs and values. Interviews can be both related to the case topic or just for providing insight on contextual factors (Yin 2003). The weaknesses found in the interview process are, according to (Yin 2003), that poorly constructed questions can lead to biases, the interview object can providing inaccurate information about the case topic, poor recall of facts of the interviewer can produce biases and there is a danger that the interview object provides the type of information that the interviewer wants to hear.

To (Bryman and Bell 2011) the unstructured interview can be conducted in an almost conversational manner where one has a list of topics, or maybe there is just one topic, that one lets the interviewee comment on one and follow up with questions on points that seems to be of interest. According to (Bryman and Bell 2011) the advantage of an unstructured interview is that it is very flexible in form and lets the interview object explain events and issues that the interview object finds important and relevant. In the case of this thesis the fact that unstructured interviews are well suited for general topics according to (Bryman and Bell 2011) made it a very suitable method of collecting data since there is not much research on the development of governance arrangement for shipyards since the 90s'. The disadvantages of unstructured interviews are, according to (Bryman and Bell 2011) that it is harder to analyse data as well as conduct cross case comparisons.

Unstructured interviews were conducted with two experienced researches early in the work of this thesis and two other unstructured interviews were conducted during the work of this thesis. During a carer day at campus several representatives from two of the major shipyards constellations in Møre and Romsdal Ulstein Group and STX OSV were interviewed using unstructured interviews. All unstructured interviews were transcribed as soon as possible after the interviews were completed.

An unstructured interview was also conducted with the technical manager at Langsten Verft founded in 1945 located in Møre and Romsdal and belonging to the STX OSC group which is one of the major ship constellations in Møre and Romsdal with long experience with shipbuilding. The transcribed record was sent to the interviewee in order to ensure that the data recorded was correct.

1.1.2.1.1 Suggestions to interview guide

(Bryman and Bell 2011) provide the following list of common sources of errors in survey research that can be applied to structured interviews and also provides valuable insight in relation to the semi structured and unstructured interviews:

1. *"a poorly worded question;*
2. *the way the question is asked by the interviewer;*
3. *misunderstanding on the part of the interviewee;*

4. *memory problems on the part of the interviewee;*
5. *the way the information is recorded by the interviewer;*
6. *the way the information is processed, either when answers are coded or when data is entered into the computer."*

(Bryman and Bell 2011, page 203)

1.1.2.2 Documentation

Documentation can, according to (Yin 2003), be in the form of letters, administrative documentations and reports, written reports of events, formal studies and newspaper and media articles. (Yin 2003) states that advantages of this source of evidence are that it can be stable and can be reviewed repeatedly, it is evidence not produced by the case study, documentation provides exact information and references and enables one to cover ~~a~~ several events over a long time horizon. (Yin 2003) further warns against the fact that documentation is not always retrievable and biases in terms of selecting which type of documentation that is collected for the case study, documentation can contain biases from the authors of documentation and some type of documentation might also be impossible to reach.

This thesis relied heavily on the reports that Møre Forskining Molde has been publishing concerning the annual status of the maritime industry in Møre and Romsdal since 1989. In addition, other publications about the maritime industry in Møre and Romsdal, conducted by researchers working for Molde University College, were also consulted. Articles from Tekniskukeblad has been crucial to this thesis as well as presentations of Verftskonferansen conducted by the employers' organization Norsk Industri as well as conferences and presentations conducted by Norwegian Centre of Expertice Maritime . Valuable information has also been obtained from annual financial reports from shipyards' constellations in Møre and Romsdal.

3. Theory

"Any problem that can be formulated, directly, or indirectly as a contracting problem can be investigated to advantage in transaction cost terms" (Williamson 1985) cited in (Rindfleisch and Heide 1997, page 32).

In the view of Transaction Cost Economics, (TCE), the firm can be seen as a governance structure, (Rindfleisch and Heide 1997). TCE tries to answer if this structure should be based on the use of market, vertical integration or some sort of hybrid arrangement for different transactions, (Douma and Schreuder 2008). According to (Riordan and Williamson 1985) the optimal governance structure is the one that has the lowest cost of production as well as the costs of running the transaction. This cost minimization also extends to minimize cost throughout the relationship of the transaction, (Masten, Meehan, and Snyder 1991). The transaction cost arises from the assumptions about the decision makers and their behaviour as well as the circumstances that surrounds the transaction and include both direct cost of managing the relationship and opportunity cost of making inferior governance decisions, (Rindfleisch and Heide 1997). Bounded rationality implies that decision makers have cognitive limitations on their ability to solve and formulate problems and opportunistic behaviour is an assumption that some decision makers might exploit the situation for their own gain if the possibility arises, (Douma and Schreuder 2008). The circumstances that surround the transaction, or its' critical dimensions, are the degree to which the asset is specific for, or has alternative applications outside the relationship, uncertainty or complexity is present in the environment and uncertainty of transaction counterpart's behaviour, (Rindfleisch and Heide 1997).

1.2 The unit of analysis

The unit of analysis of TCE is according to, (Williamson 1999), the transaction of goods and services between technological separable stages. (Douma and Schreuder 2008), try to explain an economic transaction as an exchange of scarce resources, be it favours, goods, services or information, and that the exchange has taken place when the right to use the scarce resource or resources are exchanged. According to (Douma and Schreuder 2008) there are certain costs associated with conducting such a transaction. For instance the time that is used in order to investigate and gather information before the transaction as well as the time and other costs that are used to specify the condition of how the transaction is to be handled, (Douma and Schreuder 2008). This exchange doesn't have to be mutual in the sense that for a party to be able to use a resource the other one has to get something in return; Neither does it have to take place in the form of a typical market transaction between two independent parties, (Douma and Schreuder 2008). (Rindfleisch and Heide 1997) also mention that past transactions as well as potential future transactions also affect the choice of governance arrangements.

1.3 Sources of transaction costs

1.3.1 Asset specificity and opportunistic behaviour →Safeguarding costs

Asset specificity refers to the degree an assets can be redeployed outside the relationship without incurring substantial costs, (Sergio and Senada 2009). According to (Riordan and Williamson 1985) asset specificity is the most important attribute of the transaction. (Williamson 1991) in (Masten and Williamson 1999) states that asset specificity often lead to bilateral dependence and have defined six separate specific assets. (1) It is site specificity which can be locations that are favourable in terms of inventory holding or transportation costs. (2) Physical assets specificity which is machinery and equipment for making parts and components. (3) Human-specific assets that occurs from learning by doing (Williamson 1991) in (Masten and Williamson 1999), and results in knowhow and skills with few alternative applications (Sergio and Senada 2009). (4) Brand name specific capital which is the consumer's perception of asset (Sergio and Senada 2009). (5) Dedicated assets can be investments in factories or equipment tailored for a particular customer. (6) Temporal specificity is referred to as the importance of scheduling and use of assets in a particular order and point in time (Sergio and Senada 2009).

When assuming that some decision makers might act opportunistically when the opportunity arises, deploying an asset into the transaction with few alternative applications outside the relationship creates a safeguarding problem (Rindfleisch and Heide 1997). In order to safeguard the transaction specific asset one has to make safeguarding arrangements and these arrangements increase the transaction costs. Alternatively one can choose to forgo the investment in the asset in order to protect oneself and instead face the opportunity costs of failing to invest in a productive asset (Rindfleisch and Heide 1997). According to (Williamson 1991) in (Masten and Williamson 1999) the presence of specific assets increase transaction costs regardless if it is market, vertical integration or hybrid arrangements. Such investments are only warranted unless the increased revenue and/or reduction in production costs more than outweigh the increase in transaction costs (Williamson 1991) in (Masten and Williamson 1999).

1.3.2 Environmental uncertainty and bounded rationality →Adaption problem

Environmental uncertainty stems from the uncertain circumstances surrounding the transaction and the bounded rationality of the decision makers that are not able to take everything into consideration in order to make perfectly rational decisions (Rindfleisch and Heide 1997). (Douma and Schreuder 2008) describe the environment as consisting of complexity, when decision makers have all the available information they need in order to make a decision, and uncertainty which is when not all relevant information is available for the decision makers to make a decision. (Douma and Schreuder 2008) further continue by describing that the bounded rationality of decision makers ensure that they can't comprehend all the possible consequences of different decision in a complex environment or predict all the potential consequences, and the probabilities of these consequences occurring, in and uncertain environment. This gives rise to a problem of adapting to the external environment surrounding the transaction (Rindfleisch and Heide 1997). The more complexity and the more uncertainty that exists in the environment the higher the transaction costs become. The direct costs that occur because of a problem of adaptation are related to costs that are induced when communication of new information, negations of problems or coordination between the parties are taken in order to avoid the opportunity cost of maladaptation (Rindfleisch and Heide 1997).

1.3.2.1 Behavioural uncertainty and bounded rationality→ Performance evaluation problem

According to (Rindfleisch and Heide 1997) behavioural uncertainty is described by (Williamson 1985) as coming from the difficulties of observing performance of exchange partners. When combining the difficulties of observing performance with bounded rationality of the decision makers of evaluating the performance of exchange partners, then one get a performance evaluation problem (Rindfleisch and Heide 1997). According to (Rindfleisch and Heide 1997) TCE predicts that the harder it is to observe the behaviour of exchange partners, and thereby making their behaviour more uncertain, the higher are the transaction costs. The transaction cost arises from two sources, the direct cost of having to take measure to evaluate the performance of potential transaction counterpart initially, (ex ante), before the transaction to ensure that a counterpart with sufficient performance is chosen, (Rindfleisch and Heide 1997). The direct ex post cost of monitoring to ensure that the chosen transaction counterpart does not resort to

shirking and opportunistic behaviour (Rindfleisch and Heide 1997). By not taking the direct cost of screening potential transaction counterparts or monitoring their performance one risk facing the opportunity cost of picking the wrong transaction counterpart, (adverse selection), or not getting sufficient performance out of the chosen counterpart (Rindfleisch and Heide 1997).

1.3.3 Frequency

According to (Douma and Schreuder 2008) in cases of high asset specificity high frequency of the transaction helps to justify the costs of more specialised governance arrangements. (Rindfleisch and Heide 1997) have found little empirical support for the effect of frequency in their review of empirical research of TCE. However (Buvik 2002) is one of those who have found empirical support for this.

1.4 Governance arrangements

1.4.1 Market

(Heide 1994) view the main characteristic of market governance as discrete exchanges, which in its' most extreme form can look like *"a one-time purchase of unbranded gasoline out-of-town at an independent station paid for by cash"* (Dwyer and Oh 1987) cited in (Heide 1994, page 88).

In cases where there are a large number of small buyers and sellers, no barriers to entry or exit for actors, standardized products and services, all the actors in the market have perfect information and all consumption is instantaneous, transaction parties discuss only the price for a given volume of goods and services (Douma and Schreuder 2008). This is what (Douma and Schreuder 2008) call an ideal market, or what micro economic theory describe as perfect competition, where price carries all the relevant information for the transaction parties to make a transaction. The situation described above might not always be the case in real life, but using the discrete or short term characteristic used by (Heide 1994) can be a good rule of thumb in recognising market governance.

According (Rindfleisch and Heide 1997) market governance has production cost advantage over other governance forms. According to (Riordan and Williamson 1985) a firm can principally utilize the same scope and scale advantage as an independent supplier,

by selling the units/service hours to the market. However (Riordan and Williamson 1985) state that doing so might mean selling to rivals as efficiently as an independent supplier and (Riordan and Williamson 1985) maintain that it is very unlikely that a firm can sell to a rival without having to incur extra bureaucratic and incentive costs. (Riordan and Williamson 1985) state that this is the case when there is low asset specificity in the production process and that when the asset specificity increases the advantage of the independent supplier decreases, purely in terms of production cost, because there is nothing that principally stops the firm from making the same specific investments.

According to TCE the market is suitable as governance from the cases where the transaction costs related to safeguarding, adaptation and performance measurement are low (Rindfleisch and Heide 1997). Based on the description made of market governance by (Heide 1994) safeguarding mechanisms are the use of legal system, forces of market competition and threats of reducing investments in other relationships. In terms of adaptation planning and adjustment procedures are almost non-existing due to the short time horizon of a transaction conducted under market governance (Heide 1994). Potential problems are tried and solved as they occur at the best of the ability of the parties and adjustment procedures are related to terminating the transaction or making a one term payment for compensation, (Heide 1994). All form of measurement under market governance is related to the output of the transaction, (Heide 1994). According to (Riordan and Williamson 1985) the market also has a superior incentive system compared to the firm and according to (Heide 1994) the incentive system of the market is short term in nature and directly tied to the completion of the transaction.

However as soon as there are fewer buyers and sellers, less standardised products and all relevant information for making decisions are not present the parties of an transaction doesn't have to only agree on the price for the goods or service, but also on things like how spare parts are to be arranged, type of features and characteristics the product or service should contain and also how to ensure that both parties have gotten what they asked for in the end. Agreeing on this every time one makes a transaction is both very time consuming and very expensive.

1.4.2 Vertical integration

An alternative to the market and the price mechanism is to rely on completing the transaction within one's own firm or organization. Cases where one has complete ownership and control of an activity are called vertical integration (Douma and Schreuder 2008). As an opposite of the ideal market where the price mechanism carries all the necessary information to complete a transaction, (Douma and Schreuder 2008) present the ideal organization as one that doesn't use the price mechanism at all to transfer all the necessary information in order to complete a transaction. An example that is close to such an ideal organization is the way the former Socialist Federal Republic of Yugoslavia organized shipbuilding (Sergio and Senada 2009). (Heide 1994) see departure from discrete exchange as forming of some sort of relation and that it can rely on more bureaucratic mechanisms or socialization processes.

(Douma and Schreuder 2008) present the 6 organizational coordination mechanisms of (Mintzberg 1989) as ways an organization can coordinate a transaction. Coordination within an organization can be achieved through mutual adjustment, like informal communication between employees, like a peer group, or direct supervision in the sense that one has a hierarchy with a boss that directs or instructs several employees. One can standardize work processes and output by having detailed specifications over how work is to be done or desired output. Standardization of skill which implies that all employees for instance go through the same training and standardization of norms means that everyone in the organization has the same values and beliefs.

Based on these 6 organizational coordination mechanisms of (Mintzberg 1989), (Douma and Schreuder 2008) present 3 different organizational forms. The first one is the peer group which, according to (Douma and Schreuder 2008), has an advantage over a group of independent workers since it can better utilize economy of scale of work as well as information sharing, however as the peer group grows bigger, monitoring shirking becomes difficult. A solution to this is to use direct supervision instead, which means fewer channels of communication and faster communication as well as someone that can monitor shirking, (Douma and Schreuder 2008). As the firm grows larger it is not enough with one boss and several layers of management are needed for coordination and supervision, a so called U-form organisation, (Douma and Schreuder 2008).

As a result of this important information might get lost on the way to the decision makers on the top and also strategic decision making becomes more difficult since the top managers loose overview needed to make strategic decision making, (Douma and Schreuder 2008). In the M-form organization operational decisions are transferred to more independent operational units, while the top management make overall strategic decisions and monitor the financial performance, (Douma and Schreuder 2008). Goods and services are bought and sold between the different units and the head office based on transfer prices and there is also an internal market for labour and capital as well, (Douma and Schreuder 2008).

According to TCE the organization has an advantage over the market in the cases when transaction costs related to safeguarding, adaptation and performance measurement are higher than the production cost advantage of the market, (Rindfleisch and Heide 1997). According to (Rindfleisch and Heide 1997) there are 3 distinctive assumptions that are made about using internal organization of the transaction for the firm. The first one is that organizations have better monitoring and control mechanisms than the market since it enables observations and rewarding of both behaviour as well as output. The second assumption is that internal organization is better equipped to provide rewards that have long time horizons and thereby counteract opportunistic behaviour, like promotions. Lastly an organization can also deploy culture and socialization processes in order to reduce friction between parties as well as opportunistic behaviour ex ante. (Douma and Schreuder 2008) present the problem of "lemon cars" from Akerlof where information of the state of the car is "hidden" from the buyer while the seller has full information of this and the buyer thereby risks ending up with a car in a bad state, referred to as a lemon. If a buyer vertically integrates the seller than hidden information will be easier available. Also (Douma and Schreuder 2008) state that not all knowledge is possible to explain fully like some types of skills and routines, thereby making this knowledge tacit. Tacit knowledge is also something that vertical integration can give access to.

1.4.3 Hybrid modes

In real life it is seldom that one come across transactions that are governed by what (Douma and Schreuder 2008) has deemed ideal markets and organization, either only relying on price as coordination mechanism or using (Mintzberg 1989) six organizational

governance mechanisms, most of the time there is something in between. This in between governance arrangement is known as hybrid governance (Rindfleisch and Heide 1997) and hybrid governance is defined by (Douma and Schreuder 2008) as

"... a set of organizations such that coordination between those organizations takes place by means of the price mechanisms and various other coordination mechanisms simultaneously" (Douma and Schreuder 2008, page 339).

According to (Douma and Schreuder 2008) some hybrid governance arrangements rely more on organization based coordination mechanisms, like franchising, while others, like long term buyer supplier relationships, relies more on the pricing mechanism. Within hybrid governance (Heide 1994) has identified 2 forms of interfirm governance. One of the forms of (Heide 1994) refers to what he calls unilateral or hierarchical governance, which is when one of the transaction parties is given authority to instruct, make rules and make decisions impacting the other party. An example of such a hybrid arrangement can be franchising (Rindfleisch and Heide 1997). (Douma and Schreuder 2008) explains franchising as the way McDonalds gives local entrepreneurs the right to use the McDonalds brand name if they sign a contract where, they among other things, agree to prepare food in a given way, having a certain type of interior as well paying a fixed fee and a certain percentage of sales to McDonalds. The other form (Heide 1994) presented ~~he~~ names bilateral governance which differs from unilateral governance by the fact that transaction parties jointly develop rules of conduct in order to achieve common goals. (Heide 1994) mentions implementation of a Just-in-time logistics system as an example of a bilateral from of hybrid governance.

According to TCA hybrid arrangements are can be sufficient in order to safeguard transaction specific assets from the threat of opportunistic behaviour when there is a medium level of transaction specific assets present, (Douma and Schreuder 2008). ~~In these~~ when there is need of more coordination than can be offered by the price mechanism solely, but completely forgoing it and using a bureaucracy instead can be very expensive, hybrid arrangements can be very effective, (Douma and Schreuder 2008). (Rindfleisch and Heide 1997) has found that both unilateral as well as bilateral forms of hybrid governance arrangements occur empirically.

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1.5 Applications of TCE in shipbuilding

One of the first and most researched applications of TCE is according to (Rindfleisch and Heide 1997) is the decision to make or buy for a firm.

Within shipbuilding the following has been done. (Masten, Meehan, and Snyder 1991) have investigated 74 components of naval shipbuilding projects in the USA in order to investigate what determined the use of governance arrangements. One of the major findings was that the presence of temporary asset specificity increased the hazards of conducting market exchange and lead to the use of vertical integration. According to (Masten, Meehan, and Snyder 1991) this is due to the fact that shipbuilding is more similar to a construction process of an unique unit, which means that one can't have inventories of components, parts of the ship or semi assembled ship parts stocked up. Since every ship more or less has to be built from scratch, this implies that things need to be done in a specific order. (Masten, Meehan, and Snyder 1991) maintain that this can tempt suppliers to act opportunistically and try to stall deliveries in order to renegotiate and improve their terms with the shipyard. Therefore the more sensitive the phase is to the completion time of the ship, the higher is the probability of this phase or activity being completed through the use of vertical integration as governance form, (Masten, Meehan, and Snyder 1991).

Similarly (Masten, Meehan, and Snyder 1991) found that in cases where an activity was very complex the likelihood of vertical integration was also higher as well as when human specific knowledge and skills needed to complete the activity was higher. (Masten, Meehan, and Snyder 1991) found that this was due to the fact the very complex activities and high degrees of human specificity the cost of internal organization was reduced instead of increasing the cost of market governance compared to vertical integration. This puzzled

the authors who predicted that high degrees of complexity and human specificity would increase the potential danger of opportunistic behaviour from suppliers and subcontractors and thereby lead to higher cost of conducting the transaction under market governance than by using vertical integration. While the very complex components and tasks were cheaper to vertically integrate, the opposite was true for simpler tasks that were subject to complexity, (Masten, Meehan, and Snyder 1991).

(Masten, Meehan, and Snyder 1991) predicted that physical asset specificity would slightly increase the cost of market governance since the fact that shipbuilding means constructing unique projects and this implies that tools and equipment can't be very tailor made to the task. The empirical findings suggested a slight reduction in cost of market governance. The last of the predictions of (Masten, Meehan, and Snyder 1991) was related to Ronald Coase's statement that internal organization cost of activities similar to the primary operation of the firm would be lower than under market governance. According to the authors shipbuilding is mainly based on low tech and labour intensive activities and it was also found empirically support for the fact that the more engineering heavy tasks were outsourced.

