Vaasan yliopisto
UNIVERSITY OF VAASA

JUHA KYTÖLÄ

Sustainability in shipbuilding innovations and reflections on management

ACTA WASAENSIA 383

INDUSTRIAL MANAGEMENT

ACADEMIC DISSERTATION

To be presented, with the permission of the Board of the Faculty of Technology of the University of Vaasa, for public dissertation in Auditorium Kurtén (C203) on the 6th of October, 2017, at noon.

Reviewers ASSOCIATE PROFESSOR RODRIGO LOZANO
UNIVERSITY OF GÄVLE
KUNGSBÄCKSVÄGEN 47
SE-801 76 GÄVLE
SWEDEN

Professor Pirjo Ståhle
Intangible Capital and Innovation Management,
School of Engineering,
Aalto University
S P.O. Box 11000
FI-00076 AALTO
FINLAND

Julkaisija	**Julkaisupäivämäärä**	
Vaasan yliopisto	Lokakuu 2017	
Tekijä(t) Kytölä, Juha	**Julkaisun tyyppi** Väitöskirja	
	Julkaisusarjan nimi, osan numero Acta Wasaensia, 383	
Yhteystiedot Vaasan yliopisto Teknillinen tiedekunta Tuotantotalous PL 700 FI-65101 VAASA	**ISBN** 978-952-476-764-4 (painettu) 978-952-476-765-1 (verkkoaineisto)	
	ISSN 0355-2667 (Acta Wasaensia 383, painettu) 2323-9123 (Acta Wasaensia 383, verkkoaineisto)	
	Sivumäärä 192	**Kieli** englanti

Julkaisun nimike
Kestävä kehitys laivanrakennuksen innovaatioissa ja vaikutukset johtamiseen

Tiivistelmä
Tämä tutkimus keskittyy selvittämään kestävän kehityksen innovaatioita laivanrakennuksen alalla ja vaikutuksia johtamiseen. Tavoite oli luoda tieteellisen tutkimuksen kautta ohjeistus käytännön johtamistyöhön.

Ensin kehitettiin teoreettinen viitekehys kirjallisuuteen pohjautuen. Sitä testattiin käyttäen laivanrakennuksesta kertovaa ei-tieteellistä kirjallisuutta. Viitekehys oli pohjana hermeneuttiseen strategiaan perustuvan empiirisen tutkimuksen suunnittelussa. Viiden Etelä-Koreassa ja neljän Kiinassa sijaitsevan telakan johtajia käytettiin laadulliseen tutkimuksen tiedonlähteinä.

Tutkimustulokset visualisoitiin alustavassa mallissa, joka koostuu ohjaavista tekijöistä, jotka vaikuttavat kestävään kehitykseen innovaatioissa. Liiketoiminnan kannattavuus on sisällytetty alustavaan malliin uudenlaisella tavalla. Tulokset antavat viitteitä siitä, että ylimmällä johdolla on voimakkain ohjaava vaikutus, ja seuraavana tulevat strategia ja liiketoimintaan liittyvä lainsäädäntö. Tuloksissa on esitelty uudella tavalla ajan merkitystä johtamisprosesseissa, jotka ohjaavat innovaatioita kestävän kehityksen suuntaan.

Tutkimustulosten pohjalta luotiin käytännöllinen tapa arvioida yritysten suoriutumista kestävän kehityksen tuomiseksi innovaatioihin. Lopuksi luotiin tehtävälista yritysjohdolle, joka haluaa johtaa innovaatioita kohti kestävää kehitystä liiketoiminnassaan.

Asiasanat
Kestävä kehitys, Innovaatio, Johtaminen, Yrittäjyys, Laivanrakennus

Publisher	**Date of publication**	
Vaasan yliopisto	October 2017	
Author(s) Kytölä, Juha	**Type of publication** Doctoral thesis	
	Name and number of series Acta Wasaensia, 383	
Contact information University of Vaasa Faculty of Technology Industrial Management P.O. Box 700 FI-65101 Vaasa Finland	**ISBN** 978-952-476-764-4 (print) 978-952-476-765-1 (online)	
	ISSN 0355-2667 (Acta Wasaensia 383, print) 2323-9123 (Acta Wasaensia 383, online)	
	Number of pages 192	**Language** English

Title of publication
Sustainability in shipbuilding innovations and reflections on management

Abstract
This research focuses on identifying sustainability in shipbuilding innovations and reflections on management. The aim was to develop practical guidance for managers and leaders in their work through systematic scientific research.

First, a theoretical framework based on literature was developed. It was tested using secondary literature from shipyards and used as a basis for empirical research based on hermeneutic strategy. The management teams from five shipyards in South Korea and four in China were used as sources for data for qualitative analysis.

The research results were visualised in a proposed, new model consisting of drivers that impact sustainability development in innovations. The profitability of the business is included in the model in a novel way. The results indicate that top management is the strongest driver, followed by strategy and relevant legislation in the business context. The aspect of time in management activities whilst developing sustainability is presented in a new way.

Based on the research, a practical concept for assessing company performance on the journey towards sustainability in innovations was developed. Finally, a 'to-do' -list was created for management personnel who wants to lead innovations towards sustainability in their businesses.

Keywords
Sustainability, Innovation, Management, Leadership, Entrepreneurship, Shipbuilding

ACKNOWLEDGEMENTS

I have always taken a keen interest in learning new things and also in achieving milestones in my life. This has been seen in my passion in doing things with my own hands: repairing cars, building a house for our family, constructing small or bigger machines etc. One of the milestones that I had in my mind straight after graduating with MSc degree was to continue with post-graduate studies. But at that time it was more attractive to start in working life and also to get salary from an engineer's job. And I also obtained highly interesting work in the combustion engine business which I have never regretted.

However, the idea of pursuing post-graduate studies and to obtaining a doctoral degree stayed in my mind during all the years at work. After first consideration straight after MSc graduation, I had serious thoughts about studying after having been ten years in working life. I then concluded, however, that the time was not right: our children Aleksi and Laura were young and family life was busy for me and especially for my beloved wife Anne. My work was also occupying a lot of time and offering a lot of opportunities to learn new things and it kept me busy with new responsibilities, projects and travelling etc.

My third time to consider further studies was also when I decided that I would actually now start them. I had been 23 years at work all the time in the same company but had changed the job and tasks several times and had the opportunity to learn the business from various viewpoints. Our children had started moving away from home but the job still kept me busy. Luckily I had learned to manage time and control stress better than earlier and thus I felt that this was the moment. And, most importantly, my beloved wife Anne supported me with the decision despite fully knowing how much it would occupy me and thus result in having less quality time together.

Half a year after starting the studies I again got another job opportunity within the same company but now to lead a newly established team. That job also required me to move to England in order to establish myself well in the new role. My first thought was that I can perhaps utilize my time for the studies even better there since my family stayed in Finland and I could use the evenings efficiently. That dream was however not that easy to realize since living in a new environment both offered a lot of interesting opportunities but also demanded a lot since getting even simple practical matters taken care of took a lot more time in unfamiliar surroundings.

However, I managed to make progress continuously and used numerous hours in airports, airplanes, at home and abroad for conducting studies and learning new

things. And, from the very beginning the studies felt highly motivating. I have all the time been able to reflect on the studies against my own experience from work. Several times the studies have given me opportunities to test theories at work and to try different approaches in a real working environment. I have all the time been positively surprised at how good and motivating the material given to me by my supervisor Adjunct Professor Marja Naaranoja from the Department of Industrial Management has been. I owe big thanks to her for the advice, discussions and guidance that she has given me during all these years. I have also been pleased with the positive approach that all departments at the University of Vaasa have shown towards a post-graduate student working in industry alongside the studies.

Whilst performing my studies, I have several times been thankful for the working life experience that my employer has given me. I feel that these experiences have been essential in order to grasp the potential from the studies. At the same time I have also wondered how difficult it must be for young, newly graduated MSc students to start post-graduate studies especially in management straight after graduation since they will miss the depth that comes with experience.

For me the studies have given a lot of joy and inspiration and I am very pleased that I started them after so many years of working experience. I hope this publication gives important additions and new insights into research theory and leads to further development of the science of sustainability management.

Finally, I want to thank my family, friends and colleagues for the interest and support they have given. Most importantly: Anne, thank you for your love, patience and encouragement.

Contents

Figures

Tables

Abbreviations

BWMS	Ballast water management systems
CO2	Carbon dioxide (emissions)
EEDI	Energy efficiency design index according to IMO MARPOL Annex VI
IMO	International Maritime Organisation
NOx	Nitrogen oxides (emissions)
SOx	Sulphur oxides (emissions)
SFOC	Specific fuel oil consumption
Tier III	Nitrogen oxides emissions limitation according to IMO MARPOL Annex VI regulation 13 and the NOx technical Code 2008

1 INTRODUCTION

The purpose of this research is to find important aspects of sustainability in innovations. In order to obtain a deeper understanding the work is limited to the area of shipbuilding. Shipbuilding has long traditions in adopting and creating innovations and is therefore very suitable for this purpose. Reflections related to practical management and leadership are identified in light of the results.

Many businesses today face the need to satisfy customer needs for more eco-efficient products and to meet increasingly stringent environmental legislation, whilst at the same time the requirements of involving social aspects, 'doing the right thing', and business ethics and morality are becoming more and more important in society as a whole. The needs are sometimes local but more and more often global regulations and concerns need to be met.

Although these trends have been visible for a few years already, only limited guidance has been found in professional literature or in management training in terms of how to lead companies to develop their innovation activities in a sustainable direction. The non-existence of such guidance raises concern about the question being relevant at all and whether or not there is something different in managing a business with sustainability-oriented innovation compared to 'traditional' innovation.

A quick overview of the academic literature reveales that there have been others who have asked the same question, such as the seminal work of Rennings (2000), and that academic research in the same area has been started by many researchers already (Schaltegger & Wagner, 2011; Adams et al, 2015; Lozano, 2016). The topic is quite new, with most of the research coming from this millennium and the amount of research is increasing. Probably due to the newness of the topic, the studies performed have been rather theoretical and at some distance from practical management praxis. The results that are available cover more the phenomena of sustainability and describe the drivers impacting it, but do not present activities or priorities that would need to be taken into account in conducting management activities.

The research gap that has been identified is thus in the area of sustainability and innovation management: how to take sustainability targets and aspects into account when managing innovations in businesses. What are the practical approaches that work well? Are there mandatory focus areas, and are perhaps some other aspects less important, thus not requiring active attention?

1.1 Research on innovation

Innovation activity is important for companies in order to maintain their business position and to expand to new areas. The measure of business success has traditionally been the financial performance of the enterprise. Financial figures tell if a company is successful in conducting business or not. The challenge with financial numbers and data is that although these are important as a measure of the company's wellbeing, they mainly indicate the historical and present performance and less about the future performance.

Innovation gives possibilities to increase competitiveness for the future, to be able to react to market changes and to create new opportunities. A typical way of measuring the efficiency of innovations and the management of innovation activity is to measure the financial impact resulting from the activity. Due to the importance of innovation and the importance of managing it well, the history of innovation research is already long.

Schumpeter (1934) identified already early in the industrial age that innovation is an independent societal and business factor and therefore needs to be studied and understood. He later connected the management of innovations to entrepreneurial activity and explained the impact of those on the economy (Drucker 2015). Since the 1950's it has been emphasized that technical innovation is a key driver of growth in the economy. Theories supporting this observation have been created (Solow 1957) and later proven by empirical studies.

Innovation in this research is understood as the set of activities and operations that are performed in order to bring a new idea, invention or a solution to be part of the business operations and fulfil the needs of the markets or to create new markets. It is not limited to products only but can cover service offerings as well.

1.2 Sustainability in connection with innovation

The sustainability viewpoint has recently been noticed to give a broad and balanced view of a company's performance since the wellbeing of society and nature cannot be ensured by focusing only on economic performance. Growing concern about resource over-consumption, environmental degradation and social inequity have resulted in calls for a transition toward a more sustainable society and economy (Adams et al., 2015).

Sustainability in innovation is a relatively new area of research. Sustainability is generally understood to consist of three main elements: financial, social and

environmental (Elkington, 1997; Adams et al., 2015; Engert et al., 2015), but also other viewpoints have been presented (Lankoski, 2016). Innovation in connection with financial performance has been an area of research for a longer period, but the social and environmental sustainability elements as part of innovation activity have been considered in research only since the beginning of this millennium (Rennings, 2000). Research in these areas is rapidly increasing since the results indicate that these areas have relevance, and at the same time businesses themselves have also started to put more focus on them. Additionally, it is believed that the importance will further grow in the future when business environments need to focus more and more on social aspects, morale and ethics and also to take both local and global environmental aspects into account in their operations.

Interested parties in this wider context are several and therefore stakeholder theory is one of the major, if not most frequently used, approaches in social, environmental, and sustainability management research (Frynas & Yamaki, 2013; Montiel & Delgado-Ceballos, 2014; Morioka & Carvalho, 2016). Time is seen as having importance as well (WCED, 1987; Lozano 2008) and some consider that time should also be included as the fourth element due to its importance in sustainable development (WCED, 1987; Lozano, 2015).

The wide focus of sustainability is not commonly recognised yet, but positive signs can be seen already (Lozano, 2015). The business performance pressure of many companies has significantly changed since openness, the availability of information and awareness of the global and local surroundings have increased via communication and information over the Internet and other modern channels (Kytölä & Naaranoja, 2016). Recent research suggests that big changes in society and technology will fundamentally challenge conventional understanding of what is valuable (Verganti 2016).

Increased public interest in sustainability can be seen in recent scandals regarding business ethics, lately globally seen in the car industry (the car manufacturer Volkswagen's exhaust gas emission performance fraud/scandals) and earlier in the energy business (the energy producer Enron's business ethics scandals leading to the bankruptcy of this giant energy conglomerate). Individuals can nowadays practically experience environmental changes like extreme changes of weather, the extinction of species etc. The importance of environmental aspects is today known by most people in the world. In China most people have as their first page on mobile smart phones the measure of local air quality index for the day. In Europe the ambitions set in the EU 2020 and 2050 environmental targets are well communicated, as are globally the recent United Nations Climate Change Conference (Paris 2015) decisions, in which global agreements on the reduction of

climate change were agreed on on the 12th of December 2015, and which China and the USA decided to ratify in September 2016.

The elements of sustainability as part of innovations in this research are selected to consist of financial, social and environmental aspects. The viewpoint will be from the management side, which means that the sustainability elements will be studied from a holistic point of view and not split into small details.

1.3 Innovation management

Innovation is sometimes confused with invention. Invention is only the first step in a long process of bringing a good idea into widespread and effective use. Innovation is the process of growing ideas into practical use (Tidd & Bessant, 2010). Innovation is about managing knowledge – creating new possibilities through combining different knowledge sets. Innovation rarely involves dealing with a single technology or market, but rather a bundle of knowledge which is brought together into a configuration. Successful innovation management requires that we can obtain knowledge about components and also about how these can be put together – called the architecture of innovation.

According to Tidd & Bessant (2010), although innovation sometimes involves a discontinuous shift, most of the time it takes place in an incremental fashion. Disruptive or new-to-the-world innovations are only 6-10% of all innovation projects. The cumulative gains in efficiency are often much greater over time than those which come from occasional radical changes. Regarding discontinuous innovation, which means shifts in technology, in new market emergence or in new business, established companies have difficulties. New players tend to do better because they do not have to grapple with learning new tricks and letting go of their old ones. Additionally, established companies tend to listen to their customers so well that they miss opportunities with radically new possibilities. Thus, under discontinuous conditions, different approaches are needed for organising and managing innovation.

Rogers (2003) presents how innovations and new ideas are spread via communication channels over time and through the social system. He shows the logic from innovators to early adaptors, early majority and late majority ending with the laggards until a saturation in market share is reached. McGahan (2004) describes that when developing innovations, companies need to manage the evolution that is natural for a company. If the planned developments of the company break the rules of the category, then the development fails. Failure to achieve better performance almost always occurs because of a gap between the

understanding that innovation drives performance and an understanding that only some forms of innovation work within an industry context. After recognising the category, company strategies can be developed using the rules that are dominant in that category.

The defining criteria for identifying the trajectory of change in a particular industry involve assessing different levels of threats from new technology, globalisation, buyer tastes, and other factors. Where threats exist, they motivate change by exerting pressure on existing elements of an industry's revenue and cost. Innovation in an industry is vital for profitability under all trajectories of change, and innovation is vital to survival when threats are broad and intense (McGahan, 2004).

The management aspect in this research is seen as the set of actions and activities that are taken by the top management in order to lead the business towards more sustainable development. It is built upon looking at the big picture and making necessary choices and activities for performing successful business and satisfying the long term benefits for the business.

1.4 Innovation in shipbuilding

Shipbuilding is an industry that has gone through several transformations as a result of continuous innovation. During their existence, ships have been used to support businesses by transporting important and valuable goods economically and thus have been important elements of doing business (Fayle, 2006). Those who had bigger or faster or safer ships could benefit from making more successful business (Davies, 2014). Ships have also been effectively utilized by nations for military purposes for conquering the world with ever faster, bigger and more powerful ships (Davies, 2014). All these aspects have triggered the need for continuous innovation, and thus shipbuilding provides an interesting platform for innovation research (Lindsay, 2013).

Early ships were large boats built of wood and powered by sail and/or oars. The construction of ships has changed from wood to steel and the manufacturing methods of steel structures have changed from riveted structures to welded designs (Åkesson, 1999). Development in powering ships has changed from oars and sails to steam engines fired by wood and coal and later these changed to steam turbines (Davies, 2014). Nuclear reactor produced steam driven turbines have also been used in rare special cases, but the main technological trend for powering ships has been the shift to diesel and gasoline driven piston engines and in

innovations in those technologies (Kytölä, 1997) and also later with the introduction of gas as a fuel for such ship engines (Kytölä & Heim 2007).

Shipbuilding is a business with global reach and global competition. Ships are used all over the world and many of these are also in global traffic. Building ships employs a lot of people and generates wealth to the surroundings. Therefore, governments and nations have a big interest in maintaining and developing shipbuilding in their countries and thus promote innovations in order to increase competitiveness. Whilst North European countries used to dominate global shipbuilding until the 1960's, Japan took a leading position in the world thereafter, mainly thanks to investments in modern production technologies. Since the 1980's South Korea has become dominant due to modern and efficient production technologies, and recently China has become the leading shipbuilding nation in the 2010's due to further simplification and cost efficiency. Simultaneously, all the global trends towards privatization and global trade have further boosted innovations in the business.

Since shipbuilding has gone through massive waves of innovations, it provides an interesting platform for research in innovations (Greve, 2003). Fierce competition between companies and nations has enabled rapid development of the industry and forced even radical solutions to be taken into use in order to find areas of competitive edge in businesses. Today all ships are designed for a specific customer need. The needs are covered by new designs that need to satisfy the expectations of customers in the most optimal way. Therefore new innovations are always included in the process from idea to design and further to manufacturing in shipbuilding. All new ships are thus a part of such an innovation process.

Companies in the industry such as shipyards, ship operators and owners are typically large companies and employ many people and therefore have a close focus on social wellbeing. Shipping is also globally regulated by the International Maritime Organisation (IMO), which is part of the United Nations, and a major focus in regulations is now given to environmental aspects. Therefore, the shipbuilding business needs to have a major focus on all sustainability elements, which makes it an especially attractive research area for studies in sustainability in innovations.

The shipyards in focus in this study are limited to yards that do global business and which build large, ocean going ships. Such ships may be for merchant business such as bulk carriers, tankers, ferries, cruise ships or other kinds of vessels and also vessels used for offshore purposes for oil and/or gas exploration, research and production purposes. Such shipyards exist mainly in Europe and Asia and perform

innovations practically in all their projects since every new ship today is a result of new innovation.

1.5 Target for the research

This dissertation is aimed at leveraging existing knowledge of sustainability in innovations and developing it further by conducting academic research. The aim is to create practical guidance for managers in leading innovations in their businesses towards sustainability. There is no current research presented for the practical management aspects. Many research papers have identified important aspects impacting sustainability management (Elkington, 1997; Adams, 2015; Lozano, 2015) but have not gone so far as to create tools or processes for businesses.

The reflections on management are looked at holistically in this research. The target is to use the results of the research to identify different important management focus areas, to create understanding of the priorities of these and to highlight the mechanisms and dependencies between them. Thus the goal is to contribute to academic knowledge in the area of the research and to create practical tools and processes for management in order to conduct efficient management of innovations towards sustainability.

2 RESEARCH QUESTION

2.1 Focus area of the research

Focus on sustainability research and the number of related scientific journal articles have both increased rapidly since the beginning of 2000. Theories have been created for the development of sustainability-oriented innovation (Adams et al., 2015) and for the integration of corporate sustainability into strategic management (Engert et al., 2016). Some research shows that combining sustainability with business gives contradictory guidance for managing businesses and thus creates a complex environment to manage, and therefore traditional innovation management practices do not result in favourable development (Vitezic et al., 2015; Adams et al., 2015; Engert et al., 2015). Some also say that the combination of sustainability and innovation presents a conflict which leads to sustainability-oriented innovations being different from economic-oriented innovations both in scope and in the forces that drive their dynamics (Adams et al., 2015; Siqueira and Pitassi, 2016), and therefore new business models and company strategy fields are needed (Boons et al., 2013).

Despite the fact that theoretical models have been created, only a few published research papers have focused on the practical aspects of managing sustainability in innovations in practice, such as Matos and Silvestre (2013). This research is based on literature study and raises important elements and drivers for sustainability in innovations by adding practical management processes and priorities into the literature based framework. This research is aimed at clarifying the importance of the drivers in ship-building companies, and not at empirically verifying the framework. The research focuses on identifying priorities and powerful activities that are relevant for leaders and managers when striving to drive their businesses towards sustainable innovation development.

2.2 Key research questions

This research attempts to identify priorities and activities that are relevant for leaders and managers when striving to drive their businesses towards sustainable innovation development.

The research focuses on the following research questions:

Research question 1: What have been the most important factors and priorities impacting business development towards sustainability in innovation?

Research question 2: How can performance of sustainability in innovation be assessed?

Research question 3: How can management guide businesses to develop towards sustainability in innovation?

These research questions are intended to bring clarity to the practical approaches that are needed in analysing business environments and leading businesses towards sustainable innovations. The purpose is to find priorities and focus areas that have the biggest impact in the journey the companies make. For management the importance is to find observations and parameters that will most efficiently support decision making when striving for sustainability, which in practice consists of financial, social and environmental elements. The research focus covers innovation activities for new products but does not exclude businesses offering services.

The area of the research is wide. As such, it touches on many aspects of management within a company. Additionally, external factors like policies, customers and other stakeholders have a role which may be beyond the influencing power of management. In order to avoid too much generalisation, which could dilute the value of the findings, the research has been narrowed down to one specific industry, and that was selected to be shipbuilding. It is a traditional sector, but is known to have continuously adopted new technologies and processes and is in a situation of fierce global competition, securing rapid progress and a high level of management practices. This narrow industry focus is used in order to find answers that hopefully serve the purpose of covering the more generic area of the research questions. The generalisation possibility needs to be studied in tandem with interpretation of the research results.

3 SUSTAINABILITY IN INNOVATIONS

In order to capture the status of research in the focus area, a literature study was performed. The following research libraries were used: ABI Inform Complete (Proquest), Academic Search Elite (EBSCO), ACM Digital library, Business Source Premier (EBSCO), Emerald Journals, IEEE Xplore – IEEE/IE Electronic library, JSTOR Arts & Sciences I Collection, SAGE Journals Online (Sage Premier), ScienceDirect (Elsevier) and Wiley Online Library. This was the widest possible search through Finnish Universities 'Nelli' database.

Research and publications on innovation management have a long history since the late 1950's, but searches of the above databases showed that research on sustainability combining social, environmental and economic aspects as part of innovation management has been mentioned only since the late 1990's. This trend can be evidenced by using the keywords 'sustainability' and 'innovation' only, see Figure 1. A similar trend has also been pointed out by Adams et al. (2015), Engert et al. (2015), Kalluri et al. (2014), Huge et al. (2016), and many others.

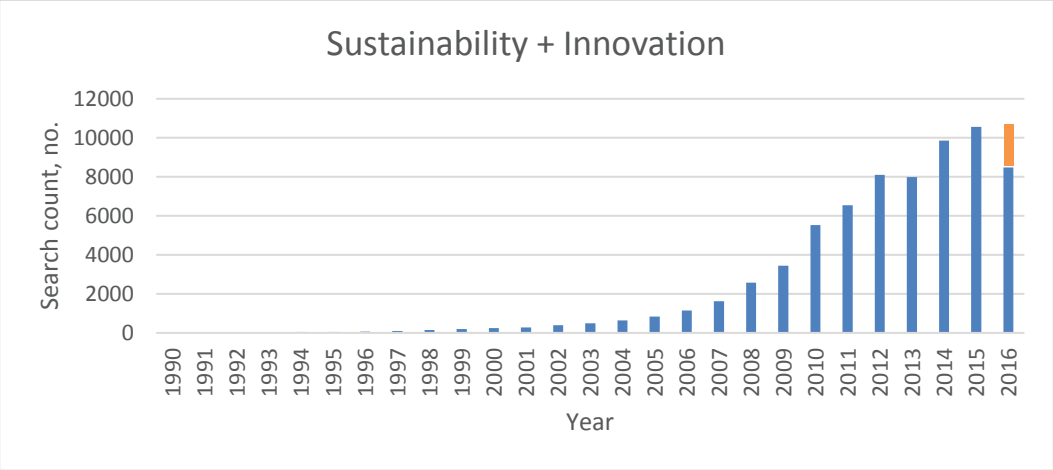


Figure 1. Scientific publications with the keywords 'sustainability' and 'innovation'. Extracted 05.12.2016, full 2016 estimated with orange column.

Although the data in the figure looks convincing, there is a risk in this kind of electronic database result that the number of documents in the databases is simply increasing so quickly that a similar increase in results would be evidenced for whatever search words were used because the documents are registered in ever increasing numbers. Additionally, the volume of research may be increasing as well, both due to increasing use of English as the common academic language, and also because the volume of research done in the world is simply increasing all the time.

In order to become certain of the observation that academic publications with the search words 'innovation' and sustainability' really have increased considerably, it was decided to compare the result to a search made with some of the most common search words. Wikipedia shows a list of the most common words in English, based on the Oxford English Corpus of over a billion words, and ranked based on a study done by Oxford Online. The five most common words are 'the', 'be', 'to', 'of', and 'and'. A database search was done for each of these words separately from the same scientific database that was used to search for 'innovation' and sustainability'. It was found that the biggest number of publication results was found by using the word 'of': the total count of the search result was 214, 434, 227 documents (search performed on 5th of December 2016). Since this is the most common word used in any documents in the academic literature, the result can be generalised with high confidence to represent the frequency of any documents in the academic literature, and thus it provides a comparison base for the frequency of other search results. The distribution per publishing year of the documents found is shown with a line in Figure 2.

The result from the search with the word 'of' clearly illustrates that there is a general growth in the number of published scientific documents, as was also assumed. In Figure 2 the results of the search with the words 'innovation' and sustainability' is also illustrated, with columns. Both the line and columns are scaled to show 100 as the result for the year 2015, and thus the results are visually comparable, even though in 2015 the absolute count for the word 'of' is 27,906,870 and for 'innovation' and sustainability' 19,143 (thus the difference is almost times 1,500). The comparison between the line and the columns shows that the volume of publications with the search words 'innovation' and sustainability' has clearly increased much faster that the general growth of publications and therefore the observation earlier expressed and the similar result published in earlier literature can be proven to be correct.

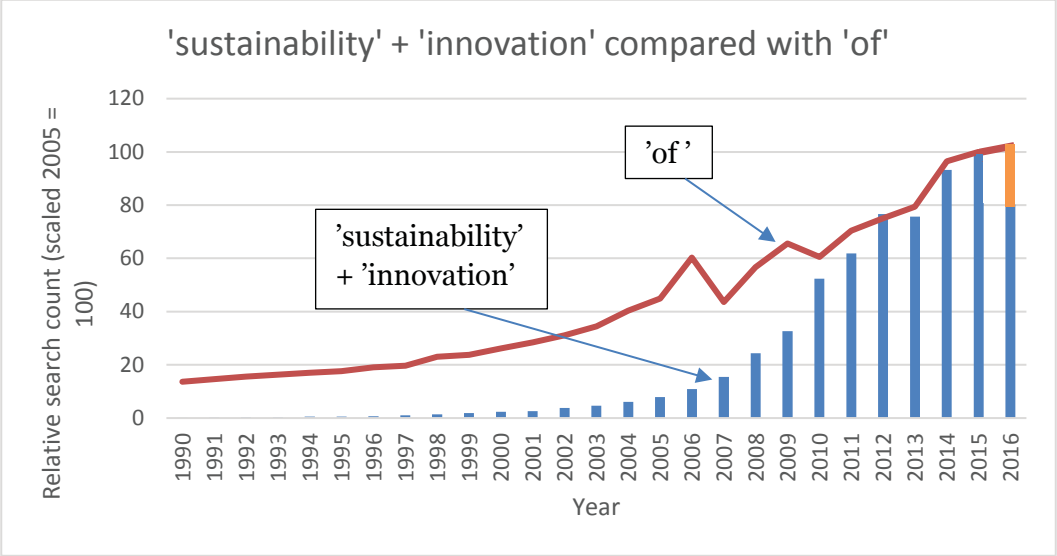


Figure 2. Scientific publications with the keywords 'sustainability' and 'innovation' (columns) compared to the most common word 'of' (line) found in the scientific literature. Extracted 05.12.2016, full 2016 estimated with orange column.

The keywords "corporate" and "sustainability" produce similar results (Figure 3), with low counts for the first years of this millennium, but after 2005 the count starts to rise considerably. In all searches the number of publications found for 2016 seems to be lower than 2015. That does not necessarily indicate that the publications for the full year of 2016 are less, but merely indicates how the registration of publications takes some time, and since the extraction of data was performed on the 5th of December and not at the end of the year, some publications were still to be filed and registered for 2016. A few results have been found already for 2017 publications, so obviously completely similar timelines and practices for registering are not used everywhere.

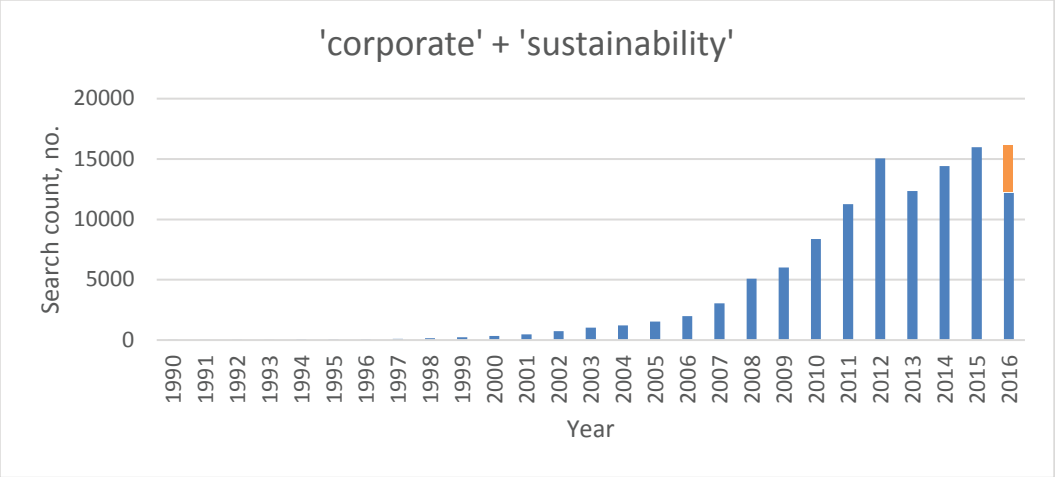


Figure 3. Scientific publications with the keywords 'corporate' and 'sustainability'. Extracted 05.12.2016, full 2016 estimated with orange column.

The keywords 'strategic management' and 'sustainability' also produce similar results (Figure 4), with low counts for the first years of the observation period, but surprisingly stable development in the count of results. In the last four years some signs of a kind of saturation may be seen since the numbers have not been growing anymore with the same speed as in previous years. The absolute number of search results seems to be lower than in the two other searches shown earlier, perhaps showing a lesser link between strategic management and innovation than with earlier combinations.

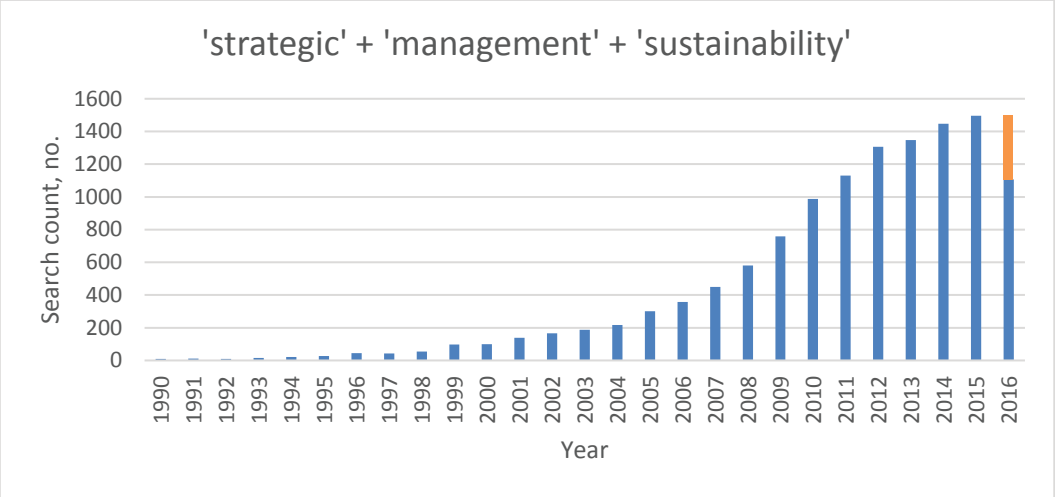


Figure 4. Scientific publications with the keywords 'strategic management' and 'sustainability'. Extracted 05.12.2016, full 2016 estimated with orange column.

The actual material for the literature study was collected by using many more search words and combinations than shown in the figures above. The most important keywords that were used were 'sustainability', 'innovation', 'entrepreneurship', 'strategic management', 'social performance', 'environmental performance', 'business ethics', 'management', 'corporate' and 'strategic leadership' in different combinations. The searches resulted in numerous results and the most relevant were selected and studied. Finding an interesting article often led to finding other referenced research within it, and definitions like 'triple bottom line', 'corporate citizenship' and 'corporate social responsibility (CSR)' were discovered. The criteria for selecting an article for the literature review were based on a critical perspective (Saunders et al. 2012). Since the publications were mainly from recent years, the number of references was not used as the guiding criterion for the selection of the material but more the relevance of the contents.

In the second step of the literature search a study of shipbuilding was performed. The keywords 'shipbuilding', 'shipyard', 'sustainability', 'entrepreneurship', and 'innovation' were used. Only a few scientific publications were found that matched the search criteria. Therefore, the research was widened to cover also secondary literature sources (see Saunders et al., 2012), which in this context consisted of company annual reports.

3.1 Sustainability challenge

Many research papers indicate that in the past a risk was perceived of the dilemma that focusing on sustainability may reduce the economic performance, or vice versa, and thus cause a conflict of interest (e.g. Schaltegger & Wagner, 2011; Adams et al., 2015; Lozano, 2015). These same research papers show, however, that improvements in economic value added can be achieved, but it requires the integration of sustainability into company strategy and a new way of working. Visionary management is needed (Paraschiv et al., 2012). There is discussion as to whether natural capital should be afforded special protection, or if it can be substituted by other forms of capital, especially produced capital. This dilemma causes a conflict between strong and weak sustainability (Dietz & Neumayer, 2007).

Most obviously, complexity in management processes will increase when adding social and environmental aspects to other business priorities. Therefore, new tools (Schneckenberg, 2015) and management systems are needed in order to manage effectively (Hart & Milstein, 2003; Elkington, 1997; Koudal & Coleman, 2005; Adams et al., 2015; Vitezic & Vitezic, 2015, Baumgartner & Ebner, 2010). The role

of top management in guiding the focus on sustainability is important in getting the focus in place (Epstein & Roy, 2007; Nidumolu et al., 2009; Appelbaum et al., 2016).

Business models are also important in guiding development towards sustainability (Schaltegger et al., 2016a; Abdelkafi & Täuscher, 2016). Sustainability development correlates positively with success when companies focus on hard corporate identity drivers, which are culture, behaviour and philosophy (Staub et al., 2015).

3.2 Definition of sustainability

The concept of sustainability is not always clear and self-evident (Morioka and Carvalho, 2016, Huge et al., 2016). Various companies and stakeholders run the risk of seeing it from different viewpoints in the business context and therefore a risk of misunderstanding exists. Sustainability has also become a buzzword in business: "claims of sustainability have become part of the rhetoric of virtually every enterprise" (Connelly, 2007 p 273). Lankoski (2016) concluded that the lack of clarity of the definition causes problems because sustainability includes a wide area of activities, it binds many actors and collaboration is difficult between them if they understand the definition in different ways. Within a firm this will cause difficulties for the management when trying to get everybody to work towards the same goals and therefore may hinder the achievement of sustainability transitions. It also causes tension and runs the risk of wasted resources and miscommunication if the enterprise and its external stakeholders have different views of the goals for sustainability.

There are, however, also some positive aspects resulting from the vague definition of sustainability. Having some ambiguity in the concept can open views for new perspectives and help to create new ideas (Lankoski, 2016). It allows people with conflicting positions to look for common ground, and thus the value is in its broadness and ability to stimulate vigorous and open discussion (Kajikawa et al., 2007).

The United Nations formed a group in 1983 to unite countries in pursuing sustainable development together. The leader of the work was Gro Harlem Brundtland, the former Prime Minister of Norway. In 1987 the group produced a report "Our Common Future" (WCED, 1987), also known as the Brundtland Commission Report, which defined the meaning of 'sustainable development' in detail. The Brundtland Commission's brief definition of sustainable development was the 'ability to make development sustainable - to ensure that it meets the needs

of the present without compromising the ability of future generations to meet their own needs' (Kates et al., 2016). This classic definition of sustainability development has probably received wide acceptance simply because it allows so many different interpretations (Lankoski, 2016).

3.2.1 Sustainability concepts

Some attempts have been made in order to explain the idea of sustainability. Mebratu (1998) has presented the historical development of sustainable development and categorised the early approaches and shown that most of the approaches fail to capture the whole spectrum of sustainable development. Hopwood et al. (2005) present three categories for sustainable development: status quo, reform and transformation where the first looks for gradual, smooth development and the last is the most radical concept. Lozano (2008) describes the importance of time in sustainable development and has created a model in three dimensions to visualise the time horizon and continuous development.

Christen & Schmidt (2012) created a formal framework for conceptions of sustainability (Figure 5). With the model the authors describe the interrelations of the different elements and illustrate the path from theory to practice. This approach frames the rational discourse on sustainability and relates the different elements that comprehensive conceptions of sustainability necessarily must refer to. It lays the foundation for the development of a concrete conception but does not provide for it definitively.