Limitation in (Masten, Meehan, and Snyder 1991) are that there are very few observations related to a sample of one firm that makes it hard to generalize. The defence industry is also subject to governmental regulations and it was only possible to obtain data on cost of internal organization, which makes it hard to compare the cost of internal and external organization.

(Sergio and Senada 2009) investigated the make-or-buy decisions for the state owned Croatian shipyards producing complex medium sized merchant ships and oil platforms. (Sergio and Senada 2009) found that complexity and physical asset specificity increase the likelihood of vertical integration. The arguments and predictions were similar to those proposed by (Masten, Meehan, and Snyder 1991), that complexity would increase the probability of vertical integration and that physical asset specificity would not increase the probability of vertical integration. However, the presence of temporal asset specificity, which was predicted to have a significant positive effect on vertical integration as according to (Masten, Meehan, and Snyder 1991), turned out to play an insignificant role in governance decisions. (Sergio and Senada 2009) argued that when the frequency of the

transaction increases it is easier to recover investments made in governance arrangements and that this should imply that more frequent use of an activity should be positively related to vertical integration. It turned out the frequency had no effect at all.

Human specific assets also increased the likelihood of outsourcing, completely against the predictions and arguments that was supported by (Masten, Meehan, and Snyder 1991). (Sergio and Senada 2009) did as (Masten, Meehan, and Snyder 1991) find support for the notion that activities that are labour intensive in nature are more likely to be vertically integrated since it is similar to the core activities of shipbuilding. Further (Sergio and Senada 2009) found that shipyards that already have a lot of activities vertically integrated are more likely to integrate an additional activity. Potential problems with the findings of (Sergio and Senada 2009) can be errors in measuring the variables, lack of control variables due to lack of data, sample selection that is not representative of the population and the fact that is very hard to check if asset specificity indeed is independent from the decisions of governance arrangements. In addition the authors say that TCE might not be valid for Croatian shipbuilding since the shipbuilding industry in Croatia is under state ownership and subject to political pressure and lobbyism, for instance, buy Croatian parts even if they are 15-20% more expensive. Also the shipbuilding industry was subject to central planning in the former Socialist Federal Republic of Yugoslavia and has according to the authors still not completely finished the adaptation to a market driven system yet.

(Guisado-Tato, Vila-Alonso, and Ferro-Soto 2004) have investigated the make-or-buy decision for 18 different activities for 11 privately owned small and medium shipyards in the Vigo area in north-western Spain. Through the use of personal interviews 9 hypothesis where tested. That high degree of physical asset specificity, human specific asset specificity, temporal asset specificity as well as the presence of small numbers of players would lead to internal production. Similarly it was hypothesised that high degree of demand uncertainty and technological complexity would lead to relying on external sourcing while high degree of technological unpredictability would lead to hybrid arrangements, high degree of internal uncertainty and frequency would lead to internal organization. In the end (Guisado-Tato, Vila-Alonso, and Ferro-Soto 2004) only found that demand uncertainty, (measured as the difficulty of predicting demand), technological complexity (measured as degree of familiarity of activity) and frequency, (frequency of transaction), were significant in explaining governance arrangements. This confirmed the

hypothesis that demand uncertainty leads externalized activities, low tech complexity and familiarity leads to insourcing and that frequency had a high probability of increasing vertical integration. However the authors state that even though the other variables weren't significant the direction of them was correct except for the variable behavioural uncertainty which seemed to point towards market governance and not vertical integration.

4. Empirical data

Here relevant background information on the current structure of the shipyards is provided.

1.6 Characteristics of shipbuilding

One of the characteristics of the current shipbuilding industry in Norway is, according to (Hervik, Aslesen, and Oterhals 2005), that even in the cases where the same yard is building a series of similar vessels for the same shipping company there are often specifications and requirements that are unique for every vessel. (Hervik, Aslesen, and Oterhals 2005) point at the high degree of capital intensity of delivering one- of- a-kind vessels and that this makes macroeconomic factors like price of capital and currency important factors that influence shipbuilding in Norway. Further (Hervik, Aslesen, and Oterhals 2005) point to the shared complexity of constructing a vessel because of all the components, work processes, disciplines and professions, suppliers and sub-suppliers involved in every vessel. (Aslesen 2008) adds that the tight quarters make installation of equipment and outfitting tasks difficult and that having several actors working in parallel at the same time in the tight quarters of the ship creates major coordination problems. Because of this even though shipbuilding can be described through a chain of activities with a pre-specified order, there are elements of unpredictability involved, (Hervik, Aslesen, and Oterhals 2005). (Hervik, Aslesen, and Oterhals 2005) remark that the construction process often is of a temporary nature since the suppliers and sub-suppliers can vary a lot from vessel to vessel.

Change orders from the shipping company are also common (Aslesen 2008). According to (Nordbye 2012) because of all the complexity in shipbuilding change orders, from customers or because of errors in the design, is a big problem. (Nordbye 2012) refers to studies that state that engineering changes can consume from 30%-50% of the engineering capacity on a project and that changes during production can have major cost impact.

According to (Shetelig 2013) that refer to several studies that state that during the design phase that, in itself, might count for 10% of the total cost might decide lock in 70-90% of the total cost of the shipbuilding project. An example to illustrate the consequences of a change order is presented by (Kawser 2012). According to (Kawser 2012) changing a crane on a offshore construction vessel has implications on the structure and stability of the vessel, there might have to be changes in the steel structure to accommodate the new crane foundation and there might be changes to the power pack of the ship because of the new crane.

(Aslesen 2005)characterise the international competition that the Norwegian shipyards face as based on the factors of price, delivery time and quality. Short delivery time (Aslesen 2005) as well as high quality delivery (Hervik, Aslesen, and Oterhals 2005) has been one of the strongest competitive advantages of Norwegian shipyards while high cost level has been the biggest challenge (Aslesen 2005). Particularly delivery time has always been something that has been important and according to a key informant at a major shipyard in Møre and Romsdal delivery time has gone down and the amount of vessels that can be produced in a year has without doubt gone up since 1990. Another informant from a shipyard in Møre and Romsdal stressed the importance of always delivering on time. According to (Johannessen, Olaisen, and Hauan 1993) customers see delivery time as a very important feature of the vessel delivery and not meeting deadlines can lead to fines and economic penalties (Aslesen 2008). Also by reducing construction time some of the shipyards could traditionally generate more money by constructing more vessels (Johannessen, Olaisen, and Hauan 1993).

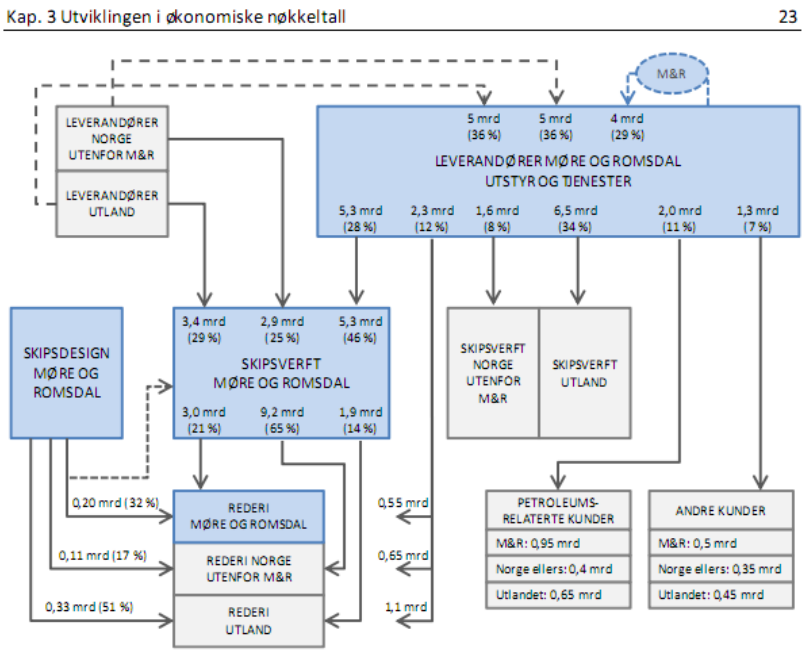
1.6.1 Cyclic nature of shipbuilding

(Solesvik and Westhead 2010) describe the cyclic nature of shipbuilding as following the similarly cyclic nature of shipping. During a peak in the shipping phase the existing fleet is fully utilized leading to a high willingness to pay for the shipping companies' services resulting in both high profit and cash flows that can manifest in contracting for new vessels at shipyards or investments in second hand vessels (Solesvik and Westhead 2010). If the amount of new capacity introduced exceeds the customer needs, some shipping companies may not be fully able to utilize its' fleet and may respond to the following increased competition by substantially reducing both rates and profit margins to try and attract customers (Solesvik and Westhead 2010). It takes between 1 and 2 years to complete a

ship, and it is therefore hard for the shipyards to adjust to the new demand situation (Solesvik and Westhead 2010). The decreasing demand for new capacity may trigger a fierce price competition among the shipyards to gain contracts and this can motivate cost reduction strategies like laying off workers and outsourcing to countries with lower production costs (Solesvik and Westhead 2010). When the rates for the shipping companies are low old and inefficient vessels are usually scraped and this reduction of capacity can help improve the rates and thereby the demand for new capacity which can benefit those shipyards that survive the down phase (Solesvik and Westhead 2010).

1.6.2 The close interplay between the different actors in the maritime industry in Møre and Romsdal

Møreforskning Molde is a research company delivering contract based research within the fields of Transport Economics, Logistics, Industrial Economics Policy and Society and Organization and Management, and has done a lot of research on the maritime industry in Møre and Romsdal http://www.mfm.no/. Since 1988 they have conducted status reports of the maritime industry in Møre and Romsdal and in 2011 an update was presented of key figures relating to turnover, profitability, employment, market development and factors influencing competitiveness (Hervik et al. 2011). From the very start in 1988 the 4 main players in the maritime industry in Møre and Romsdal were identintifyied as consisting of shipyards, suppliers of ship equipment, shipping companies and technical consultants selling ship design.



Figur 3.7 Det økonomiske samspillet i den maritime næringen i Møre og Romsdal 2010.

Figur 1: Economic interplay in maritme industry Møre and Romsdal (Hervik et al. 2011, page 23)

There has to be a strong degree of interplay between the actors meaning that in the case of Møre and Romsdal that shipping companies must buy local design and shipyard capacity and that designers must utilize equipment produced locally while shipyards utilize local service providers. Among others (Hervik, Dedekam jr., and Warnes 1993), (Hervik, Nesset, and Opdal 1998), (Hervik and Jakobsen 2001) and (Hervik et al. 2011) has found support for this.

The second criteria are that there has to be a knowledge transfer. This can be done through people switching jobs and bringing with them knowledge they have from different companies or by cross deliveries between actors so that a supplier might transfer clever solutions employed at one shipyard to another one. According to (Jakobsen 2011) there are substantial mobility in terms of labour within the maritime industry in Norway. This is particularly true among shipyards according to (Jakobsen 2011) which found that 1,80% of all employees in at the shipyards in 2008 had switched jobs to another shipyard. 1,05% had switch jobs from a shipyard to an equipment supplier(Jakobsen 2011).

The last one is that the companies enjoy benefits from close geographical location they wouldn't have had without belonging to the cluster. Examples can be access to skilled labour; lower transaction costs due to close ties to maritime actors in terms of easier information transfer or economies of scale since en equipment supplier are delivering

several shipyards in close proximity. According to (Aslesen 2008), skilled labour has in the past been something that the shipyards in Norway have had a lot of. (Asheim and Isaksen 2002; Jakobsen 2011; Hervik and Jakobsen 2001; Hervik, Oterhals, and Bergem 2007; Hervik et al. 2009) found that there is a high degree of contact between the different members of the maritime industry and according to (Asheim and Isaksen 2002) that this contact can often take the form of informal personal relations where engineers and sailors might sit down and discuss current products, improvements of products and also competitors' products. Also because of the close proximity it is common that people meet in their spare time, on ferries and at airports and then end up discussing business (Asheim and Isaksen 2002).

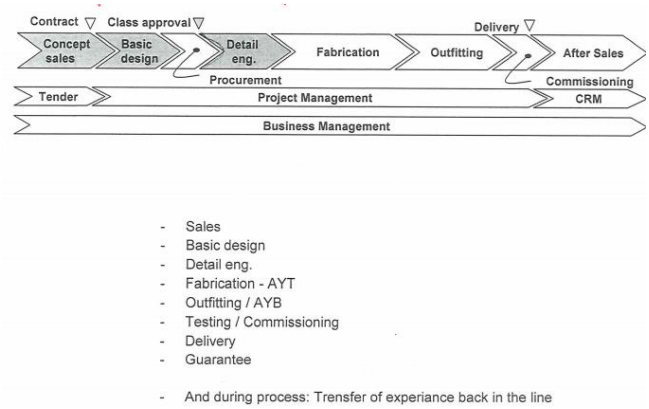
(Aslesen 2008) further adds that these mechanisms can be self-reinforcing once the number of participants reaches a critical mass. A hypothetical example can be that because of all the equipment suppliers that are present design firms are drawn to co-locate and that this draws more equipment suppliers which again draws more designers. To have a self-reinforcing effect, (Aslesen 2008) state that there has to be monopolistic competition and economies of scale somewhere in the cluster. (Aslesen 2008) points to the equipment sector as the place where this occurs.

Lastly (Aslesen 2008) state that the maritime cluster in Møre and Romsdal have existed for a while and that close relations have had time to develop between the different actors. Because of this (Aslesen 2008) point to the fact that there will be some slowness in terms of relocation unless there will be substantial changes in the economic conditions, but when that happens the change is inevitable.

1.6.3 The shipbuilding project

According to (Aslesen 2008) Norwegian shipbuilding is marked by building few and very unique vessels that has a very sequential production process involving a big amount of actors where the suppliers, labour and main components used vary from vessel to vessel. The sum of all this is according to (Aslesen 2008) that shipbuilding in Norway take on a form of project based production. (Larson and Gray 2011) define a project, as a *"...temporary endeavour undertaken to create a unique product, service or result"*(Larson and Gray 2011, page 5). Further (Larson and Gray 2011) presents the following characteristics of a project as something with an established objective, defined beginning

and end, often involvement of several departments and professionals, relating to something that hasn't been done before and with specific time, cost and performance requirement. This description of the ship construction project is mainly based on informal interviews with experts and members of industry.



Figur 2: Shipbuilding project (Vard/STX OSV)

1.6.3.1 Concept sale:

The first step in the ship building project is the step where one competes for the contract based on the building specifications of the shipping company. In order to make a bid one needs to present a design concept, cost estimate of building the ship and a Makers list, which is a list of different equipment the shipping company can choose from (Hervik, Nesset, and Opdal 1998). Sometimes the design concept come from the shipyard itself while at other times it is an external technical consultant that deals with the design, is the one that picks the shipyard and creates the Makers list. It is only the ones that get offered a contract that get paid for the work they have done. Many shipping companies are very loyal to a design provider and ~~can~~ have been faithful to the same provider for several decades. According to (Kanerva, Lietepohja, and Hakulinen 2002) in the concept sale phase the design that is offered is focusing on defining the main characteristics like general dimensions, hull shapes, machinery arrangements, tank arrangements, simulations of main flows, calculations related to impact damage and structure, weight as well as powering, electric and heat balance specifications. Design information also lay the foundation for calculating the cost of the vessel, income potential, feasibility of the project and development of a rough, but realistic schedule, (Kanerva, Lietepohja, and Hakulinen 2002). Already in this early phase equipment might be ordered or capacity booked. This is usually major equipment like winches, propellers and engines. Sometimes the shipping

company also contacts the designers/yards directly in order to start developing a new type of ship, (Maritimt Magasin 2011).

1.6.3.2 Basic design:

In the basic design phase one builds on the concept sold to the shipping company in the first place. According to (Kanerva, Lietepohja, and Hakulinen 2002) basic design is the phase where the contractual design is defined to a functional level for all involved technical disciplines. (Kanerva, Lietepohja, and Hakulinen 2002) mentions the following types of normal disciplines involved steel and structural design, interior, outfitting, HVAC, machinery and electrical and automation. If the vessel is of similar design, and experience is called into play, one makes only slight modifications to the design. In this phase one ensures that the equipment that is to be bought fits the overall design and that one makes equipment specification that are in accordance with the overall plan. Also a milestone plan when one will be needing equipment, personnel and capacity is created.

1.6.3.3 Purchasing:

In this phase major equipment that is not yet ordered is placed on order and general equipment is purchased. It is important to find the right price, quality, reliability and secure turnkey delivery, meaning that equipment is tested before it leaves the supplier and is ready to be installed as soon as it gets to the shipyard. In the purchasing phase one collects documentation from suppliers needed for the detailed engineering phase and follows up progress relating to both documentation and equipment. Terms of payment are linked to the progress of both documentation and equipment. One criteria that according to (Aslesen 2008) is getting more important when choosing suppliers is capacity. Lately when there has been high demand for offshore vessels the shipyard might have taken on too many contracts so that the capacity of the equipment suppliers has been pushed to its limits and queues have arisen (Aslesen 2008). These long queues have increased the lead-times and resulted in, increased costs, delays in deliveries of ships and a hard time sticking to the internal budgets (Aslesen 2008). One of the most important selling points of Norwegian shipyards have been short delivery times and delays that can threaten the reliability of Norwegian shipyards and their competitive advantage (Aslesen 2008).

1.6.3.4 Detailed engineering:

In this phase the detailed engineering and technical drawing is conducted. According to (Kanerva, Lietepohja, and Hakulinen 2002, page 29) *"The main purpose of detail engineering is to provide sufficient information for the production and material department to build the ship"*. The amount of information that the designers have to related to is according to (Kanerva, Lietepohja, and Hakulinen 2002) the following:

- Basic design documentation,
- Equipment data,
- Rules and regulations,
- Contract documentation,
- Shipyard standards,
- Shipyard material system information,
- Shipyard production information,
- Design manuals
- Architectural documentation

One needs to ensure that the detailed engineering specifications are of-such a manner that, for instance, pipes don't get in the way of electronic equipment and that it is possible for people to get access in the often tight quarters in order to install what needs to be installed. Everything must in the end be approved by the shipping company, the equipment suppliers involved as well as the classification authorities that in the end will supervise testing in order to ensure that the vessel is safe and that all systems are working as they are supposed to. In cases when there is an external consultant the provides design it is common that this provider also stand for the detailed engineering and drawing of the vessels as well since they know the design best.

1.6.3.5 Fabrication (Hull building):

According to (Westby 1991) important parts of the hull fabrication process of steel vessels consists of cutting materials, forming and shaping materials, welding and joining materials together as well as surface treatment in order to put them into sections and modules that can be assembled into a final ship. (Westby 1991) also state that crane and lifting capacity

is very important in order to move the steel sections onto the slipway, dry dock, floating dock or elevator.

According to (Hammer 2002) as much as possible of outfitting should be done before the steel structure is mounted on slipway or in dry dock. Engines and thrusters are also often installed at this stage because it is not as easy to get access after the hull is completed. In order to get in the engine after the hull is completed one sometimes has to saw the ship in half. It is important that the documentation is delivered and that problems that occur or are detected are solved as early as possible since changes at later stages can be really expensive. In order to problem solve good communication between purchasing, engineering and the hull building department is essential. Delays can also increase cost in the sense that if the hull is built in a low cost country in Eastern Europe that means not finished work will have to be carried over and completed in Norway which has substantially higher labour costs.

1.6.3.6 Outfitting:

Outfitting means that installation of a whole range of equipment, pipes, electronic components and outfitting of the living quarters. Examples of equipment and outfitting tasks in an offshore vessel are engines, generators, stand-by-power units, separators, compressors, conducting isolation, installing ventilation systems, sanitary installation, switchboards, automation, interior installation, radar, navigation and communication equipment (Halvorsen 2011). According to (Aslesen 2008) this is a very complex process and demands a lot of coordination because many people are involved doing things in parallel in often restrained physical quarters or areas that are hard to get access to. The level of complexity involved in the outfitting process demands a high level of skills that quite often has to be specialized(Hervik, Aslesen, and Oterhals 2005). In the cases where hull production is done in a low cost country the outfitting is usually conducted in Norway. One of the reasons for this is that a lot of the equipment that is going to be installed is produced in Norway (Stensvold 2012b).

1.6.3.7 Testing and Commissioning:

According to (Kanerva, Lietepohja, and Hakulinen 2002) commissioning is a continuous process that starts at the beginning of steel manufacturing as well as at suppliers where factory testing of equipment that will be installed in the ship is started before delivery to

shipyard for installation. The commissioning process is continuous during installation and outfitting and culminates in a final system test as well as a sea trial, (Kanerva, Lietepohja, and Hakulinen 2002). The commissioning process involves ship owners, classification societies and national authorities, (Kanerva, Lietepohja, and Hakulinen 2002). During final system testing and sea trials all the important equipment suppliers are on board in order supervise their respective equipment and ensuring that it works as it is supposed to.

1.6.3.8 After Sales:

The after sales phase is related to repairs, maintenance and service of ship and equipment on board. After market is something that is a priority for several of the shipyards in Møre and Romsdal ,(Stensvold 2008) and (Stensvold 2012e), and something that shipping companies are more and more interested in (Stensvold 2011c).

1.7 Development in the Maritime industry in Møre and Romsdal since 1990

Since 1988 Møreforskning has been presented reports about the development of the maritime industry in Møre and Romsdal. Since that time there has been a focus on the shipping companies, shipyards, equipment suppliers and the ship consultants selling technical solutions and therefore it is natural to use the same structure for this thesis when trying to describe important events that has taken place during the period since the 90's.

1.7.1 Shipping companies

1.7.1.1 Growth for the shipping companies:

Since the 1990s' there has been growth in both the number of companies and turnover in the number of employees. The number of shipping companies in Møre and Romsdal has increased from 13 in 1997, (Hervik, Nesset, and Opdal 1998), to 17 shipping companies in 2011, where 13 are mainly focused on offshore services while the remaining 3 deals with ferries, well boats and coast guard vessels. Without taking inflation into consideration the turnover has increased from 2.2 billion NOK in 1997, (Hervik, Nesset, and Opdal 1998), to 11.5 billion NOK, (Hervik et al. 2011). 10 billion NOK of the total turnover came from offshore service activities, (Hervik et al. 2011), while the operating margin has dropped from 24% ,(including the regional ferry company), to 11%. The numbers from 2011 might have been influenced by selling of tonnage, (Hervik et al. 2011). Employment has also

increased from 2717 man labour years in 1997 including the regional ferry company, (Hervik, Nesset, and Opdal 1998), to slightly over 6800 man-labour years where almost 6300 of these are seamen in 2011, (Hervik et al. 2011). Also of the 6800 man labour years in 2011, 2300 were foreign seamen and administrative employees working abroad, (Hervik et al. 2011).

1.7.1.2 Change in area of operation:

According to (Halse and Bjarnar 2011) today's offshore service vessel based shipping companies in Møre and Romsdal can trace their roots back to the humble beginning of the coastal and seasonal fishery. According to (Bukve, Løseth, and Gammelsæter 2004) as technology evolved in the later part of the 1800s with the introduction of the steam engine and later the motor in the early part of the 1900s. (Bukve, Løseth, and Gammelsæter 2004) state that this led the coastal fishers in southern and central parts of Møre and Romsdal to team up as partners in order to invest in these new technologies. Also it was not unusual for fishery merchants to also make investments in fishery vessels, (Bukve, Løseth, and Gammelsæter 2004). According to (Bukve, Løseth, and Gammelsæter 2004) this development continued and led to a departure from wood in favour of steel hulls and to the development of international deep sea fishing companies in the 1960s and 70s'.

(Halse and Bjarnar 2011) state that because of bad times in the fishery sector due to overfishing and introduction of international fishing regulations in the 80s' fishery companies started to go into the offshore service business that sprung out of the oil discoveries in the North Sea. According to (Hauge 1992) all parts of the fishing fleet suffered in the period between 1985 and 1990 while the offshore sector on the Norwegian Continental shelf had a steady demand development throughout the 70s' and 80s'. The trend of shipping companies switching from deep sea fishing to offshore service continued with full force through the 1990s', (Halse and Bjarnar 2011), and built up a strong offshore fleet located in Møre and Romsdal. This development continued into the 2000s and the OSV fleet continued to grow, (Hervik, Nesset, and Opdal 1998) and (Hervik et al. 2011)

(Oterhals et al. 2008a) have found that the offshore fleet has started to move away from the traditionally home ground of the North Sea after 2002. In 2002, 74 vessels were assigned to contracts in the North Sea while 38 had contracts in international markets, but in 2007 there was 82 vessels assigned to the North Sea and 81 vessels to international markets

(Oterhals et al. 2008a). Of the 38 vessels operating in international markets in 2002 more than 10 were operating in Brazil, 10 were in Australia, more than 5 were in Asia and 5 were operating in the Gulf of Mexico (Oterhals et al. 2008a). In 2007 the 81 vessels were divided so that more than 20 were in Brazil, 20 were outside Australia, more than 15 were in Australia, 10 outside West Africa and about 5 were in Asia (Oterhals et al. 2008a).

Investigating the thoughts of the shipping companies regarding the future (Hervik et al. 2011) found that 50% of the shipping companies in Møre and Romsdal consider the North Sea as very important in the future while the other 50% attach medium importance to the North Sea. 43% of the shipping companies in Møre and Romsdal see Brazil as very important and following closely thereafter are Australia, Africa and Gulf of Mexico (Hervik et al. 2011).

1.7.1.3 Competing on quality of service, technology and certificates:

(Hervik, Aslesen, and Oterhals 2005) claim that international oil companies are really concerned with health, environmental and safety regulations, and that this favours the Norwegian offshore shipping companies, which have a good reputation for delivering high quality services. According to (Stensvold 2012a) the publicly owned Brazilian oil company Petrobras has, for instance, looked at the standards used and developed by the Norwegian petroleum industry called NORSOK in order to provide safe, value adding and cost efficient development of petroleum, (NORSOK 2004), when they ordered 14 drillship in order to operate outside Brazil.

In addition (Hervik et al. 2010) state that incidents like the Deepwater Horizon accident in the Gulf of Mexico in 2011, for more information see (Tinmannsvik et al. 2011), have led to an increase in the demand by the oil companies on their suppliers and offshore service providers. (Hervik et al. 2010) indicates that this might lead to competition on the quality of equipment and on suppliers. For the offshore service providers this means that they will face increased demands on ship, equipment onboard and services provided, (Hervik et al. 2010) notes that there were several Norwegian shipping companies that were involved in the rescue operation following the Deepwater Horizon accident. According to (Hervik et al. 2011) about 75% of all the shipping companies in Møre and Romsdal considered the ability to provide innovative solutions as a very important factor for competitiveness and

60% consider Health, Environmental and Safety standards as a very important factor for competitiveness.

An example of shipping companies that takes innovation and HSE seriously can be Farstad Shipping, which is one of the most experienced and biggest offshore shipping companies in Møre and Romsdal. They are a global provider of support vessel services for the international oil and gas industry (Bakken 2009). For them safety is a stated priority and they focus on large and advanced vessels within PVS, AHTS and subsea construction markets (Bakken 2009). Another global offshore service provider with emphasis on safety and innovative solutions is the Hordaland based shipping company DOF. They have a high focus on environmental aspects as well as on performance of equipment and the ship when they contract a new vessel (Kløvrud 2011).

1.7.1.4 Change where tonnage is contracted:

In the past shipping companies in Møre and Romsdal used to go to foreign shipyards when they wanted to contract new tonnage, but the tides have changed and currently the shipyards in Møre and Romsdal are favoured. In 1992, 93% of the contract reserve on 10 billion NOK for the major shipyards in Møre and Romsdal was for foreign shipping companies (Hervik, Dedekam jr., and Warnes 1993). While in 2010, 21% of the contracts reserve on 3 billion NOK came from shipping companies in Møre and Romsdal and one third of the order reserve for shipyards in Møre and Romsdal came from local shipping companies (Hervik et al. 2011). (Hervik et al. 2011) notes at the same time that there are fluctuations in ratio of locally awarded new contracts. For instance in the period between 1998 and 2000, 79% of the contracts, of a total value of 2.5 billion NOK, given by shipping companies in Møre and Romsdal, were given to local shipyards (Hervik, Nesset, and Opdal 2000).

1.7.1.5 Shipping companies still the source of innovation

According to (Bukve, Løseth, and Gammelsæter 2004) a lot of the innovation in the maritime industry in Møre and Romsdal in the past happened in a close relationship between the shipping companies, ship consultants and equipment suppliers. According to (Oterhals et al. 2008a) the shipping companies in Møre and Romsdal still see themselves as the drivers for and the big risk takers regarding innovation. They keep presenting new

solutions to the oil companies as well as ordering new tonnage without having landed contracts with the oil companies, (Oterhals et al. 2008a).

Traditionally the shipping companies have often been the ones that initiate the innovation process by having clear opinions and demands based on practical experience (Bukve, Løseth, and Gammelsæter 2004). Examples provided by (Bukve, Løseth, and Gammelsæter 2004) is that ship owners have made observations of manoeuvrability of a vessel and have stated that they want the same equipment as on the vessel. It is not uncommon that a ship owner has been working with an equipment supplier in order to develop new equipment that the designer has been tasked with incorporating into the vessel design, (Bukve, Løseth, and Gammelsæter 2004). Innovations made in such a relationship is often the result of input and modifications from both sides so that determining who's idea it really was and taking a patent on the idea can be difficult (Bukve, Løseth, and Gammelsæter 2004). Still (Bukve, Løseth, and Gammelsæter 2004) adds that such close relations are also occurring with other Norwegian firms outside Møre and Romsdal and that ship owners in Møre and Romsdal can also be conservative and scared of radical changes provided by design firms. This might have something to do with the fact that practical experience is highly valued among shipping companies in Norway (Reegård and Rogstad 2012).According to (Reegård and Rogstad 2012) shipping companies within the offshore sector are the ones with the highest degree of employees with ship officer training and experience in Norway.

(Jakobsen 2011) has found that overall in the maritime industry in Norway 70% state that the customer is their most important source of innovations and that this is particularly the case for shipyards and equipment suppliers while offshore shipping companies have the equipment suppliers as their most important source of innovations. Further (Jakobsen 2011) refer to a previous study that found that the R&D expenditures are lower in Norway than countries that it is natural to be compared with and that the national maritime cluster mechanisms and Norwegian way of developing innovations gave a higher return on the R&D investments made.

According to (Jakobsen 2011) 69% of the shipping companies, 58% of the providers of financial, technical and juridical services, 36% of the equipment suppliers and 47% of the shipyards spent less than 1% of their turnover on R&D activities in 2009. (Jakobsen 2011) state that there are estimates that the entire Norwegian maritime industry spends about 2-

2,5 billion NOK annually on R&D activities and that big actors like Det Norske Veritas, (DNV), Kongsberg Maritime, Rolls- Royce Marine and Ulstein Design stand for major part of this.

For Møre and Romsdal the situation in the past has been similar. According to (Hervik, Nesset, and Opdal 2000) in Møre and Romsdal in 2000 about 20 million NOK out of a turnover of 6,6 billion NOK was spent on R&D by the shipyards and about 59 million NOK out of a turnover of 7,4 billion NOK was used on R&D by the equipments suppliers. According to (Hervik 2003) a minimum of 3,3 % of the turnover in 2002 for the equipment suppliers were spent on R&D while the shipyards focusing on new building spent a minimum of 2,6 % and the design consultants focusing on total project delivery spent a minimum of 20%.

According to (Hervik, Bræin, and Oterhals 2005) there has been built a close relationship between the F&U institutions like Marintek, SINTEF and NTNU and the actors in the maritime industry in Møre and Romsdal. An example of such cooperation can be a research project for dynamic strain on ship hulls that was meant to help develop functional specifications for ships and was ordered by the Norwegian and American Navy (Hervik and Bræin 2010). The Norwegian side of the project was financed by the Norwegian Department of Defence and the Norwegian Navy, The Norwegian Research Council, Norwegian Industry and NTNU (Hervik and Bræin 2010). Rolls Royce was part of the initial project and later prolonged the work with NTNU/Marinetek and used the results to both develop new products as well as providing solid documentation and calculation to demanding customers and thereby gaining a competitive advantage (Hervik and Bræin 2010). (Hervik and Bræin 2010) also mentions a case were Brunvoll Thrusters and a consortium of 10 sub-suppliers cooperated with Marintek, NTNU, The University of St. Petersburg and China Scientific Ship Research Center in Shanghai about developing calculation tools in order to better model and document propulsion, thrusters and rudder systems. All cooperation is not always as formal as the example stated, it can also be that the consultants are having a problem and then phone a researcher at NTNU/SINTEF they have personal relationship with in order to get some tips (Bukve, Løseth, and Gammelsæter 2004).

At the same time (Jakobsen 2011) acknowledge that it is hard to define what R&D really is since one for instance can argue that every new offshore service vessel can be defined as a

R&D project since it demands development of new and unique solutions. This can indicate that the investments in R&D might be higher than in the numbers given above. (Jakobsen 2011) characterizes the Norwegian way of doing investments is noticed by being customer driven and the fact that there are close relations between customer and supplier. The interaction is often informal, flexible and trustful based on common culture, close geographical relations and a long working relationship between the actors (Jakobsen 2011).

An indication of the importance of customers in driving innovation can be given from (Wilhelmsen 2011). According to (Wilhelmsen 2011) Wärtsilä Ship Design has experience with both the European and Asian offshore industry and is of the opinion that Europe and Norway is dominated by demanding shipping companies. On the other hand South East Asia is dominated by strong shipyards that build on speculation and sell to many shipping companies or even operate the vessels themselves (Wilhelmsen 2011). Norwegian shipping companies want to implement the newest of technology in order to reduce cost and have the attitude that they want to be better than the competition while Asians go for more proven designs and repeat successes of their competitors (Wilhelmsen 2011). In Europe there is a higher focus on HSE and more purpose built and tailored solutions for a wider use of scope with demands for performance guaranties related to such factors as speed, cargo and bollard pull for anchor handling winces (Wilhelmsen 2011). While European owners want to reduce operating cost, in terms of fuel and crew, Asians are more interested in low investment costs and providing accommodation for additional crew and crew based solutions rather than relying on technology that is not sufficiently tested (Wilhelmsen 2011). In general the design provider is more involved in the shipbuilding process in Europe and there are more shipyards in Europe that has design and other technological capabilities (Wilhelmsen 2011).

While there is a very close relationship between shipping companies, ship consultants and equipment suppliers related to developing innovations in Møre and Romsdal (Bukve, Løseth, and Gammelsæter 2004) notes that the shipyards are usually entering the picture later in the process. Still even if they are not directly involved in the developing of the innovation they are working very closely with the ship consultant when building the ship, and thereby implementing the innovation (Bukve, Løseth, and Gammelsæter 2004), and ship consultants get engineers with experience from shipyards or equipment suppliers that is in position of practical experience that one can't get from just working at a consultancy

firm (Bukve, Løseth, and Gammelsæter 2004). While the value chain in shipbuilding is marked with an extensive and close cooperation the relationship between the ship consultants is marked with strong competition and keeping the cards close to the chest (Bukve, Løseth, and Gammelsæter 2004). Shipyards with own design department or equipment suppliers with design capabilities are also seen as competitors and an independent design firm would be very sceptical to work with someone that could exploit their ideas (Bukve, Løseth, and Gammelsæter 2004).

1.7.2 Shipyards

1.7.2.1 Change in the shipbuilding structure:

According to (Dedekam jr. and Hervik 1989) there has been a reduction in the Norwegian shipbuilding capacity in Norway since the 1970s'. This has also been the case in Møre and Romsdal where in the early 90s' there were 43 shipyards (Dedekam jr. and Hervik 1989) employing about 3700 people. In the late 90s' the number of shipyards had dropped to a total of 23, where 13 were mainly focused on new building, and the level of employees was 2963 (Hervik, Nesset, and Opdal 1998). In 2011 there were 14 yards in Møre and Romsdal employing 3800 people (Hervik et al. 2011).

According to (Hervik, Dedekam jr., and Warnes 1993) the end of the 80s' and beginning 90s' was marked by economic downturn and oversupply in the European shipbuilding market. In 1988 it was decided by the European Union that the level of state subsides of shipbuilding should be reduced from a level of about 28% of the contract value for contracts over 48 million NOK in 1993 value, to a level of 9% (Hervik, Dedekam jr., and Warnes 1993). This decision also lead Norway to reduced its' shipbuilding subsidies, (Hervik, Nesset, and Opdal 2000). The shipyards in Møre and Romsdal were not so dependant as the rest of Norway on these subsidies according to (Dedekam jr. and Hervik 1989) because they produced tonnage that one didn't get subsidies for and sold them to foreign clients. Before 1995 the support level was higher in Europe than in Norway, but from then on the support was equal and the 1st of January 2001 the support level of 9% disappeared (Hervik 2003).

(Hervik, Aslesen, and Oterhals 2005) mention two global trends that they see as important for Norwegian shipbuilding industry that they have named as the "Eastern Europe effect"

and the "China effect". The Eastern Europe effect is according to (Hervik, Aslesen, and Oterhals 2005) the outsourcing of production to, and hiring of labour from Eastern Europe. This is something that has been going on since the end of the 90s', (Rogne 2008), and increased with the introduction of the new members to the European Union (Hervik, Aslesen, and Oterhals 2005). (Hervik 2003) measured the level of outsourcing in the maritime industry in Møre and Romsdal in the early 2000s and found that the biggest part of the outsourcing happened to Eastern Europe and that it most of the actors hadn't planned additional outsourcing of activities after 2002. Similarly in the last years there has been some that have turned the tide and moved activities that first was outsourced in-house again (Stensvold 2012b) and (Mauren 2012).

According to (Hervik, Aslesen, and Oterhals 2005) the China effect is related to the rapid economic growth in China that has led to a high demand for oil, which in turn has increased the rates for oilrigs, offshore service vessels and demand for the new building of both rigs and service vessels. The second part of the China effect is according to (Hervik, Aslesen, and Oterhals 2005) is that the economic growth in China has also led to an increase in demand for other types of shipping, a growth which has increased from 4% annually in the period from 1990-2002 to 9% annually from 2003-2004. According to (Hervik, Aslesen, and Oterhals 2005) this has led to an expansion in the building capacity in Asia in order to meet this explosion in demand. For more information on the Asian shipbuilding market please see, (Jiang and Ge 2006).

According to (Hervik et al. 2010) the financial crises has led to a global oversupply of new building capacity, particularly in China, and that this can lead to a high degree of price competition. (Hervik et al. 2010) also adds that many countries have learned to build the type of vessels that Norway is famous for so that the yards in Møre and Romsdal might face tough competition on price. According to (Stensvold 2012f) officially there are 900 yards in China, but only around 90 are active and it is speculated that this is further being reduced.

1.7.3 Change in employment:

(Hervik, Dedekam jr., and Warnes 1993) found that there were about 3700 employed in shipbuilding in 1993 while at the same time noticing a trend of taking the fluctuations in need for manpower by hiring instead of employing workers. The trend noticed by (Hervik,

Dedekam jr., and Warnes 1993) is supported by (Hervik, Aslesen, and Oterhals 2005) which has found that the basic employment at shipyards is constant and one uses more and more hired workers to take the peaks in good times.

According to (Hervik, Oterhals, and Bergem 2007) the shipyards in Møre and Romsdal conducted substantial downsizing in the period between 2002-2004 and the increase that occurred in 2006 was mostly related to the use of hired workers and sub-contractors. According to (Hervik et al. 2011) there are currently 3800 fully employed people at the shipyards in Møre and Romsdal in 2011 and about 2000 hired workers. According to (Ødegård and Andersen 2011) the hired labour at four shipyards in west Norway comes from Eastern European countries, mostly Poland and Romania, but also from countries like Lithuania and Bulgaria. Further (Ødegård and Andersen 2011) found that most of the labour was related to such positions as welders, painters, plumbers, mechanics and scaffold workers. (Hervik, Bræin, and Oterhals 2005) found that activities handled by hired workers from low wage countries or given to subcontractors using hired workers from low wage countries could be steelwork, industrial plumbing, electronic installation and surface treatment. Even though this labour that don't need years of higher education to do their job, to be a good skilled labourer you need quite a bit of practical experience. According to (Hammer 1999) it takes time and practice to become a competent labourer for steel fabrication of ship structures and that a competent steel workers needs to know a lot of skills to do his job. It is also common to use engineers from countries with lower cost levels than Norway and they are being used in order to work out detailed engineering drawings, (STX OSV 2012a; Ulstein Group 2011, 2012; Vard 2013).

Motivation for importing labour from Eastern Europe was according to (Ødegård and Andersen 2011) mostly related to lack of Norwegian labour. Another reason (Ødegård and Andersen 2011) presented was that hired Eastern European labour was an easy way of getting temporary labour, there was less risk involved than permanent hiring and flexibility regarding work hours. Even though reduced labour cost wasn't the biggest reason given by the shipyards asked (Ødegård and Andersen 2011) state that the hired labour from Eastern Europe was paid the minimum Norwegian wage according to the standardised agreement. They were not recognised as skilled labours since the standardization requirements in their respective countries differs with those in Norway, (Ødegård and Andersen 2011). Since there are a lot of labourers involved this substantially reduces the labour cost for the ship

building project while at the same time provides skilled and experienced labour, (Ødegård and Andersen 2011).