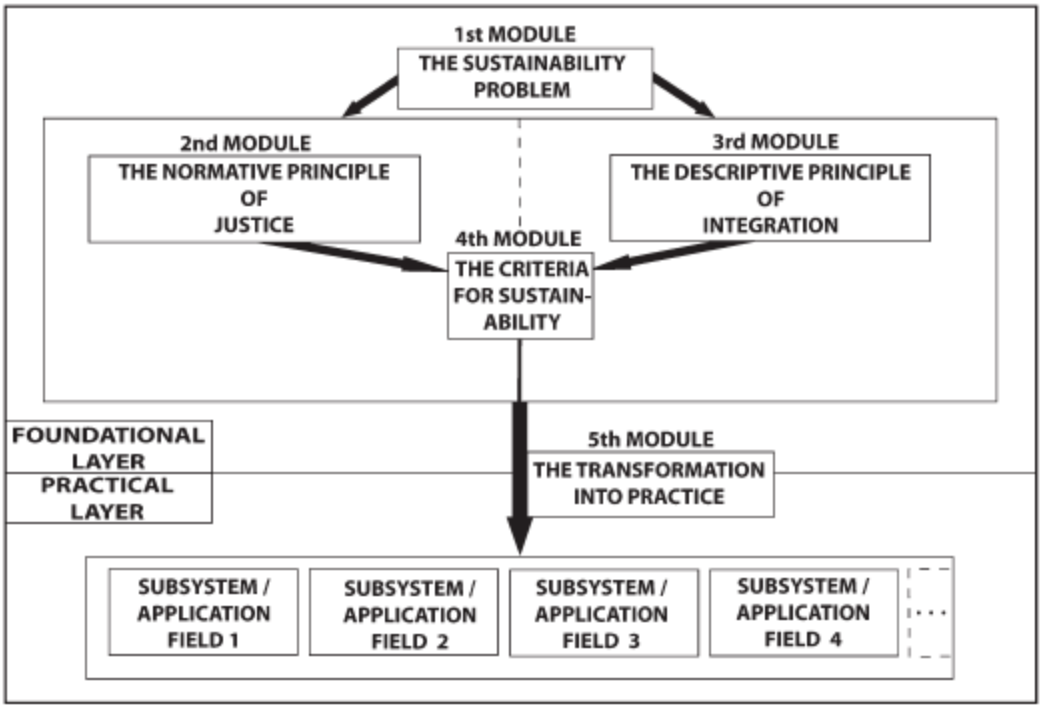


Figure 5. Formal framework for conceptions of sustainability by Christen & Schmidt (2012)

The model of Christen & Schmidt (2012) also provides a reference for any sustainability research project by providing the reference framework. If the elements of such research can be found within the modules of the model, the research can be claimed to serve as a contribution to the science of sustainability. The model can also be used for analysis of practical sustainability challenges (such as judging the sustainability of nuclear energy vs CO2 emissions by taking the unsolved problem of radioactive waste into account) by enriching the elements of the model with concrete content to specifically evaluate activities.

Another model, based on the principles of systems theory, has been developed by Lankoski (2016). She has concluded that the concept of sustainability is not well defined and has therefore created a model to give clarity to sustainability in the business context. Systems theory helps to define the system boundaries, interrelations between components in the system and interactions across the system boundaries for open systems.

In her model, Lankoski (2016) has focused on three grand themes: Where is the boundary of the concept of sustainability? How do elements that are external to, or within, that boundary relate to each other? How do they relate to the external world? These three questions were used as a framework for the analysis against which material from literature research was used and the constituent dimensions

of sustainability identified. Through identification of constituent dimensions for alternative conceptions of sustainability in a business context, Lankoski (2016) identified three constituent dimensions of sustainability: scope, substitutability and goal orientation, see Figure 6.

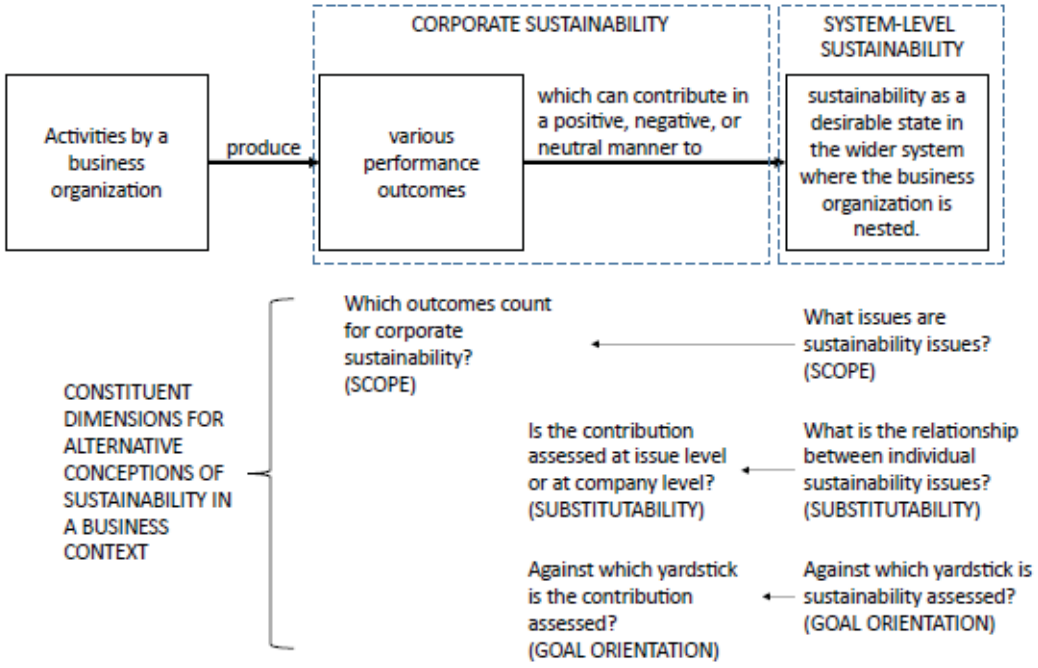


Figure 6. Concept used by Lankoski (2016) for illustrating the three constituent dimensions underlying alternative conceptions of sustainability in a business context

In all of these three dimensions Lankoski (2016) was able to define binary alternatives for describing variation in the area (Figure 7). Scope, the first dimension, relates to the breadth of the scope of sustainability and the variation ranges between narrow and wide. In the narrow conception sustainability is seen only as covering environmental considerations and in the wider consideration it is seen to cover a tridimensional construct that also includes social and economic issues (Montiel, 2008). The second dimension is substitutability, and it varies between weak and strong. In weak substitutability some sustainability components can be compensated with another. The overall portfolio is more important than the individual components, and substitution between economic, environmental and social issues may happen. In strong sustainability, however, such substitution is not accepted, and each individual issue of sustainability has a range of acceptable outcomes within which the performance should stay (Lankoski, 2016).

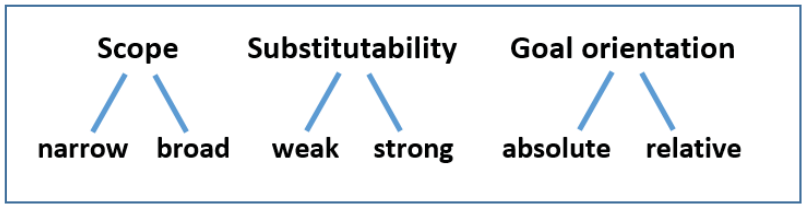


Figure 7. Sustainability model based on work by Lankoski (2016)

The third dimension is about goal orientation and measures whether the target is based on absolute targets defined by measurable metrics or if the targets are relative to some other performance like earlier achievements or the performance of other organisations. Absolute targets give a clear indication of whether the goals have been met or not, but the challenge is to define targets that reflect in a balanced way what the critical outcome should be. Relative targets are efficiently driving continuous improvement, but may due to their relative nature give a false sense of security or even end up optimising systems that are inherently unsustainable (Björn & Hauschild, 2013).

3.2.2 Sustainability approach in this research

In order to have a systematic approach when selecting the material for the literature study, the model of Lankoski (2016) was used. The model helps in clarifying the perspective and also guides the approach for the research part of this dissertation.

The first element of the model, scope, should either be selected to cover only some elements of sustainability issues or to have a wider coverage. Although there is recent research which shows that many businesses still limit the sustainability focus in business only to financial aspects in combination with social or ecological ones (Schaefer et al., 2015), the majority nowadays stress the importance of having a wider view in their sustainability coverage (Hart & Milstein, 2003; Baumgartner & Ebner, 2010; Lozano, 2015). Therefore, the selection for this research is to have an approach with broader scope.

The second element to be defined is substitutability. Some research shows the difficulty of managing the business due to the tensions between different sustainability elements (Hahn et al., 2015; Svensson & Wagner, 2015). The definition of weak or strong substitutability outlines whether some sustainability issues can compensate for each other in economic, environmental and social

issues. Typical examples of such compensation considerations are whether employment success can compensate for environmental pollution or if intensive use of natural resources can be compensated by climate neutrality (Lankoski, 2016). Since the research in this study is looking for answers to research questions about how to manage sustainability in real businesses, the attempt needs to include the most stringent conditions which are categorised as strong sustainability. However, in reality businesses may face situations where compromises need to be selected. Therefore, also weak sustainability will be included in this research.

The third viewpoint on sustainability is goal orientation: whether the targets are set as absolute targets or relative targets. Some research shows that there is a huge difference between these two extremes (Acosta-Alba & van der Werft, 2011). Absolute targets are set to achieve a critical outcome like payment of wages, whilst relative targets are compared to other performance like better wages than the industry average (Lankoski, 2016). Generally, it is understood that absolute targets are more demanding, and defining these is challenging (Björn & Hauschild, 2012). Since the line between sustainability and unsustainability may actually be more hazy than sharp, making the determinations of exact critical values may also be impossible (Phillis & Andriantiatsaholiniaina, 2012). Since this research will focus on finding ways of managing businesses without defining the goals for the businesses to be studied, it is necessary to include both businesses with absolute and relative goals in this research. Obviously, the reality in many businesses is that they have multiple targets, where some are absolute (like financial targets where shareholders expect an absolute return on their investments) and some may be relative (such as a gradual reduction of accidents at work with year-on-year improvements).

In addition to the areas specified in the work of Lankoski (2016), time is also defined as an important element in sustainable development (WCED, 1987; Lozano 2008). Although some research suggests that there may be step changes during development towards sustainability (Adams et al., 2015), in this research gradual development is seen as more feasible (similar to what was selected with goal orientation). Thus continuous improvement in sustainability is the focus for the time aspect.

Based on the models and selections presented earlier, a concept of sustainability to be used in this study can be constructed. The resulting definition for sustainability used in this work is:

> *The ability of a business to run continuous improvement in economic, environmental and social aspects together, with the least compromises between these.*

3.3 Drivers for sustainability in innovations

From the models in the previous chapter it becomes clear that there are several aspects to be taken into account when studying sustainability. Linking sustainability together with innovations brings further viewpoints into focus. As explained in section 1.1, innovations in this research are understood as the set of activities and operations that are performed in order to bring a new idea, invention or solution to be part of the business operation and fulfil the needs of the markets or to create new markets. Thus, linking innovations adds more dynamics into sustainability.

In order to understand the dynamics in sustainability in innovations, various guiding principles and boundaries can be identified from the literature. Lozano (2015) calls such aspects drivers, and the same definition will be used in this research as well.

The earlier research contains various viewpoints that are relevant for sustainability or for innovations (and even for both) and these are presented in the next sections. Each section contains aspects that are clustered under the same common theme. The purpose with the sections is to explain the multitude of aspects that can work as drivers.

3.3.1 Conflicts in triple bottom line

Managing corporate sustainability is "a strategic and profit-driven corporate response to environmental and social issues caused through the organization's primary and secondary activities" (Salzmann et al., 2005 p. 27). Financial performance is commonly monitored to show performance "in the bottom line", meaning that financial performance is equal to the result of a company's success. Innovation process success can be modelled in a similar way as well (Bogoviz & Mezhov, 2015). For measuring a company's sustainability success, a triple bottom line concept is introduced (Elkington 1997), where in addition to financial, also environmental and social performance are included.

Time is also seen as having importance in sustainability development (WCED, 1987; Lozano 2008). Therefore, proposals have been made that it should be

included as the fourth element in addition to the three in the triple bottom line (WCED, 1987; Lozano, 2015)

Optimising three triple bottom line dimensions instead of only financial performance increases complexity and may even cause conflicts of interest within a business (Siqueira & Pitassi, 2016). However, Moran & Ghosthal (1996 p. 45) already indicate this challenge but comment on it with: "to reflect the fact that what is good for society does not necessarily have to be bad for the firm, and what is good for the firm does not necessarily have to come at a cost to society". According to some research (Engert et al., 2016; Epstein et al., 2007; Hart & Milstein 2003) there are studies suggesting a negative link, a neutral link and also a positive link between environmental, social and economic performance. Some recent research (Schaefer et al., 2015) even indicates that although there is a strong drive towards all these focus areas, financial profit still dominates as the goal. Many more studies have been performed regarding financial performance together with environmental focus. Song et al. (2017) show that corporate environmental management has a significant positive correlation with future financial performance in A-share listed companies in China.

In a holistic approach the intention is to consider all three triple bottom line dimensions separately, as well as their impacts and interrelations. The holistic perspective on sustainability has been proposed by several authors (Hart & Milstein, 2003; Baumgartner & Ebner, 2010; Lozano, 2015) and the necessity to integrate corporate sustainability into strategic management and corporate strategy (Epstein & Roy 2007). However, Engert et al. (2016 pp. 2834-2835) have studied 114 peer-reviewed scientific journal articles and state that "While there have been many papers focusing on strategic management or corporate sustainability in the last decades, there is to the knowledge of the authors, as yet, no extant summary of literature dealing with the specific topic of integrations of corporate sustainability into strategic management and the interrelated issues". In their work, they focus on the necessity of reducing complexity or finding new ways of dealing with complexity to help in integrating sustainability into strategic management in practice. Boons and Lüdeke-Freund (2013) went so far as to even challenge the neoclassical economic worldview in order to define new business models which give a better balance to aspects of sustainable innovations.

The time aspect has been less discussed in the sustainability literature although it has a direct impact on the balance between the elements of triple bottom line. Developments in sustainability may call for financial investments, which in the short term cause a burden on financial performance, whilst in the longer term bringing financial benefits back to the business. Lozano (2008) shows a way to

illustrate the long-term effects of today's decisions and gives a holistic perspective to the triple bottom-line elements together with the time perspective.

3.3.2 Social elements and ethics

In social and sustainability management research, stakeholder theory is one of the major and possibly most frequently used approaches (Frynas & Yamahaki, 2013; Montiel & Delgado-Ceballos, 2014; Hörisch et al., 2014). Stakeholder theory is originally explained by Freeman (1984), who identifies the roles of internal and external views.

Responsible global citizenship is an integral element of the social elements of sustainability (Blewitt, 2008) and ethics and morale are a substantial part of it. High business morale results in increased employee satisfaction, customer satisfaction, productivity and quality and thus improves company financial performance in the long term, although it may cause some loss of business in the short term due to lost business when business opportunities with non-ethical conditions are rejected (Aaltonen & Junkkari, 2000).

3.3.3 The role of society

Fonseca et al. (2015) studied the correlations between sustainability, innovation and competitiveness at a country level. They used economic indices in order to compare the correlations between different countries and found that there is a high correlation between social sustainability, innovation and competitiveness. Based on their results, they conclude that sustainability and innovation policies, strategies and practices have a strong link to competitiveness.

Kivimaa et al. (2016) argue that societies can guide and stimulate innovation and technology change through policy mixes and these are especially important in the field of sustainability transitions. Such policies can be aimed at the creation of new and destabilising of the old. They conclude that policy mixes that cover both creative functions and creative destruction are more likely to achieve sustainability transitions. Similar results are confirmed by Pulkka et al. (2015). They found that creativity oriented policies like environmentally oriented regulation can also hamper sustainability innovation by encouraging a lock-in into a technological trajectory that limits opportunities for discontinuous innovation. Companies do not necessarily have to be victims of rules and regulations in societies; they can also themselves initiate socio-cultural changes and thus improve favourability for sustainability innovations (Planko et al., 2016).

3.3.4 The people aspect of sustainability

Innovation activity on a company level greatly depends on the people working in it. The cognitive abilities, attitudes and behaviours of individuals within organisations are important for identifying and utilising creative solutions that can lead to sustainability-oriented innovation (Siqueira & Pitassi, 2016). In their theoretical research, Siqueira & Pitassi connect the people aspect to mindfulness, through which individuals can be trained to support better the reaching of the sustainability targets, both regarding individuals as team members and as leaders. They claim that there is a conflict between the implicit rationale of the industrial economy with an increased state of mindfulness, which leverages creative potential, ecological concern, ethical behaviour and empathy for others. They suggest that the conditions of and limits to the capacity of mindfulness to produce sound sustainability-oriented innovation are strongly related to the motivations of the training, in addition to the organisational culture and core values. Dong et al. (2017) show that strong environmental management can promote innovative behaviour, resulting in more efficient technology innovation, differentiated products, new markets and a competitive edge. Kazmi (2016) highlights the importance of good team dynamics and efficient communication for the innovation performance of teams.

The people aspect of sustainability is also raised in the research of van Heyningen et al. (2012). They studied core factors required for orienting innovation systems towards sustainability in the cleantech sector in Austria. They show that the actors in society and socio-cognitive paradigms taking place within grassroots movements are important in understanding transition processes and how innovation systems become oriented towards sustainability.

The impact of skills and capabilities or individual persons' competencies on the ability to create strong sustainable business models is studied using experimental research by Lejeune (2012). Hörisch et al. (2014) show the role of raising the interest of the stakeholders in sustainability and empowering them as important elements for making them act as intermediaries for nature and sustainable development. They propose that these challenges are addressed through education, regulation and sustainability-based value creation.

Nidumole et al. (2009) raise the importance of recruiting and retaining the right kind of people. They also observed that workforce entrants in the US focus on social responsibility and the environmental commitment of the employer as important criteria in selecting a place to work.

3.3.5 Entrepreneurship

Market mechanisms and capitalism are strongly connected to advances in successful sustainability development (Elkington, 1997). When the policies, stakeholders and market drivers push development towards sustainability, entrepreneurs in business naturally strive towards that as well. Sustainable entrepreneurship combines its mission of contributing to sustainable development (Schaltegger et al., 2016b; Abdelkafi & Täuscher, 2016). Schaltegger & Wagner (2011) state that in a market system sustainable development requires sustainability innovation and also entrepreneurs who can achieve environmental or social goals with superior products or processes that are successful in the marketplace of mainstream customers. They also state that people are important in this aspect since entrepreneurial talent has a direct relation to business success, which is good for the companies (Badal, 2015; Esposito et al., 2015), and entrepreneurial drive can also exist within a big corporation (Pinchot, 1985; Kanter, 1997; Lee & Williams, 2007). In such big corporations, top managers have an important role in facilitating entrepreneurial activities (Williams & Lee, 2011).

3.3.6 People management

Van de Ven et al. (2008) claim that entrepreneurs and managers cannot control innovation success, only its odds. This principle implies that a fundamental change is needed in the philosophy of conventional management practise. They highlight that Western managerial society may be in trouble with the managing of innovation, since based on it, even if things are going well, there is a need for being in charge. This may raise challenges with the management of innovation because the innovation process may be partly uncontrollable, and therefore traditional management may need to be relaxed to an extent. Rogers (2003) also shows how underlying matters like the social system may cause challenges for managing innovations and their diffusion. However, there are also other views on the importance of management of innovations and a few such aspects are introduced in the following sections.

People management is an important aspect of leading a company. There is a strong correlation between proactive people management practices and the performance of firms in variety of sectors. The more effective the people management practices, the better the company result (Tidd & Bessant, 2010). Central to effective people management in innovating companies is the management of creativity and innovation potential within individuals (Mumford et al., 2002) and the required

supporting mechanisms, systems and context variables (Hotho & Champion, 2011).

Leading people in an innovative organisation is closely similar to leading creative people in any organisation, in that all are high potential employees on whom their employers depend (Hotho & Champion, 2011). All of them are engaged in a creative process that integrates the duality of "novelty" and value to generate innovation (Bilton, 2007; Mumford & Gustafson, 1998). SME specific empirical research shows that innovation in companies, alongside with management systems, requires an empowerment culture, a transformational leadership style, supportive people management practices and a management mindset predicated on flexibility, responsiveness and space for creativity (O'Regan et al., 2005).

Regarding an organisation, there is a fine balance between structure and innovation atmosphere. In an organisation, too little order and structure may be as bad as too much. The senior management needs to find a balance between leading through creating space and support and having direct involvement. You cannot empower people – you can only create the climate and structure in which they will take responsibility (Tidd & Bessant, 2010).

3.3.7 Strategic leadership

Elenkov et al. (2005) have studied the importance of strategic leadership on innovation processes in organizations. They define strategic leadership as the process of forming a vision for the future, communicating it to subordinates, stimulating and motivating followers, and engaging in strategy-supportive exchanges with peers and subordinates (p. 666). They used a framework (Figure 8) to study the impact of strategic leadership behaviours, the impact of social culture and the impact of the top management team (TMT) tenure heterogeneity on the relation between strategic leadership and executive innovation influence.

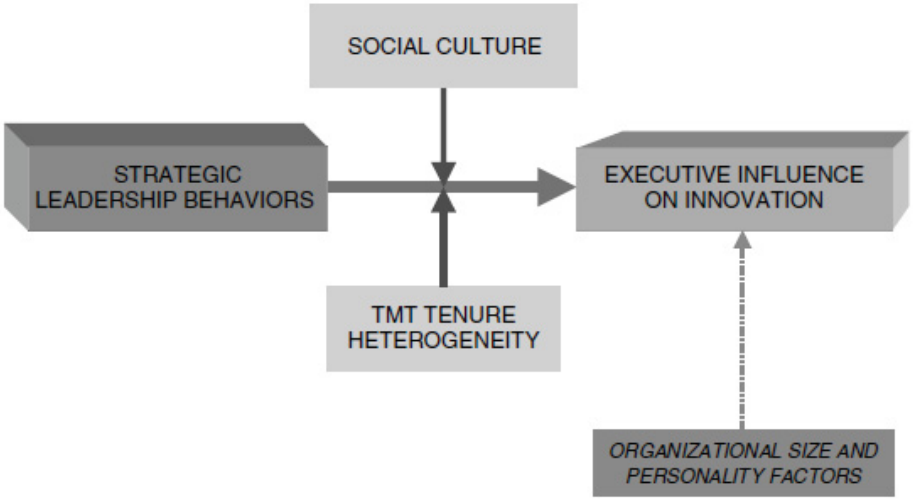


Figure 8. Theoretical model for studying strategic leadership behaviours and executive innovation influence by Elenkov et al. (2005)

The results from Elenkov et al. (2005) show that strategic leadership behaviours have a direct influence on product – market innovation performance, and TMT heterogeneity has a similar impact whilst social culture has less impact: "Strategic leaders working with relatively heterogeneous TMTs will be more effective in influencing the innovation process if they emphasize vision development and intellectual stimulation to promote product–market innovations, and if they focus their efforts on vision development, intellectual stimulation, and contingent reward leadership to bring about administrative innovations" (pp. 678-679).

Wong (2013) emphasises that since innovation is inherently risky, management involvement plays a crucial role in lowering the risks associated with innovation. Senior managers, by virtue of their prominent positions, should have direct access to critical information about the firm and the market in which the firm is operating. Their positions allow them to see or possibly ride the trends that are set to affect the future of their firms (Elenkov et al., 2005). To succeed in global competition, managers should first work closely with marketing to identify market opportunities (Wong, 2013). But before deciding on how an opportunity should be met, the management need to have full knowledge of the firm's competence gaps and work to close them by leveraging its innovation capabilities in administration, human capital, product, process or marketing. The results from Wong (2013) show that the way the top management can influence innovation may be via direct involvement or indirect action. In an effort to boost product innovation, senior management may leverage administrative and human capital innovations and work out an administrative system that fosters innovative culture, work efficiency

and devise reward systems and human resources processes that recognize innovation and creativity.

3.3.8 External innovation challenge

Sometimes innovations involve not only resources inside a company but also externals. A major source and external driver for innovations, according to von Hippel (2006), are the users. They are unique in that they alone benefit directly from innovations. All others must sell innovation related products or services to users, indirectly or directly, in order to profit from innovations. Innovations developed by lead users tend to be more commercially attractive. The reason why users develop products themselves has been found to be that when one or a few users want something special, they will often get the best result by innovating for themselves.

One of the reasons for users innovating is that both the needed information and solution information are often very "sticky" – that is, costly and difficult to move from the site where the information was generated to other sites, and thus the knowledge remains with the users only. As this is a management challenge for a company, the users generally have a more accurate and more detailed model of their needs than manufacturers have, while manufacturers have a better model of the solution approach in which they specialise than the users.

3.4 Sustainability oriented models

The combination of sustainability and innovations presents an intriguing conflict (Siqueira & Pitassi, 2016). Therefore, there have been many attempts to create models that help to visualise the challenge. This is needed in order to support the establishing of research and interpretation of the results.

Common to all these studies is that they are based on literature studies and consist of combinations of previous research and observations together with common research theory practices. The outcomes illustrate potential interpretations of the logics that drive sustainability in innovations and create potential concepts of how to avoid conflicts when going forward.

Additionally, common to all these studies is that they are very generic in nature. They are not focused on a certain environment and do not specify whether they are better applicable in businesses, public organisations or non-profit welfare organisations or others. The models also all lack verification against real life and

tests against empirical data. The most relevant models for this research are presented in the following sections and their relevance for this research is analysed.

3.4.1 Model of sustainability-oriented innovation

Adams et al. (2015) first introduced the definition of sustainability-oriented innovation (SOI) to the research community. They show that intentional changes are needed to an organisation's philosophy and values as well as to its products, processes and practices to serve the specific purpose of creating and realizing social and environmental values in addition to economic returns. In their research they have reviewed 100 scholarly articles and 27 sources from grey literature and found that little attention has been paid to sustainability-oriented innovation and what has been found is only partial. They have found four reasons why addressing SOI has been so limited:

1) it remains uncertain as to precisely what sustainability means or how it can be achieved;

2) previous work tends to treat sustainability dichotomously (sustainable/not sustainable) rather than embedding SOI as a dynamic, unfolding process that is achieved over time;

3) most of the previous work overlooks the social dimension; and

4) many reviews of environmental management and sustainability exclude contemporary grey evidence and are thus prone to time lag and incompleteness of reach

Adams et al. (2015) present how to create evidence of SOI by identifying, analysing and synthesizing firm-level SOI practices and processes and aim to create guidance on becoming and remaining sustainable. In order to achieve these targets, they approach the research by first developing an initial architecture for reviewing SOI and hence systematically analyse literature that has been published between 1992 and 2012. Thereafter, they adopt a framework synthesis methodology in order to create an architecture which they further develop by testing, shaping reinforcing and refining. In refining the model, they notice that the scholarly literature is widely distributed (found from many different kind of publications) and of variable quality, immature and skewed. Therefore, grey literature also has great importance alongside scientific literature. One of the main reasons was explained in terms of the average time lag of the scientific papers selected being four years from study

stage to publication. Grey literature is more contemporary and thus gives a fresher input in this quickly developing field of research. Another reason for using grey literature was explained to be because it is grounded and thus has a close link to practice for the findings in mind.

Adams et al. (2015) categorised the literature material for their model according to the following dimensions: strategy, innovation process, learning, external and internal linkages and organisation.

The model for sustainability-oriented innovation by Adams et al. (2015) is shown in Figure 9. The model is vertically divided into three categories, depending on the maturity of sustainability that businesses can demonstrate.

Figure 9. Model for sustainability-oriented innovation (SOI) by Adams et al. (2015)

The first step for businesses in their way towards sustainability is the focus on operational optimisation. Companies in this stage reflect an internally oriented perspective on sustainability, referring to a 'doing the same things but better' approach when focusing on reducing harm through reactive, incremental improvements driven by compliance or proactively pursuing efficiencies. In this stage companies may already realise that adopting social and environmental policies is not completely disadvantageous to firms, as also Porter and Van der Linde (1995) claim. Development in this stage drives firms to be more proactive with sustainability-oriented innovation when they notice that reactive innovation is becoming uneconomic, e.g. when add-on solutions incur costs that are greater than the cost of process redesign. Moving beyond operational optimisation

requires a more radical approach that produces innovation that is more complex and ambiguous, and that is part of the second step of development.

Organizational development is the second step in the model by Adams et al. (2015) towards more sustainable business. It represents a fundamental shift in mindset and purpose from 'doing less harm' to creating shared value and delivering wider benefits for society: 'doing good by doing new things'. Activities become more people oriented, and sustainability becomes more deeply integrated within the organisation and activities less insular. The focus is still largely internally oriented but extends to immediate stakeholders as well. At this stage the social dimension of sustainability emerges more strongly than in the first step. Also, radical innovation is more usual and even required for success (Sandström & Tingström, 2008). The importance of leadership is recognised and it is understood that knowledge resides in value chains, and thus interactions with suppliers and customers can contribute to successful SOI. Whereas technological innovations reduce or eliminate impact at a product level, in the long term a collaborative approach is necessary to make the whole supply chain sustainable (Stubbs & Cocklin, 2008). Top management has a major role to play in defining policies, strategy, values and goals and in the communication of all these. Typically, companies also focus on this step in 'designing green' from the outset of the product development process for delivering more in terms of services and less on creating just products (Sandström & Tingström, 2008).

The third step in the model of Adams et al. (2015) is about systems building. This step requires another radical shift in philosophy to thinking beyond the firm and reframing the purpose of business in society to 'doing good by doing new things with others'. The focus is more on a global and no longer a company level. This step is characterized by a shift toward networks of relations in which sustainability value is created collaboratively rather than individually. Shared value is addressed through these novel collaborations (Porter & Kramer, 2011). The firm becomes a part of society and is no longer apart from it. System builders also create constructive dialogues with multiple stakeholders and have the ability to build, manage or participate in complex coalitions over time involving many actors and stakeholders (Mulgan & Leadbeater, 2013). Although Adams et al. (2015) found a good logic for this step, they could identify only a few cases where companies had been able to reach this level of development of SOI.

Adams et al. (2015) present their model in terms of consisting of steps, but they say that it is not proven that the development towards sustainability in the model is a linear process, and they firmly state that the model is not a stage process. It provides a quasi-laboratory in which scholars can generate concepts and theories

and investigate empirical domains. Also it helps managers to understand how their world works in a practical sense.

Regarding the research in this monograph, the SOI model by Adams et al. (2015) gives a good framework of various aspects and dimensions that are relevant for sustainability in innovations. The model describes different levels of maturity and identifies various elements that have importance when developing towards sustainability. The scope covered in the model is very broad, from 'slightly sustainable' to 'most sustainable', but because of the wide view it also lacks the aspects of incremental and gradual development towards sustainability. The research questions in this research look for practical management measurement and guidance in order to become more sustainable. In real operations, big turnarounds are seldom possible and these mostly only through some crises. The model from Adams et al. (2015) does not cover the elements that leaders and managers need to use to bring their businesses gradually towards sustainability.

3.4.2 Corporate sustainability driver model

When considering the development of businesses and innovations, one of the viewpoints is to look at the drivers and motivations for the development. Lozano (2015) focused on identifying the various drivers that impact the development towards sustainable innovations and created a model based on these. He starts his analysis from corporate sustainability (CS) and defines that to consist of "corporate activities that proactively seek to contribute to sustainability equilibria, including the economic, environmental, and social dimensions of today, as well as their inter-relations within and throughout the time dimension, while addressing the company's systems, i.e. operations and production, management and strategy, organisational systems, procurement and marketing, and assessment and communication; as well as its stakeholders" (Lozano, 2015, p. 33).

The development of corporate sustainability is presented by Lozano (2015) as a journey requiring continuous adjustment and improvement to internal activities, structure and management and to how companies engage and empower stakeholders in contributing to sustainable societies more effectively. There may also be resistance to change. Since the development is a journey, Lozano (2015) concluded that there are drivers impacting the journey and guiding the development and he therefore focused his research on identifying these drivers and created a model consisting of them.

For developing the model, Lozano (2015) reviewed the existing literature and conducted 13 semi-structured, qualitative interviews with top level corporate

managers, complemented by three interviews with experts in the field. The responses from the interviews were analysed with the help of constant comparative analysis from grounded theory (Glaser & Strauss, 2012).

Lozano (2015) found that the drivers identified from the literature and from the interviews were very similar and supported each other. Leadership was found to be the main driver in both studies, although Lozano notes that there may be a bias in the results of the interviews since these were held with the top management of the companies. Also the importance of reputation was high. The model created is presented in Figure 10.

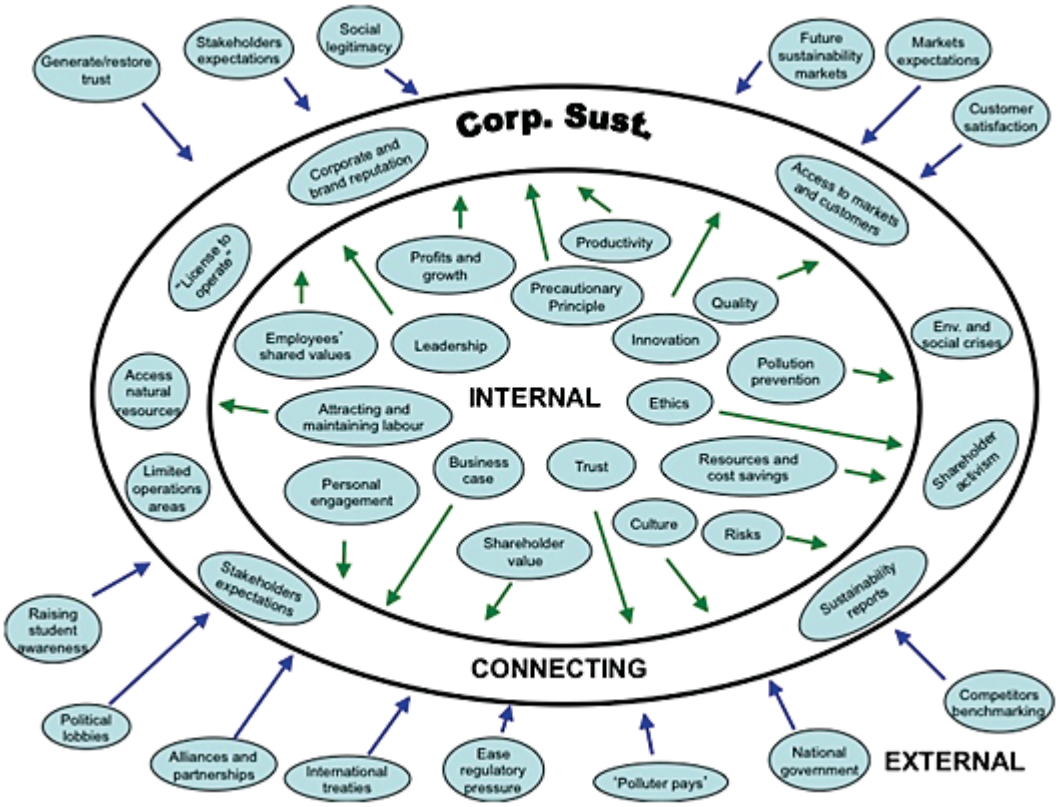


Figure 10. Corporate sustainability driver model by Lozano (2015)

In the model Lozano used the categorisation of the drivers into external and internal drivers, where external drivers tend to result in reactive measures (DeSimone & Popoff, 2000), being less likely to help in moving towards sustainability, and internal drivers, which are more proactive. Additionally, Lozano studied companies not as closed systems but as semi-open or semi-closed

systems, and that resulted in the discovery and categorisation of connecting drivers, in between external and internal drivers.

Lozano concludes that his model gives a holistic perspective on how companies can be more proactive in their journey to becoming more sustainability orientated. He proposes that the research should be followed by a quantitative study to provide more information on the drivers and their importance.

For this monograph, the research of Lozano (2015) provides a base for companies when moving towards more sustainable operations. Although Lozano does not mention innovations in his research, he takes into account the dynamics and development of businesses, and as such his work can be seen to be valid also for sustainability oriented innovation. The challenge with Lozano's work is that although it identifies the drivers, it raises so many areas simultaneously that it does not help the management of businesses which need to make selections and prioritization in their activities, and thus the complexity of management is increasing.

3.4.3 Mindfulness-based sustainability-oriented innovation model

Sustainability and innovation concepts represent a fundamental conflict of objectives (Siqueira & Pitassi, 2016) and thus challenge people working with them. Thus the people perspective is important. One of the perspectives on how to impact sustainability in innovations is to study the influence potential of mindfulness. Mindfulness is the psychological process of bringing one's attention to the internal and external experiences occurring in the present moment (Baer, 2003). Although the term is generally often linked to mental health and human development in connection to an individual's health and also in managing emotions, it is also used in connection with raising awareness and opening thoughts for new ideas in order to support transitions from the current state to new directions. Since innovations typically require an open mind and since the addition of sustainability elements into business priorities require an openness to see new possibilities, the mindfulness concept may have a place in this kind of transition.

Siqueira & Pitassi (2016) stated that market dynamics and environmental dynamics differ from each other and thus result in businesses being unable to ensure sustainable economic development despite the claimed values and codes of ethics in many for-profit companies. Gilding (2001), with his background of being a previous leader of Greenpeace, writes that without a systemic change in the socio-technical foundations it will not be possible to solve the many problems that

are caused by industrial capitalism. Adams et al. (2015) state that the additional complexity that is afforded by the introduction of environmental and social dynamics into innovation objectives can make sustainability-oriented innovations different from economic-oriented innovations both in scope and in the forces that drive the dynamics.

Radical transformation was selected by Siqueira and Pitassi (2016) as the basis for their work, and they approach sustainability-oriented innovation as a concept which concerns interest in human civilization's continued existence. They conclude that sustainability-oriented innovation in this light is a multi-level phenomenon that requires focus on three levels: i) at the macro level governmental policies and actions are needed to overcome the immeasurable risks that are involved in radical innovations, ii) at the company level the development of new business models is needed, and iii) at an individual level changes are needed in people's cognitive mechanisms, attitudes and behaviours. All these three levels would need to interact in order to change the present sociotechnical paradigm for sustainable economic development.

Mindfulness has received ever more attention and interest in the conversions of operations for radical change, and companies like Google, General Mills and Aetna have adopted mindfulness programmes (Macaro & Baggini, 2015; McCartney, 2016). It is shown in experiments (Ruedy & Schweitzer, 2010) that there are important connections between mindfulness and ethical decision making. Shaphiro et al. (2012) also show that training in mindfulness is associated with an increase in moral reasoning, which suggests that mindfulness might make us more ethical. Highly mindful individuals are, according to Barber and Deale (2014), more concerned about others and society as a whole and therefore search for services and products that have high emotional and environmental benefits. Barbaro and Pickett (2016) have discovered that mindfulness is significantly associated with pro-behaviour and feeling connected to nature, indirectly affecting the relationship between mindfulness and pro-environmental behaviour.

Despite the wider use of mindfulness for transformations, Siqueira and Pitassi (2016) state that there are no empirical or theoretical studies in the literature, including management studies, that show directly a link between mindfulness and sustainability-oriented innovation. They therefore conducted exploratory research in order to develop an analytical framework to study the influence of mindfulness on the cognitive abilities, attitudes and behaviours of individuals within organisations to identify and utilize creative solutions that can lead to sustainability-oriented innovation. They selected 20 articles from highly reputable scientific journals and focused on concept and model definitions.

Based on their research from the literature, they created a model consisting of three elements (Figure 11): mindfulness, creativity (based on Nonaka & Takeuchi, 1995) and sustainability-oriented innovation. They show that mindfulness feeds the creativity which itself has a direct impact on the sustainability-oriented innovation process, which in turn is also impacted by social pressure and governmental actions. The model is called MBSI: mindfulness-based sustainable-innovation model.

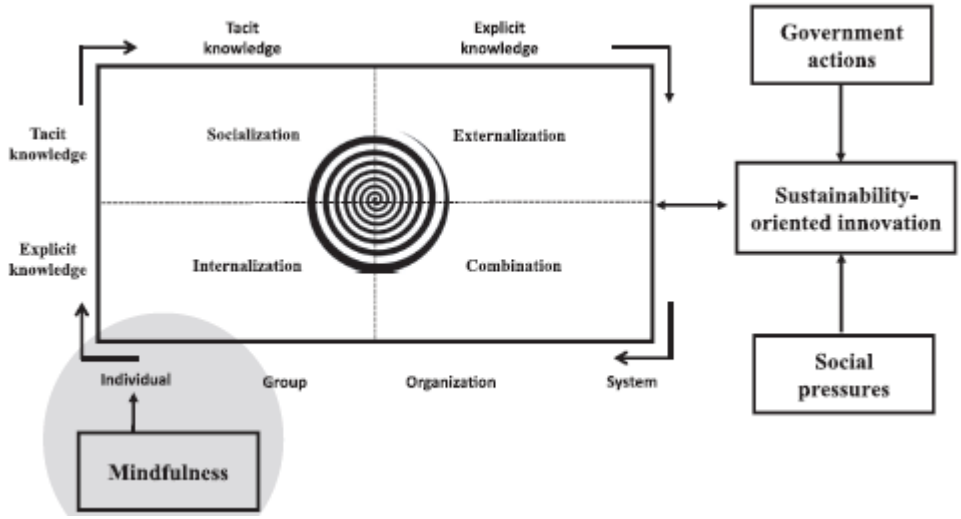


Figure 11. Mindfulness-based sustainability-oriented innovation model (MBSI) by Siqueira & Pitassi (2016), including knowledge spiral from Nonaka & Takeuchi (1995)

In the inside-out direction the model shows how systematic practise of mindfulness affects the cognitive ability of individuals, allowing them to view, decode and interact with the world around them. The BBSI model assumes the presence of an organisational culture that promotes individual autonomy and supports the emergence of creative and ecological concerns. Inspirational leadership capabilities are necessary to drive changes in the corporate culture that will favour sustainability principles (Adams et al., 2015).