(Ødegård and Andersen 2011) found that 60% of the managers were of the opinion that Eastern European labourers are more willing to work than Norwegian labourers and 50% were of the opinion that there is less sick leave among Eastern European labourers and indications that many of them are very experienced with shipbuilding. But at the same time the Eastern European labourers are less flexible and more specialized in terms of tasks that they do as well as less independent in the sense that they need to have more supervision and guidance throughout the work (Ødegård and Andersen 2011). A key informant also indicated that Eastern European labourers are more dependent on detailed drawings of what they are supposed to do while Norwegian ones know the rules and regulations and are thereby less dependent on detailed drawings to complete the task. In addition, not all the foreign labourers were used to the modern tools employed and that the tools were used wrong (Ødegård and Andersen 2011). Culture and language problems were also a big hindrance and often resulted in the fact that one worked in groups according to nationality(Ødegård and Andersen 2011).

1.7.3.1 Outsourcing and insourcing:

According to (Aslesen 2008) the shipyards in Norway have traditionally always hired electricians, steelworkers, painters, carpenters and other type of workers to do work at the shipyards and rely on sub-suppliers for completing certain tasks. Even though the hull fabrication has been central to the self-perception of the shipyards in Møre and Romsdal, (Oterhals 1998) and (Rørhus 1999), it has also been common to cooperate with other local yards in Møre and Romsdal and Norway in order to deliver entire hulls or parts of hulls (Oterhals 1998) and (Bukve, Løseth, and Gammelsæter 2004). The advantage of this was that one could take on bigger contracts and that contracts could be completed faster (Bukve, Løseth, and Gammelsæter 2004).

This trend continued throughout the 90s' and according to (Hervik, Dedekam jr., and Warnes 1993) there was a development from 1993 and outwards towards a "system" approach to shipbuilding. This meant that one left more and more to be bought from sub suppliers and one just focuses on assembling the ship together with more technological complex systems. An example of this can be to build the hull in subsections that are put

together into bigger sections (Johannessen, Olaisen, and Hauan 1993). According to (Aslesen 2008) there has also been a trend for Norwegian shipyards of having more ships to be built on less time than before. This trend very much includes the shipyards in Møre and Romsdal since most of the shipbuilding capacity in Norway is located in Møre and Romsdal, (Hervik and Jakobsen 2001) and (Oterhals, Johannessen, and Hervik 2011).

Even though it has traditionally always been common to make use of sub-suppliers and production outside one's own shipyard there was an increase in this tendency around 2000. (Hervik 2003)found that 33% of the shipyards in Møre and Romsdal had outsourced something and 13% had outsourced a major part of the business in the period from 2000 until 2002. Most of it was to Eastern Europe, (Hervik 2003), which has substantial lower wage levels than Norway and was related to production activities that are labour intensive (Aslesen 2005). For instance several shipyards bought or produced their hulls in Eastern Europe (Stensvold 2008), (Oterhals, Johannessen, and Hervik 2011) and (Stensvold 2012b). Examples of countries where hulls have been constructed and bought are Romania, Poland and the Baltic states as well as Ukraine and Turkey (Hervik, Bræin, and Oterhals 2005). According to (Aslesen 2005) a hull manufactured in a shipyard in Romania where it was undertaken substantial investments in machines, equipment, buildings and competence was 55% cheaper than a hull manufactured in Norway in 2004. On the other hand towing such a hull from Romania to Norway where most of the outfitting takes place (Oterhals, Johannessen, and Hervik 2011) takes on average 21 days (Rogne 2008) or about 3-4 weeks (Vard 2013). (Aslesen 2008) also points to a trend of hiring sub-suppliers in order to complete so called "work packages" for a fixed price. An example provided by a key informant from a shipyard in Møre and Romsdal was for instance the use of hiring plumbing firms for the installation and outfitting of piping.

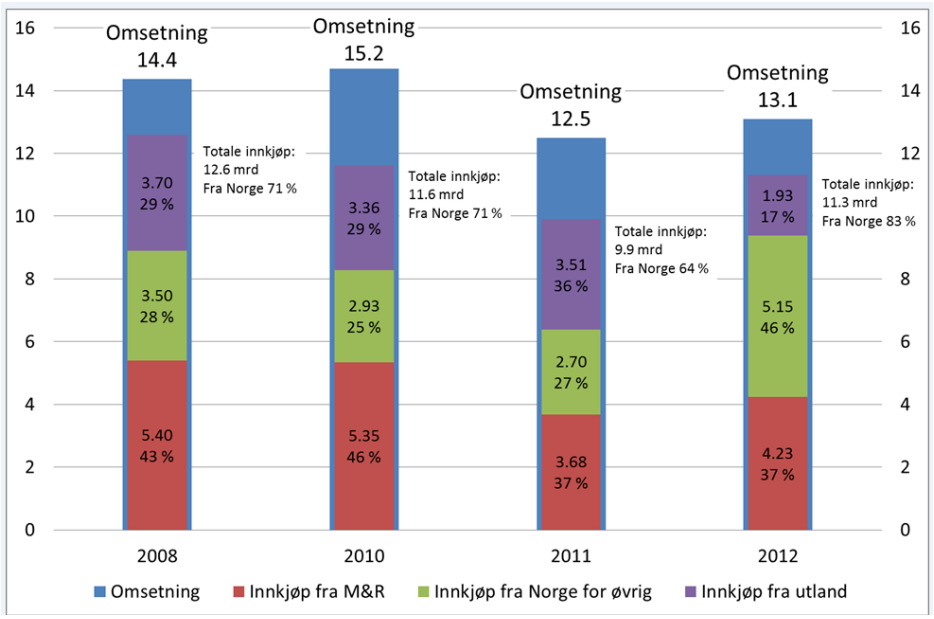
This increase in outsourcing also coincides with other events. According to (Hervik, Aslesen, and Oterhals 2005) 2002 was a year when the Norwegian shipyards experienced shock effects due to expensive national wage settlements, strong Norwegian currency compared to our competitors as well as increased competition from Eastern Europe and Asia. According to (Hervik, Aslesen, and Oterhals 2005) this led to a painful turnover process that among other things led to a reduction in employees and introduction of cost saving measures at the same time as there was an improvement of the Norwegian Krone towards the Euro and moderate national wage settlements. A key informant in the industry said that ~~at~~ around the year 2000, one started to gradually shift from organizing the

shipbuilding process according to functional departments to a more project based approach where functional departments assign their employees to temporary projects (Aslesen 2008). First of January 2001 was also the date when the European Union removed all subsidization of shipbuilding (Hervik 2003). Even though the level of the subsidies at times was lower in Norway than in the rest of EU (Hervik 2003), according to (Hervik, Nesset, and Opdal 2000) it was important for the competitiveness of the shipyards.

On the other hand (Hervik 2003) also found that only 13% of the shipyards in Møre and Romsdal planned to outsource a small part of their business after 2002. (Hervik, Aslesen, and Oterhals 2005) state that before it was only outsourcing of activities, but it has also been a trend of buying up activities in other countries as well as integration of activities in the value chain in order to become a more complete actor.

In some cases activities that first were outsourced were taken in again, (Stensvold 2012b) (Mauren 2012). By integrating towards the oil companies it is, according to (Hervik, Aslesen, and Oterhals 2005), possible to develop innovative solutions in close relations with the end customer and thereby creating quality that there is a high willingness to pay for. Also (Hervik, Aslesen, and Oterhals 2005) state that the benefit of integrating backwards to the equipment suppliers is that it strengthens the position of the shipyard and enables it to collect more of the value of the ship they deliver.

When looking at the development from 2008 and outwards (Hervik et al. 2009), (Hervik et al. 2010), (Hervik et al. 2011) and (Hervik 2012) the degree of value created that is bought from external suppliers are higher than 80% except in 2010. When looking at the average values form the period before and after 2005 one see that average ratio has increased from 71,8% to 82,5% which, despite limited data, gives an indication that there has been an increase in the



Figur 3: Purchase volum 2008-2012 (Hervik et al. 2009), (Hervik et al. 2010), (Hervik et al. 2011) and (Hervik 2012)

Year	1997	1999	2002	2003	2004 (prediction)	2008	2010	2011	2012
Turnover			9,9	6,6	4,3	14,4	15,2	12,2	13,1
Total purchase volume			7,4	4,6	3	12,6	11,6	9,9	11,3
Percentage of value creation	68,00 %	77,00 %	75,00 %	69,00 %	70,00 %	87,50 %	76,30 %	81,10 %	86,30 %
Average Percentage of value creation	71,8 %					82,8 %			

Figur 4: Percentage of value creation (Hervik, Nesset, and Opdal 1998), (Hervik, Nesset, and Opdal 2000), (Hervik, Bræin, and Oterhals 2005), (Hervik et al. 2009), (Hervik et al. 2010), (Hervik et al. 2011) and (Hervik 2012)

(Oterhals, Johannessen, and Hervik 2011) have investigated how the four shipyards in Møre and Romsdal and the one in Telemark in STX OSV, which have stood for 40% of the total Norwegian shipbuilding capacity the last years, affects the region and community they are located in. The total purchase volume divided by turnover was 84% in 2009 and 77% in 2010 for all the STX OSV yards. During their investigation (Oterhals, Johannessen, and Hervik 2011)found that more than 70% of the purchasing volume of the Norwegian suppliers came from buying components and parts. They further found that hired workers and subcontracted work was the second biggest and constituted about 20% of the purchasing volume, technical services and R&D was about 3%, logistics and transport services constituted less than half a percentage and operational support makes about 1 % of the purchase volume. Since all these ratios are based on data provided by Norwegian suppliers which constitute about 66% of the total purchasing volume this should give a good indication on the overall situation (Oterhals, Johannessen, and Hervik 2011).

(Oterhals, Johannessen, and Hervik 2011) grouped the overall purchases for both the Norwegian as well as the foreign yards from the Norwegian suppliers according to the SFI code. According to (Kristoffersen 2011) the SFI code *"is a system for classifying a ship's parts according to their functional structure"* (Kristoffersen 2011, page 13). In 2010, 48% of the purchase in terms of value are related to Machinery Main components , (some suppliers might also have included assembly work in this figure so the number can be to big), (Oterhals, Johannessen, and Hervik 2011), which are the most important components in the engine room like main and auxiliary engine, propeller plants, boilers and generators (Kristoffersen 2011).The second biggest group was Ship Common systems that in 2010 constituted 17% of the purchase in terms of value, (Oterhals, Johannessen, and Hervik 2011). Ship Common systems are related to central ship systems like means ballast and bilge systems, firefighting systems, wash down systems and electrical distribution (Kristoffersen 2011).

SFI Code	Precentage	
	2009	2010
Machinery Main components	45,70 %	47,90 %
Ship Common systems	17,60 %	17,00 %
Equipment for Crew and passengers	8,20 %	8,50 %
Ship Equipment	7,80 %	8,30 %
Equipment for Cargo	6,50 %	7,00 %
Systems for Machinery Main Components	5,50 %	5,00 %
Ship General	6,50 %	4,80 %
Super structure and material protection related to Hull	2,30 %	1,50 %

Figur 5: Cost split on SFI code (Oterhals, Johannessen, and Hervik 2011)

Equipment for Crew and passengers, (lifesaving equipment, furniture and sanitation), Ship Equipment, (navigation, communication and anchoring equipment, manoeuvring machinery and also special equipment for fishery is placed here) and Equipment for Cargo, (loading and unloading systems as well as cargo winches and hatches), (Kristoffersen 2011), constituted between 8,5 to 7% respectively in 2010 (Oterhals, Johannessen, and Hervik 2011). Systems for Machinery Main Components, (fuel and oil lubrication systems, exhaust systems and automation), and Ship General, (details and costs that can't be charged on a specific function like quality assurance, launching and dry docking), (Kristoffersen 2011), both constitute around 5% of the overall purchase value of the Norwegian suppliers in 2010 (Oterhals, Johannessen, and Hervik 2011). Super structure and material protection related to Hull, (Kristoffersen 2011), constituted 1,5% in 2010 (Oterhals, Johannessen, and Hervik 2011).

(Shetelig 2013) present some estimates grouped after the SFI code based on design made by Ulstein Group of a Platform supply vessel were the hull was built in Poland and outfitting conducted at Ulstein Yard in Ulsteinvik. (Shetelig 2013) argued that this vessel should be very representative in terms of size and class for other PSV's that were built in the period after 2000 and until today.

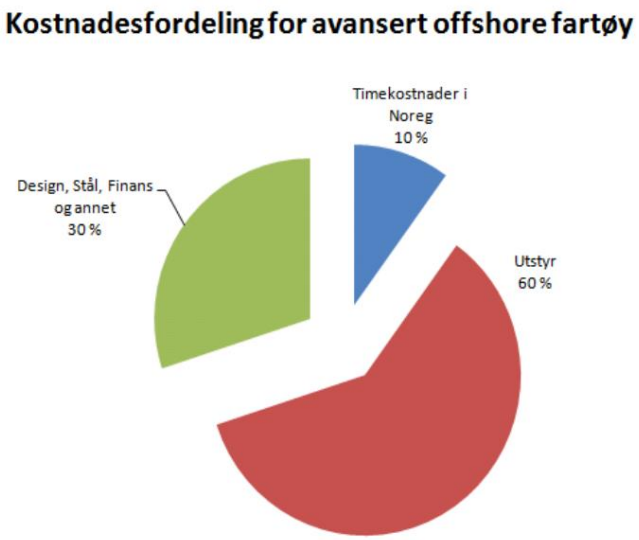
Technological group	Portion of total cost
1 - HULL	27 %
2 - MACHNIERY AND PROPULSION	31 %
3 - CARGO CONTAINMENT AND HANDLING EQUIPMENT	8 %
4 - COMMON SYSTEMS AND COSTS	25 %
5 - SHIP GENERAL	9 %

Table 5 - Cost distribution M/V Bourbon Monsoon

Figur 6:Cost stucture SFI code (Shetelig 2013, page 32)

If one compares the number from STX OSV and Ulstein Group it seems like some of the numbers are not directly comparable for instance hull and hull structure. This can have something to do with the type of vessels that are being produced. For instance an AHTS and an OCV have more equipment on board than a PSV in terms of winches and cranes that can make the hull and hull structure on such type of vessels a smaller part of the total cost of the vessels.

According to (Roppen 2010) 60% of the total cost of an advanced offshore vessels come from equipment while the remaining 40% constitute other parts like design, steel, financial cost and work hours. Further according to (Roppen 2013b) only 15% of the total cost of building an advanced offshore vessel is related to labour, the remaining 85% is other factors.



Figur 7: Cost splitt for advanced offshore vessel (Roppen 2010)

1.7.3.2 Change in customers for the shipyards:

According to (Dedekam jr. and Hervik 1989) most of the vessels built at shipyards in Møre and Romsdal were for foreign clients and also (Oterhals 1998) describe a lot of foreign clients in the 80s' and early 90s'. According to (Hervik, Dedekam jr., and Warnes 1993) only 7% of the new production in Møre and Romsdal came from Norwegian shipping companies in 1993. This has changed, today (Hervik et al. 2011) found that 21% of the turnover for the shipyards in Møre and Romsdal come from shipping companies located in Møre and Romsdal and that 86% of the total turnover comes from Norwegian shipping companies. The Møre and Romsdal based shipping company Rem Offshore ASA started out with fishing in the 80s' and later turned to focus more on offshore service vessels (Remøy 2010). Rem Offshore ASA has contracted all their vessels at Norwegian shipyards for various reasons like payment terms during construction, quality, flexibility and patriotism (Remøy 2010). Shipbuilding is a very capital intensive industry and it is common for offshore shipping companies to pay 20% of the contract sum at contract signing and the remaining 80% at delivery of vessel (Stensvold 2008). This is very beneficial for the shipping companies and places a big financial strain on the shipyards (Stensvold 2008).

1.7.3.3 Type of vessel more and more high tech and high value:

According to (Aslesen 2008) the maritime industry in Møre and Romsdal was in the past mostly producing fishery vessels for local fishery companies. In 1990 shipbuilding in

Norway was focused on building small specialized vessels like fishing vessels, supply vessels, ferries, fast passenger vessels, navy vessels and specialized smaller cargo vessels like reefers and gas ships (Dedekam jr. and Hervik 1989). These type of vessels could be characterized as specialized and high tech, and there was a lot of emphasis on product development (Dedekam jr. and Hervik 1989). According to (Hervik et al. 2011) 90% of the new building orders for the shipyards in Møre and Romsdal since 2009 came from the offshore service business, indicating that there has been a specialization in terms of vessels produced.
(Oterhals et al. 2008a) presents the following types of offshore service vessels:
Platform Supply Vessels (PSV): Platform supply vessels are vessels that deliver cargo as well as bulk products offshore (Oterhals et al. 2008a). For further information on PSVs and the role they play in the North Sea, please see (Aas, Halskau Sr, and Wallace 2009).

Anchor Handling Tug Supply Vessels (AHTS): Anchor handling tug supply vessels are vessels that are equipped with lifting capacity up to 500 tons and help oil rigs with anchor mooring (Oterhals et al. 2008a).

Multi-Purpose Supply Vessels (MPSV): Multipurpose supply vessels, (MPSV), are vessels that are built for supply service, but with additional capabilities and functions (Oterhals et al. 2008a).

Remote Operated Vehicle vessels (ROV): Vessels that have remote operated vehicles, (ROV), are capable of using these for underwater inspections or work (Oterhals et al. 2008a).

Construction vessels: Construction vessels are vessels that are equipped with heavy crane capacity for doing construction activities on the ocean floor related to the new subsea installations that are used instead of traditional oil platforms for producing oil and gas (Oterhals et al. 2008a).

Well intervention vessels: Well intervention vessels are vessels that are specially built for early production and maintenance of oil wells, tasks which were in the past conducted by platforms or rigs (Oterhals et al. 2008a).

For more information about the search and development of oil please see (Bedringås 2006) and (Nedregaard 2003).

(Oterhals et al. 2008a)indicate that with the introduction of the new offshore vessels related to subsea operations on deep waters and in areas with very strict health, environmental and safety standards offshore fleets are getting more technically advanced and that the price of these new type of vessels are higher than the traditional ones. It has been stated by informers that an offshore vessel can cost between 200 million NOK and 1 billion NOK depending on type of vessel and capabilities.

But also among the more traditional offshore vessels there has been a technological development. (Oterhals et al. 2008a) describe the introduction of a new generation of AHTS vessels with capabilities at greater depths and winches with more pulling power. Also for the PSV vessels there has been a development with the introduction of new motors, so-called dual fuel engines, which can run on both liquid natural gas, (LNG), and diesel, as well as experiments with fuels cells and hybrid technology, (Stensvold 2010a). According to (Stensvold 2009a) investing in equipment relating to environmental performance higher than those demanded by national and international authorities might increase contract cost up to 10%, but these investments often payoff in terms of reduced fuel consumption.

Anchor Handler Vessels:

Far Sword:	**Far Sapphire:**
- Diesel mechanic propulsion	- Hybrid propulsion (DM + Diesel Electric)
- Fixed RPM heavy consumers	- Variable RPM (frequency ctrl)
- Bollard pull 180 tonnes	- 270 tonnes
- Clean Class	- Clean Design, Comfort, Naut OSV A, Ice C, DP 2,
- No emission cleaning	- Cathalytic Converters
- 29 persons	- 60 persons
- Winch 400 tonnes, 2 drums	- 500 tonnes, 3 drums Large Capacity, High Speed
- AHTS	- AHT(S)
- 78,3 x 17,2 meter	- 92,7 x 22,0 meter
- Deck area 500 sqm	- 800 sqm
- Standard deck outfitting	- Safe AH deck equipment CRCranes, ARFrame,
- Main crane 6 tonnes	- 20 tonnes with AHC
- No ROV	- Integrated ROV hangar

Figur 8: Technology of AHTS vessels (Nakken 2008)

1.7.3.4 Development in fabrication technology:

Since the 90s' there has been a development in the fabrication of ship hulls with the introduction of robots. According to (Mandic, Domazet, and Stipanicev 1989) and (Blasko,

Howser, and Moniak 1992) robots in shipbuilding was something that was introduced during the 80s' and according to (Blasko, Howser, and Moniak 1992) Japan started early with introduction robots. According to (Mitchell et al. 2012) most of the major shipyards in Japan and South Korea have made substantial investments in robotics for welding, cutting and coating/painting. This is also something that has affected how shipbuilding is conducted for the shipyards in Møre and Romsdal in terms of investments in equipment in Møre and Romsdal (Stensvold 2012b) and also in foreign yards that are owned by shipbuilding constellations located in Møre and Romsdal, (Vard 2013).

According to (Mandic, Domazet, and Stipanicev 1989) it is particularly surface cleaning, surface protection, coating, painting and welding are suitable for being performed by robots and particular welding is very suitable for robotics because it constitutes a big part of the operation and energy consumption. According to (Westby 1991) traditionally welding robots that were customized by combining different modules for mobility and welding machines were preferred over more standardised ones because in order to justify the investment economically one has to have a high utilisation. Since the type of welds can vary a lot from ship to ship the risk is having a welding robot that can only perform certain types of welds standing ideally over longer periods of time, (Westby 1991). (Behrentz 2012) state that robots are something that can be taken off the shelf, but has to be modified in order to suit the needs of the shipbuilding industry and set up for use in effective production lines.