From the outside-in direction, Siqueira and Pitassi (2016) say the model shows how government policies regarding both demand and supply impact firms in supporting sustainability-oriented innovations. It also shows how incumbent firms are forced "to replace efficiency-driven strategies with a life-cycle perspective in which the economic, environmental and social consequences of their business decisions, from raw materials to disposal, are considered" (p. 1186).

Siqueira and Pitassi (2016) show that the conditions of and limits to the capacity of mindfulness to produce sustainability-oriented innovation are strongly related

to the training of personnel and leaders. They also highlight the importance of organisational culture and core values. They claim that the rationale of the industrial economy is based on business models that focus on pure cost reduction and that productivity improvement conflicts with the increased state of mindfulness, and on the opposite side they stress that mindfulness leverages creative potential, ecological concern, ethical behaviour and empathy for others, all being good for sustainable business conduct.

The MBSI model created by Siqueira and Pitassi (2016) identifies some dimensions of importance for the research in this paper. It shows the importance of training, both of individuals and leaders. It highlights the role of people in the organisations as individual thinkers and creators, and it also recognises the responsibility of leaders. It also raises the role of corporate culture and external factors like government actions and social pressure. However, it lacks the identification of mechanisms for how to impact all these drivers except the direct impact on individuals and leaders, and the way to impact these areas is via mindfulness. As such, mindfulness is obviously an important element in the toolbox of leaders and managers when driving businesses forward towards sustainability-oriented innovations.

3.5 Chapter summary

As presented in the previous sections, although the research about sustainability in innovations is a relatively new area of research, there is literature available on this topic. Aspects and viewpoints impacting such activity have been identified and analysed in various papers. The analysis made in the previous sections show that many management and leadership aspects are important together with empowering and motivating people.

Additionally, some models have been created for illustrating the concepts of sustainability together with innovations. These models highlight different viewpoints. Some show the causal relationship between activities (Nonaka & Takeuchi, 1995), some show the time perspective in the evolution of concepts (Adams et al. ,2015) and some show the interfaces and give visibility to the drivers (Lozano, 2015). Common to all the research is however that the results are theoretical and links to practical ways of working are lacking. Much of this research proposes empirical testing and creating structured approaches via simplification and prioritization as the next step of research.

4 PHILOSOPHICAL ASSUMPTIONS AND RESEARCH PLAN

The target for the research was to find guidance, methods and priorities that support businesses that want to have sustainability aspects taken into account in their innovations. In order to come as close to practical aspects as possible, the scope has been narrowed down to one industry, and that has been selected to be shipbuilding.

The literature review foregrounded valuable research done in the area of sustainability in innovation. A lot of work has been done in order to understand the fundamentals and challenges in regard to sustainability. Models have been created in order to help in understanding the relationships of different aspects and drivers in sustainability oriented innovation. The aspects and priorities have, however, not been addressed in a way that would guide actions and help to manage in practise.

The focus in this research is on learning from the practices in one specific industry and on finding answers to the research questions from there. The research focuses on management as a subjective reality. The researcher comes from the same industry and thus represents a subjective view and is personally directly involved in the research. The research can be arranged to be performed in close connection with top management in companies in the selected industry. These facts form the basis and guide the selections for the research philosophy, paradigms and methodological choices and they are explained in the following sections.

4.1 Structure of the research

In order to clarify the overall research approach, selections are needed for the structure of the research. The input for creating the structure is mainly based on Sunders et al. (2012) and Collis & Hussey (2014) and other literature is used for refining the contents more in detail.

The structure consists of selections made for the philosophy, approach, method, design, strategy and time horizon. A summary of the selections made for each of these areas is shown in Table 1. The logic behind these selections is explained in sections 4.3 – 4.7. This structure is used as the basis of planning the actual research, data collection and analysis.

Table 1 Selected research structure

Philosophy	Approach	Method	Design	Strategy	Time horizon
Interpretivism	Induction + abduction	Qualitative, data triangulation	Exploratory for open questions, explanatory for literature verification	Hermeneutics + Case study with data triangulation	Cross-sectional

The research philosophy of this research is based on interpretivism. The social reality is subjective since the researcher has direct links and experience from shipbuilding and thus cannot be assumed to be objective. The knowledge comes from subjective evidence from the participants and the findings may be biased and value-laden. Qualitative terms are accepted and an inductive approach used.

The dissertation is mainly inductive but includes some elements of abduction. The research starts with a literature review and builds a theoretical framework. The abductive element is used when the observations in companies are compared against the created theoretical framework and for developing it further.

The research method is qualitative data collection. The research analyses the annual reports of shipyards and collects data from the heads of the shipyards by interviewing them both with open ended questions and letting them answer the structured questions on paper. Data triangulation is performed by combining data from oral and written sources.

The strategy of the research is hermeneutics. The most decisive reason for using hermeneutics is the fact that it allows the researcher to be involved in the topics under study and to be biased but still able to perform scientific research. A combination of hermeneutics with case study is proposed by Rendtorff (2015) and is also selected here.

The choice of time horizon is either longitudinal or cross-sectional research. Since the data collection in this research is planned to be performed through one round of interviews only, the selection for cross-sectional methodology is obvious.

4.2 Research plan

The research plan is constructed for managing and leading the steps that are needed for conducting the research. The philosophical and methodological choices made earlier are guiding the steps together with practical possibilities for data gathering and data access.

Sekaran (1992) has created a useful general model for research process design for basic and applied research. The model describes a process for creating the structure for research, starting from an early idea, proceeding through problem definition, creating a theoretical framework, designing the scientific research and collecting the data and conducting an analysis and interpretation of the results. Walker (1997) presents how this method is successfully used in PhD research for studying practical management aspects in the construction industry. Although that model is for positivism philosophy research, the process from Sekaran (1992) provides a good structure for this dissertation as well.

A similar visualisation approach is used here in order to illustrate the planned structure for the research. The structure of the research is presented in Figure 12, illustrating both the actual steps of the research and, in addition, the strategic hermeneutic cycles.

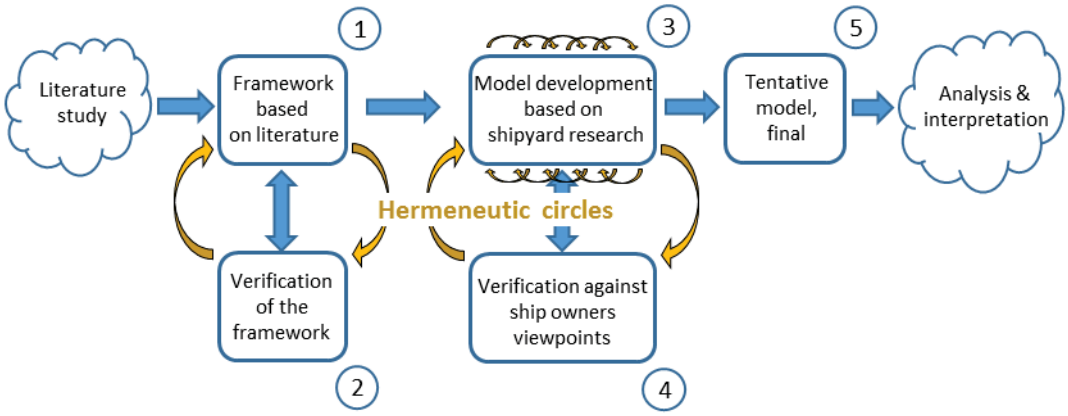


Figure 12. Research plan structure

The first step in this dissertation research is to create a theoretical framework that focuses on identifying relevant drivers for sustainability in innovation from the point of view of relevance for the research questions (step 1 in Figure 12). That framework is created basing on literature studies.

Once the framework is constructed, it needs to be verified in order to test its applicability for the shipbuilding industry (step 2 in Figure 12). This verification is needed in order to see the applicability of the framework to the shipbuilding industry. The testing is performed against selected reference data available from the literature. That forms the first hermeneutical cycle in the research.

After the framework is created and proven to give an acceptable platform for understanding the management aspects of sustainability in innovations, a case study is planned for the shipbuilding industry, based on the framework. The framework acts as a concept map (Addeo, 2013) that supports building the research questions. Whilst doing the research through interviews with top management in the industry, the hermeneutic cycle approach is used for creating and developing the knowledge between interviews in order to improve the approach for the following interviews (step 3, Figure 12). The purpose with the research is to create the basis for a tentative model for the drivers of sustainability in innovation. The interviews are conducted in two steps in order to get two kinds of data. Firstly, qualitative open research questions are used in order to find out which drivers for sustainability in innovation the shipyards bring up themselves. These questions are further developed in between the interviews and thus are slightly modified from one shipyard to another (hermeneutical approach). Secondly, a fixed qualitative questionnaire is used for measuring the priority of those drivers that were identified to be relevant for the frameworks in step 1 and 2 (Figure 12). These questions are kept the same throughout all the interviews.

After collecting the research data from the shipyards, the results are combined using data triangulation (Saunders et al., 2012). The purpose is to combine the two sources of data from the shipyard interviews: the drivers identified via the interview questions and the weight given to the drivers from the framework based on the literature. The triangulation is a part of step 3 in Figure 12.

There is a potential bias risk with the shipyard data collection. The managers of the shipyards are asked to share their views and to give a score on aspects of sustainability in innovations, but it is difficult to know if those shipyards are skilled in these aspects or not. Thus strong input data may be received from any of the interviewees but the good performers may be mixed in with input from low performers. Therefore, the research design includes a way to compensate for data input from shipyards at different performance levels.

This potential problem is overcome by asking for an external view of the performance. Therefore, the following step in the research is to verify the data from the shipyards using an external view, namely the customers of the shipyards. Ship-owners and ship brokers are such customers. The aim is to receive external

verification data for the actual performance in sustainability in innovations that the interviewed shipyards have. The purpose is to find out which shipyards are extremely strong in sustainability in innovations and which may be weak. Thus, a higher priority can be given for the data gained via interviews from strong shipyards and similarly less priority for data from shipyards that do not perform well in sustainability in innovations. This verification process forms the last hermeneutic cycle in this research and thus refines the understanding and priority of the drivers even further.

The last step (step 5 in Figure 12) is the consolidation of the data resulting from the various research steps. The aim is to create a tentative model for the drivers that are important for sustainability in innovation for the business of shipbuilding. That model can then thereafter be used for further analysis and finally as an aid for answering the research questions.

4.3 Choice of philosophy

In order to be able to plan the process and design for the research, the philosophy and paradigm need to be defined. Research philosophy relates to the development of knowledge and the nature of knowledge. Philosophy is a set or system of beliefs stemming from the study of the fundamental nature of knowledge, reality and existence (Waite & Hawker, 2009). The research strategy chosen reflects the assumptions about the way in which the world is viewed (Saunders et al., 2012). At every stage of the research, assumptions are made. These assumptions will provide the basis for the research strategy and be a guide for choosing the methods for conducting the research.

A research paradigm is a philosophical framework that guides how scientific research should be carried out. Researchers who share a commitment to a particular paradigm are committed to the same rules and standards for scientific practise (Jupp, 2006). Ideas about reality and the nature of knowledge have changed over time and therefore new research paradigms have emerged in response to the perceived inadequacies of earlier paradigms (Collis & Hussey, 2014). The main paradigms used today in business research are positivism and interpretivism (Collis & Hussey, 2014). Positivism has its roots in the philosophy known as realism and interpretivism is based on the principles of idealism. Another paradigm used in social sciences research is pragmatism, which represents a philosophy that supports multiple views and mixes different philosophical concepts (McKerchar, 2008). In addition to these main paradigms of interest, realism represents a philosophy that focuses on that what we sense is

reality and that objects have an existence independent of the human mind (Saunders et al., 2012). Since realism is closely linked to positivism, it will not be analysed separately for this research.

Important viewpoints for the philosophy are the choices made for the ontological assumption (the nature of reality), the epistemological assumptions (what constitutes valid knowledge), axiological assumption (the role of values), rhetorical assumption (the language of research) and the methodological assumption (the process of research). The differences between these assumptions are described in Table 2 for the main paradigms of positivism, interpretivism and pragmatism.

4.3.1 Ontological assumption

This dissertation focuses on defining the aspects of sustainability in innovations by studying the practices used in the shipbuilding industry. The plan is to find the priorities, best approaches and concepts that are used in various companies in the business. The researcher has a background in businesses that are part of shipbuilding and thus cannot be assumed to have an entirely neutral role in the research.

There are no fact-based databases or statistics available for studying sustainability in innovations and thus the data needs to be collected to a large extent from people who interpret their roles in their daily jobs and act according to what they believe is their purpose in the organisations. The data is provided by people who are active in business and can make observations and judgements based on their own experience.

The positivist view in ontology is that social reality is objective and external to the researcher. Based on the research platform as explained above, this is not the situation in this case. In the pragmatism paradigm the ontological assumption is that the research view for observing reality is external. This is not fully supported in this research for the same reason as is mentioned for the positivist paradigm: the researcher comes from the same industry and is involved in activities of the area being researched.

Table 2 Philosophical assumptions for the main paradigms according to Collis & Hussey (2014) and Anderson (2013)

Philosophical assumption	Positivism	Interpretivism	Pragmatism
Ontological assumption (the nature of reality)	Social reality is objective and external to the researcher There is only one reality	Social reality is subjective and socially constructed There are multiple realities	Reality is the practical effects of ideas The view chosen for observing the reality is external
Epistemological assumption (what constitutes valid knowledge)	Knowledge comes from objective evidence about observable and measurable phenomena The researcher is distant from phenomena under study	Knowledge comes from subjective evidence from participants The researcher interacts with phenomena under study	Any way of thinking/doing that leads to pragmatic solutions is useful Empirical research in a natural context. Partnership between researcher and practitioners
Axiological assumption (the role of values)	The researcher is independent from phenomena under study The results are unbiased and value-free	The researcher acknowledges that the research is subjective The findings are biased and value-laden	Values play a role in the research
Rhetorical assumption (the language of research)	The researcher uses the passive voice, accepted quantitative words and set definitions	The researcher uses the personal voice, accepted qualitative terms and limited a priori definitions	The researcher takes an external view for observing the reality
Methodological assumption (the process of research)	The researcher takes a deductive approach The researcher studies cause and effect, and uses a static design where categories are identified in advance Categorisations lead to prediction, explanation and understanding Results are accurate and reliable through validity and reliability	The researcher takes an inductive approach The researcher studies the topic within its context and uses an emerging design where categories are identified during the process Patterns and/or theories are developed for understanding Findings are accurate and reliable through verification	Empirical research in natural context Mixed methods. Design-based research, action research. Development of theory and 'design principles'

The interpretivism paradigm is based on the ontological assumption that reality is strongly subjective because it is socially constructed, and each person involved has his/her own sense of reality and there may be multiple realities. This assumption is closest to the research setup in this research, and therefore the selected ontological assumption focused on interpretivism, where the researcher needs to understand the differences between people in their role as social actors.

4.3.2 Epistemological assumption

As explained in the ontology analysis, there are no databases or hard facts available on the topic of the research and the data needs to be collected from people. In a positivist view of epistemology the knowledge and data would be observable and measureable so that it gives an independent and objective stance. The researcher can stay distant from the phenomena under study and there is no difference in who is collecting it. In this research, however, the data and knowledge is with people who are involved in the business. The researcher thus needs to understand the phenomena and knowledge being collected and needs to interact with the business in order to obtain valuable observations of knowledge and data and needs to understand that the data is subjective and not objective. Thus, the positivist view of epistemology is not supported.

In the pragmatism view, research based on a partnership between the researched and practitioners is supported. Any way of thinking and/or doing that leads to a pragmatic solution is useful. These assumptions are supported in the research of this dissertation. The pragmatist view also proposes empirical research in a natural context. This is less supported here since the work is done through interviews and not by observation of real activities, although the interviews are done in as natural and familiar environment for the interviewees as possible. Thus, some elements of pragmatism could come into question in the epistemology, but some doubt is left.

For an interpretivism view, the distance between the researcher and the target is small. Knowledge comes from subjective evidence from the participants. The aim is to understand how social reality is created. These views are all well supported by the research approach here and therefore the epistemological assumption in this dissertation represents an interpretivism viewpoint.

4.3.3 Axiological assumption

The analysis of ontological and epistemological assumptions already clarified that reality is subjective and that subjective data needs to be used for the research. The

data and knowledge is registered via people, who interpret the world around themselves based on their own knowledge and experience. The role of values therefore comes to have some significance as well. People see the world from their viewpoint and are more or less biased when making their observations and conclusions. In the data collection the approach would naturally need to find neutral and fact-based sources and persons who can see the big-picture from a 'helicopter view', but in practice some bias is anyhow expected.

The fact that non-biased data is not available and that values are of importance is guiding the axiological assumption in this research as being in the areas of interpretivism and pragmatism, but some close links even to realism can be seen as well. The researcher needs to understand that there are differences between people as their role as social actors. The researcher needs to adopt an empathetic stance and enter the social world of the research subjects and understand their world from their point of view. The situations being studied may be complex and unique and they are a function of a particular set of circumstances and individuals coming together at a specific time (Saunders et al., 2012).

4.3.4 Rhetorical assumption

The language of research is typically in a formal style using the passive voice when a positivist study is being made. In an interpretivist study the case is not that clear. If the researcher is very close to the subject, the first person can be used as the style. In pragmatism the external view is most often used. Collis & Hussey (2014) instruct that guidance for the language of the research should be obtained from the literature in the discipline in question.

When reviewing the literature for this research, it became clear that most of the research was written in the passive style. A few researchers (like Adams et al., 2015) have partly used the first person together with the passive voice in some parts of their research publication, but the great majority is written in the passive style.

Although many of the assumptions explained above point towards selecting interpretivism philosophy, which could allow using the first person as the style, it felt more motivating to use the passive format for this dissertation. It was both supported by observation of the literature and also by the tradition in which dissertations are made in Finnish universities.

4.3.5 Summary – selected research philosophy

The analysis of the various philosophical assumptions above shows that the main philosophy for this research is in accordance with interpretivism. All the areas of interpretivism are supported by this research setup and thus create a strong focus. Pragmatism could partly be considered when it comes to epistemology since the work in this research happens in close relation between the researcher and the phenomena, but the focus for arranging empirical research in a natural work context may be challenging. From the axiology point of view pragmatism is supported since values are recognised to play a role in the research. But the ontological assumptions are not well supported, since in pragmatism the view chosen for observing the reality should be external and the position of the researcher in this research did not reflect this. Since there are practically no elements of positivism in the area to be studied, that philosophy can be disregarded.

Based on the analysis and conclusion the philosophy selected accords with interpretivism and the research methodologies are selected accordingly. Some elements of pragmatism can be considered as well, and that is an important aspect when deciding about the data collection methods so that the choices made do not limit the perspective too much.

4.4 Research approach

The research approaches are typically selected between deductive and inductive reasoning, although abduction can be considered as well. Deductive reasoning occurs when the conclusion is derived logically from a set of premises and the conclusion is true when all the premises are true. This is the dominant research approach in natural sciences, where laws present the basis of explanation, allow the anticipation of phenomena, predict their occurrence and therefore permit them to be controlled (Saunders et al., 2012). In inductive reasoning, there is a gap in the logic argument between the conclusion and the premises observed, the conclusion being 'judged' to be supported by the observation made (Ketokivi & Mantere, 2010). Research using an inductive approach is likely to be particularly concerned with the context in which such events take place, and therefore a study with a small sample of subjects may be more appropriate than a large number as with the deductive approach (Saunders et al., 2012). Abductive reasoning begins with a 'surprising fact' being observed (Ketokivi & Mantere, 2010). This surprising fact can be the conclusion and a set of possible premises are defined to fulfil the conditions to support the surprising fact.

The natural way for using deduction is by conducting research which starts by forming a theory, learning from the literature, examining the premises and logic of the theory and testing it in practice. This is not the case in this research since no theory exists to start with. Induction, however, starts from creating an understanding of the problem, collecting information and then creating a framework or theory. Thus, in induction the theory would follow the data rather than vice versa as in deduction. Induction is appropriate when trying to understand why something is happening and deduction when trying to describe what is happening.

In an abduction approach there is no choice from moving from theory to data or data to theory, but deduction and induction are combined (Suddaby, 2006). It is well suited to research areas where a lot of information is available in one context, but far less in the specific area under research in this dissertation.

Due to the nature of the research problem herein, it is natural to start from data in the literature and then move to theory, since no early assumption of a theory exists to the knowledge of the researcher. Thus, an inductive approach is the natural starting point. Some abductive elements may be considered, however, since there is a need to reflect back on the observations to compare against the theory or models being created and to develop these further.

4.5 Methodological choice

As described above, the selected main research philosophy paradigm is based on interpretivism, with possibly some elements of pragmatism and realism added. The research approach is inductive, with potentially some abductive element added. Based on these selections, the research methodology can be developed.

Research methodology defines the process of the research and covers the choices for research design, strategy and method for defining the technique for collecting and analysing the data. The following sections explain the choices that best fit the research in this dissertation.

4.5.1 Quantitative vs. qualitative

The choice of method for collecting the data is important for the research process. The methods are categorised into either quantitative or qualitative methods. It is possible to choose only one method, but also a combination of both can be used for methodological triangulation (Collis & Hussey, 2014).

Quantitative research is generally associated with positivism, and sometimes with the realist and pragmatism philosophies. It is typically used with a deductive approach, but can also be used for an inductive approach where data is used to develop theory (Saunders et al., 2012). Qualitative research is associated with an interpretive philosophy (Denzin & Lincoln, 2005). It is interpretive because researchers need to make sense of the subjective and socially constructed meanings expressed about the phenomenon being studied (Saunders et al., 2012).

The research in this dissertation relies on data that is available from two sources in two separate steps: the first step from the literature and the second from industry. The data from the literature creates the foundation for the knowledge of the area under research and also supports in creating an understanding about various relationships and dependencies between different actors and parameters and conditions in the area of research. The data from industry deepens understanding and creates the source for analysis and conclusions.

4.5.2 Foundation from the literature

The literature research did not reveal previous theoretical work performed for similar research as in this dissertation. The theoretical models that were found represented either some specific aspects of management (like Siqueira & Pitassi, 2016 on the mindfulness emphasis, or Baumgartner & Rauter, 2017, on the strategy perspective) and not widely general management, or they had an overall view without separating the management aspect from all other drivers or perspectives (like Lozano, 2015, having a holistic perspective, or Adams et al., 2015, presenting a generic conceptual framework).

An increasing amount of research is being done in the area of sustainability and innovation, but practical ways for managing this are not presented. The literature did, however, provide interesting insights on how to categorise different approaches and to create models based on these but do also show the need for conducting further research.

The challenge with the existing research in the literature is that a great majority of it is based on theoretical material and not supported by empirical research. Actually, most of this research proposes as next steps performing empirical studies in order to verify the results and to develop the theory forward. Siqueira & Pitassi (2016) have created their model based on literature and propose as a next step to examine via empirical research the impact of mindfulness training on the attitudes and behaviour of organisational leaders in favour of sustainable development in corporations. Lozano (2015) carried out some empirical research in addition to a

literature search, but still proposes as the next step to perform a quantitative empirical study to provide more information about the sustainability drivers and their importance, and proposes various aspects to be considered in the research. Baumgartner & Rauter (2017) provide a holistic perspective on corporate sustainability management based on literature studies and finally propose the concept to be used as an agenda for empirical research. Adams et al. (2015) have made their research based on literature and state that in order to give further practical value to the findings in their sustainability-oriented innovation model, future research efforts should be directed towards both empirically testing the framework and operationalizing it in the form of a maturity model.

Based on this learning and on the knowledge provided, it is possible to develop a new framework for describing the landscape of different actors, conditions and concepts that suit the purposes of this research. That framework can then be used as the platform on which the planning of empirical data collection from the shipbuilding industry is constructed. The industry data collection can thus be conducted by direct research from selected companies in the business. Based on the data, further refinement of the model can be performed.

4.5.3 Collection of empirical data

As explained earlier, the research philosophy in this dissertation is based on interpretivism. This choice guides the research data collection so that small samples are enough and the data is used for generating a theory. The aim is to create 'rich', subjective, qualitative data. This philosophy uses findings with low reliability but high validity and allows findings to be generalised from one setting to another similar one. (Collis & Hussey, 2014).

The industry specific empirical data for this research is sourced directly from some selected companies. Management of the companies represent an important source of information for the research topic. Such top management have busy schedules and thus access to them is there for one time only and repeated data collection events are not possible. Thus, the data for the research needs to be collected at one instance. This causes some constraints for the data collection and thus as wide as possible a view of the research topic needs to be gained in one instance when management participation is available.

4.5.4 Research methods

In order to be able to collect as rich data as possible in one data collection event with industry leaders, two sets of data are collected from each interview. Use of the qualitative method is natural since the philosophy is based on interpretivism philosophy (Saunders et al, 2012; Collis & Hussey, 2014). Two different ways of collecting qualitative data are used in order to obtain a wide view for the research. The first uses open questions and the other a questionnaire.

Use of quantitative research is not possible due to the challenge of getting enough data. In the world there are only approximately 500 shipyards that are building ships of ocean going vessel size. In order to make good statistical analysis for a population of 500, data from 217 sources is needed (Collis & Hussey, 2014). There are no realistic possibilities in this research to reach such data using the planned method of face-to-face meetings with top management of shipyards. Thus, collection and use of quantitative data does not come into question.

The use of two quantitative data collection ways provides an opportunity for data triangulation (Collis & Hussey, 2014) that enriches the quality of the research. Since the leading method is the qualitative method (as the philosophy is interpretivism), a sequential exploratory research design is used where qualitative is followed by another qualitative data collection (Saunders et al., 2012).

4.6 Research design

The approach to research design is found through the research questions. The way in which the research questions are asked leads to research design. The nature of the research design follows a descriptive, explanatory or exploratory purpose.

The object of descriptive research is to gain an accurate profile of events, persons or situations (Saunders et al., 2012). Descriptive studies merely describe the situation in terms of how it is found, but not the end conclusion, which is often based on the description of as-is. The purpose of this research is to find the underlying reasons and motivations for management and thus descriptive studies do not bring the answers that are needed.

Explanatory studies establish causal relationships. The emphasis in exploratory studies is to observe a situation or a problem in order to explain the relationship between variables. Both quantitative and/or qualitative data can be used for supporting the analysis and making the conclusions. This is a valid method where there are ready ideas of relations between parameters that the study will try to

explain. It is less well suited for research where causalities and relations and involved parameters are unknown.

Exploratory studies are valuable for asking open questions and for gaining insights into a topic of interest. They are particularly useful if there is a need to clarify understanding of a problem, the precise nature of which is not known beforehand.

For this research, the exploratory research is well-suited for the literature research part. It helps in finding relevant items and priorities and opens possibilities for modifying understanding freely whilst learning more from different sources.

The empirical research consists of two qualitative parts. The first part is structured to find out the priorities and drivers that the shipyards have in sustainability in innovation. That data gathering takes place via open questions and thus follows the exploratory research design.

The other part of data gathering is to find out the priorities of the drivers that were identified in the literature analysis. Here, there is an understanding of the causalities and parameters already when conducting the interviews with the selected companies. The questions reflect the framework that is constructed based on literature study and the research tries to identify dependability between the elements of the model. This part of the data gathering is based on explanatory design.

4.7 Research strategy

The choice of research strategy is the fundamental plan of action to achieve a goal. It is the methodological link between the philosophy and subsequent choice of methods to collect and analyse data (Denzin & Lincoln, 2005). It defines a plan for how the researcher should act to find the way to answer the research question.

There are many types of research strategies that are linked to research philosophies, research approach and also to research traditions in a certain area of focus (Saunders et al., 2012). In the following sections the most potential research strategies linked to interpretative philosophy are analysed and their potential explained and finally a choice of strategy is made.

4.7.1 Ethnography

Ethnography is a method that has its background in anthropology, wherein the researcher uses socially acquired and shared knowledge in order to understand the

observed patterns of human activity (Collis & Hussey, 2014). It is based on the collection of empirical data on human societies and cultures in the form of a holistic study where observed behaviour is recorded and described. It is field-based and conducted together with real people and conducted by researchers who are in day-to-day, face-to-face contact with the people they are studying and they become a part of the group being studied. Therefore this requires a long term commitment. Ethnographers are interested in studying people in groups who interact with each other and share the same space (Saunders et al., 2012).

There are some elements in ethnography that would have supported such research in this dissertation. It supports interpretivism, it allows the use of mixed- or multi-methods and it allows the researcher to be familiar with the knowledge of the area to be studied. However, the necessity of working as a part of the team, to have a long-term presence in the teams under study and to even become a member of the team ruled out the possibility to use this otherwise interesting strategy for this research project. Also, the need to have the research taking place in a clearly defined natural setting and direct participation in the activities taking place (Collis & Hussey, 2014) limit the possibility for a European researcher to conduct research in several different Asian shipyards.

4.7.2 Participative inquiry

Another methodology that involves the researcher as a member of the teams or group under study is participative inquiry. In this concept the teams under research may themselves be involved in the data collection and analysis. The participants also determine the progress and direction of the research and thus allow the researcher to use the group as co-researchers to develop questions and answers (Collis & Hussey, 2014). This method is about research with people and not research on people (Reason & Bradbury, 2001).

The requirement to have the researcher as a part of the team and to collaborate integrally with the team in order to develop the research limit the possibility to use this strategy in this research. Access to the interviewees is limited in terms of time and it was expected that the planned top-level managers would not invest a lot of their time in developing the research questions and approach. Therefore, this strategy was not selected for the research in this dissertation.

4.7.3 Action research

Action research is another type of research strategy used for empirical studies. It has close links with participative inquiry but involves more of a dynamic situation than in participative inquiry. In action research the aim is to enter into a situation where change occurs and to monitor the results. It is usual to conduct action research within a single organization (Collis & Hussey, 2014). Some of the challenges with this methodology are the involvement of the researcher, which would need to be close enough but still not impact the results, and also the required understanding of the activities so that correct notations of the impact of change can be correctly registered (Robson, 2016).

Action-orientation does not fit well with the research in this dissertation. Being part of a change and observing the impact requires a longitudinal time-element and that limits the suitability for this research since access to the organizations under study is limited and also timewise restricted. The need of action research to study mainly one organisation also poses a problem since the target is to make research with multiple companies in two countries and thus action research would not satisfy the chosen research philosophy. Therefore, action research was not selected as the research strategy.

4.7.4 Grounded theory

Grounded theory refers to a theory that is grounded in or developed inductively from a set of data and was developed to reveal a pre-existing reality (Glaser & Strauss, 1997). It is well suited for interpretivism, where reality is seen as being socially constructed through the meanings that social actors ascribe to their experiences. Grounded theory has during its existence gone through evolution and new versions of it have emerged (Collis & Hussey, 2014). The grounded theory presented here is based on classic grounded theory or Glaserian grounded theory (Collis & Hussey, 2014). It is used as a process to analyse, interpret and explain the meanings that social actors construct to make sense of their everyday experiences in specific situations (Saunders et al., 2012). The aim is to discover or generate theory grounded in the data collected from the accounts of social actors and is not dependent on a priori theories (Collis & Hussey, 2014).

In grounded theory research each item of data collected is compared with others and against codes that are used to categorise data, and it involves moving between inductive and deductive data. The researcher should enter the research setting with as few predetermined ideas as possible (Glaser, 1997). In case some prejudices exist, the researcher should question their validity and thus eliminate

their impact. Hutchinson et al. (2010) define the key characteristics for grounded theory research as:

- Iteration – early data collection and analysis inform subsequent sampling and analysis procedures, requiring concurrent involvement in data collection and analysis.

- Sampling aimed at theory generation - sampling decisions are a function of the research question and the ongoing theoretical development. As a result, grounded theory research involves both purposive and theoretical sampling.

- Coding - the analytical process through which concepts are identified and their properties and dimensions are discovered in the data. These should be representative of the data itself and cover a wide range of observations.

- Theorizing - a range of techniques can be used to advance theory development during each step of data collection and analysis. The choice of techniques depends on the epistemological and theoretical stance of the researcher.

- Making comparisons - making comparisons at every stage of the analysis (e.g. within and between cases or over time) helps to establish analytical distinctions by identifying variations in the patterns to be found in the data.

- Theoretical density - it is commonly accepted that there must be evidence of theoretical density or depth to the observations presented, resulting in the presentation of a theory from which hypotheses can be generated. This should also include evidence of theoretical saturation (when new data reveals no new theoretical insights).

There are many appealing factors in the grounded theory concept for the research in this dissertation. The process allows gradual development based on initial studies from the literature and refinement using empirical data from the companies being studied. It supports the plan to focus on practical management aspects and to find aspects from real life situations.

There are, however, some limitations in the possibilities of using grounded theory for this research. The main difficulty comes from the need to have a non-biased researcher with no earlier knowledge about the research topic. In this research, the researcher does have a long history in the business and thus has major challenges in utilising this approach. The other limitation is the need to have a long timeline in order to have enough research cycles for producing good enough saturation of

the theory. Therefore, this strategy was not chosen as the main path for conducting the research, although some areas of interest were identified.

4.7.5 Case study

Research based on case study explores the research topic or phenomenon within its context, or within a number of real-life contexts (Saunders et al., 2012). Case study is relevant for cases where rich understanding of the context of the research and the processes are needed (Eisenhart & Graebner, 2007). Yin (2014) defines a case study as an empirical study that has the following aspects:

- Investigates a contemporary phenomenon in depth in its real-life context
- Copes with the technical distinctive situation where variables are more than data points
- Multiple sources of evidence are used, with data needed to converge in a triangulating fashion
- Prior development of theory is used to guide data collection and analysis

Case study is a strategy often used with interpretivist philosophy, although it can be used for some positivist research as well. It can be used for a single case. Opportunistic case study is used for research where the researcher has access to a particular business, person or other case (Otley & Berry, 1994). The main contents of a case study are (Collis & Hussey, 2014):

- Selecting the case. The cases can be one or several (multiple cases).
- Preliminary investigations. This helps in getting familiar with the context
- Data collection. The methods can include documentary analysis, interviews and observations. The evidence can be qualitative, quantitative, or both
- Data analysis. Analysis can be within-case or cross-case requiring either in-depth familiarization with the material or finding similarities and differences between the cases
- Writing the report. In interpretivist studies this contains extensive quoting of the data that has been collected

Case studies often use several techniques for collecting the data in quantitative and/or quantitative form. Triangulation is commonly used for combining the

results obtained with several methods and/or from several cases and thus for ensuring that the data reflects the actual situation. It can reduce bias in data sources, methods and investigators. Methodological triangulation refers to research done using more than one method and, despite the risk that replication of such research is more difficult, it provides a broad view of the research problem or issue when embedded as an integral part of the research project.

Using case study as the strategy for the research in this dissertation is appealing since many elements of such a strategy match the conditions and settings that this research has. The researcher has access to companies in the selected business in a manner that an opportunistic case study would support. The slight challenges using this strategy come from the potential bias of the researcher due to deep involvement in the business being researched and also due to the limited (only one interview per company) access to the case companies being investigated though their top management. The strategy of case study also has a limitation in terms of the development of theory during the research. It is not naturally suited to situations where understanding is being developed during and in between interviews with the investigated companies. It was expected that this kind of evolution would happen in this particular research. Therefore the choise was not to build the strategy on case study concept but to create a research strategy that could fully support it.

4.7.6 Hermeneutics

Hermeneutics is a research strategy that has originally been used for interpreting messages from the Bible and other religious material (Malpas, 2016). The purpose has been to find meanings behind the text and to understand the messages in the context of other texts. Use of the strategy has thereafter been widened to research in law and later to the social sciences as well.

Dilthey and Jameson (1972) explain how hermeneutics provides a way to preserve the general validity of interpretation against subjectivity and gives a theoretical justification for knowledge. The basic focus in hermeneutics is to combine understanding, interpretation and application as internally related moments of the single process of understanding (Bernstein, 1982) and understanding of information in the context of the underlying historical and social forces (Sparrowe, 2005; Petruescu, 2013). It assumes that a relationship exists between the direct conscious description of experience and the underlying dynamics of structures. It is applied to situations in which one wants to recover historical meaning, and the

process involves continual reference to the context (Ricoeur, 1997). It is anchored in the interpretative paradigm (Burrell & Morgan, 1979).

Central for hermeneutics is the definition of a hermeneutic circle. This means that details and the whole content are dependent on each other since the meaning of any part of the text cannot be understood without reference to the other parts, the complete text and social context (Collis & Hussey, 2014). Understanding of individual parts of a text is based on understanding of the whole text, while understanding of the whole text depends on the understanding of each individual part (Forster, 2015). Neither the whole text nor any individual part can be understood without reference to one other, and hence it is a circle. In social science, hermeneutics has been gradually extended to the study of every act of process involving interpretation: verbal and nonverbal communication as pre-suppositions, preunderstanding, and so on (Addeo, 2013).

The process for conducting hermeneutic research in social science is structured according to Addeo (2013) as follows:

- Use of a concept map. Based on literature review, building a theoretical frame into something that can be tested empirically. This creates a general research scheme and indicates the relations among research concepts/dimensions

- Role of the interviewee. In the hermeneutic approach the interviewee has the central role in the whole research process and thus upturns the classical interview session (the usual asymmetric power relation is virtually dissolved). Qualitative interview techniques are most suitable to collect narrations since these allow the interviewees to use their own personal way of communicating. Everything that the interviewee says is important; not only what is said but also how it was said

- Sensitivity of the researcher. The researcher should be aware of his/her own limitations, have ethical sensitivity, be a good listener and establish an equal relationship with the interviewee

- Selection of the interviewees. Most commonly, convenience sampling is used based on the relative ease of access. Also judgement or purposive sampling is possible, where the researcher chooses the interviewees based on who he/she thinks is most appropriate for the study. Also snowballing can be considered, where existing interviewees help the researcher in recruiting new interviewees from among their acquaintances

- How to conduct a hermeneutic interview. A flexible guideline listing the main topics and subtopics is recommended, based on the initial research frame. The interview should be conducted in the form of normal conversation, and questions should be of the open type (yes/no answers are to be avoided).

- How to analyse and interpret a hermeneutic interview. All answers and non-oral reactions should be recorded. Tape-recording of the interview is recommended and transcription also recommended. Interpretation of the results should follow the iterative cycle of hermeneutics, where iterations between the details and the whole context vary

- Criticism of the hermeneutic approach. There is a risk that interviewees say things that we know are not true, the researcher intervenes in the conversation, the empirical basis is not available, or generalization is not possible. All these need to be judged by the researcher when conducting the interview and analysing the results

Hermeneutics raised a lot of interest for use in the research in this dissertation. This strategy allows the researcher to have experience of the topic under research and actually also expects such a basis to be there. It allows gradual (cyclic) development of the theory when moving from one interview to another and therefore supports the collection of data from several companies, as was the initial plan in this research.

Rendtorff (2015) has proposed combining case study with hermeneutics in order to gain better understanding of the structures of action. He claims that this combination is a method that makes knowledge concrete, especially when dealing with understanding of the ethics of management and organizations. He proposes that the researcher is placed in the hermeneutical circle of interpretation in relation to the case where through questions and experiences he/she contributes to the production of knowledge: "The task is to create interaction and development so that the circle of understanding is not meaningless and tautological, where we go in a vicious circle, but rather is an activity of interpretation that mobilizes the potential cognition that emerges from the specific case in a play of interpretation between the parts and the whole of the circle, between the case and general macro-conditions of society, between the case and historical époque, and between the particular knowledge in the case and the general social and economic development of society" (Rendtorff, 2015, pp. 44-45).

In the strategies for case studies, multi-methods are often used. Hermeneutics most commonly rely on qualitative research methods, although quantitative

material can be used as supportive element as well. Combining the strategies of hermeneutics and case study, Rendtorff (2015) provides a method where the researcher can have experience of the topic and does not have to be non-biased.

4.7.7 Time horizon

In this research, the plan is to collect data from the top management of selected companies. The access is limited to one occasion per company only. The focus industry is shipbuilding. The data available from the literature regarding the specific industry is limited.

Based on these boundary conditions, it was not possible to consider the research to be done as a longitudinal study where repeated observations are used in order to reveal the relative stability of the phenomena under study (Collis & Hussey, 2014). Therefore, cross-sectional study was selected as the research time horizon for this research.

5 SUSTAINABILITY FRAMEWORK

A theoretical framework is needed in order to have a basis and platform to supporting building the following steps of the research plan. The data for the framework comes from various sources identified in the literature study and needs to be arranged and clustered in order to put it into a format that illustrates the relations and supports continuing the research plan.

Before taking the framework into further use, the plan is to make a verification of the contents. The verification will be made by using data available from the literature. Since the industry specific primary data was not available through typical literature search tools, the data will be collected from secondary sources to be analysed and used for verification.

5.1 Data collection

The selected way of working in this research was to use the observations from the literature study and to create a theoretical framework that highlights the importance of such parameters that have significance when managing sustainability in innovations. As the method for reviewing the literature and selecting the parameters, qualitative content analysis was selected. Cho and Lee (2014) and Lankoski (2016) present two important characteristics in qualitative content analysis that are important in this research. First, the qualitative method is able to identify content meaning and thus give a deeper interpretation and reach to the underlying meaning of the data. Secondly, the method allows the use of inductive and deductive approaches, or even combinations of both. Regarding the methodological steps of qualitative data analysis, Cho and Lee (2014) and Shannon (2005) present a three step process:

1. Sampling of the materials
2. Reduction of data through selection of which aspects to focus on
3. Coding of the material with iterative loops until the final categories have been created.

This research uses qualitative method to develop categories inductively and directly from the data during the analysis using successive iterations. Therefore, content of the material was analysed through identifying patterns in it, with the aim of extracting categories and groups that are meaningful for the research. This required collection and arranging of the data so that priorities and interlinks between the parameters could be defined. The outcome of qualitative analysis is

often a framework, model or display (Collis & Hussey, 2014) based on created categories. This was selected to be the target also in this research and the target was also to create a visual framework so that the communication and use for later purposes would be easy.

5.2 Clustering of the data from the literature

The literature study showed that the parameters that influence the sustainability in innovations are many. Lozano (2015) calls such parameters drivers, and the same definition will also be used in this research.

Some of the research in the literature identified such drivers and listed them, but most only mentioned them in the text and thus these needed to be collected through analysis of the text. The number of drivers found was high. Lozano (2015) alone identified 40 drivers in his research. Altogether, 87 different drivers were identified in the literature study, some being very specific and some very general in nature (Table 3).

After collecting all this material, reduction of the data took place. The drivers were clustered and categorised using the technique of sampling, reduction and iterative loops as described in the previous chapter. The process consisted of iterations that were conducted by looking for similar aspects between the drivers, connecting similarities with a corresponding driver and iteratively continuing the reduction until no more similarities were identified. The guiding decisive principle in this iteration and clustering work was the identification of the drivers from the sustainability and innovation viewpoint. The areas mentioned most often or aspects with obvious similarities (like ‘stakeholder expectations’ and ‘stakeholder relations’ or ‘legislation’ and ‘international treaties’) worked as the core for the clusters around which the iterations expanded the clustering further. The terms selected for the clusters were chosen as the strongest or one of the strongest aspects that best described the full content and meaning of that cluster.

Table 3 Drivers for sustainability in innovation, identified from the literature

Generate/restore trust	Leadership	Net positive impact
Stakeholder expectations	Precautionary principle	Incremental improvements
Strategy	Innovation	Fundamental shift in firm purpose
Policies	Quality	Insitutional change
Social legitimacy	Eco-efficiency	Attracting and maintaining labour
Future sustainability markets	Ethics	New market opportunities
Markets expectations	Pollution prevention	Societal change
Customer satisfaction	Personal engagement	Top management
Raising studnet awareness	Business case	Resources and cost savings
Political lobbies	Peace and security	Cultural values
Alliances and partnership	Trust	Technology
Tools	Top management	Institutional/administrative arrangements
International treaties	Shareholder value	Corporate and brand reputation
Ease regulatory pressure	Culture	Politics
'Polluter pays'	Risks	People
National government	Socialization	Operational optimization
Competitors benchmarking	Internalization	Access to markets & customers
'License to operate'	Externalization	Processes
Access natural resources	Mindfulness	Motivation
Limited operations areas	Government actions	Philosophy
Stakeholder expectations	Social pressures	Training
Sustainability reports	Creativity	Linkages
Shareholder activism	Inspirational leadership	Communication of values and goals
Env and social crises	Compliance	Social justice
Profits and growth	Efficiency	Morale
Productivity	Harm reduction	Stakeholder relations
Employees shared values	Shared value	Entrepreneurship
Political action	Attitude	Behaviour
Competencies	Values	Legislation

This condensation finally resulted in 11 drivers that represent the outcome of the known research. These drivers are listed in Table 4 together with the lists of the original drivers that form the group belonging to the final driver. Some original drivers belong to more than one group and are thus seen twice in the table. The iteration loops performed in coming to this result are not shown in detail but the condensation took three loops to come to this conclusion.

Such iterative synthesis naturally includes a risk that some important aspects are lost in the reduction. The potential damage is anyhow corrected later when the empirical data is collected and thus omitted important drivers brought back again as being found to be of high importance for the shipyards.

Table 4 Driver synthesis to 11 logical themes

Stakeholders	**Policies**	**Top management**
Stakeholder expectations	Legislation	Leadership
Stakeholder expectations	Government actions	Strategy
Shareholder value	Compliance	Inspirational leadership
Stakeholder relations	Politics	Communication of values and goals
Shareholder activism	Ease regulatory pressure	Fundamental shift in firm purpose
Future sustainability markets	International treaties	Internalization
Markets expectations	'Polluter pays'	Externalization
Customer satisfaction	Political lobbies	Insitutional change
Access to markets & customers	Access natural resources	Alliances and partnership
Limited operations areas	Limited operations areas	**Philosophy**
New market opportunities	Socialization	Quality
Sustainability reports	'License to operate'	Shared value
Social pressures	National government	Pollution prevention
Culture	**Entrepreneurship**	Access natural resources
Cultural values	People	Institutional/administrative arrangements
Employees shared values	Resources and cost savings	Social justice
Precautionary principle	Business case	**Motivation**
Profits and growth	Creativity	People
Peace and security	Personal engagement	Raising student awareness
Social legitimacy	Risks	Corporate and brand reputation
Societal change	**Ethics**	Attracting and maintaining labour
Env and social crises	Ethics	Creativity
Competencies	Morale	**Tools**
Training	Values	Processes
People	Trust	Operational optimization
Efficiency	Generate/restore trust	Linkages
Eco-efficiency	**Behaviour**	Competitors benchmarking
Productivity	Mindfulness	Technology
Innovation	Attitude	Sustainability reports
Net positive impact	Harm reduction	
Incremental improvements	Political action	

In order to arrange the identified 11 drivers into a logical relationship order, a framework was built. These final drivers were analysed further by dividing them into two categories as proposed by Hotho & Champion (2011): drivers that are decided and managed by externals to a company and drivers that can be impacted internally in the company. The external drivers are such that they tend to result in reactive measures since they are not decided on and managed by the company management directly. The internal drivers are those that the company can influence more directly with its own activity and thus are more proactive. Lozano (2015) has even presented a third category, connecting drivers, in order to reflect the semi-open or semi-closed systems of corporations. Since this research is not limited to semi-open or semi-open organisations only, that categorisation is not used for this analysis.

Staub et al. (2015) show that internal drivers can be grouped into those that can be changed quickly and those that take a long time to be changed. In their research, they list culture, behaviour and philosophy as being hard corporate identity drivers, meaning they take a long time and lot of effort to be changed. Ethics is strongly connected to culture (Aaltonen & Junkkari, 1999) and therefore is similarly a driver that takes a long time to be changed. The categorisation of the drivers resulting from the iterative process are categorised into internal vs external and long term to impact vs short term to impact as shown in Table 5.

Table 5 Identified drivers impacting sustainability in innovation

Driver	*Category*
Top management guidance	Internal, short term
Stakeholders	External & internal, long term
Ethics	Internal, long term
Culture	Internal, long term
Behaviour	Internal, long term
Philosophy	Internal, long term
Competence	Internal, short term
Motivation	Internal, short term
Entrepreneurship	Internal, short term
Tools	Internal, short term
Policies	External, long term

5.3 Theoretical framework

In order to be able to detect sustainability activities in practice, a framework was developed based on the drivers that were identified in the literature. There are some models built in earlier research as well, such as Engert et al. (2015), where emerged issues have been modelled, Adams et al. (2015), where a model for sustainability oriented innovation (SOI) has been presented, and Lozano (2015), who presents a corporate sustainability driver model. The challenge with these

models is, however, that the links to practical detectable parameters and activities are not identified and thus they do not assist in verifying and observing sustainability in practice.

The drivers and categorisation from Table 5 were used to create a new kind of visual sustainability framework as shown in Figure 13. The activities related to sustainability in innovations are located in between the market opportunities and the intended outcome which is sustainable innovations. The activities within a company are drawn in blue colour in the middle of the picture. This figure thus illustrates the most important drivers for sustainability in innovations based on the knowledge gained from the literature and it presents the logical connections between them.

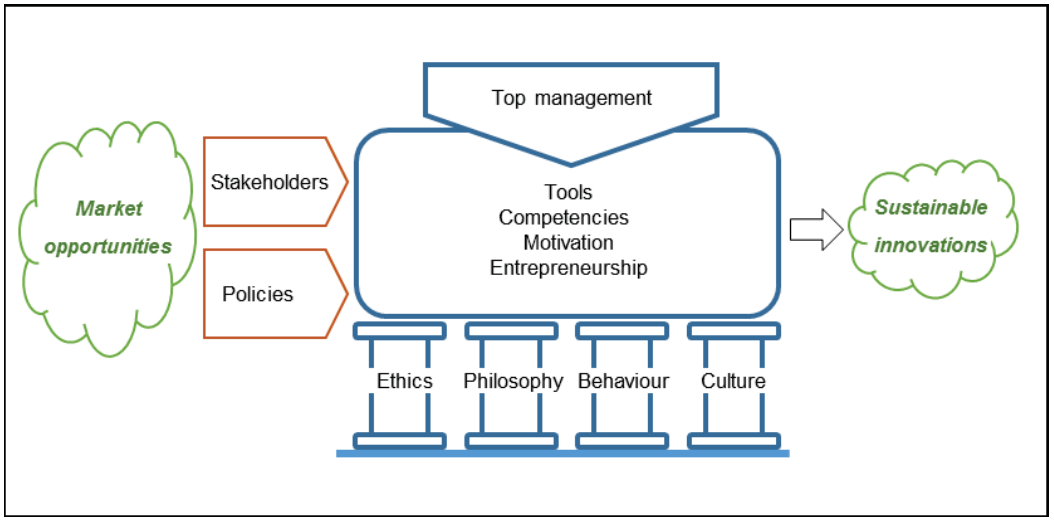


Figure 13. Framework of drivers impacting sustainability in innovation

The logical connections between the drivers and company operation can be described in the following way:

- Stakeholders connect the market opportunities to the company and thus act as a driver by facilitating or limiting sustainability in innovations

- Policies create a filter or boundary that impacts the development of sustainability in innovations

- The most important internal drivers of the company operations (the rounded box) are tools, competencies, motivation and entrepreneurship. These have the highest impact on internal operations and can be impacted and modified in the short term.

- The drivers that act as a foundation for a company are ethics, philosophy, behaviour and culture. Those take a long time to be changed and are visualised as the pillars supporting the company's activities and thus act as a foundation for it.

- Top management is an important driver for the company activities and is drawn to the top of company activities. Although top management is also a stakeholder, it is described here separately due to the unique role that it has, and also in order to separate the role of the management for the purpose of responding to the research questions.

The first key research question in this dissertation research was: What have been the most important factors and priorities impacting business development towards sustainability in innovation? The illustration now shows the main elements of this key question. Such development is in the interest of top management and the system can be analysed from the point of view of top management. First, the most direct management is possible regarding tools, competencies, motivation and entrepreneurship. Tools for managing and measuring triple bottom line performance and other aspects can be developed or acquired. People can be trained or newly recruited with the needed competencies. Motivation is a result of leadership and human resource activities and thus can be impacted. Entrepreneurship is a choice of a management system: allowing employees to have visibility over the entire business, having the possibility to impact and to take controlled risks.

Top management can also impact the foundations of the system, but the efforts will take a longer time and thus managing that part is less dynamic. The most difficult areas to manage are the external stakeholders and the policies in society. A lot of effort can be made to facilitate change, but since there are also other sources impacting these areas the results of the efforts remain uncertain.

5.4 Sustainability in shipbuilding

Before continuing with the empirical research it was seen necessary to validate the framework presented in Figure 13 against business in shipbuilding. Therefore, it was decided to study the literature on sustainable innovations in that industry and compare the framework against it.

Only a few academic articles were found of relevance to sustainable innovations regarding shipbuilding. Greve (2003) has studied innovations in Japanese shipbuilding between the years 1971-1996, during the period when Japan was the leading nation in shipbuilding. Innovations were introduced frequently as a response to the changing environment, but mainly economic aspects were identified as key drivers. The study by Fornahl et al. (2012) shows how policy decisions on feed-in tariffs for offshore wind energy production impacted activities in shipbuilding. Van Oorschot et al. (2014) have studied knowledge transfer in shipbuilding and show the role of management decisions in facilitating trust between persons and how that positively stimulates creativity and thus supports long-term success.

Poulsen & Sornn-Friese (2011) have studied shipbuilding in Northern Europe and especially in Denmark. They show that social performance has been recognised as a measure of success during many periods in history, even more important than financial success. Their research shows that institutional, entrepreneurial and political decisions have a strong impact on success in shipbuilding.

None of the studied empirical scholarly papers on shipbuilding could indicate evidence of whether sustainability has been integrated into practice in shipbuilding innovations. Further material would have been needed in order to test the framework against data from the shipbuilding industry. Data collection was therefore selected to be made from secondary (grey) literature sources similar to Adams et al. (2015) when testing their sustainability-oriented innovation model.

5.5 Testing the framework

Since no industry specific scientific material was available the study needed to focus on grey literature, which was defined to be publicly available material directly from some shipyards. Annual reports represent a good source for information and give a wide view of the activities of a company.

When planning to use publicly available annual reports, a problem was encountered. Although the drivers that were selected for the framework in Figure 13 are general and well defined, they are defined with terms that are not used by companies in their public material. Companies do not explain their philosophies, do not present their internal tools or behaviour etc. in their public documents. In order to overcome this challenge, it was decided to do some further grouping of the drivers that are presented in Table 4 and focus on such terms that are more typically used in public material.

The following modifications were concluded to be needed in order to identify drivers that are detectable from annual reports:

- 'Stakeholders' is a wide definition containing many interest parties. The group in Table 4 shows that the most common part of stakeholders are 'customers'. Customers are also such stakeholders that can be mentioned in the public documentation of the companies and thus the term 'customers' is selected here to replace 'stakeholders'.

- Although policies is a recognised definition, it is not directly referred to in most company external language. From Table 4 the most similar definition is 'legislation' and that is also used in external company documentation.

- The foundations for the company activities 'ethics', 'philosophy', 'behaviour' and 'culture' are all rare in public documents. From the groups in Table 4 it is visible that 'values' are mentioned in most of the groups and can be used as a broad term for the foundation. It is also a term that is typically not a secret for a company and thus is used also in public material. Therefore the foundation is described with the term 'values'.

- The drivers within the companies are similarly seldom mentioned in external documents. Using the groups in Table 4 and looking for commonalities for ''tools', 'competencies', 'motivation' and 'culture' two matching drivers were identified: 'people' and 'processes'. These are both part of common company communication.

- The 'top management' is neither directly referred to as a driver in company documents. The closest similar term in Table 4 is 'strategy' and it was selected to be used here.

Based on the modifications of the drivers, a new framework was constructed in order to be able to use public company annual reports as the source for driver identification. This simplified framework is shown in Figure 14.

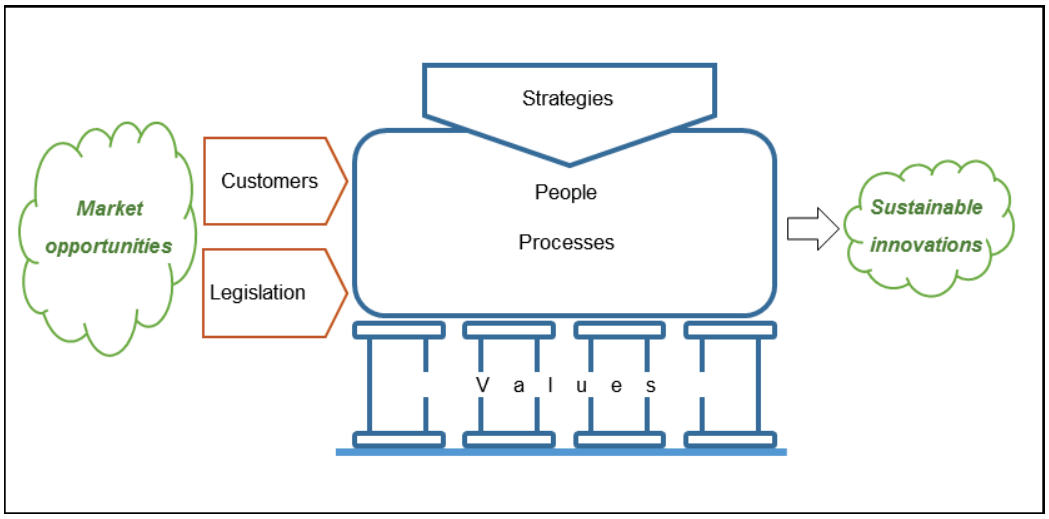


Figure 14. Modified driver framework for verification purposes

This new, simplified framework obviously loses some of the aspects of the original framework. The main logic, however, remains the same and it now contains such drivers that can be studied with data from public documents. The aspects lost are mainly due to the more narrow focus of the drivers than in the framework in Figure 13. This compromise is, however, not harmful for the purpose of testing. If the testing shows that drivers for sustainability in innovations can be identified with this more narrow focus, then possibly a broader view is also possible if only access to data is available.

5.5.1 Selection of the test cases

The shipyards to be studied ought be representative of their business and have annual reports available in English. The requirement of being representative for this research was that the shipyard should do business internationally. Geographically different locations should give some variation, which helps in identifying differences between the cases and thus validation of the framework. In order to give focus and limit the data volume, the number of cases was limited to three. The following shipyards were finally selected for the review (since the material comes via public sources, i.e. the Internet, also the names of the shipyards are mentioned):

- Yard 1: STX France, Europe. Known to be innovative and to build sophisticated vessels with focus on the environment and energy efficiency for the cruise industry, navy and special use.

- Yard 2: Hyundai Heavy Industries, South Korea. The biggest shipyard in the world and known for efficiency and high capacity of building vessels for merchant and offshore markets.

- Yard 3: Guangzhou Shipyard International Company Limited, China. A large shipyard in China and part of the shipping conglomerate CSSC. Has high capacity in merchant and special vessel construction and competitive price levels.

For testing the framework, official company annual reports were identified from the respective Internet sites of the selected shipyards. The purpose was to identify the drivers presented in Figure 14. The viewpoints for such a study need to be sustainability and innovation.

All the shipyard projects are part of innovation work because all new ships have new designs and optimisation for customer purposes. Therefore the innovation viewpoint is obviously part of the priorities in every shipyard and thus not looked for separately and the focus is on identification of sustainability.

Sustainability consists of financial, social and environmental views. High interest is in understanding if the social and environmental aspects are visible in the companies and therefore the detection of the drivers was designed to have those two separately viewed for such drivers where possible. The drivers and viewpoints to be looked for from the annual reports are thus:

- Values, social point of view
- Values, environmental point of view
- Strategies, social point of view
- Strategies, environmental point of view
- Customer focus
- People focus
- Processes, sustainability focus
- Legislation focus

Measurement was performed based on a binary criterion so that identification/ observation of the presence of a driver in the list above gave one point for scoring, and if the driver was not identified in the annual report, it got zero points. Thus, eight points is the maximum score if all the eight drivers were identified. The minimum is zero if none of the drivers were mentioned.

The annual reports (STX France, 2014; Hyundai Heavy Industries, 2013; Guangzhou Shipyard International Company Limited, 2014) from the companies were used for scoring of the visibility of the drivers. The results of the scoring based on the binary criteria are shown in Table 6.

Table 6 Scoring sustainability drivers in shipyards' annual reports

Driver	*Yard 1*	*Yard 2*	*Yard 3*
Values, social point of view	0	1	0
Values, environmental point of view	1	1	0
Strategies, social point of view	1	1	1
Strategies, environmental point of view	1	1	1
Customer focus	1	1	1
People focus	1	1	1
Processes, sustainability focus	1	0	0
Legislation focus	1	0	0
TOTAL	**7**	**6**	**4**

Source: Author's analysis from annual reports of the shipyards.

5.5.2 Results of the verification using grey literature

The results show that strong drivers can be identified from the annual reports. The reporting structures are naturally different in different countries, but the results clearly indicate a difference between the companies. There is naturally the risk of greenwashing, meaning that the words in the reports are not reflected in practise, but rather are only nice words that the companies want external stakeholders to see but without any internal real content. Since all the shipyards in the study are doing international business and have audited reporting systems in place, it is, however, justified to rely on the data available in their public annual reports.

The results indicate that yard 1 has the highest score and yard 3 the lowest. As such, the result is not a big surprise. Yard 1 has been building ships for 150 years and has

the longest history, is located in Europe, where the sustainability focus has long traditions, and is also supplying vessels to the USA for the cruise industry, which is generally known to have a high focus on sustainability. Yard 1 had all the drivers mentioned in their annual report except the one with values from the social point of view.

Yard 2 had a very high score as well: six out of the maximum eight points and only one point less than yard 1. The missing elements were regarding processes from the sustainability viewpoint and invisibility of the legislation focus. This shipyard was founded in 1972 and thus has a history of 45 years and has specialised in international business and building more and more advanced and technical vessels. Due to international business demand, also the focus on sustainability has been high as is seen from the results as well.

The result for yard 3 was not a surprise for this research. Many important sustainability drivers were identified from the annual report and the scoring was four out of the maximum eight. The focus on values, both from the social and environmental point was missing and no identification of processes from the sustainability viewpoint and focus on legislation was found. This shipyard was founded in 1954 and thus has a long history and is the largest modern integrated shipbuilding enterprise based in Southern China and is listed in the stock exchange in Hong Kong. It has, however, entered into modern international shipbuilding with higher volumes from the beginning of this millennium and thus has also had the latest exposure to the international sustainability requirement focus. The merits of this shipyard in its entrance to the international market have been in its cost-efficiency when delivering standard types of ships for the volume markets.

Summarizing the scoring, it follows rather well the general understanding of the level of sustainability focus that these companies produce and thus can be deemed to reflect reality as well. The main purpose of this verification was not to judge the level of development that these companies have. The aim was to test the framework concept and see if the drivers as such can give a picture of the level of sustainability that various companies have in their business.

This verification of the driver framework is naturally a rough simplification of the concept and as such gives reason for doubt in terms of the measuring accuracy. But, on the other hand, it shows a simple method for indicating relevant areas for sustainability in innovations and is thus the only framework available in the literature and gives a possibility for further refinement in the future. The shipbuilding business is based on project business where every ship project is an innovation itself. Thus, shipbuilding gave a good verification basis for sustainability in innovation.

5.6 Conclusions of the chapter

The key research questions serve as a guide in looking at practical aspects of operations in terms of bringing the sustainability element to be part of innovations. This study, based on empirical scholarly papers and secondary literature, shows that it is possible to find knowledge and make general verifications based on the information available in the literature.

The first observation is that a literature study can be used to create a meaningful framework for the drivers impacting sustainability in innovation. The framework shows the relations of various drivers and thus helps to manage the complexity involved in sustainability.

The framework was tested with material available from shipbuilding. Three shipyards were selected for analysis. Since direct research data was not found to be the basis of the verification, secondary data was used. In order to be able to use such data from general, published material, the framework needed to be simplified to correspond to the depth and nature of the data. Since modern ships are optimised for customer needs, the business around them is fully based on innovation. Therefore, the observation and measurement of drivers was built for detecting drivers impacting social and environmental aspects of sustainability

It was found that a simplified version of the framework gives a possibility to compare businesses against each other and to rank the level of progress in sustainability. The results reflect a general understanding of the status of the selected comparison companies and give an indication of the progress of use of different drivers in the business. Thus, the framework can be considered to be useful for measuring sustainability in innovations in real operations and it serves as a good platform for planning the research in this area further.

Since the results indicate that all the different types of drivers in the simplified framework could be identified from the industry-specific literature, it is concluded that the framework as such is feasible. An aspect that could be studied is whether there would be some other, additional drivers that should be included in the framework as well. Hermeneutic strategy gives a possibility to develop the framework further on the basis of the verification. The review of the annual reports did not, however, indicate any additional aspects that would be of value to the framework. Therefore, the framework could not be developed further during the hermeneutic cycle review.

6 INTERVIEWS WITH SEMI-STRUCTURED INTERVIEW

After building the theoretical framework of the sustainability drivers and dependabilities, the next step is to study the research questions via empirical research. The theoretical framework is used as a support for selecting the focus and questions.

The aim of the qualitative research is to collect information on the relevant drivers for sustainability in innovations in the industry. Additionally, qualitative research is used to measure the strength and relevance of the drivers identified already earlier in the literature analysis.

The development of the research questions for these qualitative studies are explained in this chapter, as well as the selection process of the companies to be studied and the key persons to be interviewed. Also the interview process is presented and the format for collecting the data.

Due to the estimated data sample size from the planned interviews, there is no possibility to also perform quantitative analysis. The face-to-face interviews can only be conducted in some of the shipyards in the world and therefore there is not enough data for statistical analysis purposes.

As a part of the hermeneutic strategy, some analysis and research development was performed in between the case study interviews by reflecting the interview observations against the holistic big picture. The evolution of the focus is presented and the final analysis of the results explained for the qualitative and combined data triangulation analysis.

6.1 Development of the semi-structured interviews

The qualitative open question research aims to collect information about the relevant drivers for sustainability in innovations in the shipbuilding industry. The research questions were thus developed on the basis of important aspects of sustainability in innovations. The target was to obtain data for identification of industry-specific drivers and later to see if those deviate from the drivers found in the literature review.

Since the qualitative verification research measured the strength and relevance of the drivers found in the literature study, the research questions were developed using the theoretical framework created earlier. The simplified framework (Figure 14) gave clear results in the verification based on literature. However, it was

decided to also use the drivers of the original framework (Figure 13) as the basis for the questionnaire in order to have as many dimensions covered as possible.

6.1.1 Qualitative open questions

The hermeneutic approach in a case study allows the possibility to produce the research results during the data collection using reflective judgement combining both inductive and abductive approaches (Rendtorff, 2015). The focus is to interpret the situations based on the interview and find the underlying sustainability drivers and their importance.

Since the plan was to develop understanding during the interviews, the interview questions were arranged in a semi-structured way. A set of questions was created and are shown in Table 7. Although the questions were planned before the interviews were started, the use of these varied depending on how the knowledge increased and on how the interview situations developed.

6.1.2 Logic behind the qualitative open questions

The qualitative open questions were designed in order to measure the drivers that the companies have. However, the questions cannot be designed around the drivers that were identified from the literature in the previous chapter since such questions might guide the responses. Therefore, a different logic is needed around which the questions are constructed.

Since the target for this research is to find information about factors impacting sustainability in innovations, the focus area for the questions is on sustainability and innovations. Sustainability itself consists of three areas: social, environmental and financial viewpoints. Therefore, these three areas are focused on separately in the questions so that environmental, social and a balance between environment, social and financial aspects create three focus areas for the questions.

Table 7 Qualitative open questions for the semi-structured interviews

1. Have you done new ship/vessel development in recent years?
2. Are you planning to focus on new areas in shipbuilding or business in general?
3. Cruise/ferry as new markets?
4. What are the drivers when creating new solutions/innovations?
5. Is it important for you to include environmental and social aspects to your new innovations?
6. Is environment important in new innovations in your company?
7. Is there an increase or decrease in the importance of environment in the recent times?
8. How do you take environment into account in your new innovations?
9. Are the customers ready to pay extra for good environmental performance?
10. How do you measure your success in environmental performance?
11. Is good social performance, =good citizenship important for your company?
12. Are the social aspects taken into account in new innovations?
13. Do your customers value social aspects?
14. Are they ready to pay extra for it?
15. How do you measure your success in social performance?
16. Is it difficult to balance between financial/social/environmental aspects?
17. Have you been able to create processes to make it easier?
18. Do you have design/system/other tools to help being sustainable?
19. Do your personnel care about sustainability?
20. Are you training them to be better in these aspects?
21. How many ships did you deliver last year?
22. How many employees approximately do you have?

Additionally the people aspect was emphasized in the literature from many different viewpoints (motivation, entrepreneurship, mindfulness, management and leadership) and thus the fifth focus area for the questions is selected to be people. Thus the following five themes build the structure for the questions in the following way:

- Questions of innovations. Is the shipyard involved in innovations?
- Environmental questions. Is the environment valued and visible?
- Social focus. Are there traces of social aspects in the operations?
- Sustainability questions. Is there an attempt at a balance like triple bottom line?
- People focus. Are people getting the possibility to contribute efficiently?

In addition to the questions with the logic as explained above, some generic questions are added to the beginning and end of the set of final questions. This is done in order to have a smooth start and end of the interview session.

In total, a set of 22 questions were created for the interview. This is an amount that can be managed in a face-to-face interview and does not take too much time, keeping in mind that a quantitative questionnaire also needs to be filled in by the interviewees in the same session.

Each of the questions for the qualitative open question research has been built around the logic explained above. The reasons and motivations are explained in more detail for each question here, one after the other. It is important to understand that these questions were intended to guide the interview, but not limit it. The purpose was to have the interviews face-to-face and the questions were also formulated to facilitate such data collection. Many of the questions are open questions which require a longer, developed answer, which is good for exploration and gathering broad information (Collis & Hussey, 2014), but some are closed in order to get more factual content. However, the closed questions can also be followed with an additional, open question like 'how', 'when' or 'why'. The detailed explanation for the logic behind each of the questions is explained in Appendix 1.

6.1.3 Qualitative verification questions

In order to perform mixed method research using data triangulation and to find the relevance of drivers identified in the literature research, qualitative verification research was carried out in each interview session. This was done straight after the qualitative open question interview by handing over a questionnaire to the interviewees and asking them to complete it within the same face-to-face session.

The main purpose for the verification questions was to gain understanding in the following three areas:

- Are the drivers used in the models presented in Figure 13 and 14 relevant to the shipbuilding industry? Are some perhaps non-existent or non-relevant and thus not necessary even though they have been identified from the literature?

- Do the drivers used in the simplified framework (Figure 14) and more detailed framework (Figure 13) support each other? The simplifications were made in order to find drivers that are more easily available from

public material and by comparison the interest is to find out if this methodology can be supported with the empirical data that was collected

- Difference in drivers between China and South Korea. The empirical data was collected from shipyards from two different countries and there is interest in understanding if there are differences with the results. This may impact the judgement on generalising the results.

The qualitative verification questionnaire is designed according to the Likert scale in order to assess the existence and strength of the drivers. That technique is often used for multiple item measures (Collis & Hussey, 2014). Most commonly, a 5-point scale is used but there is some evidence that a 7-point scale is slightly better because it gives a good balance between having enough points of discrimination without having to maintain too many response options (Sauro, 2010). Therefore, a 7-point scale is used for this research. The questionnaire that was developed is presented in Table 8. A similar questionnaire could be used also for quantitative research if the accessible data volume is big enough.

Table 8 Qualitative verification questions

Sustainability in Your company.

Please indicate the importance by choosing a number. 1 = not important, 7= high importance

	Low 1 2 3 4 5 6 7 High
Q1 The customers focus on environment	
Q2 Our top management focus on social aspects	
Q3 Laws and legislation guide our sustainability	
Q4 People are valued in our company	
Q5 Our strategy is focusing on social aspects	
Q6 External policies guide our sustainability	
Q7 Our tools support sustainability	
Q8 Our company strategy is focusing on environment	
Q9 Our people have skills & competence about sustainability	
Q10 Our company culture is supporting sustainability	
Q11 Ethics and morale are important in our company	
Q12 Our company culture is supporting sustainability	
Q13 Personal behaviour towards sustainability is supported	
Q14 Our company philosophy supports sustainability	
Q15 Our processes support sustainability	
Q16 Values of our company support sustainability	
Q17 Our people are motivated to focus on sustainability	
Q18 We support internal entrepreneurship	
Q19 External stakeholders impact our sustainability focus	
Q20 Our top management focus on environment	
Q21 Is it difficult to combine environment and social to business?	

6.1.4 Logic behind the qualitative verification questions

The qualitative verification questions were constructed around the theoretical frameworks that were created earlier in this research based on the literature studies. Each question includes one driver from the frameworks (either from Figure 13 or 14). The questions are planned to give an indication of the weighting of the importance of these drivers.

The questions have been developed systematically to address all the identified drivers. In addition, some of the drivers are split into two and both these parts have their own questions. Such questions focus separately on the environmental and social aspects of a specific driver in order to see if there is an uneven balance between the two (non-financial) elements in the sustainability triangle (financial, social and environmental). In the case of some drivers, one of the two non-financial elements is left out (as with customers, the social aspect is left out) since it would have little relevance.

After creating the questions, their order has been mixed stochastically so that filling in the table from top to bottom would not guide the answers. Additionally, questions 10 and 12 are copies of each other in order to measure and increase the focus of the respondents (trusting that they observe it). These two questions are almost next to each other so that the respondents notice this repetition test themselves and therefore stay sharp and keep focused on their responses.

The logic for each question is presented in the text below. The earlier created theoretical frameworks for sustainability drivers in innovation are presented in Figure 15. Both the detailed and simplified frameworks are shown, and in addition the drivers in them are marked with alphabetic characters for identification purposes. Altogether, there are 17 drivers in these two frameworks. For the questionnaire, 21 questions were made in order to measure their importance.

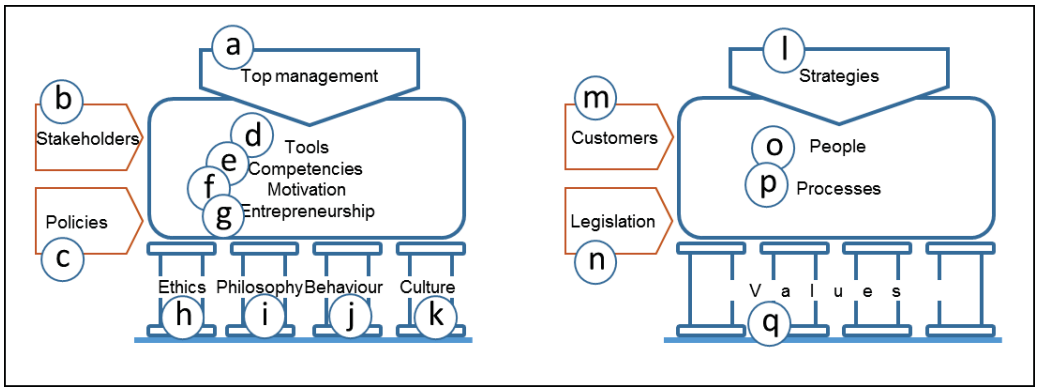


Figure 15. Driver identification with alphabetic characters for both the detailed and simplified frameworks from literature study

Question 1. Assessment of driver m = Customers. Focus on environmental aspects only in order to be specific since the direct focus of customers on the social aspects is not expected to be high. That focus will anyhow be measured via question 19 regarding driver b = Stakeholders.

Question 2. Assessment of driver a = Top management. Focus on social aspects only, the same driver from the environmental view is measured in question 20.

Question 3. Assessment of driver n = Legislation. The reference will be question 6, where parallel driver c = Policies measured

Question 4. Assessment of driver o = People.

Question 5. Assessment of driver l = Strategies from the social point of view only. The same driver is measured from the environmental point of view in question 8.

Question 6. Assessment of driver c = Policies.

Question 7. Assessment of driver d = Tools.

Question 8. Assessment of driver l = Strategies from the environmental point of view. The same driver is measured in question 5 from the social point of view.

Question 9. Assessment of driver e = Competencies.

Question 10. Assessment of driver k = Culture. Note that the same question is repeated in question 12 in order to identify the quality and focus of the respondents and also in order to keep the respondents observant.

Question 11. Assessment of driver h = Ethics.

Question 12. Assessment of driver k = Culture. Note that the same question is repeated in question 10 in order to identify the quality and focus of the respondents and also in order to keep the respondents observant.

Question 13. Assessment of driver j = Behaviour.

Question 14. Assessment of driver i = Philosophy.

Question 15. Assessment of driver p = Processes.

Question 16. Assessment of driver q = Values.

Question 17. Assessment of driver f = Motivation.

Question 18. Assessment of driver g = Entrepreneurship.

Question 19. Assessment of driver b = Stakeholders. Note here that the question is focusing on the external stakeholders only in order to identify the external impact. This focus corresponds well to question 1, where driver m = customers measured (but from the environmental focus only).

Question 20. Assessment of driver a = Top management. Focus from the environmental view only; the same driver from the social aspect view is measured in question 2.

Question 21. Assessment of general view of the difficulty of sustainability, not directly linked to any of the drivers in the frameworks.

6.2 Case study process

An important part of the research was the selection of the case study companies. In this research the selection process started by selecting the countries where the shipyards forming the research came from. Thereafter, the actual shipyards were selected and then finally the persons to be interviewed from the organisations.

A major help for this process was available from the global organisation of the researcher's own company, Wärtsilä, which has a network office organisation in all important shipbuilding countries all over the world. These offices have close contacts with all major shipbuilders and through continuous commercial collaboration also have an understanding of the capabilities and preparedness to respond to questions about sustainability.

6.2.1 Selection of shipbuilding countries

As earlier stated, shipbuilding is an industry that has undergone several transformations and also has geographically moved from certain countries and continents to others. Whilst the European countries still dominated shipbuilding until the 1980's, Asian countries then started rapid growth and investment in this business. Japan was the first to start and was once the biggest in the world, and thereafter South Korea became the number one and now recently China has become the biggest shipbuilder in the world, based on the number of received orders and size of ships. These two countries have thus shown the highest speed and ability to adapt to the market conditions in an ever-changing market and thus have shown the biggest innovation power.

Figure 16 presents the share of different countries in shipbuilding in the world for the recent period. The statistics are from an independent company, Clarkson's Research (2016), which follows trends in the shipping and shipbuilding industry.

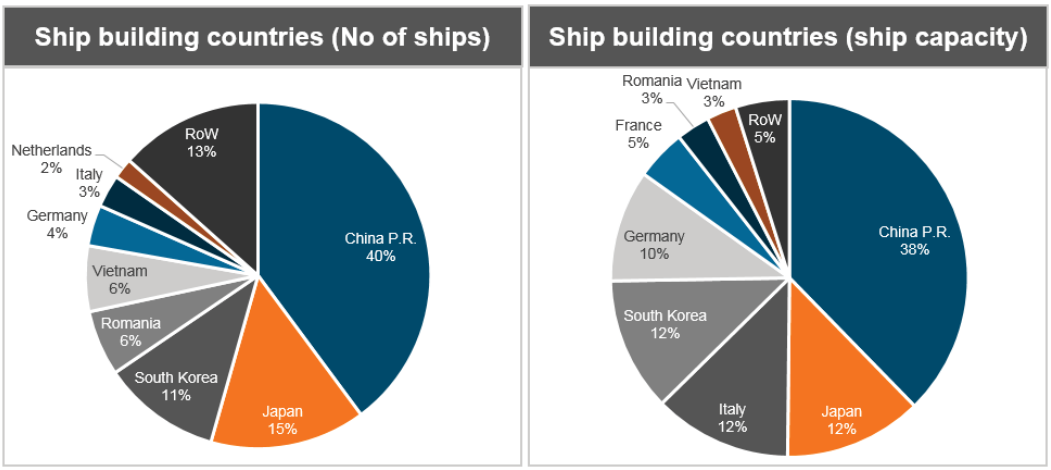


Figure 16. Shipbuilding orders received per country in the world. Both per number of ships (Nos) and per carrying capacity (CGT, combined gross tonnage). Source: Clarkson's Research: Shipping Intelligence Network, data retrieved August 12th 2016

The time of selecting the shipyards for the interviews was in March 2016. At that time China had just passed South Korea as the country receiving the most orders for ships. Temporarily Japan was the second biggest in receiving numbers of ship orders due to high number of smaller ships being ordered domestically but in ship capacity it was equal to South Korea and Italy. European countries were a minority in this business. Although the number of ships being built in Europe is low, the

size and value of these ships is high. Typically, these are passenger ships, either cruise ships or ferries. Such ships require, in addition to the carrying capacity, also customer comfort and entertainment, dining possibilities and shopping experiences. The value can be as much as five times higher compared to a merchant ship of a similar length of carrying capacity in tons. Despite the obviously higher value of such ships, the majority of ship business revenue is nevertheless in Asia at the moment due to the much higher number of ships being built there.