According to (Roppen 2010) there has been a major development in robot welding technology since 1998. (Roppen 2010) see this advances in terms of getting the robot to following the intended seam without programming from the drawing, better quality of the welding preformed without extra work, welding of wider seam openings and more than a doubling of performance and the same time there has been a major reduction in the investment costs. Also (Roppen 2010) is of the opinion that the cost per hour of robotic welding when correcting for effectiveness has gone down since 1998, while the same hour cost for manual production in Norway or Poland has increased.

1.7.4 Equipment suppliers

1.7.4.1 Growth and changes in market for Equipment suppliers since 1990's

According to (Dedekam jr. and Hervik 1989) the equipment sector was already bigger than the shipbuilding sector in 1989. There were 109 equipment suppliers in Møre and Romsdal that employed about 4000 people in 1989. In 1993 (Hervik, Dedekam jr., and Warnes 1993) found that there were 133 companies that could be classified as equipment suppliers with a total employment of about 4700 and a total turnover of about 4,8 billion NOK. In 2011 (Hervik et al. 2011) indentified 160 equipment suppliers that employed about 7000 employees and had an annual turnover of about 17,9 billion NOK.

In the past the shipyards in Møre and Romsdal were very important for the equipment suppliers since they provided a "home" market where products could be tested, knowledge gained and economies of scale secured(Dedekam jr. and Hervik 1989). In a survey conducted by (Dedekam jr. and Hervik 1989) 80% of the equipment suppliers said that they would have to close down or flag out if the local shipyards disappeared. This has changed a bit and the export share has risen from 41,3% in 1989, excluding the Norwegian ships built for export, (Dedekam jr. and Hervik 1989) to 49% 2008, 55% in 2009 (Hervik et al. 2010) and 46% in 2010 (Hervik et al. 2011). Also when the equipment suppliers were asked about the importance of the local shipyards in 1997 only 58% said they were very important for the survivability of the equipment suppliers and it is also stated that the local shipyards weren't so important in terms of marketing for export and development of innovations (Hervik, Nesset, and Opdal 1998). (Hervik, Bræin, and Oterhals 2005) sites a monthly report from the offshore broker Platou Offshore from November 2004 that states that most of the offshore vessels contracted in the period of the reports were based on Norwegian design, most were due to be built at a foreign yard and often Norwegian equipment suppliers followed in close pursuit of the Norwegian design bureaus. (Hervik, Bræin, and Oterhals 2005) follow up by saying that although 70%-80% of the turnover in 2004 for the Norwegian equipment suppliers came from the more price sensitive Eastern clients with lower demand specification. However when shipping companies want the most sophisticated offshore ships they use Norwegian equipment suppliers, (Hervik, Bræin, and Oterhals 2005).

1.7.4.2 Development of selling packages:

According to (Hervik, Bræin, and Oterhals 2005) there has been a consolidation of equipment suppliers in Møre and Romsdal that deliver bigger packages of more standardised equipment. (Hervik, Bræin, and Oterhals 2005) mention Rolls Royce and Wärtsila as examples of companies that deliver such type of packages.

In May 1999 the British engineering firm Vickers bought the Norwegian family owned Ulstein group and in November 1999 Vickers was bought by another British industrial giant Rolls Royce (Hervik, Nesset, and Opdal 2000). Rolls Royce kept the equipment supplier part as well as the consultancy firms Nordvestconsult and Ship Technology Ulstein, but the local owners kept the shipbuilding bit (Hervik, Nesset, and Opdal 2000) and thereby acquired the world renowned UT-design brand (Halse and Bjarnar 2011). Rolls Royce also acquired Hydraulic Brattvåg (Halse and Bjarnar 2011) and can deliver complete ship design as well as engines, gears and propulsion systems, thrusters, rudder, deck machinery, electrical systems and automation and control systems (Stensvold 2012d).In 2000 Rolls Royce had almost 50% of the employees of technical consultants and 25% of the employees of equipment suppliers (Hervik, Nesset, and Opdal 2000) and are still the biggest equipment supplier in Møre and Romsdal (Bremnes, Hervik, and Sandsmark 2008). Wärtsila is a Finish engine manufacturer that has decided that the best way to improve their position in relation to both shipyards and shipping companies was by starting with the design and concept development of the ship (Stensvold 2011c). In order to do so they have bought renowned design firms worldwide including the Norwegian offshore ship design firm Vik-Sandvik in 2008 known for their VS designs (Stensvold 2011c). Wärtsila doesn't specify ship equipment (Stensvold 2011c) in the same way as Rolls Royce do, but they have also noticed a trend of shipping companies wanting to have more holistic ship concepts that is safe and simple to build and with a provider that can guarantee ~~for~~ the performance of the ship throughout its' life time(Stensvold 2011c). According to (Hervik, Bræin, and Oterhals 2005) the introduction of big international corporations that provide integrated packages opens up the market for smaller and more custom made producers serving a niche market. (Hervik, Bræin, and Oterhals 2005) mentions Brunvoll, Frank Mohn and Sperre as examples of such companies.

1.7.4.3 Market willing to pay for quality:

Since the 1990s' the equipment suppliers in Møre and Romsdal have developed quality that the market is willing to pay for. According to (Hervik, Nesset, and Opdal 1998) one of the main reasons that shipping companies in Møre and Romsdal preferred to have equipment from equipment suppliers in Møre and Romsdal in 1997 was because of the high quality of equipment that comes from these suppliers.

(Bremnes, Hervik, and Sandsmark 2008) operationalize the potential for acquiring brand value through the concepts of innovation, product differentiation and marketing. (Bremnes, Hervik, and Sandsmark 2011) tested these concepts empirically with observations from 2007 to 2009 among companies in the petroleum related business in central Norway, were among others many companies in the maritime industry in Møre and Romsdal are included like the equipment suppliers. (Bremnes, Hervik, and Sandsmark 2011) found that being innovative, expressed as the ability to provide customized solution, being adaptive and providing new solutions, contributed significantly to a higher operational result. It was also the case that the companies that had a high score on innovativeness were the ones that had highest growth in operational result in the period between 2007 and 2009 (Bremnes, Hervik, and Sandsmark 2011). Price was included as a control variable, but showed no significant impact on operational result and this strengthens the belief that the petroleum industry in central Norway competes on being innovative not on cost according to (Bremnes, Hervik, and Sandsmark 2011). Similarly the ability to provide differentiated products, expressed as delivery of quality and functional products as well as being a reliable supplier, contributes significantly to a higher export share (Bremnes, Hervik, and Sandsmark 2011). The companies that scored high on features related to marketing like developing network and relations had a significantly higher growth in export share in the period between 2007 and 2009.

The findings of (Bremnes, Hervik, and Sandsmark 2011) relating the overall petroleum industry in central Norway matches the competitive parameters of the equipment suppliers in Møre and Romsdal. According to (Hervik, Oterhals, and Bergem 2007) when a group of 93 and one of 82 equipment suppliers in Møre and Romsdal in 2006 were asked to evaluate important competitive advantages they had over other Norwegian and foreign competitors factors like technology/competence/innovation, quality/functionality/brand and relations to customers were rated very high. (Hervik et al. 2011) found similarly in

2011 that 70-80% of the equipment suppliers in Møre and Romsdal rated innovativeness, reputation and ability to deliver quality and custom solutions as the most important competitive factors in the industry.

There are several international companies with strong brands that are located in Møre and Romsdal like Rolls Royce, (Bremnes, Hervik, and Sandsmark 2011), and ABB , (Eilertsen 2012). According to (Hervik, Bræin, and Oterhals 2005) there are also several niche companies that have built up strong brands in Møre and Romsdal in addition to the big international companies. Examples can be the supplier of vacuum toilets for ships JETS, (Stensvold 2009c), or the thruster manufacturer Brunvoll that are doing well in business that worldwide counts less than 10 firms and include big names like Rolls Royce, Wärtsilä and Kawasaki (Krikwood et al. 2011).

1.7.5 Ship consultants

1.7.5.1 General development for ship consultants:

According to (Bukve, Løseth, and Gammelsæter 2004) the ship consultants in Møre and Romsdal were born in the 1970s' and 80s' when many of the shipyards outsourced the engineering work related to vessel design and focused more on vessel production. Further (Bukve, Løseth, and Gammelsæter 2004) divide the ship consultants into big firms that develop standard design that they sell to several shipping companies and smaller firms that deliver more custom made design to every customer. Some of the ship consultants develop more standardised designs that they sell to several shipping companies while others deliver more custom made design to each and every customer (Bukve, Løseth, and Gammelsæter 2004).

There were 18 ship consultants in 1989 (Dedekam jr. and Hervik 1989). According to (Hervik, Nesset, and Opdal 1998) they had registered 11 consultancy companies in Møre and Romsdal in 1997. These 11 companies had a turnover in 1997 on 526 million NOK, had 187 man-labour years employed a result before tax of 79 million NOK and an operating margin of 15%, (Hervik, Nesset, and Opdal 1998). Traditionally the ship consultants have always recruited from the experienced engineers with practical experience from the shipyards, (Bukve, Løseth, and Gammelsæter 2004), and according to (Hervik, Nesset, and Opdal 1998) access to knowledgeable staff is something that has always been important. In periods there has been a lot growth in employment for the ship

consultants according to (Hervik 2003) ship consultancies had the highest growth in employment in the cluster in the period from 2000-2002. In 2011 (Hervik et al. 2011) identified 15 ship consultant delivering design and engineering type services for a value of 737 million NOK and employing about 450 man-labour years where about 20 were hired workers.

According to (Hervik 2003)in general the ship consultancies have sold to foreign customers and brought the orders home to shipyards in Møre and Romsdal. In 2002 it was more the case that they brought contracts to local shipyards from other parts of Norway. According to (Hervik, Nesset, and Opdal 2000) the degree of foreign customers dropped from 52% in 1998 to 32% in 1999. In 2011 this percent was up to 56% again, (Hervik et al. 2011).

1.7.5.2 Design have been insourced by yards and equipment suppliers:

According to (Hervik, Nesset, and Opdal 1998) the consultancy firms that do full projects have played a key role in the maritime interplay because they have both Norwegian as well as foreign shipping companies as their most important customers. When a consultancy firm has gotten in position to compete for a project they first need to find a shipyard that can tender for the project and make a makers list of possible equipment that the shipping company can choose from. When the consultancy company gets an estimation of the cost from the shipyard this is then presented to the shipping company that often have several tenders to choose from. It is only the consultancy firm that wins the tendering process that gets paid for the work that is done. And similarly if the consultancy firm win the tendering the shipyard gets covered the cost of both the projecting and putting together the equipment package.

According to (Hervik, Nesset, and Opdal 2000) the external ship consultants have functioned as sellers for both local shipyards and local equipment suppliers as well as an important innovative factor for the maritime industry in Møre and Romsdal. The reason for this is that they are the ones that deal directly with the shipping companies, the local ones in Møre and Romsdal, the Norwegian ones as well as the international ones, and that they gain experience that they bring with them to the different shipyards and equipment suppliers they work with (Hervik, Nesset, and Opdal 2000). Because they are a lot in touch

with the different actors in the industry they get a good overview of what is happening in the industry and they also follow the technological developments through their close links with academic and research institutions like NTNU, SINTEF and Marintek (Hervik, Nesset, and Opdal 2000). According to (Bukve, Løseth, and Gammelsæter 2004) the combination of formalised knowledge and general competence on ship design from Marintek/SINTEF and the more practical knowledge and focused competence of the ship consultant provide a very fruitful cooperation.

(Hervik, Bræin, and Oterhals 2005) noticed a trend around 2004 that the shipyards in Møre and Romsdal started to build up in-house design capabilities. (Hervik, Bræin, and Oterhals 2005) state that the design delivered from the external consultants was very expensive and that it made the construction process very complex since the technical departments responsible for detailed engineering at the yards often had to redo a lot of the detailed design from the external consultant. (Hervik, Bræin, and Oterhals 2005) mentions an example were such are redesign of piping reduced the use of pipe bend with 27%. (Hervik, Bræin, and Oterhals 2005) state that the motivation for moving design in-house was to strategically move up the value chain and establish direct contact with the end user of the ship for contracts negotiations and completion. According to (Hervik, Bræin, and Oterhals 2005) the external consultants have had a powerful position in between the shipping company and the shipyard, in a way a "representative" of the shipping company, and had valuable experience regarding procurement and installation of equipment.

According to (Bukve, Løseth, and Gammelsæter 2004) independent design firms saw shipyards and equipment suppliers with design capabilities as competitors they didn't want to cooperate with. When (Hervik et al. 2009) asked the actors in the maritime industry in Møre and Romsdal to evaluate the relations with other actors in Møre and Romsdal on a licker scale from 1-7 the ship consultants had dropped the relation with the shipyards from 5,9 in 2006, (Hervik, Oterhals, and Bergem 2007), to 4,5 in 2009 while the shipyards had a relationship value with the ship consultants of 5,1 both years, (Hervik, Oterhals, and Bergem 2007) and (Hervik et al. 2009). Still there is growth since the first measures of this kind were done the first time by (Hervik and Jakobsen 2001). Then the ship consultants rated their relationship with the shipyards in Møre and Romsdal as 3,5 and the shipyard rated the relationship with the ship consultants with the value 2,9.

However there are still independent technical consultants in the maritime industry in Møre and Romsdal (Bremnes, Hervik, and Sandsmark 2011) and attached to it (Stensvold 2011c).

1.7.5.3 Introduction of 3D modelling and simulation software for ship design:

The use of 3d modelling and simulation software for designing ships can help decrease the time of the design process and help create design better solutions for tomorrow. According to (Strøm 2003) and (Strøm 2005) ship design used to be dominated by 2D design tools that were based on DAK/DAP programs that were based on technology from the 80s'. According to (Kanerva, Lietepohja, and Hakulinen 2002), most engineering and design work today is done by 3d modelling and further state that 3D modelling has the advantage that it if all the designers use the same database sharing of design information, this is really fast and effective. However the use of 3d modelling demands a database over all the physical dimensions of components and items that are going into the vessel, (Kanerva, Lietepohja, and Hakulinen 2002).

3D modelling is also being used in Møre and Romsdal according to (Strøm 2005) and other advantages with the use of 3D modelling software is that it makes it easier to modularize the ship and use up parts or modules of the ship on other projects and thereby save engineering time. Also it enables equipment suppliers to create 3D models of their equipment that easily can be integrated into the vessel. According to (Holmberg and Hunter) the actual design process can also be shorten by implementing 3D modelling software.

According to (Stensvold 2009b) the use of simulation software in conjunction with 3D models can help design better solutions in the future for the ship designers in Møre and Romsdal. By letting a 3D model of a vessel be subjected to data simulated waves and weather important information on the performance of hull and machinery can be visualised through the use of colour codes, (Stensvold 2009b).

1.8 Development of governance arrangements since the 90's for shipyards in Møre and Romsdal

1.8.1 Major shipyard constellations in Møre and Romsdal

Of the 17 shipyards in Møre and Romsdal identified by (Hervik et al. 2011) 7 of them belong to either STX OSV/Vard, Ulstein Group or Kleven. Based on the amount of ships delivered and the turnover in 2011, (STX OSV 2012a; Ulstein Group 2012; Kleven 2012), these shipyards are chosen as being representative for shipyards in Møre and Romsdal.

1.8.1.1 STX OSV/Vard

STX OSV is an international shipyard constellation consisting of 4 shipyards in Møre and Romsdal, 1 shipyard in the South-Eastern part of Norway, 2 shipyards in Romania, 1 in Brazil and 1 in Vietnam, (Oterhals, Johannessen, and Hervik 2011). They have chosen to specialize in designing and producing offshore service vessels and other specialized vessels like LNG-powered ferries, naval and coast guard vessels, fishing vessels and non-offshore related icebreakers with customers-specific applications (Oterhals, Johannessen, and Hervik 2011) and www.stxosv.com. STX OSV was part of the STX Business Group, but by the end of 2012 the publicly owned Italian shipbuilding group Fincantieri - Cantieri Navali Italiani S.p.A bought 50.75% of the shares in STX OSV HOLDINGS, (STX OSV 2012b). STX OSV is listed on Main Board of Singapore Exchange, (STX OSV 2012b). STX OSV changed name to Vard in 2013 (Vard 2013).

1.8.1.2 Ulstein Group

According to (Krikwood et al. 2011) Ulstein Group is a holding company that can deliver ship design packages, equipment packages, project management services and supervision on shipyards worldwide or construction of ships at their own yard in Møre and Romsdal. Ulstein Group is owned and controlled by the Ulstein family and has roots back to 1917, www.ulstein.com. Ulstein Group is mainly focusing on offshore support vessels, heavy offshore vessels and shortsea vessels, (Krikwood et al. 2011).

1.8.1.3 Kleven

Kleven is a shipbuilding group that has two shipyards in Møre and Romsdal and was before August 2012 known as Kleven Maritime, www.kleven.no. Kleven has one yard that is primarily specialized and equipped for new building of tonnage and one that is more intended to conduct service and repair operations of a wide range of tonnage, www.kleven.no. Kleven is a family owned company with an almost 100 year history and still holds on to these values today.

1.8.2 Transactions

Based on the findings in the first section of the empirical data a more thorough look at hull fabrication for the major shipbuilding constellations in Møre and Romsdal which according to (Hervik, Aslesen, and Oterhals 2005), (Hervik 2003) and (Aslesen 2008) has gone from being conducted internally to being conducted externally. Although it was also common in the past to make some parts or sometimes even entire hulls at other yards in Møre and Romsdal or Norway,(Oterhals 1998) and (Bukve, Løseth, and Gammelsæter 2004), the outsourcing of hull fabrication became a more permanent thing.
Because of the findings of (Hervik, Bræin, and Oterhals 2005) that around 2004, the shipyards in Møre and Romsdal started to build up their design capacity. This thesis will look closer at the form of governance for the major shipyard constellations located in Møre and Romsdal for the design transaction. In the past it was external ship consultants that handled the vessel design and the shipyards where just responsible for production of the ship, (Bukve, Løseth, and Gammelsæter 2004), (Hervik, Nesset, and Opdal 1998) and (Hervik, Nesset, and Opdal 2000).

1.8.2.1 Hull production

According to (Hervik, Aslesen, and Oterhals 2005), (Hervik 2003) and (Aslesen 2008) there has been a trend of outsourcing labour intensive activities related to hull production for shipyards in Møre and Romsdal as well as the rest of Norway. For the biggest shipyard constellations in Møre and Romsdal, this has played out quite differently.
Vard/STX OSV consist of 4 shipyards in Møre and Romsdal that in the in the past were originally 4 separate yards that as time progressed, the different yards grouped and allied themselves with other local yards until all 4 of them ended up with a common Norwegian owner. The Norwegian owner was first replaced with a Korean owner and later with an Italian one, but it has always been common to cooperate with other local or national yards

and have them complete parts of the hull construction at other yards (Oterhals 1998), (Rørhus 1999) and (STX OSV 2011).

The first yard, in what later became Vard/ STX OSV, to completely outsource hull production did so in 1985 to a yard located in Norway and then had the hulls towed to Møre and Romsdal (STX OSV 2011). In 1995 an agreement with a yard in Romania was made and in 1996 the first hull was delivered and towed to Møre and Romsdal (Rogne 2008). Even though there were several of the yards in the group that had their own slipway, and thereby capacity to build their own hulls in the end of the 90s', (Oterhals 1998) and (Rørhus 1999), more and more hulls were delivered from what eventually became 2 yards in Romania, (Rogne 2008). These yards are currently organized in a corporate structure as independent companies owned by a holding company 100% controlled by Vard Group, (Vard 2013). Also according to (Vard 2013) expenses and revenue related to transactions between different operational segments of the group are monitored and used as basis for decision making.

The Romanian Yards can also conduct complete outfitting and installation of a vessel although still not complete offshore vessels, (STX OSV 2012a). Currently all hulls are made in Romania for the Norwegian Yards in STX OSV, (Oterhals, Johannessen, and Hervik 2011), and according to a key informant as much as possible of steelwork is conducted in Romania. The key informant also stated that on some occasions welding on the hull and laying of new piping have been done on the hull after it has arrived in Norway. Also Vard/STX OSV also sells basic and detailed design bundled with major equipment to a few selected 3 party shipyards (STX OSV 2012a) and (Vard 2013).

In the 90s' what today is called Ulstein Group consisted of a shipyard, a design office and equipment production that among other things included production of propellers (Stensvold 2008). In 1999 the British industrial group Vickers bought the design office that gave the access to the famous UT-design as well as the lucrative propel production, (Stensvold 2008). As a peculiar twist Rolls Royce later bought Vickers and thereby gained control over the entire group and the only thing that Rolls Royce/Vickers was not interested in was the shipyard (Hervik, Nesset, and Opdal 2000). The Ulstein family took over the shipyard, (Stensvold 2008). Even if 95% of the income to Ulstein Group in 1999 came from the shipyard and there was demand enough to triple capacity this was not done

due to fear that this excessive capacity would be a problem in lower parts of the shipbuilding cycle (Stensvold 2008).