6.2.2 Selection of the shipyards for interview

The selection of shipyards was done together with the researcher and the researcher's company, Wärtsilä, and their local network sales representatives. The local persons know the market very well since their task is to be in contact with all major shipbuilders in the country and to promote and sell projects and to follow the execution as well as maintain good commercial relations. The persons assisting in the selection of the research subjects were in both countries mainly responsible for the country sales organisations, which means that they had large (5-10 persons) sales organisations reporting to them, and thus they had a very good overview of the overall market in their respective country.

The main criteria for selecting the companies for interview and research were:

- Business volume. The target was to focus on the biggest companies because they have most contact with external stakeholders, the widest demand for various features and the biggest exposure to external policies (legislation)

- Focus on the introduction of new products. Preference was given to such shipyards that have their own, strong design capability, are focusing on development and entering into the design of new ship types

- International business. In order to be exposed to multiple needs and requests, including sustainability, the preference was for selecting shipyards that are involved in business with companies all around the world. Another benefit coming together with international business is that the key persons in such companies typically are able to use English in their communication, although this was not selected as a triggering criterion

According to Yin (2014), it is recommended to choose 5-10 cases for a PhD research. Therefore the target was to select five to ten shipyards from Asia. As a reference, in South Korea there are five major shipyards, but in China more than

100 shipyards actively building ships. After a review of shipyards that could satisfy the criteria, and taking into account also the availability of key persons for interview, finally four shipyards were selected from South Korea and four from China. The smallest of these shipyards has 800 own employees (and a lot of subcontractors on top of that) and the biggest 30000 own employees. One of the selected shipyards in South Korea has two separate departments (Merchant and Offshore) and these were both selected but interviewed separately. Thus, the total number of research interviews became nine.

6.2.3 Selection of the interviewees

Walker (1997) says that the most reliable source of knowledge are the leaders of teams in a company. When selecting the shipyards for the interview, an important criterion for selection was the availability of persons with a suitable profile and responsibility for activities in the company.

The target persons were defined so that they would not be the CEO's of the companies but the following level of management down from the CEO and lower. This criterion was selected in order to avoid the risk of 'greenwashing'. With greenwashing is meant that the top management may have good intentions in their messages but fail to realise them and thus give an optimistic message without a practical basis in real operations and progress. By selecting the operational leaders of development and business planning organisations it is more likely that real activities become visible in a realistic way.

The participation in the interviews differed somewhat between the companies. In most of the companies more than one person joined in the interview and only in one company was there just one person attending. In four companies two persons attended and in four companies 3 – 7 persons. The total number of persons attending in all the interview sessions together was 29.

The persons that were invited and finally also participated in the interviews had the following types of titles: Vice President (6 persons), Director (8 persons), Manager (4 persons), Engineer (11 persons). It should be noted that the practice is slightly different between South Korea and China when it comes to titles. In South Korea a more European (or American) way of using titles is common. Thus, titles sounding highly ranked are more common in South Korea than titles for corresponding jobs in China, where titles sound more modest (engineer, manager) for jobs that are actually very demanding and high ranked. Anonymity was promised to the interviewees and thus more specific data cannot be provided.

6.2.4 Contextualization

Since the interviews took place within the working environments of people in business, it is important to take contextualisation into account both when conducting the interviews and when interpreting the results. As the trend in Figure 17 shows (Clarkson's Research, 2016), the ordering activity in shipbuilding has been cyclical along with trends in the World economy and started to reduce drastically in 2016 and all shipyards in all countries started to suffer from that. At the time of planning for the interviews, and also when conducting the research, the industry had to face the fact that there was too much overcapacity. Reductions of the workforce had already started and uncertainty about the future was strongly felt in all companies building ships.

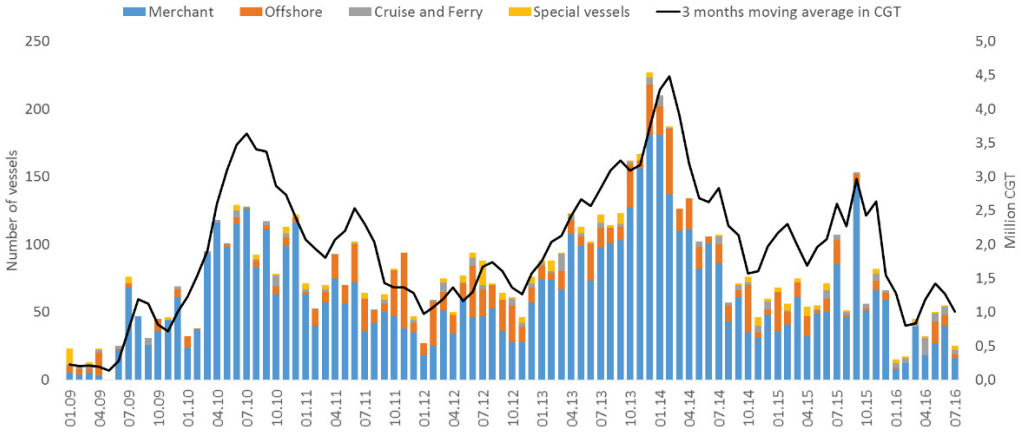


Figure 17. Shipbuilding orders received per month in the world. Source: Clarkson's Research: Shipping Intelligence Network, data retrieved on August 12th 2016

In South Korea there was a major challenge in the political situation when the President of the country was claimed to have been involved in a scandal. There were suspicions that some companies, including shipbuilding companies, had donated money to foundations which were controlled by persons close to the President and that the funds were used for the personal benefit of such persons. This caused a sudden change in the political guidance of governmental support to the shipyards and caused unrest in the otherwise seemingly market-driven development of the industry when trying to adapt to the heavily declining trends of ship ordering. The risks seen in the market caused uncertainty, the risk of losing jobs, plans for consolidating and moving department locations across the country, reductions of staff, etc. Thus, the business climate in South Korea at the time of the

interviews was challenging and may have some influence on the results which needs to be taken into account in the hermeneutic analysis of the research results.

In China the market had developed a lot similarly to South Korea. The order intake to the shipyards had drastically declined and there was a lot of uncertainty about the future. The government had, however, noticed the trend and was supporting the situation by launching a programme according to which some local Chinese ship owners were financially supported when ordering ships from Chinese yards. This created some stability and gave the possibility for planning for the future and to consider innovations targeted on building even more technical ships than ever before. The drive for more technical ships had also initiated some collaboration between Chinese and European shipyards and thus there was some general positivism in the companies towards the future.

6.2.5 Conducting the interviews

All the interviews were arranged so that the researcher visited the target companies to their own offices together with a native local sales person, who personally knew the key persons to be interviewed. The interviews were performed during normal office hours and in normal office meeting rooms. The interviews conducted in South Korea were held during 17–19.5.2016 and in China 23-26.5.2016, thus in two consecutive weeks.

All the persons participating in the interviews were well capable of communicating in English and thus no communication through interpretation was needed except at one shipyard in China, where the whole discussion was interpreted via the accompanying local sales person. Correctness of understanding in this case was verified by having additional verification questions after the main question. Additionally, the interviewees also in this company clearly understood English used by the researcher although felt more comfortable when the same questions were translated thereafter into their own language. In other shipyards only on one or two occasions during the interviews was the local accompanying person needed to assist by translating a term into the local language, and in most companies no translation was needed at all. Present in the interviewing event were: the researcher, an accompanying sales person from the same company as the researcher and the target company representatives, these being between one to seven persons. Thus, all the interviewees from the same company/group participated in the interview simultaneously and the responses were collected by the researcher as one set of company responses. In two companies the top manager was met separately to confirm/verify the qualitative input from the colleagues. The

time used for all the interviews was on average one and a half hours, the shortest being slightly more than one hour and the longest two hours.

Every interview session started with a brief introduction of the participants following some words of courtesy, moving then soon to the explanation of the reason and motivation for the meeting. The introduction was purposely kept short in order not to let the discussion deviate into general topics and possibly other areas than those targeted. In the introduction it was clearly mentioned that the information would be used as a part of confidential data for analysis and that no names of persons, companies or individual results would be published or provided further to any other company. For the hermeneutic case study analysis, it was important to create a natural and relaxed interview session, and that was well managed in every single interview session. Recording of the responses was done manually as written by the researcher during the interviews.

In order to introduce the participants to the topic, an illustration of the theme 'Sustainability' was shown (Figure 18) and explained as the first thing in the interview session using the paper shown in Appendix 2. The purpose was to bring the interviewees into the topic and to create a mutual understanding of the main terminology to be used throughout the interview. A short discussion of the coverage of the topic was held in order ensure that the respondents had understood the logic and scope. Consensus was reached in every interview with even less effort than was provisionally estimated by the researcher.

Each interview started with the qualitative open question interview with the 21 topics to be discussed, as presented in section 6.1.1 and shown in Appendix 3. The questions were raised by the researcher one after another. In many questions a further clarifying question was asked by the researcher in order to gain more in-depth information and further understanding. For the qualitative research only one set of responses was recorded per shipyard, independent of whether there were one or more interviewees attending; thus, the qualitative notes are company-specific, not per person.

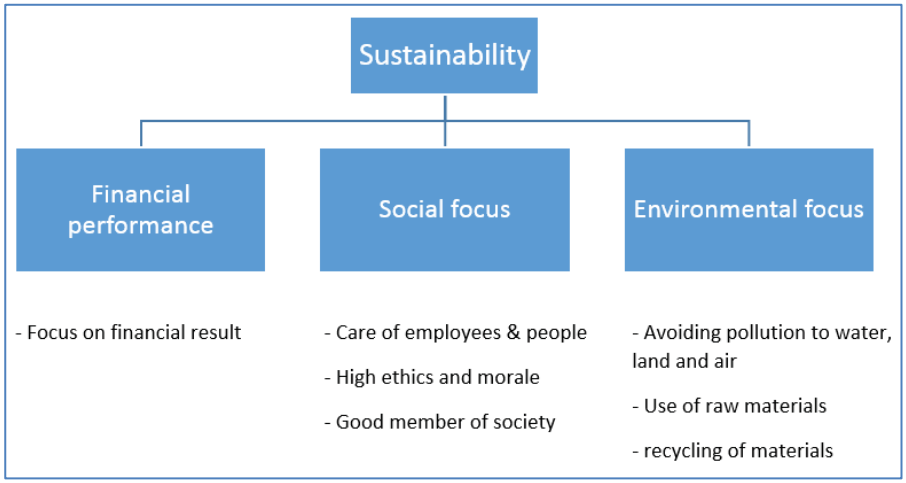


Figure 18. Sustainability concept as explained at the beginning of the interviews

Recording of the responses was done by the researcher writing notes manually. Digital recording was not used, although typically it is recommended for research done via interviews. There were two main reasons for not using this method. Firstly, the persons to be interviewed were from a high level in the organisation. If they had felt that their messages were being voice recorded and they could not control use of the recorded material thereafter, the situation would not have been sufficiently relaxed in the manner that is necessary for hermeneutic research. Secondly, there was a risk perceived of a cultural difference in the approach towards a structured and taped interview between the two countries that were selected for the interview, which would have led to bias. No pre-information was available about the direction in which such bias would be, but it was deemed better to avoid such an unknown risk. Manual recording of verbal messages is a very normal practice in meetings in Asia and therefore this method was seen to best suit conducting an interview in a relaxed and trusted manner.

Straight after each interview was finished, the respondents were given the qualitative verification questions (as presented in 6.1.3.) on paper: the document is shown in Appendix 4. In most companies one or two persons responded: those who felt most to be the spokesperson and knowledgeable in these matters. In only one case did more than two persons respond and there all six persons gave their quantitative responses. Altogether 17 responses were received.

After the qualitative verification question responses were received, the meeting either ended or discussion continued with other matters that were more daily business related.

6.3 Shipyard verification questionnaire

The basic assumption in collecting data from the shipbuilding industry is that it is an industry focused on sustainability and innovation and thus forms a good reference to be used for generalization. Every new ship is a result of planning, design and optimisation both regarding the design and also manufacturing. Thus, all ship projects are also innovation projects. However, in shipbuilding as in all other business, there may be companies that are performing very well and also companies that are not that strong. Therefore, there is a need to have some external comparison between the selected shipyards in order to be able to judge whether the input from the yards corresponds to external reality and if the input from some is more valuable than from others.

The selected method for verification was to use some key customers (shipowners) of the industry to evaluate the performance of the shipyards. These shipowners needed to have experience from the shipyards that were being interviewed. A qualitative verification questionnaire was prepared for scoring the following three matters for each shipyard:

- Focus on social aspects
- Focus on the environment
- Overall competitiveness.

These questions thus consist of all the three elements of the triple bottom line concept and should give a condensed, balanced view of sustainability. The questions were set in 7-point Likert scale and thus formed a table of three questions for each of the nine shipyards, thus totalling 27 responses. The questions were sent to the respondents by email using an introduction part (shown in Appendix 5) and the questions showed above (also presented in Appendix 6).

7 VERIFICATION OF THE RESULTS

DeVaus (2002) states that the key to empirical testing of theory is to look for evidence that disproves the theory; supporting examples can usually be found for a theory but provide a weak form of evidence. He and many other authorities on research methodologies claim that empirical research provides strong evidence for explaining phenomena, whereas the use of logical deduction, anecdotal evidence, providing examples, and personal 'gut feeling' provide only weak or supporting evidence (Walker, 1997).

In order to analyse the results from the qualitative analysis the approach used follows the concepts of Collis & Hussey (2014) and Saunders et al. (2012). A deductive approach is used throughout the analysis against the theoretical framework that was created on the basis of the literature review.

After developing the framework based on research literature and grey literature (annual reports), three new sets of data are used in the research for analysing the aspects and priorities impacting sustainability in innovations at shipyards. Firstly, the beginning of the interviews at the shipyards consisted of open questions which indicate directly the aspects and drivers that are of importance there. The approach used in this analysis starts from data reduction for selecting, focusing, simplifying, abstracting and transforming the data into a relevant format (cf. Miles & Huberman, 1994). Data reduction is followed by displaying the data in a visual way in order to reflect the results and the balance between various areas.

Secondly, a structured questionnaire was used at the shipyards to measure if the personnel recognised the drivers resulting from the literature framework. The purpose was to see if those drivers are relevant for the shipyards and if there is a major difference in importance between these drivers. Also, the data from the questionnaires is used in order to ascertain if there are major country specific differences in the weight given to the drivers.

Thirdly, data from ship-owners is used to find differences between performances in sustainability in the corresponding shipyards. The purpose in this phase is to find shipyards which perform strongly in sustainability in innovations. The innovation aspect is not measured separately since all the projects run by the shipyards for their customers are part of innovation work. Every ship project is optimised for the customer and for the purpose. New inventions and continuous development are brought into every new project and business opportunity. Thus there is no need to highlight the innovation aspect specifically since it is integrated in the shipyard activity but to focus on the sustainability aspects. Additionally,

country specific differences are looked for from the viewpoint of the ship owners by categorising the responses by shipyard country.

After all the data was collected and analysed within the three steps described earlier, consolidation of the results was performed via a hermeneutical loop. The purpose was to finalise the tentative model of drivers using the drivers discovered in the open question interviews and tuning the model further with data from the structured interviews and from the viewpoint of the best performing shipyards (based on scoring by ship owners). Additionally, country specific differences from the ship-owner point of view are compared against the differences measured from shipyards directly.

The tentative model is based on the theoretical framework created earlier in the research. The target for this further development is to create a tentative model that describes the relations and importance of drivers impacting sustainability in innovations in shipbuilding. Finally, conclusions are drawn and the validity of the conclusions are discussed.

7.1 Qualitative open question data analysis

The data with open questions was collected in interviews at nine different shipyards. There were one or more persons from the shipyard participating simultaneously in the discussions and the recording at each shipyard was done by collecting the qualitative responses from all respondents as one set of responses per company.

The purpose with the open questions interviews was to find out the aspects and drivers that are important for the shipyards when focusing on sustainability in innovation. The open questions were developed to encourage the shipyards to tell about their focus areas from different viewpoints and through that receive a representative understanding of the prioritisation in sustainability in innovation.

In the analysis phase all the input from the interviews was written into an excel sheet matrix, where data from the shipyards was collected in columns and the questions placed on different rows. Thus, a matrix of nine columns (nine shipyards) and 22 rows (number of questions) was collected, containing a lot of data in the format of text in each cell of the matrix. The hermeneutical approach was used in the data collection in order to focus on the recording of relevant data only. Thus, the collected data is valuable and not diluted by non-relevant responses. This matrix contains all the raw data for analysis.

7.1.1 Analysis viewpoint

The first data analysis was performed already when collecting the data in the interviews. The relevant and essential data was collected whilst matters outside the research were left out based on the judgement of the interviewer. Additional, clarifying questions were asked in order to gain more depth and understanding of the responses. The interview events were all topical and managed in a professional manner and thus the relevant parts of the discussions became recorded in writing.

There would be two logical ways to present the results of the interviews: either per company or per question. Presenting per question was selected for two reasons: firstly, anonymity was promised to the interviewees. Showing all the data for each company might reveal important aspects and make possible to recognise the company. Secondly, since the data collection was done in hermeneutical circles, the handling of the questions developed from one interview to the other and thus the company cases would not be comparable.

The first step in the analysis after the interviews was to consolidate the responses for each question into a more compact format. This happened by writing all responses in an excel sheet and analysing the data in order to recognise common features and aspects throughout all responses to the specific questions and by condensing the essential elements. A detailed summary for each question is presented in Appendix 7. The following sections analyse that data from different perspectives.

7.1.2 Discourse analysis

The interviews were done in two countries, South Korea and China. In South Korea five shipyards were studied and in China four. Except for one shipyard in China, all the interviews were performed using English as the language. Only in one or two specific questions did the local accompanying person from the researcher's company need to support the event by translating a single question into the local language. All the rest of the time the accompanying person was silent and the dialogue was between the persons(s) being interviewed and the researcher only.

The hermeneutic approach and the experience of the researcher from the specific industry of shipbuilding helped to interpret the results at the time of interview. Some elements of discourse analysis were used simultaneously in order to understand the hidden meanings behind the messages given and to reveal the motivations behind the respondents' responses, whether consciously articulated or not (Saunders et al., 2012). Collis & Hussey (2014) state that discourse analysis

allows the researcher to investigate how the language both constructs and reflects reality, and this was also the aim as part of the data collection in this research. The meanings and expressions were registered in writing using the words of the respondents as closely as was possible in the interview situation, and in addition supporting questions were raised by the researcher in order to get the full meaning clarified.

One might consider whether the different nationalities would make a difference to the results. However, Scollen & Scollen (2012) state that differences in communication are less to do with cultural reasons and more with being members of different corporate and professional groups. There was nothing in the interviews suggesting anything different from that, and the logical and analytical approaches that the interviewed persons had gave high confidence in the comparability of the outcome.

However, one observation about the difference of cultures by nation was made by the researcher in one specific area of research. Whilst in South Korea the respondents readily discussed the definitions of sustainability and the environmental and social elements behind them, in China the discussion about social responsibility was not that straightforward. In all the four shipyards there discussion about social responsibility was first avoided and the reason was said to be that the government is in charge, and focusing on this or that balance is done by the government and not by the yard. When asking if they care about the employment of their personnel and see a risk that there would be unemployment if the shipyard is not successful in their business, the response was that the government takes care of them and the companies therefore do not need to. After some further discussion it became clear, however, that the shipyards do have their own activities in this area as well and the focus is very much on the same level as with the shipyards in South Korea and care for social wellbeing in general and for the employees exists in China as well. The very short history of private and globally competing businesses in China thus influenced some of the first reactions to the questions, but evened out after further dialogue and finally did not cause any problem in finding the facts behind the current balance of sustainability in innovations. This area may therefore give a partial limitation to some aspects of the results.

7.1.3 Driver identification

The 22 questions that were designed for the qualitative interview questionnaire focused on specific underlying themes. These were selected in order to obtain

relevant and factual information about the drivers for companies. This approach was chosen instead of creating the questions using the earlier acquired knowledge about drivers that were found in the literature. The reason was that if the questions had been built around the drivers identified in the literature, there would have been a risk that the questions are guiding the respondents to use the same drivers in their answers and thus cause a biased response.

The basic themes selected for building the questions were: innovation, sustainability and people. Sustainability was further divided into environment, social and sustainability and thus five themes were used in order to create the qualitative questions (more detailed logic for the themes is explained in section 6.1.2).

Each of the questions included some of these themes in order to be able to find the underlying drivers from five specifically selected directions. The questions can be divided into these five different themes in the following way:

A. Questions 1-6 form a set: Innovation drivers. These open questions are posed in order to identify drivers that exist and are felt to be important for innovation by the respondents

B. Questions 7-10 form a set: Environmental drivers. These questions focus especially on drivers that are important for the environmental aspects

C. Questions 11-15 form a set: Social drivers. These questions focus especially on drivers that are important for the social aspects

D. Questions 16-18 form a set: Balance drivers. These questions focus on drivers that help to balance the triple bottom line of sustainability

E. Questions 19-20 form a set: People drivers. These questions give a view of people and drivers helping them to strive for sustainability

The interviewees mentioned several drivers in their responses and discussions. These were all collected and are presented here below in Table 9 as raw data from the data collection for each of the themes. Since some data reduction and removal of unnecessary comments was done already in the interviews, the data is not purely ‘raw’ but refined using the hermeneutical approach. All the drivers registered in that process are mentioned in the table similarly irrespective of whether they were mentioned only once or several times.

As an observation regarding the themes, it is interesting to note that there were many social drivers indicated by the shipyards. Many of the interviews on that

topic started with less lively discussion in the beginning since the participants found discussion of that topic to be more unfamiliar in the beginning and thus they were more reserved, but finally found a lot of underlying factors working as drivers.

Table 9. Drivers identified in the interviews

Innovation drivers	Environmental drivers	Social drivers	Balance drivers	People drivers
Cost	Cost	Giving for society	Manuals	Training
Efficiency	SFOC	People	Processes	Team work
SFOC	Legislation	Trust	Training	Top management decisions
Quality	Gas	Avoiding delays	Material data Tables	Mindset
Compactness	SOx	Ethics	Owners	
Strategy	EEDI	Morale	Management	
Environment	Scrubbers	Health	Government	
Legislation	Tier III	Local university co-operation		
Ethics	BWMS	Work for locals		
Energy saving	Raw materials	Cost		
Arctic	CO_2	Social responsibility		
Delivery precision	NOx	Safety		
Owner requirements		Policies		
Social		Guidelines		

7.1.4 Data reduction

The first data reduction happened already when collecting the data in the interviews. The relevant and essential data was collected, whilst matters outside the research were left out. The interview events were all very topical and managed in a professional manner and thus the relevant parts of the discussions became recorded in writing.

Some of the drivers in the table overlap with each other since the definitions used are different, but the meaning is similar. An example is the SFOC (specific fuel oil consumption) and EEDI (energy efficiency design index) since these both indicate operational economy and lower CO2 (carbon dioxide emissions) as the drivers. Therefore, some condensing of the drivers can be done.

The following consolidation is therefore formed within each of the themes:

- Innovation drivers: 'Compactness', 'Energy saving' and 'Delivery precision', Cost', Efficiency', 'Quality' and 'SFOC' are all drivers where the respondents referred to competitiveness and are thus clustered with 'Competitiveness'. 'Arctic' is a strategic choice and therefore clustered with 'Strategy'. 'Environment was commented on via regulation and therefore is combined with 'Legislation'. 'Social' was commented on with the meaning of doing well for the people and thus is combined with 'Ethics'.

- Environmental drivers: All emissions related drivers (SOx, EEDI, Scrubbers, Tier III, BWMS, CO2 and NOx) are basically driven by legislation and therefore consolidated with 'Legislation'. 'Cost' and 'SFOC' are combined with 'Competitiveness'. 'Gas' and 'Raw materials' were discussed in the light of strategic choices and are thus combined with 'Strategy'.

- Social drivers: 'Ethics', 'Morale', 'Trust' as well as well as 'Health' and 'Safety' are clustered with 'Ethics'. 'Giving for society', 'Social responsibility' and also 'Local university co-operation' and 'Work for locals' (because those were discussed as "doing the right thing") are clustered with 'Values'. 'Guidelines' is combined with 'Policies, 'Avoiding delays' and 'Cost' clustered with 'Competitiveness'.

- Balance drivers: 'Manuals', 'Material data tables' and 'Guidelines' are combined with 'Tools. 'Training' is replaced by 'Competencies' since that was given as the reason for training. 'Owners' and Government' are combined with 'Stakeholders'. 'Management' is replaced by 'Top

management' since the discussions referred to decision makers high up in hierarchy

- People drivers: 'Training', 'Team work' and 'Mindset' are combined with 'Competencies' since these all aimed to create a more skilled and competent workforce. 'Top management decisions' are replaced by 'Top management' only.

Table 10 presents the consolidated overview of drivers, where overlaps are removed and naming of the drivers developed to reflect the purpose.

Table 10 Consolidated drivers from the open question interviews

Innovation drivers	Environmental drivers	Social drivers	Balance drivers	People drivers
Competitiveness	Competitiveness	People	Tools	Competencies
Strategy	Legislation	Ethics	Processes	Top management
Legislation	Strategy	Values	Competences	
Ethics		Competitiveness	Top management	
Customers		Policies	Stakeholders	

7.1.5 Displaying the data

The interviews gave a good analysis of the importance of drivers that guide modern shipbuilding. These drivers can be compared against the drivers that are shown in the detailed and simplified frameworks for sustainability drivers in innovation in Figures 13 and 14.

As a general comment it can be said that the research interviews revealed similar drivers to those collected in the literature analysis. Only a few drivers that were captured in the literature analysis were not mentioned in the interviews. Such drivers were 'Motivation' and 'Entrepreneurship'. Similarly, weak evidence was found for 'Behaviour', 'Philosophy' and 'Culture'.

However, there was one driver, 'Cost', that came up strongly in the interviews but was not registered in the literature analysis. Eight of the nine shipyards raised

'Cost' as one of the main drivers for innovation in their activities and by that they meant the pressure to keep their products competitive in the global market. It should be noted that cost was not mentioned in the questionnaire at all by the researcher and thus this issue was raised purely by the interviewees themselves. There were in total 198 structured, open questions asked (nine shipyards, 22 questions) and in 22 responses cost was mentioned as a driver or even as the main driver for sustainability in innovation.

Cost was highlighted for two separate reasons. Firstly, due to lower ship ordering volumes globally at the time of the interview, the shipyards were all clearly afraid of their future if they did not procure more orders. The prices for new ships were seen to be going down and further reductions in ship prices were expected. Therefore, the main trigger for cost focus was to maintain the ability to get new orders and through that secure continuity. The cost focus was also triggering studies and development of competence to facilitate entering into new ship segments like passenger ships or ships using gas as fuel.

Secondly, the other reason for having cost as a strong driver for sustainability in innovations was the profitability of the shipyards. Many had financial concerns and needed to seek financial support, either from their government or from other sources. The ability to earn money with shipbuilding had become worse with lower production volumes and through the necessity to reduce selling prices to meet competition and the customer capability to pay, and thus it formed an important driver for future innovation as well.

The earlier models for sustainability in innovations like those of Adams et al. (2015) and Siqueira & Pitassi (2016) do not recognise the cost related elements as a driver but focus more on environmental and social aspects and possibly take financial matters for granted behind the activities of companies and corporations. Lozano (2015), however, has recognised profits and growth as one of the internal drivers in his corporate sustainability driver model, and a similar observation comes through now in this research as well. Also Schaefer et al. (2015) indicate that although there is a strong drive towards all the sustainability dimensions, financial profit still dominates as the goal. 'Competitiveness' is a new driver discovered in this research and it combines cost and the related drivers of 'Efficiency', 'SFOC', 'Quality', 'Compactness', 'Energy saving', 'Avoiding delays' and 'Delivery precision'.

A combination of all the drivers from the earlier created frameworks (detailed framework from Figure 13 and simplified framework from Figure 14) and these new results from the interview are shown in Figure 19 in a visualisation that was used for the frameworks earlier. All except one of the (consolidated) drivers

identified from the shipyard interviews are the same as those already found from the literature. The only exception and thus extra is 'Competitiveness' and that is now added to the figure with red colour to highlight the newness. It is located in the picture on top of the foundation pillars of the company as an arrow that is directly pointing into the internal drivers of the company. All these drivers that resulted from the interviews are drawn with yellow background.

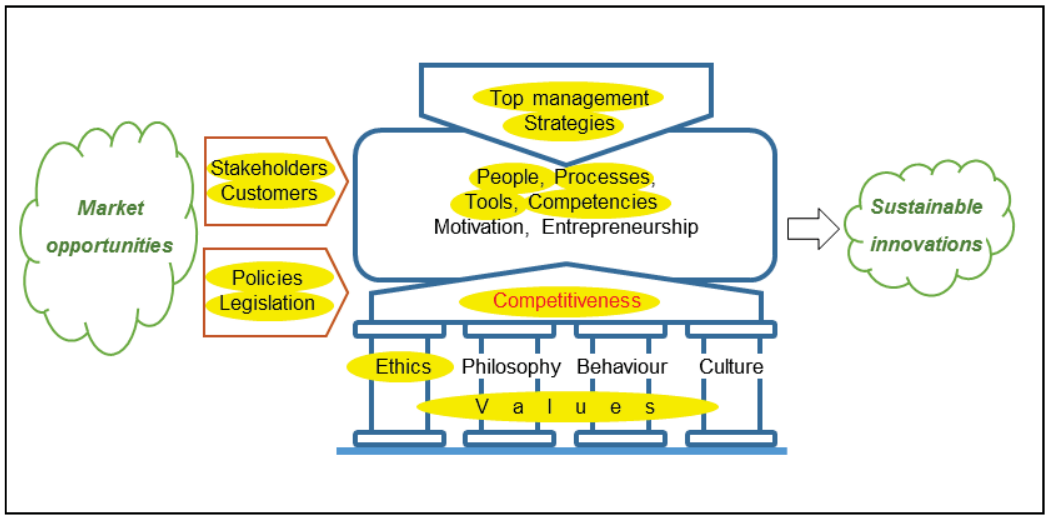


Figure 19. Framework added with drivers identified from shipyard interviews (yellow background)

7.2 Structured question analysis

The collection of qualitative data with structured questions was made by using a questionnaire with a 7-point evaluation according to the Likert scale. The questionnaire was handed over to the interviewees to be filled in straight after the oral interview. The questionnaire was filled in and handed back to the researcher in the same event.

The purpose with the structured questions was to find answers to these two questions:

- Are the drivers used in the detailed framework (Figure 13) and simplified framework (Figure 14) relevant to the shipbuilding industry? Are some perhaps non-existent or non-relevant and thus not necessary even though they have been identified from the literature?

- Is there a perceived difference in drivers between China and South Korea? There is interest in understanding if there are any country specific differences that cause variation to the outcome. This may impact the judgement on generalising the results.

In most of the shipyard interview sessions the persons present in the interview were only one or two and represented the management of the shipyard. In two cases the management had invited more persons from their organisations, resulting in three persons being present in one shipyard and six persons in the other. These additional persons were from deeper inside the organisations and did not represent the higher management but were more in an expert and doer kind of role.

The sessions were organised so that after the oral interview a Likert-scale based questionnaire was handed out to the participants to fill in. For the sake of good order and balance at the interview session, the questionnaire was handed to each of the participants present in the interview and thus three responses were received at one shipyard and six responses in the most extreme case. Since the target was to receive input from the top management of the companies, only one or two questions per shipyard were actually taken to data analysis (depending on the position of the persons). Thus, the expert and doer level quantitative responses were simply left out. This resulted in a total of 12 responses for the quantitative analysis from the 9 shipyards being used.

7.2.1 Data reliability

It is important to be assured that the data used for the analysis is reliable. In this limited sample for the structured question no real statistical methods can be used. Two different approaches can be used however: observation of the response situation and data consistency check.

The researcher was present in the event where the respondents made their evaluations. All the questionnaires were filled in in the same room where the interviews took place. All the respondents filled in the data individually and without disturbance. They clearly spent time in understanding the questions and considered the options carefully.

The other approach is based on the consistence of the responses for the two identical questions that were included in the questionnaire. Both question Q10 and question Q12 were: ‘Our company culture is supporting sustainability’. This was a

modification of the test-retest reliability test according to Collis & Hussey (2014) but integrated into the same questionnaire.

The minimum level of variance for a question pair due to individual human variance can be detected by comparing the responses for these two questions against each other. If there is difference in the responses for these two, that naturally is the minimum level of difference that comes from the same person with different responding occasions.

Figure 20 shows the responses for these two identical questions in questions Q10 and Q12. Each dot represents the response of one person. The location of the dot in the x- and y-axis is defined by the response score to the first and second question for those two questions being compared. Thus, if the dot is in the splitting line of the graph, it means that the scoring given to both questions being compared was the same. The numbers beside the dots show the frequency (how many persons) and the line shows the linear relation which represents the case when responses for these two questions have been identical. Interestingly, only six respondents gave an identical response to the two questions, meaning that 50% of respondents (the other six responses) did not respond similarly to the questions.

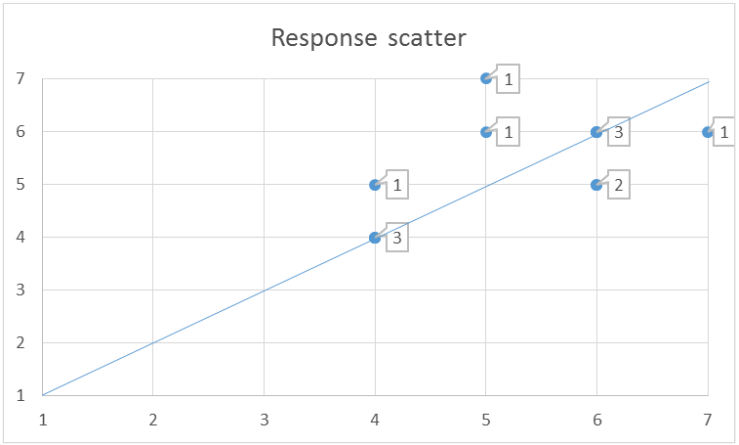


Figure 20. Responses to the two identical questions, Q10 and Q12.

No statistical analysis can be used for such a small sample. In an ideal case the answers should have been similar for these two identical questions for every respondent. This outcome, however, gives a view that although minimum half of the respondents did not notice that there were two identical questions, the spread is anyway low and not stochastic. Thus careful consideration has been applied when filling the responses.

7.2.2 Strength of the drivers

The first question for the quantitative analysis asked whether the drivers used in the frameworks presented in Figure 13 and 14 are relevant to the companies being studied. Are some drivers perhaps non-existent or non-relevant and thus not necessary, even though they have been identified in the literature? Or are some weaker than others or even non-significant in the responses from the shipyards?

The data from the research is listed in Table 11, including some analysis of the parameters derived from the input data for each of the questions. The count of responses, minimum and maximum values and average are shown for each question separately.

Table 11. General overview of the quantitative data

	Questions:	Count	Min	Max	Average
Q1	The customers focus on environment	12	3	7	5,50
Q2	Our top management focus on social aspects	12	4	7	5,83
Q3	Laws and legislation guide our sustainability	12	4	7	5,83
Q4	People are valued in our company	12	4	7	5,42
Q5	Our strategy is focusing on social aspects	12	4	7	5,42
Q6	External policies guide our sustainability	12	4	6	5,33
Q7	Our tools support sustainability	12	4	6	5,08
Q8	Our company strategy is focusing on environment	12	4	7	5,83
Q9	Our people have skills & competence about sustainability	12	4	7	5,58
Q10	Our company culture is supporting sustainability	12	4	7	5,25
Q11	Ethics and morale are important in our company	12	4	7	5,75
Q12	Our company culture is supporting sustainability	12	4	7	5,33
Q13	Personal behaviour towards sustainability is supported	12	4	7	5,67
Q14	Our company philosophy supports sustainability	12	4	7	5,58
Q15	Our processes support sustainability	12	4	7	5,67
Q16	Values of our company support sustainability	12	4	7	5,67
Q17	Our people are motivated to focus on sustainability	12	4	7	5,50
Q18	We support internal entrepreneurship	12	4	7	5,42
Q19	External stakeholders impact our sustainability focus	12	3	7	4,92
Q20	Our top management focus on environment	12	4	7	5,83
Q21	Is it difficult to combine environment and social to business?	12	2	6	4,67

The data shows that all drivers from the frameworks based on literature have been valued as very high in importance. The average scores vary between 4.92 and 5.83 on a Likert scale from 1 to 7. The narrow band of the scoring also reflects the expectations. It was not expected that any of these shipyards doing global business would score very low in some area. Neither was it expected that the average scoring

would be in top of the range for all the respondents. The scoring thus gives a reliable and credible evaluation of the situation from the respondents.

The last question Q21 does not measure the importance of the drivers but an internal perception within the company. Thus, the result for this question is not taken into account when judging the importance of the drivers. The minimum and maximum levels in the responses and the averages for each question are shown in Figure 21.

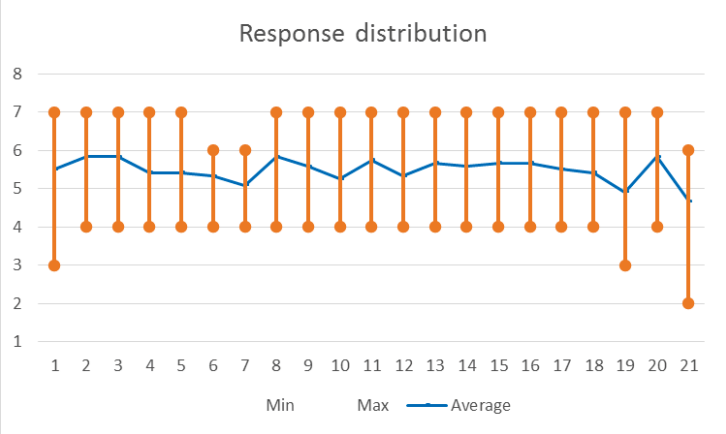


Figure 21. Response distribution for questions Q1 – Q21

Figure 21 is shows that the responses for all the questions are within a very similar data range in the 7-point Likert scale that was used. Thus, the first observation is that none of the drivers that were measured were ranked as non-significant by the respondents.

7.2.2.1 Drivers with highest scoring

The drivers that obtained the highest average scores are included in questions Q2, Q3, Q8 and Q20 (Table 12) and the result for all these is close to six. The results indicate that the role of the driver 'Top management' is important since it scores highly both for the question with social aspects focus (Q2) and also for the question with environmental focus (Q20).

The other two strong drivers are 'Legislation' (Q3) and 'Strategy' (Q8). The results are similar to the interviews.

Table 12. The questions with highest average score

	Questions:	Average
Q2	Our top management focus on social aspects	5,83
Q3	Laws and legislation guide our sustainability	5,83
Q8	Our company strategy is focusing on environment	5,83
Q20	Our top management focus on environment	5,83

7.2.2.2 Drivers with lowest scoring

Similar to the drivers receiving the highest scoring, the drivers that received the lowest scoring are identified using the average value as the indicator and the scoring for those is around five. Three questions receiving the lowest scoring are presented in Table 13.

Table 13. The questions with lowest average score

	Questions:	Average
Q19	External stakeholders impact our sustainability focus	4,92
Q7	Our tools support sustainability	5,08
Q10	Our company culture is supporting sustainability	5,25

The lowest scoring was received for the drivers of 'Stakeholders' (Q19). The average value is 4.92 and thus it is the single driver that had an average below 5. The open question interview discussions however showed that the external drivers 'Owners' and 'Government' have a role as drivers for the sustainability balance. Therefore the scoring given, which is high, also supports this driver as being important although it received the lowest scoring.