Ulstein Group has started to execute shipbuilding projects at external network shipyards, (Krikwood et al. 2011), that is spread around the world for instance in China, Dubai, Brazil and Spain, (Ulstein Group 2012). At these external network yards everything from hull fabrication and outfitting is completed with supervision from a project team from Ulstein Group, (Stensvold 2012c). According to (Stensvold 2003) the use of external partner shipyards was intended for segments that didn't directly compete with the yard in Ulsteinvik. These external network yards were intended for more standardized designs than custom design from the bottom up (Ulstein 2012). However similar ships have been built both at a partner yard and at the yard in Ulsteinvik (Stensvold 2012c). The strategy of Ulstein Group is to earn most of their money from selling design packages so the shipyard in Ulsteinvik has a limited capacity to only make a few ships per year (Stensvold 2008). Also the yard in Ulsteinvik buys hulls and other steel related tasks from cheaper yards, (Stensvold 2008), although they have capabilities to make smaller steel structures, (Ulstein Group 2012), for instance bridge modules and superstructures (Grytten 2007). According to (Ulstein Group 2012, 2011, 2010, 2009) Ulstein Group has had a long term relationship with an Ukrainian yard when it comes to supplies of hull structure as well as a long term relation with a Polish one in the past, (Ulstein Group 2009, 2007, 2006). However the use of other shipyards in Møre and Romsdal or Norway to make parts or even entire hulls is not something that is new to Ulstein Group (Grytten, Opdahl, and Eide 1992).

Kleven started out similarly like STX OSV and Ulstein Group by moving away from making their own hulls in the early 2000s. According to (Gurskevik 2006) Kleven, then known as Kleven Maritme, outsourced their steel construction to sub-suppliers in Poland and Romania in 2002. But the experiences made during the booming years of 2006-2007 in terms of problems with quality and delays led to a reversion of the outsourcing trend for Kleven (Stensvold 2012b). Kleven started to modularize where the simplest ones where built in Poland and then transported to Møre and Romsdal by barge, which takes about 5-7 days, and the more advanced ones like engine room and tank arrangements are completed by Kleven themselves, (Stensvold 2012b). The different modules are than assembled on their slipway at Kleven Verft, before the last outfitting is conducted at the outfitting quays either at Kleven Verft or Myklebost Verft although some complete hulls are also bought

externally due to capacity problems at the slipway, (Stensvold 2012b). The advantage of building the advanced modules at their own yard in Møre and Romsdal is according to (Stensvold 2012b) that by using skilled labour with long shipbuilding experience good solutions are made with fewer errors and less delays as well as easier access for equipment installation. (Roppen 2013a) also adds that design changes during the process are easier to accommodate.

In addition to relying on the 470 permanent employees, Kleven has approximately the same number hired in from a sub supplier, (Stensvold 2012b). According to (Aadland 2007) Kleven sees the use of hired workers from Eastern Europe through sub suppliers as an alternative to building hulls in low cost countries.

Another thing that Kleven has done is to invest in robot welding technology (Stensvold 2012b). According to (Roppen 2010) there has been a major development in robot welding technology since 1998 and . (Roppen 2010) see these advances in terms of getting the robot to follow the intended seam without programming from the drawing, better quality of the welding preformed without extra work, welding of wider seam openings and more than a doubling of performance and at the same time there has been a major reduction in the investment costs. According to (Behrentz 2012) welding robots are rather standardized items that can be used in a lot of different industries. Further (Behrentz 2012) adds that Kleven has had to hire in two Swedish experts in order to make the necessary adaptations to make the welding robots suitable for shipbuilding and to setting up the production line. According to (Roppen 2013b) Kleven will build 37 000 tons of steel in Poland in 2013 and that when the outbuilding is complete the capacity will be 10 000 tons steel annually. Based on this it seems that there is not a plan to move the entire hull production transaction home.

1.8.2.2 Design

In 2000 then Aker Yards had a 3 man department that was meant to develop potential projects and gave technical support to the different yards in what is now STX OSV/Vard, (Stensvold 2011a). From there it evolved and in 2003-2004 some simpler designs were made for Anchor-Handling-Tug-Supply ships for the Asian and African market, (Stensvold 2011a). When the market started to grow in 2005 and more and more designs were sold during the shipbuilding boom that followed, currently 80% of the ships build at

STX OSV yards are with their own design, (Stensvold 2011a). The design department of STX OSV/ Vard Design Norway AS is currently a 100% owned company of the Vard Group and Vard/STX OSV has also acquired 51% of the shares in a Croatian design firm, (Vard 2013). According to (Vard 2013) the reason for acquiring the Croatian design firm was to secure design and engineering capacity. During the development of their own design research and development were conducted on the different weather conditions in the different markets their designs were to operate in and how hull shapes could be optimized in order to fit this particular market, (Stensvold 2011a). An example can be how the hull is divided into sections to fit the conditions in the North Sea, were the lower part of the hull is designed with a bulb for the 77 days a year with calm sea and the middle section is designed for handling waves up to 5,5 meters which it is 252 days a year while 26 days a year the wave height is extreme , (Stensvold 2011a). According to (Stensvold 2011a) making a hull that is customized to the wave and weather conditions it is supposed to be sailing in gives reduction in fuel consumption of 10-20 % compared to more conventional hull designs.

Unlike Vard/STX OSV Ulstein Group has a long experience regarding producing their own designs. According to (Grytten, Opdahl, and Eide 1992) Ulstein Trading was created in 1968 by Ulstein Group to work with international sales and marketing. According to (Grytten, Opdahl, and Eide 1992) Ulstein Trading, later known as Ulstein International from 1988, also developed design concepts under the famous UT designation, (UT refers to Ulstein Trading (Behrentz 2014)). The world renowned anchor handling design UT-704 that was first delivered in 1974 from a finish yard and the first built at the yard in Ulsteinvik was delivered in 1975 (Grytten 2007). However when Vickers, and later Rolls Royce, bought Ulstein Group they took over the design activity and the UT brand, (Stensvold 2008).

In 1999 95% of the turnover of Ulstein Group came from shipbuilding, but a strategic decision was made to build up new design capacity and make this is a central part of their revenue generating strategy, (Stensvold 2008). A design department was created in 1999 and in 2002 Ulstein Design AS was separated into a own subsidiary company and in January 2002 the first new Ulstein design was delivered from their yard in Ulsteinvik (Grytten 2007). Today Ulstein design is known as Ulstein Design and Solution and focuses on product development and sales and marketing of design, engineering services and

equipment packages, (Ulstein Group 2013). Ulstein Desgin and Solution is 100% owned by Ulstein Group ASA (Ulstein Group 2012) and one of the 5 business units in Ulstein Group , (Ulstein Group 2013).

Ulstein Group had a clause in their contract with Vickers/Rolls Royce giving them a 5 year long ban from selling ship design that lasted to 2004, (Grytten 2007). During this period Ulstein Group developed the hull shape they decided to call X-bow (Stensvold 2008). The X-bow has a quite notable appearance and the idea behind this hull shape is that according to (Steensen 2005b) that the large volume of the hull shall create good buoyancy in rougher sea and the narrowness of the hull down at the water line gives low energy consumption. This gives higher average speed, lower fuel consumption, increased comfort for crew and increased safety when sailing in rougher sea, (Steensen 2005a).

Although Ulstein group has been selling ship designs that were built at other yards since the 70s', (Grytten, Opdahl, and Eide 1992), the selling of design and equipment packages had been more important both financially and strategically. According to (Steen 2008) selling of designs in Ulstein Group constituted about a 3rd of the annual turnover at Ulstein Group in 2008 and the total turnover of Ulstein Design and Solutions constituted 36% of the turnover and 40% of the revenue in 2013, (Ulstein Group 2013). According to (Krikwood et al. 2011) Ulstein Group offers a wide variety of designs within offshore support vessels, heavy offshore vessels and shortsea vessels and (Stensvold 2008) also mentions that Ulstein has made designs for container vessels, RO-RO vessels, chemical vessels and reefers. Many of these vessel designs are conducted at firms that Ulstein Group also has acquired or established worldwide and also some engineering for some of the vessels , (Ulstein Group 2007) and (Ulstein Group 2012).

While Vard/STX OSV and Ulstein Group have built up and strengthened their internal design capabilities, Kleven has sold out their own. Kleven created their own design firm in 1985 in Florø in Sogn and Fjordane, (Westcon 2013). According to (Kleven Maritime 2001) Kleven Florø Consult, the name at the time of Kleven's design firm, had only the Kleven owned yard in Florø as their only customer. Kleven Florø Consult specializes in special tank ships, for instance chemical tankers, but can also deliver design for modern freight ships and RO-pax, combination of passenger and vehicle ferries, (Kleven Maritime 2001). According to (Kleven Maritime 2004) Kleven Design was transformed from being

part of the integrated shipbuilding process to also selling designs that were produced at other yards.

According to (Dedekam jr. and Hervik 1989) Norwegian shipyards focused on building big oil tankers and other vessels that relied on big public subsidies had difficult times in the end of the 90s'. According to (Hervik 2003) the substitution of shipbuilding stopped from 1st of January 2001. According to (Kleven Maritime 2002) Kleven Florø faced tough cost completion with several important tanker markets was dominated by Asia and Kleven Design also had periods with low activity where they also didn't make money, (Kleven Maritime 2004).

In 2006 Kleven Design was sold to Aker Yards together with the Kleven owned yard in Florø, (Stølen and Svanes 2006). Aker Yards sold the yard and design firm in Florø to STX Europe in 2007 further on to Westcon Group AS in 2012, (Stølen 2013). According to (Kleven Maritime 2006) this was a strategic decision in order to move away from the specialized tanker market and focus resources in the market for offshore service vessels and other specialised vessels.

While the activities in Florø was centred around special tankers the activities of Kleven's other two yards were from 1997 and focused more on offshore vessels that were built with design from independent design firms, http://www.klevenmaritime.no/referansar. According to (Bremnes, Hervik, and Sandsmark 2011) one advantage of going for an independent design firm for the shipping company can be that they don't have to go for a complete package solution, but can work with suppliers that the shipping company is familiar with and equipment with which one already has experience with maintaining. In their annual financial statement in 2002 Kleven stated that they will emphasis building more standardized designs, (Kleven Maritime 2002). According to (Kleven Maritime 2002) Kleven would emphasis building close and good relations with leading design firms of building friendly and economic sustainable designs for the offshore service and other specialized vessels markets. Also according to (Molde 2013) Kleven is starting to make their own production drawings in order to more fully utilize the investments they have made in automation and welding robots, which they haven't done since 2002.

5. Discussion

The purpose of this thesis has been to describe the development of governance arrangements for the shipyards in Møre and Romsdal since the 90's in order to get more knowledge and a better understanding of the present situation.

This chapter will discuss the formulated research question:

What are the main developments in the organization of the supply chain for the shipyards in Møre and Romsdal since the 90's?

and stated prepositions:

There has been a change in the organization of the supply chain of the shipyards in Møre and Romsdal since 1990.

For the shipyards in Møre and Romsdal there have been changes in the Transaction Cost Economic drivers for the organization of the supply chain since the 90s'

In order to answer the first preposition this thesis will use the Transaction Cost Economic Theory, (TCE) framework in order to describe the form of governance the shipyards in Møre and Romsdal used to have in the early 90's and compare them with how they look today. According to (Heide 1994) and (Douma and Schreuder 2008) a strong characteristic of market governance is the very short and discrete nature of the transaction as well as the use of the price mechanism that contains most of the relevant information in order to conduct the transaction. The predominant characteristic of vertical integration of a transaction or the use of organization as a form of governance is according to (Heide 1994) and (Douma and Schreuder 2008) the lack of price as a coordination mechanism in favour of bureaucratic or socialisation coordination mechanisms. There are very few real world cases were on find transactions that fit perfectly into being either a market or an organization. This middle ground is in the TCE framework called a hybrid mode and according to (Douma and Schreuder 2008) it can be recognized by the fact that it utilizes both the pricing mechanism and other coordination mechanisms at the same time.

This thesis will use the following characteristics for forms of governance in the TCE theory:

Market:

- Short and discrete nature of transactions.
- The use of the price mechanism in the transaction.

Vertical integration:

- Ownership and control of the transaction

Hybrid form of governance:

- Longer term in nature
- Use of price as well as other mechanisms at the same time
- Involves some sort of relationship

For the second preposition this thesis will use the Transaction Cost Economic Theory, (TCE), in order to identify attributes surrounding transactions of shipyards and try to find empirical evidence for the development. According to (Sergio and Senada 2009) and (Riordan and Williamson 1985) it is the specificity of the asset, or the ability to use the asset in other transactions without having to incur substantial costs. The possibility that the counter part in the transaction can exploit this to their own advantage, according to (Rindfleisch and Heide 1997), with the possibility either pay for mechanisms to protect the asset, forgo the investment or take the risk. According to (Rindfleisch and Heide 1997) and (Douma and Schreuder 2008) another driver is that humans have bounded rationality which makes it impossible for them to comprehend consequences of the decisions made, the probabilities of consequences occurring or the evaluation of the performance of counterparts in the transaction. This can be mitigated by inducing costs related to obtaining, processing information and measuring performance of counterparts in order to face the opportunity cost of maladaptation, (Rindfleisch and Heide 1997). According to (Rindfleisch and Heide 1997) and (Douma and Schreuder 2008) the frequency of the transaction is also a because the more often the transaction is repeated, the lower the cost is for conducting the transaction for chosen governance arrangements.

Although inconclusive, the main relevant drivers of transaction costs in the shipyard found by (Masten, Meehan, and Snyder 1991), (Sergio and Senada 2009) and (Guisado-Tato,

Vila-Alonso, and Ferro-Soto 2004) were temporal asset specificity, human asset specificity and physical asset specificity, complexity, demand uncertainty and frequency.

This thesis will use the following characteristics for drivers of transaction cost according to the TCE theory:

Temporal asset specificity:

- Assets that needs to be used in a specific order or is important to keep an overall schedule and has limited use outside a specific transaction .

Human asset specificity:

- Skills and knowhow that have limited use outside a specific transaction.

Physical asset specificity:

- Machines or equipment for making parts that have limited use outside a specific transaction.

Complexity:

- The need to collect, process and evaluate a lot of information in order to conduct a specific transaction.

Demand uncertainty:

- Difficulties to predict the demands that the parties have for the outcome of the transaction.

Frequency

- Number of the transaction conducted.

1.9 Development of governance arrangements

At least 2 of the 4 yards in what would eventually would become Vard/STX OSV had their own steel fabrication and capacity to assemble hull structures on their own slipway in the early part of the 90's while one had already permanently moved out the region (Oterhals 1998), (Rørhus 1999) and (STX OSV 2011). According to (Oterhals 1998), (Rørhus 1999) and (STX OSV 2011) it was common to sometimes make parts of the hull or even the entire hull at other yards for delivery. Today all hull fabrication had been moved away from Møre and Romsdal and currently all the hulls for Vard/STX OSV, for their

Norwegian yards are delivered from 2 yards that are 100% owned and controlled by Vard/STX OSV (Rogne 2008), (Oterhals, Johannessen, and Hervik 2011) and (Vard 2013). Also according to (Vard 2013) expenses and revenue related to transactions between different operational segments of the group are monitored and used as basis for decision making.

For design Vard/STX OSV started out in 2000 with a 3 man design department to give technical support to their yards and eventually this department started to grow in size and scope to take on simpler design work (Stensvold 2011a). Currently the design department of Vard/STX OSV delivers about 80% of the design to the vessels delivered from Vard/STX OSV (Stensvold 2011a). The design department of Vard/STX OSV Vard Design Norway AS is currently a 100% owned company of the Vard Group and Vard/ STX OSV has also acquired 51% of the shares in a Croatian design firm to secure design and engineering capacity, (Vard 2013).

Based on the description from (Oterhals 1998) and (Rørhus 1999) the way steel fabrication and slipway was organized in the area of the yard sounds very similar to a vertical integrated transaction with full ownership and control. How to describe the current situation for hull fabrication is more difficult. On the one hand, the introduction of the price mechanism of transactions between operational segments in the group as well as the fact that moving hull fabrication permanently to yards in a different country sounds like reduction of control compared to having this done at the same yard where outfitting was conducted. On the other hand the 2 Romanian hull fabrication yards are 100% owned and controlled by Vard/STX OSV. When it comes to the design transaction things seems a bit clearer. Despite that still some of the designs are from external providers it seems clear that Vard/STX OSV has started using vertical integration as the primary form of governance instead of market governance.

Traditionally Ulstein Group has also bought parts of the hull or even entire hulls from other shipyards in Norway and Møre and Romsdal as well as sold designs to be built at other shipyards worldwide, (Grytten, Opdahl, and Eide 1992), but at in the end of the 90's the hull fabrication was outsourced, (Stensvold 2008). Instead Ulstein picked long term partners to deliver the hulls to their outfitting yard in Ulsteinvik as well as network yards worldwide that would not only make hull fabrication, but also the full outfitting of the

vessel of Ulstein design, (Krikwood et al. 2011). (Stensvold 2008), (Stensvold 2003) and (Ulstein Group 2012, 2011, 2010, 2009, 2006, 2007). At the same time Ulstein also had the capacity to make smaller steel structures like bridge modules and superstructures (Grytten 2007). In terms of design Ulstein Group have been designing and selling designs since the 70's, (Grytten, Opdahl, and Eide 1992), but because of the acquisition by Vickers/Rolls Royce the design transaction had to be reinvented within its design department, (Grytten 2007) and (Ulstein Group 2012). Ulstein Group also has acquired several design firms worldwide (Ulstein Group 2007) and (Ulstein Group 2012). According to (Krikwood et al. 2011) and (Stensvold 2008) Ulstein offers designs for offshore support vessels, heavy offshore vessels, shortsea vessels, container vessels, RO-RO vessels, chemical vessels and reefers.

Traditionally it was common for the Ulstein Group to sometimes buy parts or even entire hulls from other yards in Møre and Romsdal, (Grytten, Opdahl, and Eide 1992) describe the way in which the steel fabrication and slipway were organized, these being owned and controlled and thereby vertically integrated. After 1999 Ulstein have stated to use external shipyards for hull fabrication both to supply their outfitting yard in Ulsteinvik as well as conducting the entire delivery of their own design. The use of external suppliers is a clear sign of market governance. However at the same time the fact that the relationship for these suppliers seems to be very long term in nature can be used to enable other coordination mechanisms one finds within organizations to be built up and there is still some steel fabrication that is kept in-house. On one side it looks like a hybrid governance arrangement, but there is also some vertical integration present for a smaller part of the steelwork.

When it comes to the design transaction Ulstein had this as an important vertical integrated transaction in the 90's (Grytten, Opdahl, and Eide 1992). If one looks away from the fact that Rolls Royce/Vickers bought the design transaction and one had to start over again, the design transaction is still vertically integrated, (Ulstein Group 2012) and (Stensvold 2008). In many ways the design transaction has become more important than it was before and Ulstein also has vertically integrated design firms with different specialities worldwide (Stensvold 2008) and (Krikwood et al. 2011). From such a perspective the Ulstein Group has strengthen the vertical integration of the design transaction not only by

acquiring firms that have specializations in other fields than what Ulstein Group have had before, but also by acquiring firms in order to secure engineering capacity.

Like Vard/STX OSV and Ulstein Group Kleven also tried outsourcing its' hull fabrication transaction to external suppliers in 2002 but suffered big problems with delays and quality in the hectic period between 2006-2007, which led to re-thinking (Gurskevik 2006) and (Stensvold 2012b). Instead Kleven started to move more and more of their hull production to their own slipway in Ulsteinvik only buying some of the simpler hull modules from external suppliers in Poland, (Stensvold 2012b). According to (Roppen 2013b) and (Stensvold 2012b) Kleven has made substantial investments in robot welding and automations in order to deliver the more advanced modules like engine rooms and tank arrangements themselves. According to (Stensvold 2012b) and (Aadland 2007) Kleven is relying heavily on hired workers from Eastern Europe as an alternative to hull production in low cost countries.

In terms of design Kleven had like Ulstein Group their own design firm, but unlike Ulstein Group they chose to get rid of it. Kleven established their own design firm in 1985, (Westcon 2013), that specialized in the design of special tank ships (Kleven Maritime 2004). After trying to restructure the design firm from being an integrated part of their Florø yard to selling specialized tanker designs on the world market where price comepetition was fierce and dominated by Asian yards the design firm was sold in 2006 (Kleven Maritime 2001, 2002, 2004) and (Kleven Maritime 2006). The design firm had financial problems and the official reason given was that Kleven wanted to move away from the specialized tanker market and focus resources in the market for offshore service vessels and other specialised vessels , (Kleven Maritime 2004), (Kleven Maritime 2006) and http://www.klevenmaritime.no/referansar. There was also an emphasis on building close and good relations with leading design firms for building friendly and economic sustainable designs for these vessels, (Kleven Maritime 2002). According to (Bukve, Løseth, and Gammelsæter 2004) could be difficult because of the fact that independent design firms were very protective when it came to working with shipyards with their own design capacity. Also Kleven has started to make production drawings for their automated steel fabrication, (Molde 2013).