The other two with a low score are 'Tools' (Q7) and 'Culture' (Q10). Tools (in the form of 'Manuals', 'Material data tables' and 'Guidelines') actually were mentioned as an important driver in the interview discussions. 'Culture', however, was not mentioned in any of the interviews.

7.2.2.3 Relevance of the drivers

All the drivers from the frameworks based on literature received high scoring for relevance by the shipyards. The strongest drivers 'Top management', 'Strategy' and Legislation' were strongly emphasised in the open question interview by shipyards

as well. The other drivers from the frameworks also got high scoring for relevance although not all of those were identified in the interviews.

Even though some drivers got lower scoring than the top ones, none of them have a very low score. Therefore, it cannot be concluded that these drivers do not have any significance at all. These seemingly are important as well and need to be kept as parts of the models of drivers for sustainability in innovations.

7.2.3 Country specific differences

The second area to be studied in the structured qualitative research was to find if there is a difference with the results between the two countries studied, China and South Korea. An area of interest is to find out if the results from the shipyards in these two countries are similar to each other and support the same conclusions, or if there are some differences that need to be taken into account. This may impact the interpretation of the results in terms of the possibilities to generalise the results outside of the industry under research, or if limitations will be necessary.

As the first measure to compare the results, the average scores per country for the various questions are identified. Those are shown in Figure 22.

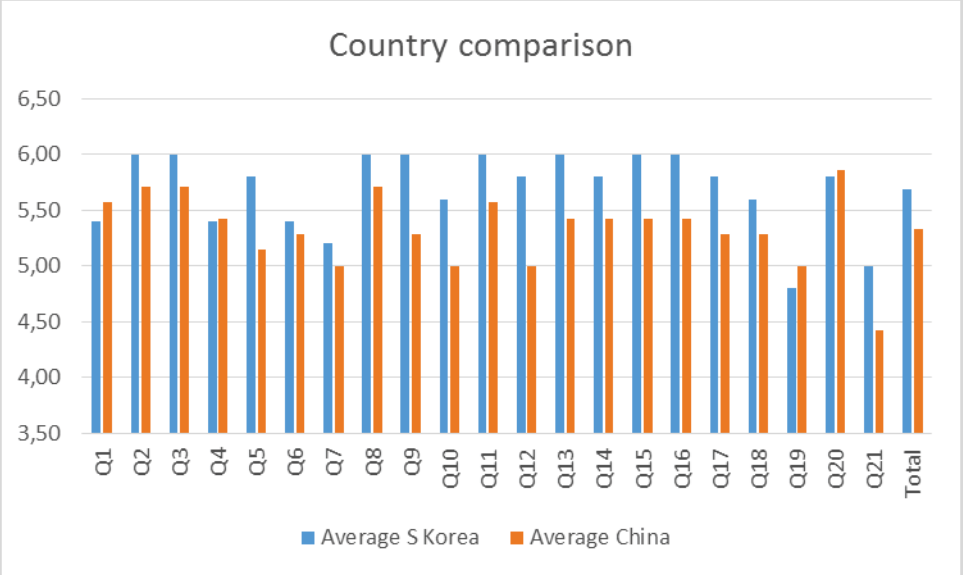


Figure 22. Average responses per country

The comparisons of average scores calculated for the responses show that the responses from South Korea are higher in the majority of the questions (17 out of the total of 21). Also the total average of all responses is higher in South Korea: 5.69 compared to 5.33 from China.

The interest is to understand if this difference is there because the strengths of the drivers actually are different in these companies in different countries or is there some other, country specific reason for the result. In the discourse analysis earlier in this research it was stated that according to Scollen and Scollen (2012), differences in communication are less to do with cultural reasons and more to do with being members of different corporate and professional groups. If the same were true for the performance in sustainability in innovations as well, then the difference is not explained by different countries. Further analysis of this topic is done when information from shipyards customers is used.

7.3 Qualitative source data verification

All the analysis in this research so far is based on the shipyards' own input. The input was given by the shipyards' own senior management. There is naturally a possibility that the results are somewhat biased when these are based on their own input only. Despite the hermeneutic research setup where the researcher has the role of interpreting the data input against experience and thus verifies the validity of the input, there may always be a risk of 'greenwashing', i.e. that the respondents want to give a different (better) picture of the situation than what the reality is: not perhaps consciously, but possibly unconsciously.

In this research, input given by the shipyards has been used to find the drivers that are essential in managing sustainability in innovations. The final aim has been to find answers to the research questions 'What have been the most important factors and priorities impacting business development towards sustainability in innovation?', 'How can performance of sustainability in innovation be assessed?' and 'How can management guide businesses to develop towards sustainability in innovations?' One may, however, wonder if the input from all the shipyards is similarly equal in weight. What if some of the shipyards that have been interviewed are less advanced or even poor in their focus on the aspects measured by the research questions? What if they thus give responses that completely mislead the results?

In order to obtain evaluation of the performance of the shipyards in sustainability in innovations, it was decided to ask their customers to evaluate their performance and maturity. The most relevant customer group for shipyards are naturally the ship owners. They have a good view of the performance in a broad sense.

The purpose of asking for the customer viewpoint was to find answers to these two questions:

- Are there differences between shipyards in their performance in sustainability? The scoring from ship-owners is used to monitor the difference. If there are shipyards with strong performance, the input from these might be more valid in defining the drivers or the weight for the drivers than input from shipyards where the performance is not that strong.

- Is there a perceived difference in drivers between China and South Korea? There is interest in understand whether the shipyards customers see any country specific differences in the performance of sustainability in innovation. This result can later be compared with the shipyards own evaluation of the importance of drivers per country in order to see if there are limitations for generalisation of the results or not.

7.3.1 Selection of responding shipowners

When interviewing the shipyards, four of them told (without asking) that the most demanding customers in respect to the environment come from North Europe. Such customers are even prepared to pay more for better environmental performance. There were no comments given about the focus on social aspects.

Since some shipowners are asking for better performance, it is obvious that they are very observant and follow the development of the shipyards very closely. Therefore, it was decided to ask some key shipowners from North Europe to give their feedback on the performance of the interviewed shipyards. A questionnaire was prepared for scoring the following three matters for each shipyard:

- Focus on social aspects

- Focus on environment

- Overall competitiveness

The questions were set in a 7-point Likert scale. Thus, the questionnaire formed a table of three questions for each of the nine shipyards and as such consisted of 27 response requests in total. The questionnaire is shown in Appendix 6.

The questionnaire was sent to several ship-owners in North Europe between late Summer and early Autumn 2016. Unfortunately, and as feared, several owners refused to respond. The reasons were twofold: firstly, some said that they did not have experience of all the shipyards that were to be analysed. Secondly, some said

that the information was confidential in nature and they did not want to respond, despite written promises of confidentiality.

In order to increase the amount of feedback, the group of respondents was thereafter increased to also cover shipbuilding brokers. These are companies that act as consultants between shipyards and ship-owners and have a good understanding of the capabilities of various shipyards. Unfortunately, none of the shipbrokers wanted to give their evaluations either.

7.3.2 Sustainability evaluations by ship-owners

Finally, input was promised from two global, North Europe based ship-owner companies and they sent their evaluations. Both these companies are amongst the biggest in the world and both operate in merchant marine and offshore business and therefore have a good view of the actual performance of the shipyards. Both these companies want to keep their view of competitiveness between the shipyards and countries as their business secret and therefore did not allow their names to be published.

One set of responses was received from both of these companies and they explained that there had been in both a group of people who had participated in the evaluation. Thus these were the consolidated views of these ship-owning companies. The sizes of the responding teams were not disclosed to the researcher. Although the details of the respondents are not know, there is no reason to doubt the honesty and truthfulness of these respected shipowners.

The first shipowner gave an evaluation for all the shipyards and the other for all except one shipyard which they had no direct experience of. The evaluations are shown in Figure 23. Shipyards 1-4 are from South Korea and shipyards 5-9 from China. Specific details about the shipyard names cannot be disclosed since confidentiality was promised to all persons and companies who have participated.

The results from the two shipowners show similarity in the evaluations. Shipyards 2 and 3 received high scores for their social focus and shipyards 1, 2 and 3 for their focus on the environment. The lowest rating for social focus was given to shipyards 8 and 9 and for the environmental focus also for the same shipyards, 8 and 9. The evaluations given for competitiveness differ somewhat between the two shipowners.

Since the sample is small, no statistical analysis can be considered. The data will be used for qualitative analysis purposes only. Figure 24 presents the average scoring from the two shipowners together.

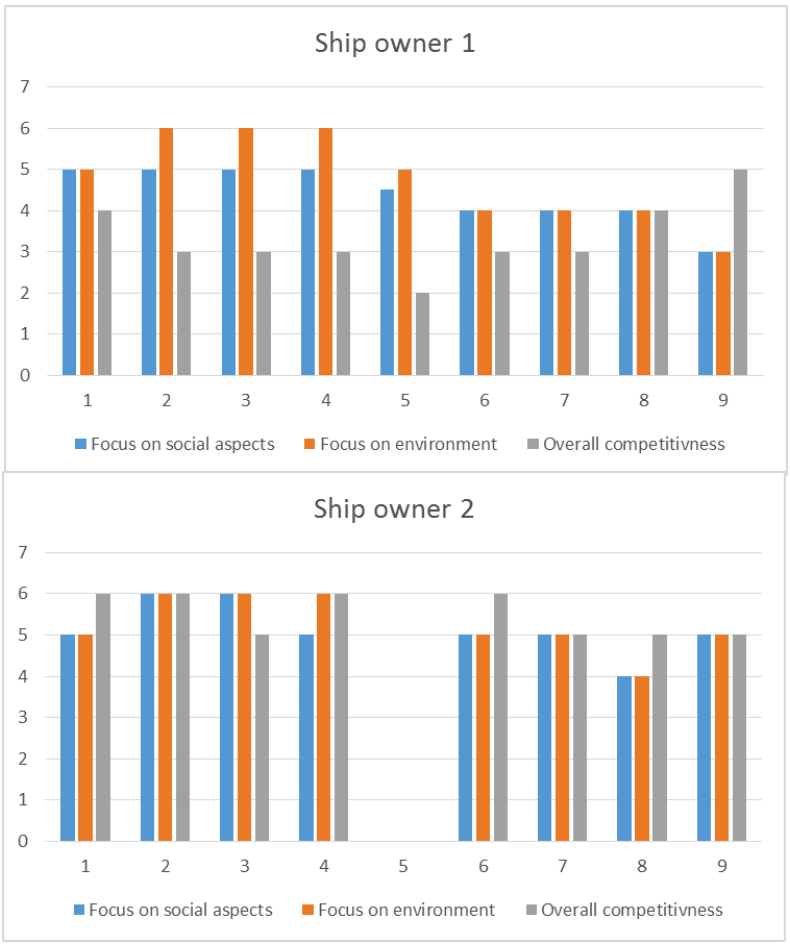


Figure 23. Evaluations by the two shipowners

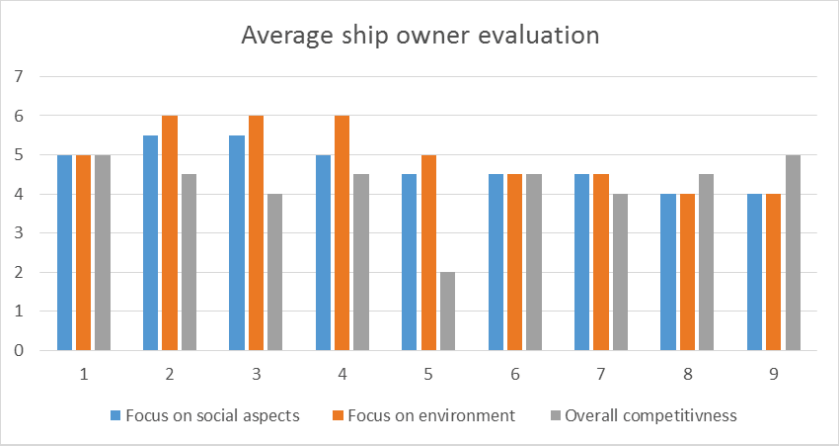


Figure 24. Averaged evaluations by the two shipowners

From Figure 24 it can be seen that shipyards 2, 3 and 4 are the best performing when looking at the social and environment aspects together, as shipyards 8 and 9 have received the lowest scoring for these two. The overall highest performance is ranked for performance in environmental focus, but scores for social focus are very high for the best performing shipyards in this evaluation as well. To be noted is that all shipyards were given relatively high scoring for environmental and social performance. Only one shipyard got a score of 3 for environmental performance, all other scores were 4 or higher. Score 4 is in the middle of the 7-step Likert scale and thus no shipyard was evaluated to have a bad performance in environmental or social performance. For competitiveness some more spreading was seen and the lowest scoring was as low as level 2.

A combined view of the overall average scoring per shipyard is seen in Figure 25. The figure shows the average score of social, sustainability and competitiveness for each of the shipyards. The strength of shipyards 2, 3 and 4 is visible here as well. Due to low scoring in competitiveness for shipyard 5, it does not have the lowest overall score although is clearly the lowest in social and environmental performance.

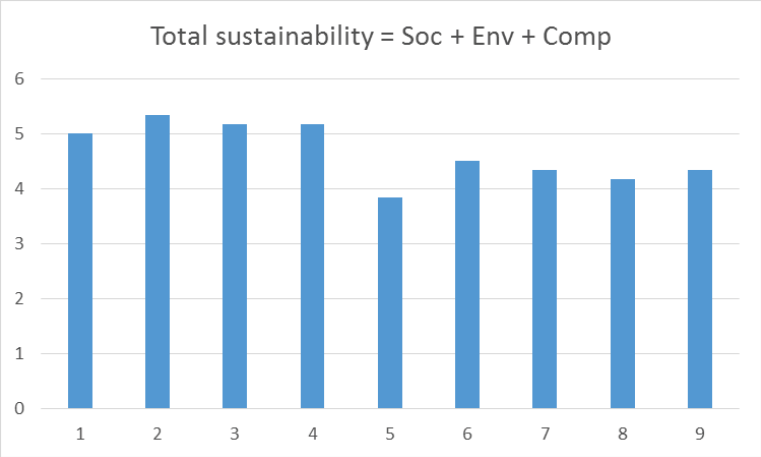


Figure 25. Combined sustainability evaluation of the nine shipyards by the two shipowners

7.3.3 Country comparison from the ship-owner viewpoint

The evaluation made by the ship-owners can also be looked at from the country specific direction. Figure 26 shows the average scoring for companies in China and South Korea regarding their performance in the social, environmental and competitiveness areas.

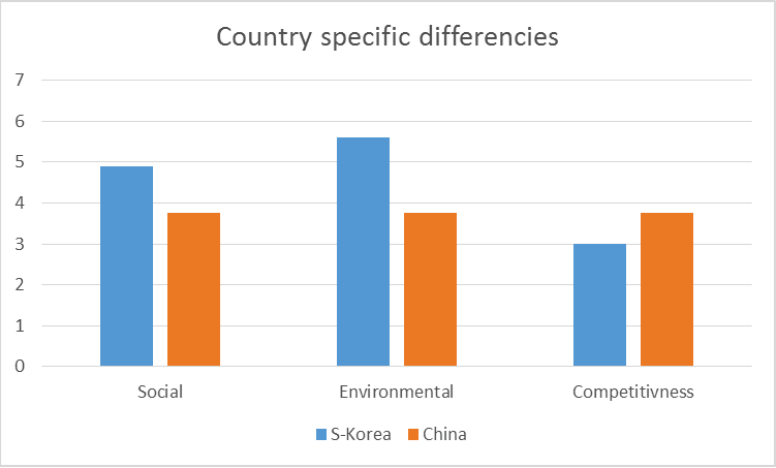


Figure 26. Ship owner evaluations per country

As already mentioned earlier, the data cannot be used for quantitative purposes due to the very small sample. However, the response is given from two very global ship owners and knowledgeable persons have given input on behalf of their companies. Thus, there is high validity in this input.

As can be seen, the performance for social and environmental areas is ranked much higher for the shipyards located in South Korea than those in China. The difference in competitiveness is the reverse. The shipyards in China are valued higher than those in South Korea. This result may indicate that whilst China has been a growing nation in ship-building and has aimed at increasing market share by focusing on low prices via low cost structures, the focus on social and environmental aspects has remained lower than that in South Korea. This result will be used later for comparison purposes with the scoring from the shipyards themselves and for judging whether generalisation of the research is possible.

7.4 Hermeneutical development of the tentative model

After collecting the data through open question interviews at the shipyards, through structured interview with the shipyards and finally through ship owner questionnaires, the target is to finalise the selection of key drivers for shipyards in their work with sustainability in innovations. The data from the interviews and questionnaires has been presented earlier and a consolidation of the data is now performed.

Additionally, comparison of country specific responses from the shipyards and from the customers is compared. The result is needed in order to conclude the potential for generalisation of the findings.

7.4.1 Key driver analysis

The main drivers for sustainability in innovations that are seen as important by the shipyards were identified from the open question interviews with the shipyards. After clustering and consolidation of the drivers, there were 13 key drivers that form the core. These resulting main essential drivers are presented in Table 14.

Table 14. Main essential drivers

Drivers
Competitiveness
Strategy
Legislation
Ethics
Customers
People
Values
Policies
Tools
Processes
Competences
Top management
Stakeholders

Out of these drivers, 12 are the same as were identified as key drivers from the literature study. One additional driver was recorded from the shipyards and that is 'Competitiveness'.

Three shipyards were ranked high by the shipowners in regard to performance in sustainability. The qualitative responses from those shipyards will now be analysed separately in order to find out if there is a difference in the priority given for the drivers compared to the input from all shipyards together. The difference will be considered in developing the selection of key drivers and finally in the development of the final tentative model of drivers.

7.4.1.1 Qualitative data comparisons, social aspects

The shipowners gave the highest scoring for social and environment aspects to shipyards number 2, 3 and 4. In the qualitative open question interview, all these three shipyards said themselves that they have high focus on social aspects. For question 11 'Is good social performance = good citizenship important for your company?', these three shipyards said yes and had various examples of selections made by their top management focus and about strategic choices. Examples included the following cases: 'Top level management is putting focus on creating trust and passion in all activities', 'Ethics and morale are trained for all personnel and reported every month' and 'Local co-operation within society is selected as a strategic theme and an important activity'. For question 13 'Do your customers value social aspects?', these shipyards responded by explaining about their

strategic choices such as: 'The customer is informed about ethics and morale actively' and 'It is important for the management to balance the workload of the employees since it is important for the people themselves and for overall productivity as well'.

The two shipyards scoring low in evaluation by the shipowners responded to question 11 that: 'The government takes care of the social aspects' and 'Safety is important', but did not widen the focus on other social aspects. For question 13 the responses only focused on safety and safety training, thus giving a rather narrow focus to social responsibility.

The conclusion from comparison of the social aspects approach between the strongly performing and less strongly performing shipyards is thus seen in the way they utilise their drivers. The drivers 'Top management' and 'Strategy' are clearly visible in the responses from strongly performing companies, whilst the focus on these drivers is less visible in companies having low scoring in performance: merely a passive role for these drivers is recognised.

7.4.1.2 Qualitative data comparisons, environmental aspects

Regarding the environment, the difference in scoring given by the ship-owners to various shipyards was even slightly bigger than it was for the social questions. For question 6: 'Is the environment important in new innovations in your company?', shipyards 2, 3 and 4 responded that their strategic choice is to focus on cost and operating economy of the vessels and thereafter on environmental impact (energy efficiency, carbon dioxide and sulphur emissions as focus areas). Shipyards 8 and 9 responded that they focus on forthcoming legislation and mentioned as examples are Tier III and BWMS legislation and related technologies.

For question 10: 'How do you measure your success in environmental performance?' shipyards 2, 3 and 4 responded that performance compared to legislation requirements is the most important driver. Additionally, comparisons are made to earlier ship designs to witness the success of innovations especially in fuel consumption and carbon dioxide emissions. Shipyards 8 and 9 referred to EEDI (Energy efficiency design index) as the design target index for their new ship innovations, thus highlighting the importance of legislation as a driver for them as well.

As a conclusion it can be said that although the shipowners saw a rather big difference in the environmental focus of the shipyards, the responses from the

shipyards gave a picture that the differences are small. 'Legislation' is clearly a strong driver for all the yards. This may be a sign of 'greenwashing' in the comments from the shipyards, although no evidence of that was detected in the interviews. Additionally, cost and competitiveness receive a lot of focus at the shipyards that were scored as performing strongly in sustainability and thus signal that the focus is wider there than in the shipyards that were scored lower.

7.4.1.3 Qualitative data comparisons, competitiveness

Regarding overall competitiveness, the scoring by the two shipowners differs rather much in this evaluation. Unfortunately it therefore does not create a good evaluation base and thus no conclusion of the performance on the shipyards can be drawn. The definition of competitiveness is also challenging. It may be interpreted as 'value for money' and thus the scoring is good for lower overall performance if only the price is low. Or, it may be understood as the overall combination of all aspects together. This research does not include enough detail for this aspect to be studied more.

There would have been interest in seeing if high focus on the environment and social aspects also gives high scoring in competitiveness, or if it is only a burden. Unfortunately, such conclusions cannot be drawn from the very limited data (only two shipowners responded) in this research.

7.4.1.4 Data comparison from the structured questions

These three top performing shipyards in the opinion of the ship owners are obviously doing things right in regards to sustainability. The interview responses from those shipyards thus give an interesting data source for analysis of important aspects and drivers in sustainability. This view might help in developing the key drivers even further. The scoring of the responses to the structured questions from these three shipyards (shipyards 2, 3 and 4) is shown in Table 15.

Table 15. Main essential drivers

	Questions:	Yard 2	Yard 3	Yard 4	Count	Min	Max	Average
Q1	The customers focus on environment	5	6	7	3	5	7	6,00
Q2	Our top management focus on social aspects	5	6	7	3	5	7	6,00
Q3	Laws and legislation guide our sustainability	6	7	7	3	6	7	6,67
Q4	People are valued in our company	6	6	5	3	5	6	5,67
Q5	Our strategy is focusing on social aspects	6	6	7	3	6	7	6,33
Q6	External policies guide our sustainability	5	5	6	3	5	6	5,33
Q7	Our tools support sustainability	5	6	6	3	5	6	5,67
Q8	Our company strategy is focusing on environment	5	6	7	3	5	7	6,00
Q9	Our people have skills & competence about sustainability	6	7	6	3	6	7	6,33
Q10	Our company culture is supporting sustainability	6	7	5	3	5	7	6,00
Q11	Ethics and morale are important in our company	6	7	7	3	6	7	6,67
Q12	Our company culture is supporting sustainability	6	6	7	3	6	7	6,33
Q13	Personal behaviour towards sustainability is supported	6	6	7	3	6	7	6,33
Q14	Our company philosophy supports sustainability	6	7	7	3	6	7	6,67
Q15	Our processes support sustainability	6	7	7	3	6	7	6,67
Q16	Values of our company support sustainability	6	7	6	3	6	7	6,33
Q17	Our people are motivated to focus on sustainability	6	6	6	3	6	6	6,00
Q18	We support internal entrepreneurship	6	6	7	3	6	7	6,33
Q19	External stakeholders impact our sustainability focus	3	7	5	3	3	7	5,00
Q20	Our top management focus on environment	6	6	7	3	6	7	6,33
Q21	Is it difficult to combine environment and social to business?	3	6	5	3	3	6	4,67

The strongest drivers from these three shipyards are: 'Legislation', 'Ethics', 'Philosophy' and 'Processes' with a score of 6.67 each. The lowest score (5.00) is given for 'External stakeholders' and that is due to one low response from one shipyard only. The differences are rather small, as expected, but very clear in any case. All the responses are between 5.00 and 6.67 in a 7-point Likert scale (the last question, Q21, is not a question related to drivers and therefore not included in the analysis). The average score in such a scale is 4, thus all the responses got a higher score than average. Obviously, none of the question areas are seen as irrelevant and therefore the responses given indicated high scoring. None of the areas dominate and therefore the differences are also small.

A comparison is also made from the responses from the best performing three shipyards compared to these two shipyards (shipyards 8 and 9) that got the lowest score on sustainability by the ship-owners. Figure 27 illustrates that difference.

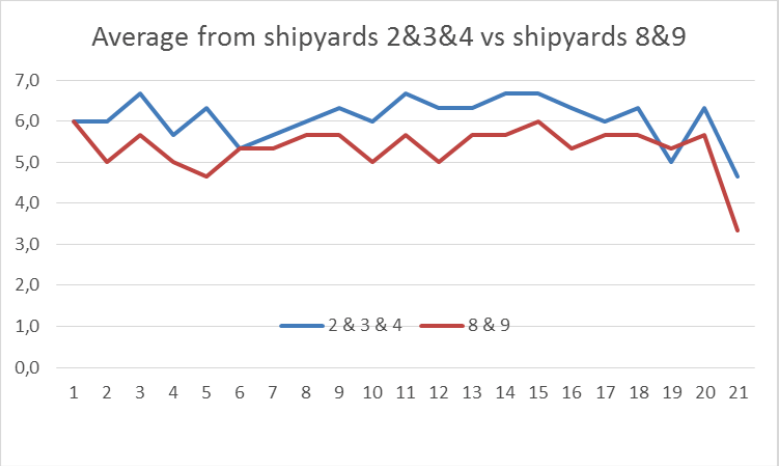


Figure 27. Structured question responses from shipyards ranked high vs low in sustainability by ship-owners

The figure shows that even the responses from shipyards 8 and 9 are above a score of 4 and thus are all high. The biggest difference between these two groups of yards is recognised for the question 'Our strategy is focusing on social aspects'. The difference is 1.7 and the score of shipyards 2, 3 and 4 are higher than for the other group.

Even though some differences can be seen from the data, they are so small that real variation is not visible. Because the sample size is also very small, no conclusions can be drawn, not even qualitative observations, based on the structured interviews.

7.4.2 Key driver selection

As a summary of the evaluation of the shipyards that are performing well in sustainability according to ship-owners, it can be concluded that the drivers 'Top management' and 'Strategy' are important for their social focus. Regarding the environmental focus, these top shipyards are focusing on the driver "Legislation". 'Competitiveness' is also recognised as a strong element in their environmental focus.

Analysis of the underlying comments and feedback to the open questions from the strongly performing shipyards did not raise any new drivers on top of the list of key drivers. Review of the structured question responses showed some differences but due to the small sample size and small differences, no new input was concluded.

Therefore, the conclusion is that the key drivers listed in Table 21 are the final ones in this research. The open question analysis from strong shipyards in sustainability gave some extra weight for the drivers 'Top management', 'Strategy', Legislation' and 'Competitiveness' and thus a prioritized list of drivers can be produced (Table 16) where these four are at the top.

Table 16. Key drivers, the four at the top with highest priority

Drivers
Top management
Strategy
Legislation
Competitiveness
Customers
People
Values
Policies
Tools
Processes
Competences
Ethics
Stakeholders

7.4.4 Tentative model for the drivers

Based on the identified key drivers, a new illustration can be drawn for the drivers. This will form the final tentative model that describes the link and relations between the drivers and thus gives a foundation for answering the research questions. The tentative model will be drawn on the basis of the framework that was developed from the literature. The earlier illustrations were called frameworks since they were based on literature studies and now when empirical data has been gained and the necessary set of drivers is further developed, the illustration will be called a tentative model.

Figure 28 shows the final tentative model. It consists of the 13 drivers that were identified from the interviews with shipyards. Some drivers that were identified from the literature study have been left out since they did not come high in the

empirical research part. This tentative model illustrates how the market opportunities are converted to sustainable innovations through the processes of a company. The external drivers impacting this process are 'stakeholders', 'customers', 'policies' and 'legislation'. Within a company the activities are guided by the drivers 'top management' and 'strategies'. The internal activities are impacted by the drivers 'people', 'processes', 'tools' and 'competencies'. 'Competitiveness' impacts the internal activities as well and the strongest drivers impacting the activities from the foundation are 'ethics' and 'values'.

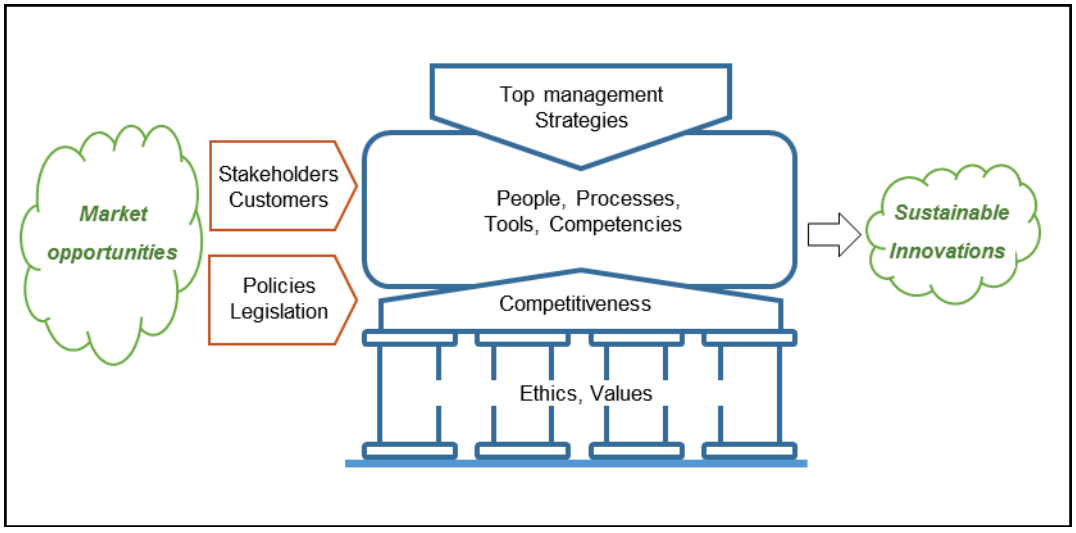


Figure 28. Final tentative model of the drivers

7.4.4 Country specific differences

This research has been performed using data from shipyards in two different countries. In order to be able to conclude if the information can be generalised, an analysis of the country specific differences will be made. There are two sources of information: the country specific differences from the structured question data where shipyards scored their own performance. The other information comes from the ship-owners who gave performance evaluations for the selected shipyards.

The responses for the structured data questions at the shipyards showed that the companies in South Korea score themselves higher than those in China. The total average of all responses in South Korea was 5.69 compared to 5.33 from China

(Figure 29). The responses from the shipowners show a similar tendency, Figure 30, thus confirming this difference.

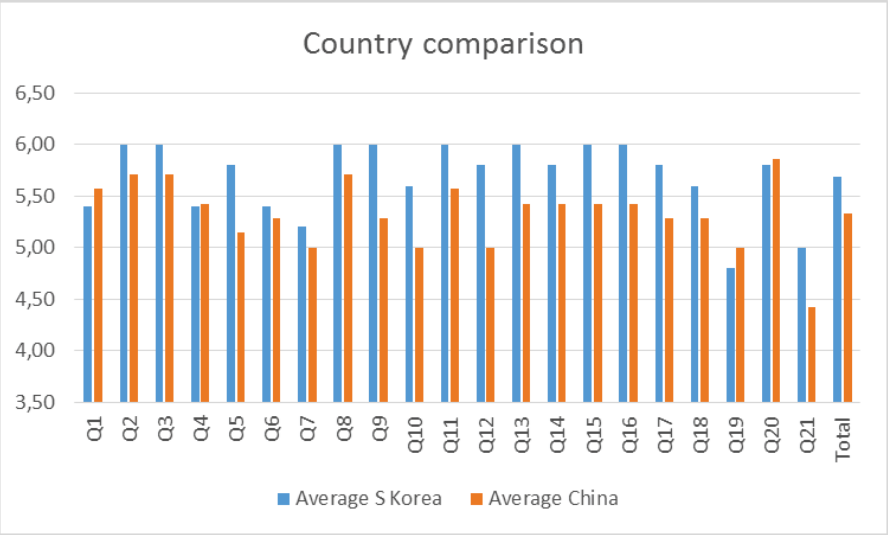


Figure 29. Structured question responses by shipyards – differences per country

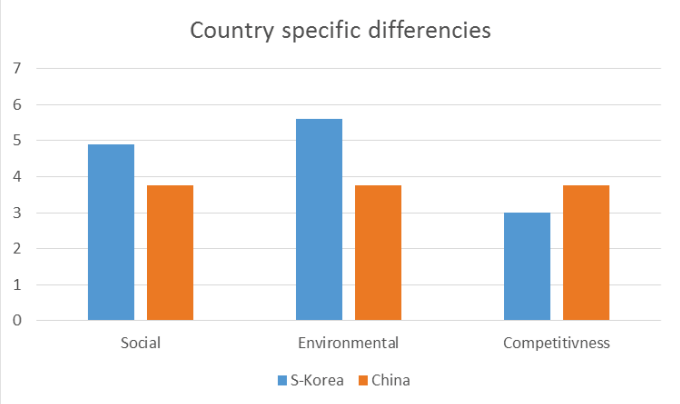


Figure 30. Ship-owner evaluations of shipyards – differences per country

These two assessments do not measure exactly the same thing. The shipyard structured questionnaire measures the priority given to drivers. The ship owner evaluation indicates the perceived performance of the shipyard. Both of these assessments are, however, relevant for evaluating the ability to create innovations

with high focus on sustainability. The similarity of the results shows that if the shipyards do not put high focus on drivers impacting strongly on sustainability, they are not perceived to perform well in that aspect as seen by their customers. Due to the small size of the samples there is no possibility to make a statistical analysis to prove the conclusion to be right but qualitative observation suggests that the difference in the scoring given to the shipyards by the ship owners does not come from country specific difference but from less focus on important drivers impacting sustainability development.

The most probable reason for the difference comes from the different stages of evolution towards sustainability. The shipyards in South Korea have worked longer with sustainability focus, whilst the shipyards in China have focused more on gaining market share by optimising for lower cost.

8 FINDINGS AND PRACTICAL WAYS OF WORKING

The results from the research provided considerable insights into focus areas and priorities when focusing on sustainability in shipbuilding innovations. The data was collected and presented in a meaningful way but not yet in a way that would support answering the key research questions. One of the targets for this research was to find practical ways of working for companies in their daily work when striving for sustainability in innovations. As indicated earlier, some previous research has been carried out in the area of sustainability in innovation, but it did not result in presenting practical guidance.

The following key research questions were created at the beginning of the research:

1. What have been the most important factors and priorities impacting business development towards sustainability in innovation?

2. How can performance of sustainability in innovation be assessed?

3. How can management guide businesses to develop towards sustainability in innovation?

The intention with these research questions was to bring clarity to the practical approaches that are needed in analysing business environments and leading businesses towards sustainable innovations. The purpose was to find priorities and focus areas that have the biggest impact in the journey the companies make. For management the importance was to find observations and parameters that will most efficiently support decision-making when striving for sustainability, which in practice consists of financial, social and environmental elements. The research focus covers innovation activities for new products but does not exclude services.

The research was done using a hermeneutical research strategy and the same approach is also used for answering the research questions. The data and models that were created within the research were used in combination with the practical experience of the researcher in hermeneutical cycles in order to produce a meaningful outcome. The outcome functions not only at the level of theory but is also developed further in order to give practical tools and ways of working for practitioners in industry. Thus, the outcome is not only academic but stretches into daily management duties as well.

8.1 Identification of key sustainability drivers

The first key research question asks: 'What have been the most important factors and priorities impacting business development towards sustainability in innovation?' In this research a clear model was created for identification of the most important and influencing drivers that impact the development of innovations towards sustainability. The model is presented in Figure 28 and illustrates the drivers and also creates clusters of these in a logical format.

The model creates a clear set of drivers that are to be identified if it is used as a reference for determining the main essential drivers guiding sustainability in innovations. The drivers from the model are listed in Table 17. Some order of priority is reflected in the list since the first four drivers were highly prioritised based on the input from shipyards performing well in sustainability in the eyes of their customers.

Table 17. Main essential drivers

Drivers
Top management
Strategy
Legislation
Competitiveness
Customers
People
Values
Policies
Tools
Processes
Competences
Ethics
Stakeholders

The first key research question asks: 'What have been the most important factors and priorities impacting business development towards sustainability in innovation?' The list presented in Table 21 provides the answer to this key research question. The factors are called drivers and are identified through rigorous analysis involving literature analysis, verification via secondary data in the literature, via direct data collection from companies in business (shipyards) by both qualitative open and structured questions, and finally via quantitative verification from customers of the industry (shipowners).

8.2 Assessing sustainability in innovations

The second key research question asks: 'How can performance of sustainability in innovation be assessed?' The tentative model that has been developed and the main essential drivers presented in it can be used as guidance for setting up a questionnaire that can be used for collecting information from companies.

However, in order to be able to use the list for practical data collection purposes, there are two questions that arise. Firstly, what kind of data is available for collection from the company and secondly, what would be a method to classify the data so that it will bring relevance for analysis?

8.2.1 Data access

From a practical point of view, the availability of data is dependent mainly upon whether the data can be accessed from the internal sources of a company or whether it needs to be found from external sources outside the company. This question was once already addressed in this research when the initial framework based on literature studies was created. There was a need to verify that framework against real company data, but there was no access to internal data sources of the relevant companies. Therefore, the framework was modified to fit such data that was accessible via secondary literature sources.

The second experience of collecting data was gained whilst doing the empirical data collection. In that research, access was arranged to top technical management of nine shipyards and data from inside these companies was collected. Thus, there is now experience both from collecting data from secondary literature with an external view and from directly within the companies with access to company management as the information source.

Based on the experience of data collection and the refinement of the driver framework, the drivers can be analysed based on the availability and source of data. In Table 18 the final key drivers are ranked based on whether access to such driver data is available from internal or external sources.

Table 18. Driver data availability

Drivers	Data availability	
	Internally	Externally
Top management	Yes	No
Strategy	Yes	Yes
Legislation	Yes	Yes
Competitiveness	Yes	Yes
Customers	Yes	Yes
People	Yes	Yes
Values	Yes	Yes
Policies	Yes	No
Tools	Yes	No
Processes	Yes	Yes
Competencies	Yes	No
Ethics	Yes	No
Stakeholders	Yes	Yes

As can be seen, the availability of all the drivers is naturally good when it can be accessed from inside the company. Therefore, all the drivers can be tracked for evaluation purposes. However, in such cases where no internal access to data is available, only some of the drivers can be identified and used for analysis.

8.2.2 Driver feasibility

As the availability of data from external sources clearly poses limitations, consideration should be given to whether the limited data will be enough to make judgement about the status of sustainability in innovations or if the data is too limited to give an indication of the status. Such an evaluation was actually done already earlier in this research in connection with the testing of the first version of the theoretical framework. It was done by using secondary literature, which mainly consisted of the companies' annual reports. Although only limited, the driver selection was used for analysing the business performance of three shipyards and it was seen that such verification gives meaningful results.

When comparing those drivers that were earlier used for assessing the performance of three shipyards using secondary literature (Figure 14) to the drivers listed in Table 22 with external access possibility, it can be seen that the drivers are all included in the final list of key drivers. The drivers 'Competitiveness' and 'Stakeholders' are additional in the final driver set. Also a slight difference is that in the earlier survey with grey literature the drivers 'Values' and 'Strategy' were duplicated in two areas to assess both the social point of view and

environmental point of view separately. This duplication seemed meaningful on the basis of the results. Despite these two differences it can be concluded that the main concept of assessing drivers with an external view has already been tested in this research and has been proven to work. Relevant data is available for external viewers via secondary sources (annual reports were used) and it gives a good balance in terms of data access and data validity.

The drivers 'Competitiveness' and 'Stakeholders' had not been considered prior to this research and thus the availability is not proven. However, in the earlier driver analysis the data was collected from secondary literature, which consisted of companies' annual reports. Such reports naturally also contain information about financial performance and the relevant interest parties. Therefore, it can be concluded that also information about financial performance and thus competitiveness is available when data is taken from annual reports or similar documentation. Similarly, stakeholders are an important source of information for the owners of the companies and can be expected to be visible in the reports.

8.2.3 Driver data classification

To be able to judge the performance and strength of the drivers in the companies being analysed, a meaningful set of criteria is needed. The judgement should provide data that can be used to compare the performance of companies against each other.

8.2.3.1 Performance criteria when only external data is available

The verification of activities done earlier in this research for the theoretical framework gave clear results for the case where only an outsider view was available. The data was procured by analysis of company annual reports and the scoring for the drivers was simply based on whether the driver existed in the material or not. Evidence of a driver gave a score of one for the driver when it was identified, and no existence gave a score of zero. Since this way of assessing gave clear and comparable results, it is also suggested as the method when going forward. Based on such criteria, it is possible to create a questionnaire for the identification of drivers and for calculating the overall performance as a summary of the scoring.