On one side it looks like the hull fabrication is still vertically integrated because of the fact that major parts of the hull building fabrication like assembly of ship modules on the slipway is still vertically integrated. On the other side most of the steel work is bought from external suppliers even if there has been made substantial investments in automated steel fabrication structures the majority of the steel structures are bought externally from the market. Another important component for hull fabrication that Kleve buys externally from the market is labour through the hiring of workers from Eastern Europe.

For the design transaction there is much speaking for that since this has gone from being vertically integrated to being outsourced to the market, as this was something that before was owned and fully controlled. On the other hand when one has close and long term relations with independent design firms it is also possible to build up more bureaucratic or socialization mechanisms of coordination in addition to the price mechanism. The fact that also some lower level of detailed engineering is being vertically integrated in order to fully utilize their investments in automated fabrication technology is also something that goes in the opposite direction of market governance.

1.9.1 Summary

When looking at the 3 shipyard constellations and how they have developed since the 90's for the forms of governance of the hull fabrication transaction and design transaction there are some patterns. It looks like the hull fabrication is marked with an attempt to balance the efficiency that market governance can offer up against the control of vertical integration and it looks like when it comes to the design transaction the focus is more on the control the more vertical arrangements can offer. In the 3 major constellations this played out quite differently.

When it comes to hull fabrication Vard/STX OSV has tried to gain this balance by moving the hull fabrication away from their yards in Møre and Romsdal to 2 yards in Romania and at the same time having full control over these firms through ownership. Ulstein's attempt is based on using external suppliers, but maintaining control by using the same yards over longer periods of time and thereby having the possibility of building up and maintaining additional coordination mechanisms to the price mechanism. Kleven wants to achieve this balance by doing central parts of the hull fabrication transaction themselves and use the market to provide the remaining.

It is also possible to see this attempt to balance the efficiency and control when one looks at the ratio of value that is bought from external suppliers of the total value created. When looking at the average percentage of value creation before and after 2005 on see that this has increased from 71,8% to 82,8% (Hervik, Nesset, and Opdal 1998), (Hervik, Nesset, and Opdal 2000), (Hervik, Bræin, and Oterhals 2005), (Hervik et al. 2009), (Hervik et al. 2010), (Hervik et al. 2011) and (Hervik 2012). There are limitations to this data, (Hervik, Nesset, and Opdal 1998) and (Hervik, Bræin, and Oterhals 2005), and part of this can be explained by the fact that in hectic periods excess capacity is bought from the market (Hervik, Bræin, and Oterhals 2005).

For the design transaction not only has Vard/STX OSV integrated the design transaction they have also acquired an external design firm in order to secure design/engineering capacity just like Ulstein Group has done. The most interesting case is Kleven which in many aspects has given up control of the design transaction by outsourcing it, but then again this move might have made it easier move closer to external design firms and build up close relations with them. When external technical consultants don't want to use shipyard capacity that also has own design capacity (Bukve, Løseth, and Gammelsæter 2004), there are less shipbuilding capacity available than it was during the 90's giving independent shipyards like Kleven increased leverage because of this position in the market. This leverage can also be seen as improved control over the design transaction compared to the 90's when its' own internal design transaction might have gotten in the way.

If one uses the alternative theoretical framework presented by (van Weele 2010), Core Competence Theory , for determining the boundaries of the firm the focus shift to look at what is the core of competitive advantage and focuses resources on this while outsourcing other activities. From such a perspective this move to vertically integrate or strengthen control over the design transaction can be understood as a realization that the design transaction is something that is defined as a strategically important activity for competitiveness and therefore something that should be done inside the firm. The transaction by its very nature is very important for shipbuilding for it determines how the vessel will look and function, and thereby to a large degree determines how it is going to be built. When looking at the arguments from the different shipyard constellations this

might be a very plausible explanation, (Stensvold 2011a), (Stensvold 2008), (Kleven Maritime 2002) and (Kleven Maritime 2006) .

All in all this thesis will argue that enough empirical evidence has been presented in order to confirm the first preposition stated earlier that there has been a change in the organization of the supply chain for the shipyards in Møre and Romsdal for the transactions that this thesis has investigated.

1.10 Underlying drivers for governance arrangements

According to (Masten, Meehan, and Snyder 1991) shipbuilding is characterized by the fact that it is a construction process where things have to be done more or less from scratch and in a specific order. If one uses the shipyards as the focal point this means that assets like hull modules and drawings specifying how hull modules are to be built both are assets that have the possibilities to cause delay in the completion of the vessel. Furthermore the hull module or detailed drawing of the hull module can't automatically be used on the next vessel project without major rework or adaptation. Because of both these characteristics, hull modules and detailed drawings can potentially be exploited opportunistically by a transaction partner making these assets temporal assets in the hull fabrication and the design transaction, respectively, for the shipyards. According to (Aslesen 2008) there has been a trend of reducing production time while at the same time increasing the amount of ships to be built for Norwegian shipyards and most of the shipbuilding capacity in Norway is located in Møre and Romsdal (Hervik and Jakobsen 2001) and (Oterhals, Johannessen, and Hervik 2011). With the reduction of delivery time for a vessel the consequences of potential opportunistic behaviour is also increased because a shorter hold up, either for a hull structure or detailed drawing, can now jeopardize the entire schedule in a much bigger way than before. Because of this, this thesis will argue that there has been an increase in the temporal asset specificity for both the hull fabrication and design transaction.

Human asset specificity can be skills or knowhow that has limited value outside the given transaction. For the hull fabrication transaction examples of skills that can be human specific is welding of ship structures, surface treatment, industrial plumbing and electrical installation (Ødegård and Andersen 2011) and (Hervik, Bræin, and Oterhals 2005) because shipbuilding often involves work in tight quarters with difficult access and a lot of coordination of different disciplines (Aslesen 2008) and (Hervik, Aslesen, and Oterhals

2005). Also it takes time to acquire the different skills needed in ship building as well as the experience and competence to become a skilled labourer, (Hammer 1999) meaning that it is not easy to replicate these skills without having to have someone go through quite a bit of training. The increase in availability of skilled workers in the EU, (Hervik, Aslesen, and Oterhals 2005), (Aslesen 2005) and (Ødegård and Andersen 2011), and increased availability of shipyards worldwide (Hervik, Aslesen, and Oterhals 2005), (Hervik et al. 2010) and (Stensvold 2012f), means that the shipyards in Møre and Romsdal can maintain a supply of skilled labour and conduct the hull fabrication transactiin several different places with several potential transaction partners. This thesis will argue that there has been a reduction in the human specific assets for the hull fabrication transaction since the 90's for the shipyards in Møre and Romdsal.

For the design transaction human specific assets can be the skills needed in order to balance the needs of customers, standards and 3rd party verification authorities. Demands of the customer for tailor and purpose made design solutions which includes performance guaranties for factors like speed, cargo and bollard pull, (Wilhelmsen 2011), standards that engineers have to relate to can sometimes be quite extensive and demanding,(NORSOK 2004), and in addition to 3rd party verification authorities. Because these are skills that can only be acquired through practical experience and because of these customer demands, demands of standards and 3rd party verification authorities are quite specific for ship design, these skills have limited value outside the design transaction. When combining the specific demands of the customer Wilhelmsen 2011) with the increase in complexty and demand uncertainy that has occurred, this thesis will argue that there has been an increase in the human specific asssets for the desgin transaction for the ship yards in Møre and Romsdal since the 90's.

Physical asset specificity for the hull fabrication transaction can be capital intensive equipment such as cranes, slipway, dry dock, floating dock and elevator that are specifically designed for shipbuilding. Moving such equipment without having to pay relatively high cost can be difficult and sometimes it is even impossible. With the increased availability of shipyards worldwide (Hervik, Aslesen, and Oterhals 2005), (Hervik et al. 2010) and (Stensvold 2012f), there is an increased availability of such equipment making these assets less specific for the shipyards in Møre and Romdsal. This

thesis will argue that there has been a reduction in the physical asset specificity of the hull fabrication transaction for the shipyards in Møre and Romsdal.

According to (Blasko, Howser, and Moniak 1992), (Mitchell et al. 2012), (Stensvold 2012b) and (Vard 2013), there has been an increase in the use of robot welding and automation for hull fabrication both worldwide and for the shipyards in Møre and Romsdal. Traditionally there were advantages in using customized welding robots because they were easier to adapt in order to get a more effective production line, (Westby 1991). However currently more modern "off the shelf" welding robots need to be modified and set up to a production line by experts, (Behrentz 2012) and (Molde 2013). Since such automated production lines for fabrication of hull structures can't be moved or rebuilt without incurring costs and since these lines are specially set up for fabrication of hull structures, this thesis will argue that there has been an increase in the physical asset specificity related to production technology for the shipyards in Møre and Romsdal for the hull building transaction. This thesis hasn't found that there has been any major development for physical asset specificity for the design transaction for the shipyards in Møre and Romsdal.

When it comes to complexity this thesis has chosen to use the characteristic related to collect, process and evaluate lots of information in order to conduct the transaction. Since the 90's the type of vessels that are being produced in Møre and Romsdal has changed from fishing vessels, supply vessels, ferries, fast passenger vessels, navy vessels and specialized smaller cargo vessels like reefers and gas ships (Dedekam jr. and Hervik 1989) to an almost exclusive focus on offshore service (Hervik et al. 2011). The offshore service vessels have also developed to include advanced offshore construction and ROV vessels that operate at great depths (Oterhals et al. 2008b) as well as a general advance in the more traditional offshore service vessels (Oterhals et al. 2008b), (Stensvold 2010a) and (Stensvold 2009a). There has also been an increase in the importance of HSE among oil companies, (Hervik, Aslesen, and Oterhals 2005) and (Hervik et al. 2010), and an increase in the demand for HSE documentation and that this has had implications on the vessel design, (Wilhelmsen 2011). This thesis will argue that the development in vessels, technology, customer demands and documentation demands has led to the fact that more information needs to be collected and processed in order to conduct the design transaction than before and that there are similar needs for the hull fabrication transaction. Therefore

there has been an increase in the complexity for the hull fabrication and the design transaction for the shipyards in Møre and Romsdal since the 90's.

Demand uncertainty is related to difficulty for the transaction parties in predicting the demand of the outcome of the transaction. According to (Aslesen 2008) change orders from shipping companies is common for shipyards in Norway. However with the increase in complexity and customer demand the consequences in terms of engineering capacity and cost, (Nordbye 2012), can potentially be severe. Also as (Kawser 2012) illustrates an offshore vessel is very interconnected so that change orders can in practice lead to a re-design of the entire vessel. With increased complexity and more detailed demands it is easier for mistakes to be made, both from the customer and from the designers. Because of this, this thesis will argue that there has been an increase in demand uncertainty for both the hull fabrication transaction and the design transaction.

According to (Aslesen 2008), (Hervik and Jakobsen 2001) and (Oterhals, Johannessen, and Hervik 2011) there has been a trend of reducing production time while at the same time increasing the amount of ships to be built for Norwegian shipyards as well as shipyards in Møre and Romsdal. This thesis will interpret this as there has been an increase in the frequency of both the hull fabrication transaction and the design transaction for the shipyards in Møre and Romsdal since the 90's.

1.10.1 Summary

When looking at the development for the underlying drivers for the shipyards in Møre and Romdsal since the 90's there seems to have been three predominant drivers that has affected the transaction costs for the hull fabrication and design transactions. It is the importance of delivery time and delivering on time, the importance of being able to meet detailed customer demands for quality and it is the structural changes in the shipbuilding structure that has increased mobility for conducting transactions.

Because of the importance of being able to deliver within a certain time frame and deliver on time drives the cost for safeguarding in terms of hours spent on follow up, meetings, scheduling and reporting to monitor and ensure that hulls and design/detailed drawings are on schedule and delivered on time. Also the frequency of use for the hull fabrication and

the design transaction has increased because of the drive to cut the delivery time while increasing the amount of vessels to be delivered.

The importance of being able to deliver the detailed demands of the customer drives the cost for adaptation to complexity and demand uncertainty for both the hull fabrication transaction as well as safeguarding human specific assets for the design transaction. One way in which one can meet increased complexity as well as demand uncertainty is by paying for access capacity in terms of design and production hours as well as access capacity in terms of performance for components and extra materials. The importance of meeting the customer demand for quality also drives the safeguarding costs of the skills and knowhow for the design engineers about design rules and regulation and problem solving. According to (Rindfleisch and Heide 1997) the ability to provide rewards for both behaviour and output can acts at tools for safeguarding.

The last driver is the increased mobility that has open up for the shipbuilding industry in Møre and Romsdal because of the structural changes within the EU regarding the subsidizing of shipbuilding, the opening of labour markets to new member states and the increase in the Asian shipbuilding industry, (Hervik 2003) and (Hervik, Aslesen, and Oterhals 2005). With the increased availability of skilled labour and the shipbuilding equipment the shipyards in Møre and Romsdal has to induce less safeguarding costs in order to conduct a hull fabrication transaction.

According to (Riordan and Williamson 1985) investments in assets that are very specific for the transaction can has cost reducing impact on production costs and are justifiable as long as these savings exceeds the added governance cost that follows with such investments. Investments in physical specific production technology for hull fabrication is according to (Roppen 2010) such investments have substantial cost savings compared to manual production. And production cost is also something that influences the governance decisions particularly for the hull fabrication transaction. According to (Aslesen 2005) a hull fabricated in Romania can be 55% cheaper than one fabricated in Norway.

All in all this thesis will argue that enough empirical evidence has been presented in order to confirm the second preposition stated earlier that there has been changes in the Transaction Cost Economic drivers for the organization of the supply chain since the 90s''.

6. Conclusion

The purpose of this thesis as stated earlier is to describe the developments of the supply chain for the shipyards i Møre and Romsdal since the 90's. The chosen method has been case study due to the ability of this method to capture contextual condition to describe the phenomena that is being researched and the ability to track development over time, (Yin 2003). According to (Hervik et al. 2011) the maritime industry in Møre and Romsdal is very tightly connected and this makes a strong argument for the fact that the use of case study methodology is a suitable research design for this research.

The following research question was formulated based on the defined research problem previously stated. What are the main developments in the organization of the supply chain for the shipyards in Møre and Romsdal since the 90's? According to (Rindfleisch and Heide 1997) Transaction Cost Economic Theory, (TCE) is a renowned and recognized theoretical framework with a rich empirical research in the field of make vs. buy decisions. Based on this the following research prepositions have been stated: There has been a change in the organization of the supply chain of the shipyards in Møre and Romsdal since 1990. And for the shipyards in Møre and Romsdal there have been changes in the Transaction Cost Economic drivers for the organization of the supply chain since the 90s''. In order to confirm these prepositions the hull fabrication transaction and the design transaction for the three major shipyard constellations in Møre and Romsdal were investigated.

When collecting evidence about the development of the supply chain since the 90s'' for the shipyards in Møre and Romsdal this thesis identified developments in terms of form of governance as well as the underlying drivers for the organization of the supply chain transaction. This thesis will argue that there has been developments were on try to balance the control that can be achieved through vertical integration of the supply chain transaction and the efficiency of the market governance for some transaction. At the same time there has been a tendency for other transactions that one seeks to increase control of the transaction. An example of the first can be the hull fabrication transaction and an example of the last can be the design transaction.

For the underlying drivers for the supply chain transaction this thesis will argue that importance of delivery time has influenced the temporal specific assets and the frequency

of the transaction while the importance of customer demands has influenced complexity, demand uncertainty and human specific assets of the design transaction. Mobility has influenced physical assets for shipbuilding equipment and human asset specificity of the hull fabrication transaction while production cost has been the drives for physical specific assets in production technology.

It is the importance of delivery time and delivering on time, the importance of being able to meet detailed customer demands for quality and it is the structural changes in the shipbuilding structure that has increased mobility for conducting transactions.

7. Limitations and recommendations for future research

This thesis has relied heavily on the secondary data that can be a problem for the construct validity of this thesis. The lack of primary data also lead to the fact that valuable empirical data about other interesting areas like the electro and automation transaction, that has shown strong indication of having developed since the 90s'', (Stensvold 2011b), (Stensvold 2011d) and (Steensen 2010). Also if time and opportunity had had allowed it more another shipyard in Møre and Romsdal, Havyard, would have been included in this thesis, http://www.havyard.com.

If time and opportunity would have allowed it more thorough literature review would also have been conducted, even if the amount of literature on TCE is very limited. Based on the information collected in this thesis it can look like other underlying drivers for transaction costs should be investigated for instance the presence of brand value and reputation (Bremnes, Hervik, and Sandsmark 2008).

According to (Williamson 1999) the unit of analysis of TCE is the transaction of goods and services between technological separable stages. It is the belief of this thesis that in order to get a better understanding of the organization of the logistic chain of given transactions by going in-depth into the technological details of shipbuilding in order to map and separate the different transactions that exists in shipbuilding. With such an understanding it would be possible to more utilize the TCE theory. For instance it would be possible to get a better understanding of that for some transactions like the hull

fabrication transaction there seems to be used more than one for of governance for this transaction. For more information on the use of simultaneous forms of governance mechanisms please see (Rindfleisch and Heide 1997) and (Rindfleisch et al. 2010).

8. Sources

Aadland, Camilla. 2012. *Vil ha alternativ til Polen*. Tekniskukeblad 2007 [cited 20.05.2012 2012]. Available from http://www.tu.no/industri/2007/01/25/vil-ha-alternativ-til-polen.

Aas, Bjørnar, Øyvind Halskau Sr, and Stein W. Wallace. 2009. The role of supply vessels in offshore logistics. *Maritime Economics & Logistics* 11 (3):302-325.

Asheim, Bjorn T., and Arne Isaksen. 2002. Regional Innovation Systems: The Integration of Local 'Sticky' and Global 'Ubiquitous' Knowledge. *Journal of Technology Transfer* 27 (1):77-86.

Aslesen, Sigmund. 2005. EU-utvidelsen-mulige tilpasningesstrategier i norske skipsverft.

———. 2008. Den maritime klynga i bevegelse. In *Fafos Rådsprogram 2006-2008*: Fafo.

Bakken, Karl Johan. 2009. VERFTSKONFERANSEN 2009 "Når kontraherer vi igjen?". Paper read at VERFTSKONFERANSEN 2009, at Ålesund.

Bedringås, Kai. 2006. *Introduksjon til olje- og gassteknologi*. Trondheim: Tapir akademisk forl.

Behrentz, Johan. 2013. *Sveiserobotar gjer revolusjon ved Kleven Verft*. Sunnmørsposten 2012 [cited 15.09.2013 2013]. Available from http://www.smp.no/nyheter/ytre/article512869.ece.

———. 2014. *Heiderspris til skipsdesigner*. Sundmørsposten 2014 [cited 02.03.2014 2014]. Available from http://www.smp.no/naeringsliv/article9185523.ece.

Blasko, G, J.;, B.C.; Howser, and D. J.; Moniak. 1992. Welding Robots for Shipbuilding. In *MSRP 1992 Ship Production Symposium*

New Orleans, Luisiana USA: THE SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS.

Bremnes, Helge, Arild Hervik, and Maria Sandsmark. 2008. *Fremveksten av petroleumsrelatert virksomhet i Midt-Norge*. Vol. 0807, *Rapport*. Molde: Møreforsking Molde AS.

———. 2011. *Merkevarer i petroleumsnæringen i Midt-Norge*. Vol. 1103, *Rapport*. Molde: Møreforsking Molde AS.

Bryman, Alan, and Emma Bell. 2011. *Business research methods*. Oxford: Oxford University Press.

Bukve, Oddbjørn, Arnljot Løseth, and Hallgeir Gammelsæter. 2004. *Nord-Vestlandet - liv laga?* [Ålesund]: Sunnmørsposten forl.

Buvik, Arnt. 2002. Manufacturer-specific asset investments and inter-firm governance forms: An empirical test of the contingent effect of exchange frequency. *Journal of Business to Business Marketing* 9 (4):3-26.

Coase, Ronald G. 1937. The Nature of The Firm. *Economica N.S.* 4:386-405.

Collis, Jill, and R. Hussey. 2003. *Business research: a practical guide for undergraduate and postgraduate students*. Basingstoke: Palgrave Macmillan.

Dedekam jr., Anders, and Arhild Hervik. 1989. Noen samfunnsøkonomiske perospektiver på støtten til norsk skipsbygging. Eksempler fra Møre og Romsdal. *Arbeidsrapport Møreforskning* 15:45.

Douma, Sytse, and Hein Schreuder. 2008. *Economic approaches to organizations*. Harlow: Prentice Hall/Financial Times.

Dwyer, F. Robert, and Sejo Oh. 1987. Output Sector Munificence Effects on the Internal Political Economy of Marketing Channels. *JMR, Journal of Marketing Research* 24 (4):347-347.

Eilertsen, Anne Gry. 2012. *100-millonars kontrakt til ABB*. Vikebladet.no 2012 [cited 14.10.2012 2012]. Available from http://www.vikebladet.no/nyhende/article462668.ece.

Grytten, Harald. 2014. *Skaparglede i 90 år : 1917-2007*. Ulstein Group 2007 [cited 02.03.2014 2014]. Available from http://www.ulsteingroup.com/kunder/ulstein/mm.nsf/inpdocuments/DEE31978F3F6A740C125737E00382AB8/$file/Skaparglede_i_90_aar.pdf.

Grytten, Harald, Ørnulf Opdahl, and Per Eide. 1992. *Maskiners arbeid og henders verk: Ulstein 1917-1992*. Ulstein: Ulsteingruppen.

Guisado-Tato, M., M. Vila-Alonso, and C. Ferro-Soto. 2004. Structural analysis of the shipbuilding industry based on transaction cost theory. *International Journal of Services Technology and Management* 5 (4):372-384.

Gurskevik, Magne. 2006. Kleven Verft og Kleven Maritime. Paper read at Fafo Østforum workshop

Halse, Lillebrygfjeld Lise, and Ove Bjarnar. 2011. Cluster Transformation from a Supply Chain Perspective: Theoretical Models and the Case of the Maritime Cluster in Mid-West Norway. In *Regional Studies Association Annual International Conference*. Newcastle.

Halvorsen, Morten. 2012. *M/S «NORMAND OCEANIC»*. Skipsrevyen 2011 [cited 30.09.2012 2012]. Available from http://www.skipsrevyen.no/batomtaler/baatomtaler-2-2011/135890.html.

Hammer, Kjell. 1999. *Tilvirkning og sammenstilling: VK1 skipsbygging*. Oslo: Yrkesopplæring.

———. 2002. *Sammenføyningsmetoder: sveiseteknikk*. Oslo: Gyldendal undervisning.

Hauge, Olav. 1992. *Strategisk næringsplan for Møre og Romsdal*. Molde: Fylkeskommunen.

Heide, Jan B. 1994. Interorganizational Governance in Marketing Channels. *Journal of Marketing* 58 (1):71-71.

Hervik, Arild. 2003. *Utviklingen i maritime næringer i Møre og Romsdal: status år 2003*. Vol. nr 0308, *Rapport*. Molde: Møreforsking Molde AS.

———. 2012. *NCE Maritime klyngeanalyse 2012: status for maritime næringer i Møre og Romsdal*. Vol. 1216. Molde: Møreforsking Molde.

Hervik, Arild, Sigmund Aslesen, and Oddmund Oterhals. 2005. *Maritime næringer i Norge: omstilling til en turbulent global framtid : sammendragsrapport*. Vol. 479, *FAFO-rapport*. Oslo: Fafo.

Hervik, Arild, and Lasse Bræin. 2010. *En empirisk tilnærming til kvantifisering av eksterne virkninger fra FoU-investeringer*. Vol. 1002, *Arbeidsrapport, M*. Molde: Møreforsking Molde AS.

Hervik, Arild, Lasse Bræin, and Oddmund Oterhals. 2005. *Med maritime næringer inn i en turbulent fremtid: status 2004 og scenarier 2015*. Vol. 0503, *Rapport*. Molde: Møreforsking Molde AS.

Hervik, Arild, Anders Dedekam jr., and Anne Bjørg Warnes. 1993. Verftstøtten i en omstillingstid. *Arbeidsrapport Møreforsknin* 17:29.

Hervik, Arild, and Erik W. Jakobsen. 2001. *Det regionale maritime Norge*. Vol. 8/2001. Oslo: Handelshøyskolen BI.

———. 2001. *Det regionale maritime Norge: en vital nasjonal næring med regionale særpreg*. Vol. 8/2001, *Forskningsrapport*. Oslo: Handelshøyskolen BI.

Hervik, Arild, Erik Nesset, and Øivind Opdal. 1998. *Utviklingen i maritime næringer i Møre og Romsdal*. Vol. nr 9805, *Rapport*. Molde: Møreforsking.

———. 2000. *Utviklingen i maritime næringer i Møre og Romsdal: status år 2000*. Vol. nr 0004, *Rapport*. Molde: Møreforsking.

Hervik, Arild, Oterhals Oddmund, G. Bergem Bjørn, and Johannessen Gøran. 2010. *Status for maritime næringer i Møre og Romsdal 2010*. Vol. 1011, *Rapport*. Molde: Møreforsking Molde AS.

———. 2011. *NCE Maritime klyngeanalyse 2011: status for maritime næringer i Møre og Romsdal*. Vol. 1110, *Rapport*. Molde: Møreforsking Molde AS.

Hervik, Arild, Oterhals Oddmund, G. Bergem Bjørn, and Gøran Johannessen. 2009. *Status for maritime næringer gjennom finanskrisen*. Vol. 0905, *Rapport*. Molde: Møreforsking Molde AS.

Hervik, Arild, Oddmund Oterhals, and Bjørn G. Bergem. 2007. *Den maritime næringen i Møre og Romsdal: en vekstkraftig næringsklynge rustet til omstilling?* Vol. 0711, *Rapport*. Molde: Møreforsking Molde AS.

Holmberg, Tomi;, and Shaun D.; Hunter. 2014. *Increasing Efficiency in the Ship Structural Design Process* http://www.maestromarine.com [cited 16.02.2014 2014]. Available from http://www.maestromarine.com/whitepapers/51_holmberg.pdf.

Jakobsen, Erik W. 2011. *En kunnskapsbasert maritim næring*. Vol. 5/2011, *Forskningsrapport*. Oslo: Handelshøyskolen BI.

Jiang, Pu, and Yihua Ge. 2006. An analysis of Chinese shipbuilding industry: how to achieve competitive advantage in the next ten years, Molde University College, Molde.

Johannessen, Jon-Arild, Johan Olaisen, and Arnulf Hauan. 1993. The challenge of innovation in a Norwegian shipyard facing the Russian market. *European Journal of Marketing* 27 (3):23-23.

Kanerva, Markku, Matti Lietepohja, and Petri Hakulinen. 2002. Shipbuilding Process-Challanges and Opportunities. Raisio: IBM.

Kawser, Zahid A.S.M. 2012. A Modular Design Methodology for OSV Accommodation Areas, Norwegian University of Science and Technology, Department of Marine Technology.

Kleven. 2012. Annual report 2011.

Kleven Maritime. 2001. Årsrapport 2001.

———. 2002. Årsrapport 2002.

———. 2004. Årsrapport 2004.

———. 2006. Årsrapport.

Kløvrud, Arnstein. 2011. New vessels and equipment for subsea operations. Paper read at Avanserte Marine Operasjoner, at Ålesund.

Krikwood, David Allan, Karolis Dugnas, Oddmund Oterhals, and Jagjit Singh Srai. 2011. Developing a network mapping approach to understanding High Value Manufacturing:

A case study of the Norwegian Maritime cluster Paper read at POMS 22nd Annual Conference, at Reno, Nevada, USA.

Kristoffersen, Steinar. 2011. *Complete documentation for commissioning*. Vol. 1111. Molde: Møreforsking Molde AS.

Lambert, Douglas M., Martha C. Cooper, and Janus D. Pagh. 1998. Supply chain management: Implementation issues and research opportunities. *International Journal of Logistics Management* 9 (2):1.

Larson, Erik W., and Clifford F. Gray. 2011. *Project management: the managerial process*. Boston: McGraw-Hill.

Mandic, Ivica; , Zeljko; Domazet, and Darko; Stipanicev. 1989. Introdiction of welding robots in shipyards. *Advanced Robotics* 3 (1):16.

Maritimt Magasin. 2013. *Normand Oceanic (04/2011)*. Maritimt Magasin 2011 [cited 16.12.2013 2013]. Available from http://maritimt.com/batomtaler/2011/normand-oceanic.html.

Masten, Scott E., James Meehan, and Edward Snyder. 1991. The costs of organization. *Journal of Law & Economics* 7 (1):26.

Masten, Scott E., and Oliver E. Williamson. 1999. *The Economics of transaction costs*. Cheltenham: Edward Elgar Pub.

Mauren, Arnfinn. 2012. *Bestiller roboter for å bygge skip*. Aftenposten.no 2012 [cited 01.08.2012 2012]. Available from http://www.aftenposten.no/okonomi/Bestiller-roboter-for-a-bygge-skip-6953357.html.

Mintzberg, Henry. 1989. *Mintzberg on management: inside our strange world of organizations*. New York: Free Press.

Mitchell, Gene;, Jim; Gardner, Matt; Sinfield, and Thomas; Lamb. 2012. A Review of Asian Shipyard

Robotic and Automated Welding

Technology. Paper read at Welding Technology Panel Meeting, at Ft. Collins, CO, USA.

Molde, Alf Inge;. 2013. *Backsourcing: Produksjonen hentes hjem*. Industri Kompetanse AS 2013 [cited 15.09.2013 2013]. Available from http://www.paaspissen.no/2013/05/backsourcing-na-hentes-produksjonen-hjem/.

Nedregaard, Tore. 2003. *Produksjon av olje og gass*. Nesbru: Vett & viten.

Nordbye, Knut Magnus Gjersen. 2012. Engineering Change Management in Shipbuilding, Norwegian University of Science and Technology, Department of Productions and Quality Engineering.

NORSOK. 2004. Surface preparation and protective coating. Oslo.

Oterhals, Leo. 1998. *Folk og fartøy: Aukra industrier 50 år*. [Aukra]: Aukra industrier.

Oterhals, Oddmund, Hervik Arild, Øyvind Opdal, and G. Bergem Bjørn. 2008a. *Internasjonalisering av offshore servicevirksomheten i Møre og Romsdal: globaliseringen har styrket maritim klynge*. Vol. 0801, *Arbeidsrapport, M*. Molde: Møreforsking Molde AS.

———. 2008b. *Utviklingen i maritime næringer i Møre og Romsdal - status 2008: rekordvekst med varierende lønnsomhet*. Vol. 0802, *Arbeidsrapport, M*. Molde: Møreforsking Molde AS.

Oterhals, Oddmund, Gøran Johannessen, and Arild Hervik. 2011. *STX OSV: ringvirkninger av verftsvirksomheten i Norge*. Vol. 1108, *Rapport*. Molde: Møreforsking Molde AS.

Reegård, Kaja, and Jon Rogstad. 2012. Fra sjø til land- Betydningen av sjøbasert erfaring i maritim næring fram mot 2020. edited by Fafo. Oslo: Fafo.

Remøy, Åge. 2010. The shipyard conference 2010-Our commitment. Paper read at Verftskonferansen 2010, at Ålesund.

Rindfleisch, Aric, Kersi Antia, Janet Bercovitz, James Brown, Joseph Cannon, Stephen Carson, Mrinal Ghosh, Susan Helper, Diana Robertson, and Kenneth Wathne. 2010. Transaction costs, opportunism, and governance: Contextual considerations and future research opportunities. *Marketing Letters* 21 (3):211-222.

Rindfleisch, Aric, and Jan B. Heide. 1997. Transaction cost analysis: Past, present, and future applications. *Journal of Marketing* 61 (4):30-54.

Riordan, Michael H., and Oliver E. Williamson. 1985. Asset Specificity and Economic Organization. *International Journal of Industrial Organization* 3 (4):365-365.

Rogne, Arne Otto 2008. Industriutvikling og faglige utfordringer. Paper read at Fafo-seminar: Maritim industriutvikling i Norge

Roppen, Tore. 2010. Kan vi bygge komplette skip i Norge? Paper read at Verftskonferansen 2010, at Ålesund.

———. 2013a. Kan vi bygge komplette skip i Noreg? Paper read at Verftskonferansen 2013, at Ålesund.

———. 2013b. Moderne Skipsbygging. Paper read at Forum for Automatisk Produksjon Konferanse 28-29 August, at Ålesund.

Rørhus, Rolv. 1999. *I Noas kjølvatn: Brattvaag skipsverft AS 50 år*. [Brattvåg]: [Brattvaag skipsverft].

Sergio, Ermacora, and Smajić Senada. 2009. The Make-or-Buy Decision in the Croatian Shipbuilding Industry: A Transaction Cost Economics Approach. *SEE Journal of Economics and Business* 4 (1):140.

Shetelig, Haakon. 2013. Shipbuilding Cost Estimation : Parametric Approach, Norwegian University of Science and Technology, Department of Marine Technology.

Solesvik, Marina Z., and Paul Westhead. 2010. Partner selection for strategic alliances: case study insights from the maritime industry. *Industrial Management + Data Systems* 110 (6):841-860.

Steen, Arvild. 2014. *Skipsdesign øker mest hos Ulstein*. Offshore.no 2008 [cited 02.03.2014 2014]. Available from http://www.offshore.no/sak/22530_skipsdesign_oeker_mest_hos_ulstein.

Steensen, Anders J. 2013. *Rompa først i sjøen*. Tekniskukeblad 2005a [cited 10.02.2013 2013]. Available from http://www.tu.no/nyheter/offshore/2005/04/18/rompa-forst-i-sjoen.

———. 2013. *Skipsdesign ble Årets ingeniørbragd 2005*. Tekniskukeblad 2005b [cited 10.02.2013 2013]. Available from http://www.tu.no/nyheter/naturvitenskap/2005/12/16/skipsdesign-ble-arets-ingeniorbragd-2005.

———. 2012. *Skipselektro stadig viktigere* 2010 [cited 23.04.2012 2012]. Available from http://www.tu.no/olje-gass/2010/04/14/skipselektro-stadig-viktigere.

Stensvold, Tore. 2013. *Ulstein til Kina*. Tekniskukeblad 2003 [cited 27.01.2013 2013]. Available from http://www.tu.no/nyheter/produksjon/2003/05/30/ulstein-til-kina.

———. *Den mystiske Ulstein-formelen avslørt* 2008. Available from http://www.tu.no/industri/article189624.ece.

———. 2012. *Ofrer millioner for miljøet*. Tekniskukeblad 2009a [cited 06.05.2012 2012]. Available from http://www.tu.no/industri/2009/04/07/ofrer-millioner-for-miljoet.

———. 2014. *Simulerer seg til bedre skip*. Tekniskukeblad 2009b [cited 16.02.2014 2014]. Available from www.tu.no/industri/2009/02/11/simulerer-seg-til-bedre-skip.

———. 2012. *Sparer drikkevann med "skipsdassen"*. Tekniskukeblad 2009c [cited 14.10.2012 2012]. Available from http://www.tu.no/industri/2009/10/04/sparer-drikkevann-med-skipsdassen.

———. 2013. *På tokt med Viking Lady*. Tekniskukeblad 2010a [cited 01.05.2013 2013]. Available from http://www.tu.no/olje-gass/2010/08/27/pa-tokt-med-viking-lady.

———. 2012. *VERDENS STØRSTE VIKINGSKIP*

BILDESERIE: Verdens største vikingskip bygges. Tekniskukeblad 2010b [cited 22.05.2012 2012]. Available from http://www.tu.no/industri/bildeserier/2010/12/30/bildeserie-verdens-storste-vikingskip-bygges.

———. 2012. *Analytisk designsuksess*. Tekniskukeblad 2011a [cited 01.05.2012 2012]. Available from http://www.tu.no/industri/2011/12/20/analytisk-designsuksess.

———. 2012. *Frykter ikke Asia-konkurranse*. Tekniskukeblad 2011b [cited 06.05.2012 2012]. Available from http://www.tu.no/industri/2011/11/28/frykter-ikke-asia-konkurranse.

———. 2012. *Kjøper seg opp i design*. Tekniskukeblad 2011c [cited 01.05.2012 2012]. Available from http://www.tu.no/industri/2011/09/01/kjoper-seg-opp-i-design.

———. 2012. *Kleven investerer i ny teknologi*. Teknisk ukeblad 2011d [cited 16.05.2012 2012]. Available from http://www.tu.no/industri/2011/11/28/kleven-investerer-i-ny-teknologi.

———. 2012. *Brasil bygger 14 'norske' boreskip*. Tekniskukeblad 2012a [cited 30.09.2012 2012]. Available from http://www.tu.no/olje-gass/2012/09/24/brasil-bygger-14-norske-boreskip.

———. *Kleven flytter stålproduksjonen hjem*, 23.01.2012 2012b. Available from http://www.tu.no/industri/article295152.ece.

———. 2013. *KOSTNADSNIVÅET I NORGE– Norge er ikke dyrere enn Dubai*. Tekniskukeblad 2012c [cited 27.01.2013 2013]. Available from http://www.tu.no/industri/2012/04/11/-norge-er-ikke-dyrere-enn-dubai.

———. 2012. *Leverer design til Italia*. Tekniskukeblad 2012d [cited 16.08.2012 2012]. Available from http://www.tu.no/industri/2012/06/20/leverer-design-til-italia.

———. 2012. *Reparerer skip i Brasil*. Tekniskukeblad 2012e [cited 16.05.2012 2012]. Available from http://www.tu.no/industri/2012/02/01/reparerer-skip-i-brasil.

———. 2013. *VERFTSKONFERANSEN 2012 – Innovasjonsevne, kvalitet og levering til rett tid*. Tekniskukeblad 2012f [cited 07.04.2013 2013]. Available from http://www.tu.no/industri/2012/11/06/-innovasjonsevne-kvalitet-og-levering-til-rett-tid.

Strøm, Knut. 2014. *Fremtidens skipsdesign*. Tekniskukeblad 2003 [cited 16.02.2014 2014]. Available from http://www.tu.no/nyheter/produksjon/2003/08/25/fremtidens-skipsdesign.

———. 2014. *Skipsdesign basert på moduler og gjenbruk*. Tekniskukeblad 2005 [cited 16.02.2014 2014]. Available from www.tu.no/industri/2009/02/11/simulerer-seg-til-bedre-skip.

STX OSV. 2011. STX Langsten - et retrospekt-. edited by S. OSV.

———. 2012a. Annual Report 2011.

———. 2012b. FINCANTIERI SIGNS AGREEMENT TO ACQUIRE 50.75% OF THE SHARES IN STX OSV HOLDINGS

Stølen, Kjell Arvid. 2013. *STX Florø seld til Westcon*. NRK Sogn og Fjordane, 02.01.2013 2013 [cited 16.02.2013 2013]. Available from http://www.nrk.no/nyheter/distrikt/nrk_sogn_og_fjordane/1.10858233.

Stølen, Kjell Arvid, and Britt Jorunn Svanes. 2013. *Røkke kjøper Kleven Florø*. NRK Sogn og Fjorande, 23.06.2006 2006 [cited 16.01.2013 2013]. Available from http://www.nrk.no/nyheter/distrikt/nrk_sogn_og_fjordane/1.641485.

Tinmannsvik, R.K, Albrechtsen E, Bråtveit M, Carlsen I.M, Fylling I., Hauge S., Haugen S., Hynne H., Lundteigen M.A., Moen B.E, Okstad O., Onshus T., Sandvik P.C., and Øien K. 2011. Deepwater Horizon-ulykken: Årsaker, lærepunkter og forbedringstiltak for norsk sokkel. SINTEF.

Ulstein Group. 2006. Annual report 2005.

———. 2007. Annual report 2006.

———. 2009. Annual report 2008.

———. 2010. Annual report 2009.

———. 2011. Annual report 2010.

———. 2012. Annual report 2011.

———. 2013. Annual report 2012.

Ulstein, Tore. 2012. Korleis skapar vi morgondagens løysingar? Paper read at Verftskonferansen 2012, at Ålesund.

van Weele, Arjan J. . 2010. *Purchasing & supply chain management: analysis, strategy, planning and practice*. Andover: Cengage Learning.

Vard. 2013. Annual Report 2012.

Westby, Ola. 1991. *Fabrikasjon av skip, plattformer og sveiste konstruksjoner*. [Trondheim]: Tapir.

Westcon. 2013. *Westcon Design Florø* 2013 [cited 16.07.2013 2013]. Available from http://www.westcon.no/WebFolder1.aspx?NodeId=a394d727-afff-492a-ac0a-fc6983b70e81.

Wilhelmsen. 2011. Verftskonferansen 2011 "Our position versus Asia" Paper read at Verftskonferansen 2011, at Ålesund.

Williamson, Oliver E. 1975. *Markets and hierarchies: analysis and antitrust implications*. New York: Free Press.

———. 1985. *The economic institutions of capitalism: firms, markets, relational contracting*. New York: Free Press.

———. 1991. Comparative Economic Organization: An Analysis of Discrete Structural Alternatives. *Administrative Science Quarterly* 36 (June):269-296.

———. 1999. Strategy research: Governance and competence perspectives. *Strategic Management Journal* 20 (12):1087-1087.

Yin, Robert K. 2003. *Case study research: design and methods*. Thousand Oaks, Calif.: Sage.

Ødegård, Anne Mette, and Rolf K. Andersen. 2011. Østeuropeisk arbeidskraft i hotell, verft, fiskeindustri og kjøttindustri. FAFO