8.2.3.2 Performance assessment when internal data is available

In such cases when there is access to the internal data of a company, it is possible to use a more refined model for assessing driver performance than that proposed for external data analysis. Since the access to data internally is good, all the identified drivers can be assessed and the responses can be more refined than just binary zero or one. A questionnaire using the Likert scale is therefore proposed. A 7-scale questionnaire was used for this research for collecting the research data. However, for a generic questionnaire for validating company performance such a scale may give too detailed information without anchoring to reality (Collis & Hussey, 2014; Sauro, 2010). Therefore, a 5-scale Likert questionnaire is proposed, which is deemed to be enough for observing differences in a meaningful way.

8.2.4 Questionnaires

In order to facilitate practical data collection and analysis of performance of sustainability in innovations, two questionnaires were prepared. Questionnaire 1 (Figure 31) was prepared for cases where only external information is accessible. The analysis gives a rough analysis only. Defining an absolute level of scoring is not meaningful when using this analysis, but a comparison of companies against each other can be performed. The proposed questionnaire visualises a comparison of three companies against each other.

Scoring sustainability in innovations, based on key drivers

Data availability: only via external sources
Information source: Annual reports or similar
Scoring:1 (one) if the driver can be identified
0 (zero) if the driver can not be identified

Drivers	Company 1	Company 2	Company 3
Company strategy contains focus on environment	1 / 0	1 / 0	1 / 0
Company strategy contains focus on social aspects	1 / 0	1 / 0	1 / 0
Company has defined processes	1 / 0	1 / 0	1 / 0
Company values take environment into account	1 / 0	1 / 0	1 / 0
Company values take social aspects into account	1 / 0	1 / 0	1 / 0
Legislation is guiding sustainability development	1 / 0	1 / 0	1 / 0
Customers ask for sustainable offering	1 / 0	1 / 0	1 / 0
Stakeholders impacting business are mentioned	1 / 0	1 / 0	1 / 0
People are valued in the company	1 / 0	1 / 0	1 / 0
Company competitiveness is emphasized	1 / 0	1 / 0	1 / 0
Total			

Figure 31. Questionnaire 1 for analysing companies, access to external data

For the purpose of assessing performance of sustainability in innovation when access to internal data is possible, a more detailed questionnaire can be developed. Figure 32 illustrates the Questionnaire 2, which is proposed for use when access to internal information can be arranged.

Scoring sustainability in innovations, based on key drivers

Data availability: via internal sources
Information source: Company management

Drivers	Not existing 1	Slightly 2	Average 3	Good 4	Very strong 5
Top management is focusing on environment					
Top management is focusing on social aspects					
Strategy contains focus on environment					
Strategy contains focus on social aspects					
Legislation drives towards sustainability					
Competitiveness is focused at in whole organisation					
The customers focus on environment					
People are valued in the company					
Company values take environment into account					
Company values take social aspects into account					
Policies guide towards sustainability					
Tools support sustainability development					
Company processes support sustainability					
Competencies about sustainability exists					
Focus on ethics can be evidenced					
Stakeholders have an impact on the business					

Total score (all scoring together) _____

Figure 32. Questionnaire 2 for analysing companies, access to internal data

The data for the questionnaire was collected using a 5-point Likert scale. The questions for assessing the drivers are developed from the qualitative structured driver questions used earlier in this research and were enriched with the viewpoints from the qualitative open question interviews. Three questions were divided into two parts in order to measure separately the aspects of environment

and social focus. Such questions measured the drivers 'Top management', 'Strategy' and 'Values'. The reason for this twin focus comes from the weight of importance seen in the earlier structured question questionnaire and also from the twin focus of comments in the open question analysis.

Use of these questionnaires gives a way of fulfilling the need in the second key research question. The question was: 'How can performance of sustainability in innovation be assessed?' The questionnaires provide the answer and content for the response. These questionnaires naturally contain some subjective viewpoints based on the experience gained in this research but anyway show the potential for using research data for practical use.

8.3 Leading innovations towards sustainability

The third key research question asks: 'How can management guide businesses to develop towards sustainability in innovation?' The aim is to find practical ways of supporting the management in their need to develop a company with improved sustainability in innovations. Many aspects are important, but the focus should be on such activities which can be impacted and where the time frame to make a difference happen meets the needs.

In order to create guidance for management, the drivers that were included in the final tentative model (Figure 34) were analysed in order to learn which ones can actually be impacted by the management and by which means. Resources are scarce and time is important and therefore prioritisation is highly important. Two specific ways for taking these aspects into account were defined.

Firstly, the drivers can be divided into internal and external based on the definitions of Hotho and Champion (2011) and Lozano (2015). Internal drivers are such that exist within a company and external drivers where the guidance comes from outside of the company. Lozano (2015) defined even a third group, connecting drivers. That is not utilised in this result analysis since such granularity was not necessary for this first empirical research within shipbuilding but could be studied in later, continued research.

Secondly, the drivers can be divided based on whether it takes a short or long time to make a change in them. The definition of Staub et al. (2015) is used, which state that some drivers can be modified or changed in a short time, whilst some are sticky and take a long time to be impacted. Some internal small investment within a company for new tools can be made in a short time but getting a change in world-wide policies or legislation may take several years (if it is even possible at all).

The logic for categorising the drivers into internal and external follows the possibilities of management to make a direct impact on the driver or not. Company internal matters can be directly impacted by the management but the external drivers typically not. The categorisation into whether it takes a short or long time to make an impact on a driver, however, is more cumbersome. The following logic was used for selecting the categories for each of the drivers:

- The values are, according to Staub et al. (2015), called hard corporate identity drivers, which take a long time to be changed

- Ethics is a driver, which, according to Aaltonen & Junkkari (1999), can be related to culture and thus also takes a long time to be impacted

- Competitiveness is dependent on many issues. In the qualitative research at the shipyards the role of cost, efficiency, quality and energy saving were recognised as elements of competitiveness. These are all operational focus areas which may be slightly impacted in the short term, but when making a permanent change take a longer time. Therefore, this driver is classified as taking a long time to be impacted

- Policies and legislation are both permanent structures due to their decision-making mechanisms and thus categorised as taking a long time to be impacted

- Customers are external stakeholders. In essence, customers basically consist of individual persons, also in the case of business-to-business relations. Although customers may have their own buying processes and procedures, these persons also have their own buying behaviour, which may be impacted with new insights, new data or with changes in business models. Therefore, this driver is categorised as taking a short time to be impacted

- Processes are about internally decided ways of working. These may require a decision from the management but the decision can be made in a limited time. Therefore, this is categorised as a short time to be impacted.

- Tools are dependent on internal decisions from the management but these can be made in a limited time. Therefore, this is categorised as a short time to be impacted.

- People as drivers can be encouraged to focus on sustainability by different means. Company management can communicate the importance of sustainability and invite people to participate. Training can be given as

well as the recruitment of individuals with a sustainability mindset. Such activities can mostly be started in a relatively short time, and therefore this driver can be impacted in short time

- Top management can make quick decisions and therefore should be able to make an impact in short time. Unfortunately, top management is not quick in all companies, but this does not prevent this driver from being chosen as one that potentially can have a short time to be impacted.

- Competencies can be developed in two ways: either by training the personnel or by recruiting new persons. Many of the tasks can be learned in a short time, but naturally most complex matters may take years to learn. Companies can also acquire competencies by making strategic alliances or by acquiring other companies. Some of these measures may take a long time to happen, but most activities can in any case be executed in a short time if and when a decision has been made. Therefore, this driver is judged to take a short time to be impacted.

- Strategy is a part of a decision process of top management. Very often, strategies in companies are modified in a short time when the need is there and thus the can be categorised as taking a short time to be impacted

- Stakeholders are about external forces and persons impacting the company. These are typically beyond the direct impacting possibility of company management and personnel. Often, indirect ways of impacting are needed. Therefore, this is categorised as a long time to be impacted.

Figure 33 presents a summary of the most essential drivers that were included in the final tentative model (Figure 34). The drivers are clustered into four areas depending on the internal/external point of influencing and a short/long time to make a difference.

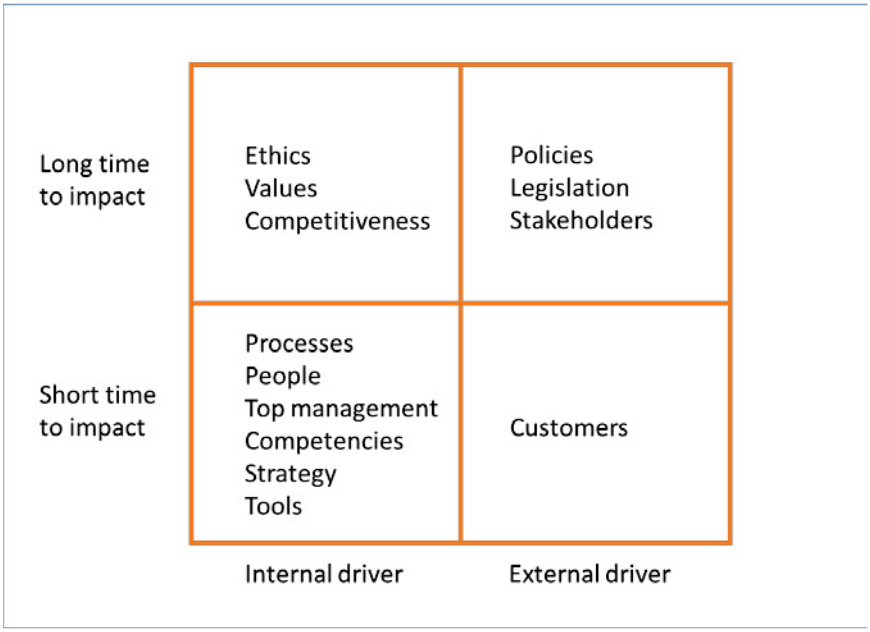


Figure 33. Categorisation of the drivers

From Figure 40 it can be noticed that most of the drivers are internal to a company. Lozano (2015) has in his model 14 external drivers and 17 internal drivers. In addition, he defined 9 drivers which were called connecting drivers and include elements of both internal and external aspects. Obviously, such connecting drivers are counted in as internal drivers in this work and thus the balance has more weight on the internal side. That is good for the management since such drivers can be impacted by them. A further positive fact is that most of these drivers are such that they can be impacted in a short time. Thus, management has six drivers that they have the possibility to modify and the results appear in a short time.

Four drivers are external and thus hard to be impacted by the company management. Naturally, some attention can also be paid to these in special cases and impact can be created, but in most cases these efforts do not bring value for the effort made. The fact that the time to create an impact on three of these is long and for one short, does not really make a difference. These drivers exist and are important but putting immediate management focus on these (like trying to change policies or legislation towards more sustainability) does not present an easy way forward. Making customers to be more sustainability oriented in their actions may work in some cases and may in special areas be worth an attempt by the management.

Based on the reasoning above, the drivers to be focused on by the management can be identified. Those that can be directly impacted and that need the shortest time to develop are such that make sense for the management to focus on when driving

a company towards sustainability in innovations. When these drivers are further arranged in order of priority based on the priority setting created earlier in this research, a sequence for management focus can be created. Table 19 presents such a sequenced list in the format of a to-do list for the management.

Table 19. Management priorities for advancing sustainability in innovations

Short term focus areas

1. Have top management show their commitment towards sustainability
2. Create a strategy that focuses on sustainability
3. Develop processes so that they include sustainability aspects
4. Raise competences by giving training in sustainability and recruiting good skills
5. Encourage people to focus on the environment and social aspects
6. Acquire tools supporting sustainability and innovation work

Long term targets

1. Focus on continuously aiming high in competitiveness
2. Create focus on high ethics in business and activities
3. Develop company values with focus on sustainability

As can be seen, the list of activities is very simple and straightforward in nature. There are six actions that can be started immediately after a decision to move towards sustainability in innovations has been made. The list also includes three actions for the longer term. These naturally can be started immediately as well but require much more tedious and repeated activity, and getting the results to be visible will take a longer time.

The list of actions is surprisingly short and includes actions which may appear simple. The practice is, however, often much more complex than it appears at first glance. Creating strategy, arranging training and changing the mindset requires a lot of effort. However, the results from short term issues mentioned here should become visible soon after the start.

The long term indication consists of three items at the end of the list that reflect a time period which requires patience from the management. Behavioural matters are sticky, and thus time and effort is needed when conducting these actions.

The list in Table 19 provides an answer for the third key research question, which was: ‘How can management guide businesses to develop towards sustainability in

innovation?' It is to be noted that although this list is based on earlier theory and on fresh results from this research, the conclusions are not tested and thus may need to be tested further. Therefore, the list also offers an opportunity for further research for validating the logic and conclusions.

9 CONCLUSIONS & RECOMMENDATIONS

The purpose of this research was to provide advancement to science and theory in the area of sustainability development. The goal was also to find ways in which management can lead their businesses to better take sustainability into account in their innovations. A central role in that journey is in recognising the drivers that impact such development. The empirical part of this research was performed using hermeneutical strategy. It was based on data that was collected from shipbuilding and came from nine shipyards in Asia: five in South Korea and four in China.

This chapter summarises the research process and reviews the main achievements. The contribution to theory is analysed and the limitations presented. Finally, there are suggestions for future research to develop the knowledge in this area even further.

9.1 Summary

The main part of the research work focused on identifying the key drivers that impact sustainability development in innovations. In order to visualise the concept the drivers were collected into a framework that was developed during the research. Some earlier research had already pointed out the importance of having a framework for describing the mechanisms and aspects in sustainability oriented innovation (Adams et al., 2015; Lozano, 2015; Siqueira & Pitassi, 2016). The challenge with this earlier work was that the connection of the results back to practical business activities was missing. Thus, no advice was presented for the management for how to act in the light of the theories that were created.

Based on literature studies and empirical research in nine Asian shipyards, a new tentative model indicating the drivers and relationships for sustainability in innovation was created, Figure 34 (the same as Figure 28).

This tentative model of the most important drivers is arranged into a visual format that explains the relationships and logic. It illustrates how the market opportunities are converted to sustainable innovations though the processes of a company. The external drivers impacting this process are stakeholders, customers, policies and legislation. Within a company the activities are guided by top management and strategies. The internal activities are impacted by people, processes, tools and competencies. Competitiveness impacts the internal activities as well and the strongest drivers impacting the activities from the foundation are ethics and values.

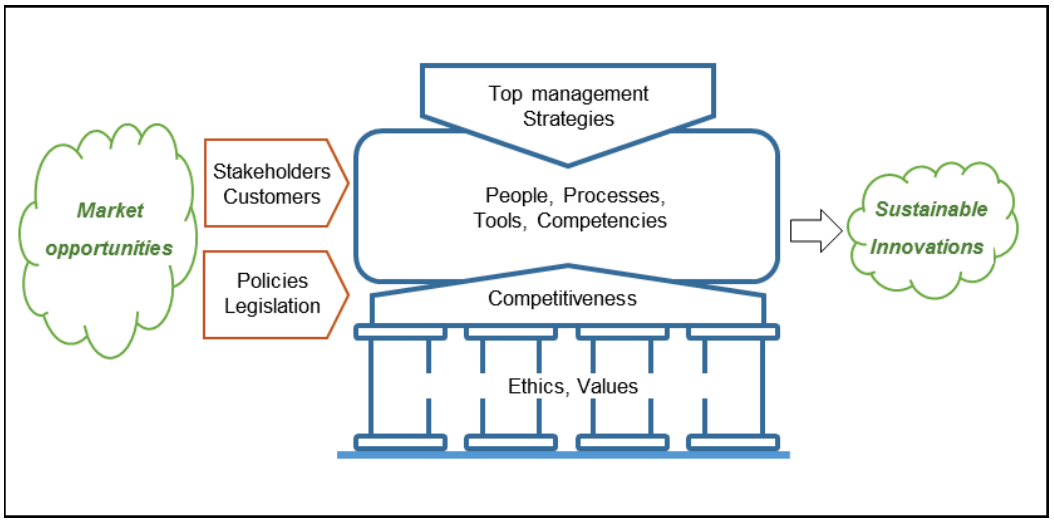


Figure 34. The new tentative model of drivers

All these items mentioned from external elements to top management and foundation are drivers that guide the journey of a business towards sustainability in innovation. There are also many other drivers in a business, but based on the research these are the strongest of all and thus included in the tentative model.

This tentative model, together with the research data, was used as a basis for answering the key research questions. The initial target for the research was to create practical guidance for companies when striving to develop sustainability as part of innovations. Based on this need for understanding and guidance, the following key research questions were created and later answered in detail:

Research question 1: What have been the most important factors and priorities impacting business development towards sustainability in innovation?

Research question 2: How can performance of sustainability in innovation be assessed?

Research question 3: How can management guide businesses to develop towards sustainability in innovation?

The response to key research question number one was created based on the literature analysis and empirical research. The literature analysis was performed in order to indicate important drivers in earlier research. Empirical qualitative open question research was performed in nine different shipyards in order to find out the drivers existing in that business. Additionally, empirical qualitative structured question research was performed in the same shipyards in order to find the relative strength of those drivers identified from the literature. Combining the drivers from the literature and the empirical research gave a consolidated set of drivers with high impact. Some drivers were identified to be the most important when studying those shipyards that were scored highly in sustainability in innovation by reputable ship owners. The most important drivers were found to be 'Top management', 'Strategy', 'Legislation' and Competitiveness'. Altogether, 13 most significant drivers were identified.

In answer to key research question number two, it was decided to use the drivers as the means to assess the performance. The strength of the most important drivers (identified in this research) in a company would tell how much focus the company has on sustainability in innovations. In order to make precise analysis, access to data needs to be good and data from inside of the company is needed. A method for assessment and a supporting questionnaire based on a 5-step Likert scale was created for this purpose (Figure 39). The strength of the scoring gives a measure of the performance of sustainability towards innovation in a company.

Often there is no access to internal data and thus the method that was described above cannot be used. For such purposes a simplified method was developed. It is based on the observation made during the literature study, where it was found that a simplified set of drivers can be used for assessing the performance of sustainability in innovations in a company. That observation was further validated as a part of the empirical qualitative structured question research in nine shipyards. This observation and the positive support from the validation made it possible to create a simplified method and a questionnaire linked to it (Figure 38).

Research question number three was looking for guidance for management when bringing more sustainability into the innovations of a company. A list of the most important drivers identified in this research was used. These were arranged into categories based on two dimensions: firstly, based on whether the driver can be impacted from inside of the company (by management) or not, and secondly, based on whether it takes a long or short time to make an impact on the driver. This analysis led to the identification of six drivers that are in the immediate focus of management. They were arranged further into activity sequence based on the importance of the drivers identified earlier in this research. The final outcome was

a practical list (Table 23) for management describing the activity areas and sequence of actions for the management in order to drive their businesses for sustainability in innovations.

In a conclusion, it can be said that all three key research questions were answered. Practical elements of management were addressed based on the theory that was created in the empirical research based on data from nine shipyards in Asia.

9.1.1 Research process

The research was started by collecting existing knowledge via literature searches. Various data searches were used from the databases of scientific libraries. The resulting knowledge was analysed, categorised and summarised in order to create a clear view of the state-of-the art academic knowledge.

The research philosophy was selected to be interpretivism, the research approach included both induction and abduction, and the research method was a qualitative method with data triangulation (open questions and structured questions). The research design was selected to be exploratory for the open questions and explanatory for the structured questions interviews. The research strategy was chosen to be according to hermeneutics, with some elements from case study and utilising triangulation. The time horizon was selected to be cross-sectional.

In the beginning of the research a literature study was performed and the resulting knowledge summarised in a visual framework. It illustrated the logic and relations of different aspects that guided the development of sustainability in innovations. These aspects were named drivers as also Lozano (2015) had previously done in his research.

In order to find whether the framework is meaningful and contains relevant data, it was tested using data from three shipyards as a reference. Since there was no access to the internal data of the shipyards, only secondary data in the form of company annual reports could be used. The framework consisted of drivers that were more academic and less practical, and these were not available in the annual reports. The drivers in the framework were therefore developed to consist of such drivers that correspond to the language of the annual reports but were close to the original meaning in nature. The verification of the modified framework gave very meaningful results and thus gave confidence to continue with the framework.

Based on the successful framework verification, a detailed research programme was designed. It included qualitative interviews at nine different shipyards in two

Asian countries: at four shipyards in China and five in South Korea. The same interview session also included the collection of qualitative structured question data using 7-point Likert scale questionnaires. The interviews and data collection were conducted according to the hermeneutic approach.

After receiving data from the shipyards, a final verification of the selected shipyards was performed by asking for evaluations of the sustainability of the interviewed shipyards directly from their customers (shipowners). The purpose of this part of the research was to obtain ratings for the interviewed shipyards regarding their performance in sustainability so that their responses could be compared with the external view of their performance. Unfortunately, only two shipowners responded and thus no statistical verification could be made. Nevertheless, the input from the shipyards could be utilised even without this additional data and thus valuable knowledge was created.

Based on the research results, the theoretical frameworks created earlier in the research (that were based on study of the literature) were developed to form a tentative model of drivers for sustainability in innovations. This model forms the core of the theoretical result of the research work.

9.1.2 Research results

The research resulted in a new tentative model, Figure 41. This model illustrates the drivers that have the most important impact on the development of sustainability in innovations. This tentative model brings a new contribution to the science and theory. It provides an illustration of priorities seen in development towards sustainability in shipbuilding innovation processes.

This tentative model was also an essential tool for being able to find answers to the key research questions. The responses to these research questions are explained here below.

9.1.2.1 Most important factors and priorities

Research question 1 was**:** 'What have been the most important factors and priorities impacting business development towards sustainability in innovation?' This research question is answered by the tentative driver model (Figure 41), which shows the most important aspects impacting sustainability in innovations and the relations between them. The drivers could be identified in the form of a simple list (Table 21). Additionally, the research produced information about the importance

of these most significant drivers when compared to each other, and thus four of them could be defined to be highest in importance and thus some relational importance is included.

The resulting list of the most essential drivers can be used for assessing management elements in a business environment in order to understand the presence or non-presence of drivers that are guiding the business towards sustainability in innovations. It may be valuable for management, customers, business analysts or other stakeholders.

The conclusion is that the new information provided responded to the first research question. In addition, input was provided about the importance of the influencing elements (the drivers) compared to each other, and thus the research question was answered.

9.1.2.2 Performance assessment

Research question no 2 was: 'How can performance of sustainability in innovation be assessed?' In order to be able to answer this research question, it is important to know if the data can be accessed from inside a company or if the data needs to be found from external or public sources. The research covered data from both cases and thus responses were created for both.

The drivers from the final tentative model were used in order to create practical questionnaires to be used for assessing performance on sustainability in innovations. Based on the data from qualitative open question research from the shipyards, some drivers were divided into the elements of environmental and social aspects instead of focus on sustainability.

The questionnaire for assessing companies when only external access to data is available is presented in Figure 38. It consists of ten questions and is simple in format, and thus the expected granularity of results is not high. This questionnaire is thus proposed to be used only for comparison purposes of different companies against each other and not for forming an opinion of the absolute level of performance in sustainability in innovations.

For analysing companies when internal access to data is available, a more refined questionnaire was prepared, Figure 39. The questionnaire uses a 5-point Likert scale for measuring performance with 16 questions. Although offering a simple format for analysing the performance, this questionnaire provides a meaningful

way of scoring company performance and thus forming a judgement of the absolute level of performance in regard to sustainability in innovation.

In conclusion it can be stated that the new information created and the questionnaires that were constructed responded to the research question. Instead of presenting only one way to assess, actually two ways were created for assessing, depending on the availability and access to data. This approach provides a novel way to evaluate the performance of businesses and thus contributes to science and theory in the area of business research as well. Based on the outcome, the conclusion is that the research question was answered.

9.1.2.3 Management guidance

Research question no 3 is: 'How can management guide businesses to develop towards sustainability in innovation?' In order to be able to define guidance for the management, the drivers in the final model were analysed based on the possibility to impact these. Some drivers are external (policies, legislation, customers) and the management will have difficulties, or even find it impossible, to try to influence them. Therefore, the attention of the management needs to be guided towards those drivers that can be impacted.

The drivers were additionally categorised into those that can be impacted within a short time period and those which take a long time to be impacted. These categorisations led to a list of six drivers which can be impacted quickly and three drivers which need to be impacted with more patience since any reactions will take more time. Additionally, based on the research process and earlier findings, a list of activities was proposed (Table 23) for management wanting to develop their companies further towards sustainability in innovations.

In conclusion, it can be stated that research question number three has also been answered. A practical and concrete task list has been created with clear tasks, and a simple timeline for the longevity and impact horizon is included.

9.2 Comparison to earlier work

The main contribution of this work to theory in the area of sustainability is in the new tentative model (Figure 41) presenting the drivers that impact sustainability in innovation. The model was constructed using earlier work and refined through empirical research. The model describes the interrelations of the drivers within a company and illustrates the role of each.

Of additional importance is the recognition of profitability as an important driver. The empirical research showed that this driver has a strong role amongst all the drivers. Elkington (1997) earlier proposed financial aspects to be important when presenting the triple bottom line concept, but most driver models still omit it. Lozano (2015) included profits, growth and productivity to his model, but other models do not include this dimension.

The aspect of time presented in this research is also new. It is not visible in the driver model, but it is taken into account in the practical guidance for management. Adams et al. (2015) have also mentioned time as an important element in their work, but have used it as a step-change element, not as an integrated element guiding the priority of actions. Lozano (2008) has also focused on the time perspective in his research but not brought it forward to the level where it can be taken into account in practice. In this work, the aspect of time is included into practical activities especially when focusing on drivers that take a short or long time to become impacted.

Finally, the direct role and importance of top management as the prime motor is unique in this work. Many research papers mention the role of management but do not define the role and concretise the tasks as done in this research. Since the interviews were made with top managers of the companies, it was possible to concretize the activities and priorities in a way that was beneficial for the theory.

A comparison of this dissertation to research in other scientific papers is presented in Table 20. The work of this research is compared against the concepts of other relevant theoretical models using the following six different dimensions:

1. Coverage of the sustainability elements
2. Role of drivers in the models
3. Time aspect
4. Prioritisation of the drivers
5. Classification of company performance
6. Concept for driving sustainability in innovation

Table 20. Differences between this research and other theoretical models (author's analysis)

	Sustainability in innovation viewpoint	Drivers impacting sustainability in innovation	Time aspect in managing sustainability in innovation	Priorisation of drivers	Company performance assessment	Approach for managing towards sustainability in innovation
Sustainability in shipbuilding innovations & reflections on management	Environmental, social and financial view in an integrated concept	A model for internal and external drivers with interlinks formed	Drivers having short / long time to impact listed, action order proposed	A selection of 13 key drivers done and four with top priority shown	Two analysis methods for comparing and ranking presented	Top management has a strong drive, activity priority proposed
Dyerson and Preuss (2012)	Entrepreneurship combined with sustainability innovation	Drivers identified but some left purposely out	Management must keep several options open simultaneously		Importance of ethical challenges emphasized	
Verhulst et al (2012)	Environmental, social and financial view in harmony		Activity order proposed for human factors and business model creation	Customers should become part of the business models		Focus on sustainable business model and on human elements
Adams et al (2015)	Environmental, social and financial view in harmony	Five focus areas listed	Step changes in philosophy, values and behaviour over time		Three stages of strategic activity ambition presented	Radical and systemic change or operational optimisation
Lozano (2015)	Environmental, social and financial view in harmony	Corporate sustainability driver model presented		Driver importance ranking presented (for most drivers)		Use of holistic perspective through the driver model
Siqueira and Pitassi (2016)	Environment and social in potential conflict with financial	Mindfulness focused at as a driver		Training of mindfulness is important, also for managers		Mindfulness to be part of sustainability in innovation strategies

Most of the models include all the three elements of sustainability: environment, social focus and financial element, as described in the triple bottom-line concept (Elkington, 1997). In a holistic approach (Lozano, 2015) the intention is to consider all these three dimensions separately as well as their impacts and interrelations. The holistic perspective is adopted in most of the models. Optimising these three areas together has, however, in some research been noticed to cause conflicts of interest (Siqueira & Pitassi, 2016). In this work such conflict was not noticed in the long term perspective but in the short term view it was seen. Sometimes financial sacrifices need to be made in order to reach a new level in environmental and/or

social performance but these sacrifices lead to better financial performance in the longer run and thus balance the triple bottom-line.

In this research the concept of managing innovations towards sustainability has been handled in an integrated manner. No special focus has been given to the three dimensions separately unless there have been activities that need to be treated separately. A new tentative model has been created, which integrates activities and focuses all sustainability elements in a practical manner. Thus, this research delivers a new way of handling the complexity in a simple way.

The elements impacting development of innovations towards sustainability are described in this research with a collection of drivers. Much other research uses drivers as well since these easily describe the logic and can be used to indicate interrelations. Some papers, however, only list focus areas or do not describe ways to influence at all.

The aspect of time is covered in different ways in past research. Some researchers propose that management need to keep several options open as long as possible in case something changes in the business environment at a late moment. Some propose priority for human factors and for a business model (but no other areas), whilst others highlight the necessity of making step changes along with the development of capabilities for implementing sustainability in innovations. In this research the focus is given to aspects based on how quickly these can be influenced, and thus a new view on the dynamics has been created.

Although many researchers have indicated the importance of drivers, very few have given them priority. Only Lozano (2015) has found priority for some of the drivers in his model. In this research 13 drivers have been selected as the key drivers and four of them given the highest priority.

Assessing of the performance of a company when implementing sustainability in innovations is not addressed in previous research. Some areas of focus have been mentioned, but no holistic proposal made. This paper proposes ways to perform such assessment. In fact, two ways are proposed based on accessibility to the performance and priorities of a company.

Most earlier research proposes some way of developing businesses towards sustainability in innovation. Concepts in these models include proposals for developing personnel, business models, making systemic change, and multiple potential focus areas without priority. However, none of these propose practical ways of working that lead to sustainability in innovations.

The difficulty of creating practical proposals is supported by Van de Ven et al. (2008), who claim that entrepreneurs and managers cannot control innovation success, only its odds. They claim that this principle implies a need for fundamental change in the philosophy of conventional management practise. Epstein & Roy (2007) state that there is a need to integrate corporate sustainability into strategic management and corporate strategy. Engert et al. (2016) suggest that there is still a lack of empirical studies on the integration of corporate sustainability into strategic management.

The challenges mentioned in these earlier studies have been overcome in this research. The drivers that have been identified focus on creating a foundation for organisations that are managed and are also self-driving. The focus on people and competence and providing training and allowing the personnel to focus on sustainability supports in overcoming the problem. Direct guidance from top management and indirectly via strategies supports activities that minimise the predicted problems when managing innovation. Thus, the concept developed in this research creates new opportunities and removes the predicted problems.

9.3 Limitations and reliability of the results

The philosophy and structure of this research was selected to give the best research setup for answering the research questions. The data for the empirical research comes from the top management of the companies. Such top persons are busy and have little time available to support research and this creates a limitation both to the quantity of data and the time available for collecting the data. The data needed to be collected in one meeting only since it was not realistic to think that all the top managers would allow access to themselves more than once. Additionally, the number of top managers of big, international shipyards is not very many (since there are not many such shipyards). Thus, the number of responses to be expected was not large and quantitative research methods could not be used.

Based on these premises, the research was conducted using interpretivism as the philosophy and with the approach of induction and abduction. The research method was qualitative. The research design was both exploratory with open questions and explanatory with structured questions. The research strategy was hermeneutics together with data triangulation and elements of case study.

Although the research structure fitted well with the purpose, there are some limitations which limit the possibilities of refining the results. One of the limitations is the size of the data. Since only nine shipyards were visited and altogether 12 structured question responses received, the data is too limited for

statistical analysis and generalisation of the results. The challenge of understanding the interviewees rightly was overcome by concentrating on qualitative analysis and clear observations and conclusions could be made, although more data would give even more insights. The challenge is that there are not many shipyards in the world. In South Korea there are six main shipyards and five of them were interviewed for this research. In China there are many more shipyards but most of them are too small for making a study amongst companies that do international business on a high level. Thus, receiving statistically significant response volumes would be difficult in the shipbuilding industry. Thus the result consisted of qualitative data collection using open questions and structured questions. These data finally supported each other. A hermeneutical approach was used both in analysis and in interpreting the input data and clear conclusions could be drawn in many areas.

The sample size turned out to be a challenge also in the data needed from shipyard customers for analysing the performance of the shipyards. Many shipowners refused to score the shipyards according to the strength of the sustainability elements, since they either had no experience of all the requested yards or they did not want to disclose such information, despite assurance of the confidential handling of the data. Since only two sets of data were received, no statistical analysis could be considered.

The possibility to generalize the results to other countries and other businesses was already discussed in the previous chapter. It was concluded that there was no evidence that would preclude the results from being generalised to cover another country or other business. The data gathered indicated that the differences seen between the two countries that were studied are not caused by country specific differences but by company specific differences. There obviously is a difference in the development towards sustainability in the individual companies. Whilst the shipyards in South Korea have developed further towards sustainability for meeting the needs of demanding ship owners, the shipyards in China have focused more on increasing market share by having low prices through focusing on low costs and therefore are slightly behind in sustainability development. However, the volume of data is too low for making any statistically significant analysis of this observation. Further work would be needed to confirm the applicability of the results and it is proposed that be left to future research.

9.4 Suggestions for future research

There are several areas where research could continue regarding sustainability in innovations. One very straightforward continuation of this research could be testing of the proposed sustainability assessments in practise and with volume that supports quantitative research. Such research would include testing of the assessment for cases where only external data is available, but more interestingly carrying out assessments in cases where internal data is available. Such research could consist of validating the proposed test procedure.

Testing of the sustainability assessment created in this research could also be used to experiment with the approach for different industries. The purpose would thus be to see if a similar logic is applicable to industries other than shipbuilding, and if not, what kind of modifications would be needed in order to build a more generic model of the concept.

A specifically interesting area for further research would be around the driver 'Competitiveness'. Sustainability consists of three elements: environmental, social and financial. The triple bottom line approach measures all of these simultaneously. Assuming that the balance of these triple parameters is always well-optimised means that the performance of a company is measured in near static conditions. In reality, the performance of the companies is always dynamic, also in the development of innovations towards sustainability. In order to be able to create new businesses with high performance in environmental and/or social matters, often some financial investments need to be made. The monetary investment usually happens much earlier than the results in the area of environment or society. The difference may be months or in some cases even years. Thus, the balance in the triple bottom line will change over time: it will first be finance-heavy and possibly reduce the profit-making capability before results start to appear, which in turn eases the financial burden and increase the profitability.

The driver model created in this research needs to be tested and then an attempt made to be falsify it. After successful testing, it could be developed to cover such dynamic phenomena as explained above in order to obtain an understanding of the dynamics of the triple bottom-line. It would be interesting to see if a model could predict when it is better to make many small, incremental steps of development instead of one major development cycle.

9.5 Implications of the findings on practice

This research was successful in creating a new tentative academic model in the area of sustainability in innovations. The theory can be applied to practical work to support managers and leaders in their work. Naturally, empirical, quantitative testing would make the model even stronger and refine it further.

This new model consists of the most essential drivers impacting sustainability in innovations. It can be used in the academic world as a reference and platform for further work. It represents one of the very few models that are based on empirical research. However, future theoretical research can benefit from the grounding of the tentative model in practice and can continue further.

The model and assessment concept can be used for educational purposes at both lower and higher academic levels. It shows the importance of management and dependencies on other issues when attempting to link environmental and social aspects together with economic goals and thus helps in creating a balance in modern business understanding.

There are some practical implications of the results of the research as well. At the end of the research work some conclusions and recommendations for the use of the research were made. Concepts were created for assessing the presence of sustainability driving elements. A simple concept was created for assessing companies in cases where only external data is available. A more detailed concept was created for cases where there is access to internal data sources of the companies. The first concept can be used by company analysts for assessing the potential of companies for making sustainable innovations. The assessments can also be used by company management in order to measure own performance and to find areas for improvement. The assessments can also be used in order to create internal awareness and to help personnel to develop their mindset towards sustainability.

A practical task list for managers when striving for the development of sustainability in innovations was also developed. The list works as an aide memoire and focuses on elements of business that can be impacted by the management and gives guidance regarding the urgency of action and for the timing of expected results. It is a very practical guide with a very powerful impacting possibility and hopefully will be used in many companies in various different industries.

References

Aaltonen, T., Junkkari, L. (1999) *Yrityksen arvot ja etiikka*. WS Bookwell Oy, Juva ISBN 951-0-23891-0

Acosta-Alba, I., van der Werft, H. M. G. (2011). The use of reference values in indicator-based methods for the environmental assessment of agricultural systems. Sustainability 3, pp 424 - 442

Adams, R., Jeanrenaud, S., Bessant, J., Denyer, D. & Overy, P. (2015). *Sustainability-oriented innovation: A systematic review*. International Journal of Management Reviews, Vol.00, 1-26

Addeo, F. (2013). *Hermeneutic as a research method*. Teaching document. http://www.slideshare.net/FeliceAddeo/hermeneutic-as-aresearchmethoddraft

Anderson, T. (2013). *Research paradigms: Ontologies, epistomologies & methods*. PhD seminar slides in eLearn Center (Universitat Oberta de Catalunya), http://www.slideshare.net/eLearnCenter/research-methods-uoc-2013

Appelbaum, S. H., Calcagno, R., Magarelli, S. M., Saliba, M. (2016). *A relationship between corporate sustainability and organisational change (part three)*. Industrial and Commercial Training Vol. 48 Iss 3 pp 133-141 http://dx.doi.org/10.1108/ICT-07-2014-0047

Badal, S. B. (2015). *What drives entrepreneurial success?* Gallup Business Journal, 8/27/2015 p1-1-1

Baer, R. A. (2003). *Mindfulness training as a clinical intervention: A conceptual and empirical review*. Clinical Psychology Science and Practice. Vol 10, Issue 2, pp 125–143

Barbaro, N., Pickett, S (2016). Mindfully green: examining the effect of connectedness to nature on the relationship between mindfulness and engagement in pro-environmental behavior personality and individual differences. *Personality and Individual Differences*. Vol 93 April 2016, pp 137-142

Barber, N. A., Deale, C. (2014). *Tapping mindfulness to shape hotel guests' sustainable behaviour*. Cornell Hospitality Quarterly. Vol 55 no1 pp 100-114

Baumgartner, R. J., Ebner, D. (2010). Corporate sustainability strategies: Sustainability profiles and maturity levels. Sustainable Development 18 pp 76-89

Baumgartner, R. J., Rauter, R. (2017). Strategic perspectives of corporate sustainability management to develop a sustainable organisation. *Journal of Cleaner Production*. Vol 140, pp 81-92

Bernstein, R. J. (1982). *From Hermeneutics to Praxis*. The Review of Metaphysics, Vol 35, no 4, pp 823–845.

Bilton, C. (2007), Management and Creativity: From Creative Industries to Creative Management. Malden MA, Blackwell Publishing. ISBN 9781405119955

Blewitt, J. (2008) *Understanding sustainable development*. London: Earthscan pp 96 ISBN 978-1-84407-454-9

Bogoviz, A., Mezhov, S. (2015). *Models and tools for research of innovation processes*. Modern Applied Science, Vol 9, no 3, pp 159-172

Boons, F., Lüdeke-Freund, F. (2013). Business models for sustainable innovation: state-of-the-art and steps towards a research agenda. Journal of Cleaner Production. Volume 45, pp 9-19

Boons, F., Montalvo, C.,Quist, J., Wagner, M (2013). *Sustainable innovation, business models and economic performance: an overview*. Journal of Cleaner Production. Volume 45, pp. 1-8

Burrell, G., Morgan, G. (1979). Sociological Paradigms and Organizational Analysis: Elements of sociology of corporate life. London, Heinemann

Börn, A., Hauschild, M. Z. (2012). Absolute versus relative environmental sustainability: what can the cradle-to-cradle and eco-efficiency concepts learn from each other? Journal of Industrial Ecology, April 2013 17 (2), pp 321-332

Cho, J.Y., Lee, E-H. (2014). Reducing confusion about grounded theory and qualitative content analysis: Similarities and differences. The Qualitative Report 2014 Volume 19, Article 64, pp 1-20

Christen, M., Schmidt, S. (2012). A Formal Framework for Conceptions of Sustainability – a Theoretical Contribution to the Discourse in Sustainable Development. Sustainable Development, Volume 20, Issue 6, pp 400-410

Clarkson's Research (2016): Shipping Intelligence Network, data retrieved on August 12th 2016

Collis, J., Hussey, R. (2014). *Business Research – A Practical Guide for Undergraduate and Postgraduate Students*. 4th Ed. Palgrave, Macmillan publishers, London. ISBN: 978-0-230-30183-2

Connelly, S. (2007). *Mapping sustainable development as a contested concept*. The International Journal of Justice and Sustainability. 12 (3) pp 259-278

Davies, G. H.(2014). *A short history of the largest and fastest ships in the world*. http://www.movehub.com/blog/largest-ships-history

Denzin, N. K., Lincoln, Y. S. (2005). *The Sage Handbook of Qualitative Research* (3rd edition). London, Sage

DeSimone, L. D., Popoff, F (2000). Eco-efficiency. The Business Link to Sustainable Development. MIT Press, Cambridge

De Vaus, D. (2002). *Surveys in Social Science Research*. 5th edition, Allen & Unwin

Dietz, S., Neumayer, e. (2007). *Weak and strong sustainability in the SEEA: Concepts and measurement*. Ecological Economics. Volume 61, pp 617-626

Dilthey, W., Jameson, F., (1972). *The Rise of Hermeneutics*. New Literary History, Vol 3, no 2, pp 229–244.

Drucker, P. F., (2015). *Innovation and Entrepreneurship: Practice and Principles*. Routledge Classics 2015. ISBN 13: 978-1-315-74745-3 (ebk)

Eisenhardt, K. M., Graebner, M. E. (2007). *Theory building from cases: opportunities and challenges*. Academy of Management Journal. Volume 50, Issue 1, pp 25-32

Elenkov, D. S., Jufge, W., Wright, P. (2005). *Strategic leadership and executive innovation influence: An international multi-cluster comparative study*. Strategic Management Journal. Volume 26, pp. 665-682

Elkington, J. (1997). Cannibals with forks: The Triple Bottom Line of the 21st Century Business. Capstone, Oxford

Engert S., Rauter, R., Baumgartner, R. J. (2016). *Exploring the integration of corporate sustainability into strategic management: a literature review*. Journal of Cleaner Production 111, pp 2833-2850

Epstein, M. J., Roy, M.-J. (2007). Implementing a corporate environmental strategy: Establishing coordination and control within multinational companies. Business Strategy and the Environment 16 pp 389-403

Esposito, M., Groth, O. J., Tse, T. (2015). *The Future of the Global Corporation: From Fortress Firms to Cambrian Organisations*. Wiley online library DOI: 10.1002/tie.21696

Fayle, C. E. (2006). A short history of the world's shipping industry. Routledge, London and New York. ISBN 0-415-38163-0

Fornahl, D., Hassink, R., Klaerding, C., Mossig, I., Schröder, H. (2012). *From the old path of shipbuilding onto the new path of offshore wind energy? The case of northern Germany*. European Planning Studies Vol. 20, no. 5, pp. 835-855

Fonseca, L.M., Lima, V.M. (2015). *Countries three wise men: Sustainability, Innovation and competitiveness*. Journal of Industrial Engineering and Management vol. 8, no 4, pp. 1288

Forster, M. (2015). *Friedrich Daniel Ernst Schleiermacher*. The Stanford Encyclopedia of Philosophy (Summer 2015 Edition), Edward N. Zalta (ed.), URL = <https://plato.stanford.edu/archives/sum2015/entries/schleiermacher/>.

Freeman, R. E. (1984). *Strategic Management: A Stakeholder Approach*. Boston: Pittman. ISBM 0-273-01913-9.

Frynas, J.G., Yamahaki, C. (2013). *Corporate social responsibility: Review and roadmap of theoretical perspectives*. Paper presented at the BAM2013 Conference proceedings, Liverpool, England

Gilding, P. (2011). The great disruption: Why the climate crisis will bring on the end of shopping and the birth of the new world. Bloomsbery Publishing, New York

Glaser, B. G. (1997). *Theoretical Sensitivity*. Mill Valley, CA: Sociology press

Glaser, B. G., Strauss, A.L. (2012). *The Discovery of Grounded Theory: Strategies for Qualitative Research*. 7th edition. Aldine Transaction, London

Greve, H. R. (2003). A behavioural theory of R&D expenditures and innovations: Evidence from shipbuilding. Academy of Management Journal Vol. 46 no 6 pp 685-702

Guangzhou Shipyard International Company Limited (2014). *Annual Report 2014*. http://www.chinagsi.com/en/back_desk/news/images/EW0317AR.pdf

Hahn, T., Pinkse, J., Preuss, L., Figge, F. (2015). *Tensions in corporate sustainability: towards an integrative framework*. Journal of Business Ethics 127 (2), pp 297-316

Hansen, M- T., Birkinshaw, J. (2011). *The innovation value chain*. Inspiring & executing innovation, Harvard Business Review, https://hbr.org/2007/06/the-innovation-value-chain

Hart, S. L., Milstein, M. B. (2003). *Creating sustainable value*. Academy of Management Executive Vol 17 Iss 2 pp 56-69
Hotho, S., Champion, K. (2011),*Small businesses in the new creative industries: innovation as a people management challenge*, Management Decision, Volume 49 Issue 1, pp. 29 – 54

Hopwood, B., Mellor, M., & O'Brien, G. (2005). *Sustainable development: Mapping different approaches*. Sustainable Development, 13(1), pp 38–52. https://doi.org/10.1002/sd.244

Hsieh, H.-F., Shannon, S. E. (2005). *Three approaches to qualitative content analysis*. Qualitative Health Research 15(9), pp 1277-1288

Huge, J., Block, T., Waas, T., Wright, T., Dahdouh-Guebas, F. (2016) *How to walk the talk? Developing actions for sustainability in academic research*. Journal of Clean Production. Volume 137, pp 83-92

Hutchinson, A. J., Johnston, L. H., Breckon, J. D. (2010). *Using QSR-NVivo to facilitate the development of a grounded theory project: An account of a worked example*. International Journal of Social Research Methodology. Volume 13, issue 4, pp. 283-302

Huyndai Heavy Industries (2013). *Annual Report 2013*. http://www.hhiir.com/en/IRBoard/AnnualReport.asp

Hörisch, J., Freeman, R. E., Schaltegger, S. (2014). Applying stakeholder theory in sustainability management: Links, similarities, dissimilarities, and a conceptual framework. Organisation & Environment Vol 27 Iss 4 pp 328-346

Jupp, V. (2006). The SAGE dictionary of social research methods. London: SAGE publications

Kajikawa, Y., Tacoa, F., Yamaguchi, K. (2014). *Sustainability science: The changing landscape of sustainability research*. Sustainability Science 9, pp 431-438

Kalluri, V., Kodali, R. (2014). *Analysis of new product development research: 1998-2009*. Benchmarking: An International Journal, Vol. 21 Iss 4 pp 527-618

Kanter, R. M. (1997). When Giants Learn to Dance: Mastering the Challenges of Strategy, Management, and Careers in the 1990s**.** International Thomson Business Press 2nd ed

Kates, R. W., Parris, T. M., Leiserowitz, A. A. (2016). *Editorial – What is sustainable development? Goals, indicators, values and practice*. Environment. Science and Policy for Sustainable Development. http://www.environmentmagazine.org/Editorials/Kates-apr05-full.html

Kazmi, S. A. Z (2016). Fusing Strategic Thinking and Transformational Leadership to Harness New Product (NPD) Team Dynamics for Innovation. Acta Wasaensia 345, ISBN 978-952-476-662-3

Ketokivi, M., Mantere, S. (2010). *Two strategies for inductive reasoning in organizational research*. Academy of Management Review. Volume 35, no 2, pp. 315-333

Kivimaa, P., Kern, F. (2016). Creative destruction or mere niche support? Innovation policy mixes for sustainability transitions. Research Policy 45, pp 205-217. Elsevier

Koudal, P., Coleman, G.C. (2005) *Coordinating operations to enhance innovation in the global corporation*. Strategy & Leadership, Vol.33 Iss 4 20-32

Kytölä, J. (1998) *Design and performance of a large-bore medium speed engine*. 22nd CIMAC Intl. Congress on Combustion Engines, Copenhagen, May 1998, pp 31-45

Kytölä, J., Heim, K. (2007). *Latest developments in Wärtsilä 4-stroke engine portfolio*. 25th CIMAC World Congress on Combustion Engines, Vienna, Austria, 21-24 May 2007. Volume 1 of 2. ISBN: 978-1-61738-630-5 pp 62-74

Kytölä, J., Naaranoja, M (2016). *Sustainable innovation in practise: Case shipbuilding*. The Proceedings of The XXVII ISPIM Conference 2016, Porto, Portugal – 19-22 June 2016. ISBN 978-952-265-929-3

Lankoski, L. (2016). *Alternative conceptions of sustainability in a business context*. Journal of Cleaner Production 139 (2016) pp 847-857

Lee, S. H., Williams, C (2007). Dispersed entrepreneurship within multinational corporations: A community perspective. Journal of World Business 42 pp 505-519

Lejeune, A. (2012). Business model innovation with weak or strong sustainability in mind. ISPIM Conference Proceedings pp 1-6

Lindsay, W. S. (2013) History of merchant shipping and ancient commerce. Cambridge University Press, New York. ISBN 978-1-108-05765-3

Lozano, R. (2008). *Envisioning Sustainability three-dimensionally*. Journal of Cleaner Production, 16(2008), pp 1838–1846. https://doi.org/10.1016/j.jclepro.2008.02.008

Lozano, R. (2015). *A holistic perspective on corporate sustainability drivers*. Corporate Social Responsibility and Environmental Management Vol 22 (1), pp 32-44. http://dx.doi.org/10.1002/csr.1325

Magaro, A, Baggini, J. (2015). *Businesses on the mindfulness bandwagon*. Financial Times 2015 March 13

Malpas, Jeff (2016). Hans-Georg Gadamer, *The Stanford Encyclopedia of Philosophy* (Winter 2016 Edition), Edward N. Zalta (ed.), forthcoming URL = <https://plato.stanford.edu/archives/win2016/entries/gadamer/>

Matos, S., Silvestre, B. S. (2013). Managing stakeholder relations when developing sustainable business models: the case of the Brazilian energy sector. Journal of Clean Production. Volume 45, pp 61-73

McCartney, M. (2016). *Mindful mindfulness*. BMJ; 352 doi:http://dx.doi.org/10.1136/bmj.i839 (17 February 2016)

McGahan, A. M. (2004). *How Industries Evolve*. Harvard Business School Press

McKerchar, M. (2008). Philosophical paradigms, inquiry strategies and knowledge claims: Applying the principles of research design and conduct to taxation. University of New South Wales, Faculty of Law Research Series. No 31

Mebratu, D. (1998). *Sustainability and sustainable development: Historical and conceptual review*. Environmental Impact Assessment Review, Vol 18 (6), pp 493–520.

Miles, M. B., Huberman, A. M. (1994). *Qualitative Data Analysis*. Thousand Oaks, CA: SAGE

Montiel, I. (2008). Corporate social responsibility and corporate sustainability: separate pasts, common futures. Organisation & Environment 21 (3), pp 245-29

Montiel, I., Delgado-Ceballos, J. (2014). *Defining and measuring corporate sustainability: Are we there yet?* Organization & Environment. Advanced online publication. doi:10.1177/1086026614526413

Moran, P., Ghoshal, S. (1996). *Value creation by firms*. Academy of Management Proceedings Vol 1996 (1), pp 41-45

Morioka, S. N., Carvalho, M. M. (2016). Measuring sustainability in practice: exploring the inclusion of sustainability into corporate performance systems in Brazilian case studies. Journal of Clean Production. Volume 136, pp. 123-133

Mulgan, G., Leadbeater, C. (2013). *Systems innovation discussion paper*. London: Nesta.

Mumford, M.D., Scott, G.M., Gaddis, B. and Strange, J.M. (2002). *Leading creative people: Orchestrating expertise and relationships*. The Leadership Quarterly. Volume 13, Issue 6, pp. 705-750

Mumford, M.D. and Gustafson, S.B. (1998). *Creativity syndrome: integration, application and innovation*. Psychological Bulletin, Volume 103, pp. 27-43

Nidumolu, R., Prahalad, C.K., Rangaswami, M.R. (2009*). Why sustainability is now the key driver of innovation*. Harvard Business Review September 2009, pp 57-64

O'Regan, N., Ghobadian, A. and Sims, M. (2005). *Fast tracking innovation in manufacturing SMEs*. Technovation. Volume 20, Issue 2, pp. 251-261

Otley, D. T., Berry, A. J. (1994). *Case study research in management accounting and control*. Management Accounting Research, Volume 5, pp 45-65

Paraschiv, D. M., Nemoianu, E. L., Langa, C. A., Szabo, T. (2012). *Eco-innovation, responsible leadership and organisational change for corporate sustainability*. Amfiteatru Economic vol. 14, no 32, pp 404-419

Petruescu, A. L. L (2013). *Economic hermeneutics – theory- methodology*. Managerial Challenges of the Contemporary Society. Issue 5, pp 120-125

Pinchot, G. III. (1985). Intrapreneuring: Why you don't have to leave the corporation to become an entrepreneur. Harper & Row

Phillis, Y. A., Andriantiatsaholiniaina, L. A. (2001). *Sustainability: An ill-defined concept and its assessment using fuzzy logic*. Ecological Economics 37, pp 435 - 456

Planko, J., Cramer, J. M., Chappin, M. M. H., Hekkert, M. P. (2016). *Strategic collective system building to commercialize sustainability innovations*. Journal of Cleaner Production 112, pp 2328-2341
http://dx.doi.org/10.1016/j.jclepro.2015.09.108

Porter, M. E., Kramer, M. R. (2011). *Creating shared value*. Harward Business Review 89, pp 62-77

Porter, M. E., Van der Linde, C. (1995). *Green and competitive: ending the stalemate*. Harvard Business Review Vol 73, issue 5, pp 120-134

Poulsen, R. T., Sorrn-Friese, H. (2011) *Downfall delayed: Danish shipbuilding and industrial dislocation*. Business History Vol 53, No4, 557-582, July 2011

Pulkka, L., Junnila, S. (2015) Gravitational slingshot analogy of discontinuous sustainability innovation in the construction industry. Construction innovation vol 15 no 4 pp 409-427

Reason, P., Bradbury, H. (2001) *Handbook of Action Research: Participative Inquiry and Practice*. London, Sage 2001, ISBN 0-7619-6645-5

Rendtorff, J. D. (2015). *Case studies, ethics, philosophy, and liberal learning for the management profession*. Journal of Management Education. Volume 39, issue 1, pp 36-55

Rennings, K. (2000). Redefining innovation – eco-innovation research and the contribution from ecological economics. Ecological Economics. Vol 32, pp 319-332

Ricoeur, P. (1997). *The model of the text: Meaningful action considered as a text*. In Dallmayr, F.R. and McCarthy, T.A. (Eds.), Understanding and Social Inquiry. Notre Dame, University of Notre Dame Press, pp 316-334

Robson, C., McCartan, K. (2016). Real World Research: A Resource for Users of Social Research Methods in Applied Settings. Fourth edition, Wiley

Rogers, E. M. (2003). *Diffusion of innovations*. 5th edition. Free Press

Ruedy, E., Schweitzer, E. (2010). *In the moment: the effect of mindfulness on ethical decision making*. Journal of Business Ethics Vol 95, Issue 1, pp 73-78

Salzmann, O., Ionescu-Somers, A., Steger, U. (2005). *The business case for corporate sustainability: Literature review and research options*. European Management Journal. Vol 23, Issue 1, pp 27-36

Sandström, G., Tingström, J. (2008). Management of radical innovation and environmental challenges: Development of the DryQ capacitor at ABB. European Journal of Innovation Management. Vol 11, pp 182-198

Saunders, M., Lewis, P., Thornhill, A. (2012). *Research Methods for Business Students*. 6th Ed. Pearson Education Limited

Sauro, J. (2010). Should you use 5 or 7 point scales? Blog article, http://www.measuringu.com/blog/scale-points.php

Schaefer, K., Corner, P. D., Kearins, K. (2015). Social, environmental and sustainable entrepreneurship research: What is needed for sustainability-as-flourishing? Organisation & Environment Vol 28(4) pp 394-413

Schaltegger, S., Hansen, E. G., Ludeke-Freund, F. (2016a). *Business models for sustainability: Origins, present research, and future avenues*. Organisation & Environment 2016 Vol. 29(1) 3-10

Schaltegger, S., Ludeke-Freund, F., Hansen, E. G., (2016b). Business models for sustainability: A co-evolutionary analysis of sustainable entrepreneurship, innovation, and transformation. Organisation & Environment Vol 29(3) pp 264-289

Schaltegger, S., Wagner, M. (2011). *Sustainable entrepreneurship and sustainability innovation. Categories and interactions*. Business Strategy and the Environment, 20 pp. 222-237

Schneckenberg, D. (2015). *Open innovation and knowledge networking in a multinational corporation*. Journal of Business Strategy, Vol. 36 Iss: 1, pp 14-24

Schumpeter, J.A. (1934). *The Theory of Economic Development*. Harvard University Press: Cambridge, M.A.

Scollen, R., Scollen, S.W. (2012). *Intercultural Communication – A Discourse Approach*. 3rd edition, Oxford: Wiley-Blackwell

Sekaran, U. (1992). Research Methods for Business – A Skill Building Approach. 2nd edition, Wiley, New York

Shaphiro, S. I., Astin, L. E., Astin, J. A., Freedman, B. (2006). *Mechanisms of mindfulness*. Journal of Clinical Psychology Vol 62, Issue 3, March 2006, pp 373-386

Siqueira, R.P., Pitassi, C. (2016). *Sustainability oriented innovations: Can mindfulness make a difference?* Journal of Cleaner Production 139 (2016) pp 1181-1190

Solow, R. M. (1957). *Technical change and the aggregate production function*. Review of Economics and Statistics. Vol 39 pp 312-320

Song, H., Zhao, C., Zeng, J. (2017). Can environmental management improve financial performance: An empirical study of A-shares listed companies in China. Journal of Cleaner Production 141 (2017) pp 1051 - 1056

Sparrowe, R.T. (2005). *Authentic leadership and the narrative self*. The Leadership Quarterly. Issue 16, pp 419-439

Staub, S., Kaynak, R., Gok, T. (2015). *What affects sustainability and innovation – Hard or soft corporate identity?* Technological Forecasting & Social Change 102, pp.72-79 http://dx.doi.org/10.1016/j.techfore.2015.06.033

Stubbs, W., Cocklin, C. (2008). *Conceptualizing a 'Sustainability business model'*. Organization & Environment, Vol 21, no 2, pp. 103-127

Suddaby, R. (2006). *What grounded theory is not*. Academy of Management Journal. Volume 49, no 4, pp 663-643

STX France (2014). *Report 2014, sustainable development*. http://www.stxfrance.com//UK/stxfrance-publications-1-publications.awp

Svensson, G., Wagner, B. (2015) Implementing and managing economic, social and environmental efforts of business sustainability: propositions for measurement and structural models. Management of Environmental Quality: An International Journal. Vol. 26 Iss: 2, pp.195 - 213

Tidd, J & Bessant, J. (2009). Managing Innovation: Integrating technological, market and organizational change. 4th Ed. Chishester: Wiley

Van Heyningen, J.P, Brent, A. (2012). Assessing the emergence of sustainability-oriented innovation systems and the transition towards sustainability in Styria, Austria. ISPIM Conference Proceedings pp 1-15

Van Oorschot, K. E., Solli-Saether, H., Karlsen, J. T. (2014). Sharing knowledge or not? Innovation and imitation in shipbuilding projects in China. Publication details – name of journal etc

Van de Ven, A. H., Polley, D.E., Garud, R. Venkataraman, S. (2008). *The Innovation Journey*: Oxford University Press Inc.

Verganti, R. (2016). *The innovative power of criticism*. Harvard Business Review January-February 2016

Von Hippel,E. (2006). *Democratizing Innovation*: The MIT Press

Waite, M., Hawker, S. (2009). *Oxford Paperback Dictionary and Thesaurus*. Oxford: Oxford University Press

Walker DHT (1997). *Choosing an appropriate research methodology*. Construction Management and Economics. Vol 15, Issue 2, pp 149-159

WCED. (1987). *Our Common Future* (First). Oxford: Oxford University Press.

Williams, C., Lee, S. H., (2011). Entrepreneurial contexts and knowledge coordination within the multinational corporation. Journal of World Business Vol 46 pp. 253-264

Vitezic, N., Vitezic, V. (2015) *A conceptual model of linkage between innovation management and controlling in the sustainable environment.* The Journal of Applied Business Research Vol 31, No1, 175-184, January/February 2015

Wong, S. K. S. (2013). *The role of management involvement in innovation.* Management Decision, Volume 51 Iss 4 pp. 709 – 729

Yin, R. K. (2014). *Case Study Research - Design and Methods*. 5th edition, Sage Publications

Åkesson, P. (1999). *History of shipbuilding*. www.abc.se/bld/tradbld

Appendices

Appendix 1 Reasoning behind the qualitative open questions

Question 1. *Have you done new ship/vessel development in recent years?* This is an opening question (Collis & Hussey, 2014) in order to make the interviewee feel comfortable and to encourage the interviewee to talk about the main topics of interest comfortably.

Question 2. *Are you planning to focus on new areas in shipbuilding or business in general?* The selection of shipbuilding as the focus industry was based on the observation that the industry has gone through continuous development and invested continuously in the skills and capabilities which are needed in order to maintain competitiveness and to respond to customer needs. This question was selected in order to obtain verification and confirmation that the selected companies are on that path.

Question 3. *Cruise/ferry as new markets?* This question is linked to question 2. The most demanding ship types for the marine market in regard to sustainability focus are passenger ships. That is because of the regulatory point of view and also because the passengers and general public observe the sustainability aspects closely. The purpose with this question was to give a broader background for the interview in order to potentially develop further questions about sustainability aspects.

Question 4. *What are the drivers when creating new solutions/innovations?* This is a direct open-ended question in order to hear the interviewees' own words about their drivers before going deeper into the questions. The purpose is to hear whether there are some other drivers of importance before starting the questions about the drivers based on the theoretical frameworks.

Question 5. *Is it important for you to include environmental and social aspects in your new innovations?* This is the first question that has its background in the theoretical frameworks. The purpose is to hear the interviewees' own comments about the weight of the sustainability elements. It is also important to hear how the interviewee differentiates new innovations from ongoing or historical projects. A typical follow-up question for this would be 'why' or 'how does it show?'.

Question 6. *Is the environment important in new innovations in your company?* The purpose is to hear the weight that the interviewee puts on the environment only and not as a combination with the social aspect as in question 5. The intention is to hear how the environment relates to the total triple bottom-line aspects in the company.

Question 7. *Is there an increase or decrease in the importance of the environment in recent times?* This is a comparison question (Collis & Hussey, 2014) in order to explore needs and values. The markets in general have become economically more demanding due to increased competition and diminishing ship orders globally, and the purpose with this question is to find out if the tougher market conditions cause an imbalance for the triple bottom line, i.e. if the environment is compromised due to the economy.

Question 8. *How do you take the environment into account in your new innovations?* The purpose is to find out if the policies and legislation drivers (as the theoretical framework proposes) are real drivers or if there are other factors that impact the sustainability development.

Question 9. *Are the customers ready to pay extra for good environmental performance?* One of the probable scenarios is that only the minimum is done for the environment, i.e. fulfilling legislation, but not extending further due to cost reasons. The purpose with this question is to find out the importance to customers as a driver for further sustainability, according to the theoretical framework. If the customers are ready to pay extra for improved performance, then they act as real drivers. A typical follow-up question to this is 'are certain kinds of customers more willing to do this?'

Question 10. *How do you measure your success in environmental performance?* The purpose with the question is to find out if key performance indicators are used to monitor the performance. The identification of such indicators would confirm the importance of the aspect and the following discussion would be about the indicators and the actual content of these since that would reveal some real drivers for the activities.

Question 11. *Is good social performance, meaning good citizenship, important for your company?* This is the first question about the social aspects. The earlier ones were specific to the environment and this order of planning the questions is based on the assumption that it is easier to discuss the environment than people and therefore the questions about the environment act as warm-up for the more 'demanding' questions. The purpose with this question is to introduce the people

aspect to the discussion and a natural follow-up question to this is 'how does it show?'

Question 12. *Are the social aspects taken into account in new innovations?* This question aims to study the importance of this aspect in the total triple bottom-line approach of the company and is related to a similar question raised about the environment earlier in the interview.

Question 13. *Do your customers value social aspects?* The intention with this question is to find out the importance of customers as drivers for the social aspects, according to the theoretical framework. A typical follow-up question is 'how does it show?'

Question 14. *Are they ready to pay extra for it?* This question is linked to question 13 and is in turn like question 9 regarding the environment, measuring if the aspect is of high importance for the customers as a driver and thus if exceeding the minimum effort is enough or if the value is so high that even better performance is necessary.

Question 15. *How do you measure your success in social performance?* The purpose is, as with question 10, to find out if key performance indicators are used to monitor the performance. Identification of such indicators would confirm the importance of the aspect, and the following discussion would be about the indicators and the actual content of these since that would reveal some real drivers for the activities.

Question 16. *Is it difficult to balance between the financial/social/environmental aspects?* This question is a comparison question in order to find out the relative importance of the aspects and also to get an indication of the actual challenges with the triple bottom-line aspects of sustainability and to hear if some drivers are stronger than others.

Question 17. *Have you been able to create processes to make it easier?* This question is related to question 16 and is based on the simplified theoretical framework where tools and processes are part of the suggested drivers. The purpose is to identify if the company has seen it as important to develop processes and if those exist, from what kind of point-of-view.

Question 18. *Do you have design/system/other tools to help being sustainable?* The purpose is to identify the presence of tools that would work as drivers for sustainability as the detailed theoretical framework is proposing. If tools, systems or methods do exist, the following questions would focus on 'what kind?'.

Question 19. *Do your personnel care about sustainability?* This question follows the aspect of 'people' in the theoretical framework and tries to identify the motivational aspects of the personnel. The company's own personnel are important stakeholders and the typical follow-up question would be 'how does it show?'

Question 20. *Are you training them to be better in these aspects?* This is a question linked to question 19 and measures the aspects of management as a driver, since training is a decision of the company. A typical follow-up question would be 'what kind of training do you give?'

Question 21. *How many ships did you deliver last year?* This question is planned to end the session with some questions of a more general kind. The purpose is to move from a narrow focus and open a wider view. This is seen to be necessary, since after these qualitative questions, the interviewee would be handed the quantitative questionnaire, where again some more generic questions come up and the plan is to approach these from a holistic perspective, not with a detailed bias. The second meaning with this question is to hear the activity level of the shipyard in order to understand the actual level of innovations, since only a few of the ships in reality are copies of each other, and most are new designs requiring new innovations and design work.

Question 22. *How many employees approximately do you have?* This is the second wind-down question like question 21 and only intended to relax the interviewee and create an open focus before the qualitative questionnaire.

Appendix 2 Background info given at the shipyards

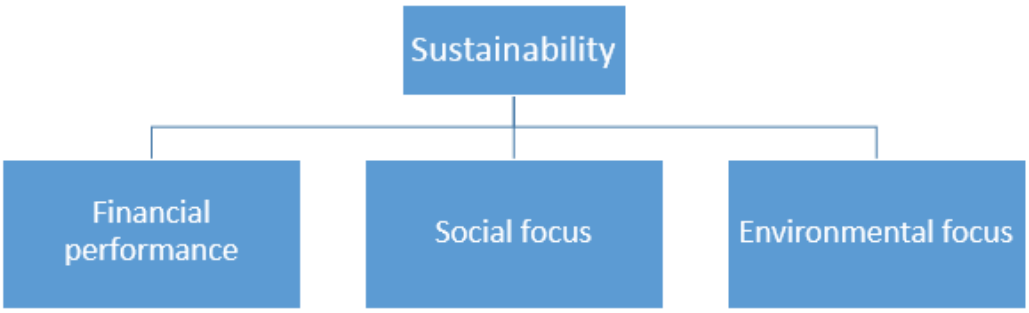
Questionnaire: importance of the three elements of sustainability in new innovations

Name _____

Date _____

Company _____

Sustainability consists of three areas:



- Focus on financial result
- Focus on financial competitiveness

- Care of employees & people
- High ethics and morale
- Good member of society

- Avoiding pollution (to water, land and air)*
- Use of raw materials*
- Recycling of materials*

*(these viewpoint cover both own operations and products)

Appendix 3 Interview questions at the shipyards

Interview questions (not shown to interviewees, verbally presented only):

The recent development in business is very challenging for all of us. It is difficult when the ship orders are so few in the whole world. I would like to raise some questions in order to get a better understanding of the challenges and future development and to find ways for how to improve together.

It is said that companies need to focus nowadays not only on financial performance but also on social aspects and on environmental performance. I would like to understand the status in reality and therefore would like to learn from you.

Explanation of sustainability using the .ppt picture on first page of this paper.

1. Have you done new ship/vessel development in recent years?
2. Are you planning to focus on new areas in shipbuilding or business in general?
3. Cruise/ferry as new markets?
4. What are the drivers when creating new solutions/innovations?
5. Is it important for you to include Environmental and social aspects to your new innovations?
6. Is environment important in new innovations in your company?
7. Is there an increase or decrease in the importance of environment in the recent times?
8. How do you take environment into account in your new innovations?
9. Are the customers ready to pay extra for good environmental performance?
10. How do you measure your success in environmental performance?
11. Is good Social performance, =good citizenship important for your company?
12. Are the social aspects taken into account in new innovations?
13. Do your customers values social aspects?

14. Are they ready to pay extra for it?
15. How do you measure your success in social performance?
16. Is it difficult to balance between financial/social/environmental aspects?
17. Have you been able to create processes to make it easier?
18. Do you have design/system/other tools to help being sustainable?
19. Does your personnel care about sustainability?
20. Are you training them to be better in these aspects?
21. How many ships have you delivered last year?
22. How many employees approximately do you have?

Appendix 4 Questionnaire for the shipyard managers

Sustainability in Your company.

Please indicate the importance by choosing a number. 1 = not important, 7= high importance

	Low						High
Q1 The customers focus on environment	1	2	3	4	5	6	7
Q2 Our top management focus on social aspects	1	2	3	4	5	6	7
Q3 Laws and legislation guide our sustainability	1	2	3	4	5	6	7
Q4 People are valued in our company	1	2	3	4	5	6	7
Q5 Our strategy is focusing on social aspects	1	2	3	4	5	6	7
Q6 External policies guide our sustainability	1	2	3	4	5	6	7
Q7 Our tools support sustainability	1	2	3	4	5	6	7
Q8 Our company strategy is focusing on environment	1	2	3	4	5	6	7
Q9 Our people have skills & competence about sustainability	1	2	3	4	5	6	7
Q10 Our company culture is supporting sustainability	1	2	3	4	5	6	7
Q11 Ethics and morale are important in our company	1	2	3	4	5	6	7
Q12 Our company culture is supporting sustainability	1	2	3	4	5	6	7
Q13 Personal behaviour towards sustainability is supported	1	2	3	4	5	6	7
Q14 Our company philosophy supports sustainability	1	2	3	4	5	6	7
Q15 Our processes support sustainability	1	2	3	4	5	6	7
Q16 Values of our company support sustainability	1	2	3	4	5	6	7
Q17 Our people are motivated to focus on sustainability	1	2	3	4	5	6	7
Q18 We support internal entrepreneurship	1	2	3	4	5	6	7
Q19 External stakeholders impact our sustainability focus	1	2	3	4	5	6	7
Q20 Our top management focus on environment	1	2	3	4	5	6	7
Q21 Is it difficult to combine environment and social to business?	1	2	3	4	5	6	7

Thank you for your valuable responses!

Appendix 5 Background info for the shipowners

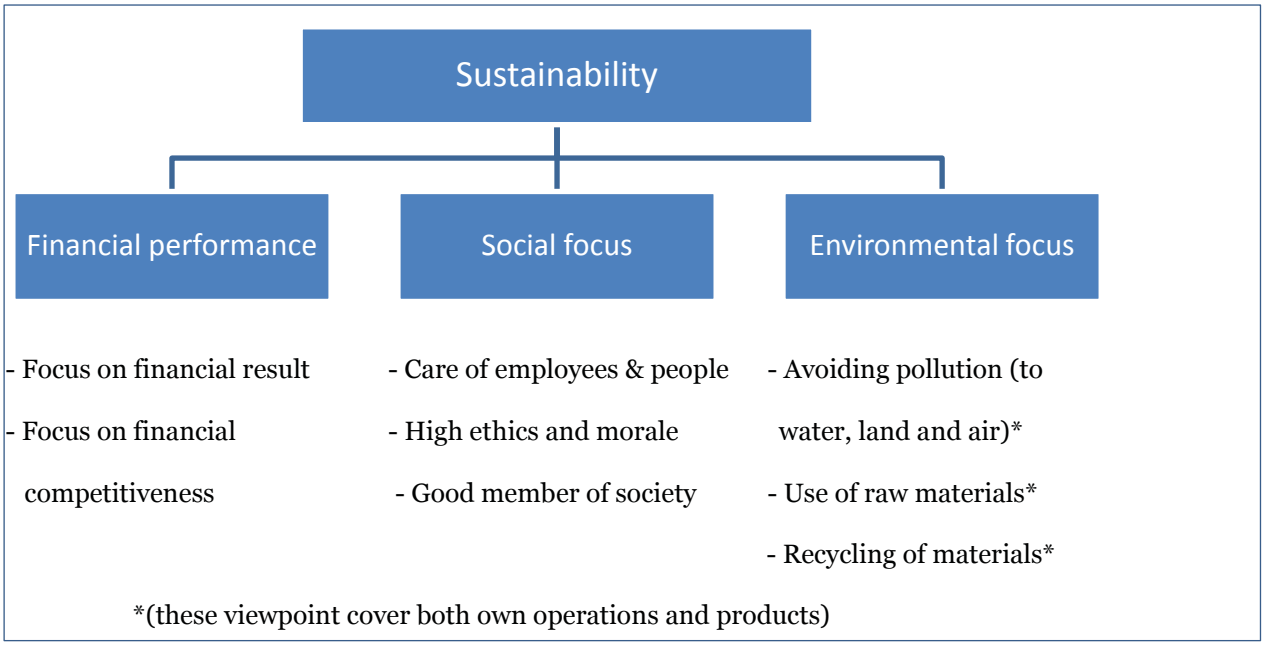
Questionnaire: verification of sustainability of Asian shipyards

Wärtsilä is participating to a University of Vaasa (Finland) research regarding sustainability in Asian shipbuilding. We would like to receive Your input in order to progress with our study.

The research results are handled discretely so that no company names nor any participating person's names will be published.

Certain Chinese and South-Korean shipyards have been selected to this study and the need is to get your personal opinion of those shipyards that you have experience of. The questions are about sustainability performance.

Background: Sustainability consists of three elements, financial, social and environmental:



All the shipyards in this research have shared their management practices and given scoring for themselves about their own sustainability. With this questionnaire the purpose is to get data from their potential customer perspective which will be compared against their own input. The final target with this research is to find out best practices and most important management elements when leading businesses towards sustainability in practise.

The questions about Sustainability in the shipyards are on the second page of this document

Appendix 6 Questionnaire for the shipowners

Sustainability scoring for 9 different Asian shipyards

Please indicate your views on three aspects for those shipyards that you have experience/opinion about. Give scoring by selecting how weak or strong the yard is, using the range: 1 = weak, 7= strong.

		Weak 1	2	3	4	5	6	Strong 7
Shipyard 1,	Focus on social aspects	☐	☐	☐	☐	☐	☐	☐
South-Korea	Focus on environment	☐	☐	☐	☐	☐	☐	☐
	Overall competitiveness	☐	☐	☐	☐	☐	☐	☐
Shipyard 2,	Focus on social aspects	☐	☐	☐	☐	☐	☐	☐
South Korea	Focus on environment	☐	☐	☐	☐	☐	☐	☐
	Overall competitiveness	☐	☐	☐	☐	☐	☐	☐
Shipyard 3,	Focus on social aspects	☐	☐	☐	☐	☐	☐	☐
South Korea	Focus on environment	☐	☐	☐	☐	☐	☐	☐
	Overall competitiveness	☐	☐	☐	☐	☐	☐	☐
Shipyard 4,	Focus on social aspects	☐	☐	☐	☐	☐	☐	☐
South Korea	Focus on environment	☐	☐	☐	☐	☐	☐	☐
	Overall competitiveness	☐	☐	☐	☐	☐	☐	☐
Shipyard 5,	Focus on social aspects	☐	☐	☐	☐	☐	☐	☐
South Korea	Focus on environment	☐	☐	☐	☐	☐	☐	☐
	Overall competitiveness	☐	☐	☐	☐	☐	☐	☐
Shipyard 6,	Focus on social aspects	☐	☐	☐	☐	☐	☐	☐
Shanghai, China	Focus on environment	☐	☐	☐	☐	☐	☐	☐
	Overall competitiveness	☐	☐	☐	☐	☐	☐	☐
Shipyard 7,	Focus on social aspects	☐	☐	☐	☐	☐	☐	☐
Shanghai, China	Focus on environment	☐	☐	☐	☐	☐	☐	☐
	Overall competitiveness	☐	☐	☐	☐	☐	☐	☐
Shipyard 8,	Focus on social aspects	☐	☐	☐	☐	☐	☐	☐
Shanghai, China	Focus on environment	☐	☐	☐	☐	☐	☐	☐
	Overall competitiveness	☐	☐	☐	☐	☐	☐	☐
Shipyard 9,	Focus on social aspects	☐	☐	☐	☐	☐	☐	☐
Guangzhou, China	Focus on environment	☐	☐	☐	☐	☐	☐	☐
	Overall competitiveness	☐	☐	☐	☐	☐	☐	☐
		1	2	3	4	5	6	7

Please return to: juha.kytola@wartsila.com. Thank you for your valuable response!

Appendix 7 Analysis of shipyard responses to open question based qualitative research

Question 1. Have you done new ship/vessel development in recent years? Every shipyard had made new designs and new innovations lately. The drivers had been cost (including personnel reductions), the environment (involving legislation and striving to use gas as fuel) and new strategic direction (to lower emissions, look for new organisational models, to use gas and enter into shipping in arctic conditions). The responses show that shipyards are continuously developing their businesses in new areas and thus provide a very good platform for this research. They need to innovate and develop in order to stay competitive and win more orders. The responses also show that drivers for innovation come both from external and internal directions.

The shipyards approached the question from a rather similar viewpoint. They listed the market segments (ship types) that they had in focus and they focused on measures that improved their competitive position. A lot of the competitiveness was believed to come from new designs for better environmental status. Obviously, the brief introduction to the topic of sustainability before starting the discussion helped them to create a focus including both commercial and environmental elements.

Question 2. Are you planning to focus on new areas in shipbuilding or business in general? Due to the challenging market conditions, every shipyard is looking for a new direction and focusing their innovations in areas where they plan to be more competitive. The responses confirm that there is a continuous need to innovate. The need comes to a large extent from external reasons and strategic choices that follow from the external pressure.

Question 3. Cruise/ferry as new markets? Five of the interviewed nine shipyards told that they are making studies on passenger ships. This truly confirms their attempt to innovate since passenger ships are known to be most demanding to build and none of the shipyards had previous strengths in this area. The yards see the challenge to be in the building process since their traditional strength is in steel work, but that has a relatively low focus on passenger ships compared to traditional merchant ships and thus new skills and competences need to be acquired. A challenge is thus seen in the financial profitability as well. Despite hesitations, more than half of the yards were ready to move this way. Environmental or social drivers were not mentioned amongst the challenges when going into this new area, but financial issues, cost, need for new competences and logistical approaches were.

Question 4. What are the drivers when creating new solutions/innovations? Altogether a lot of drivers were mentioned. The most common was costs, which were mentioned by six shipyards. The operating economy of the ships was raised by four yards, environmental drivers by three, and customer needs also by three. The other drivers were customers' own innovations, quality, arctic conditions, safety, gas and strategic choices. As a summary of this open-ended question, more external drivers were mentioned than internal ones. Additionally, adaptation to the changing business environment was common to all the responses.

Question 5. Is it important for you to include environmental and social aspects into your new innovations? The environment was mentioned by most of the shipyards, but without especially asking they mentioned cost as an important driver as well. Thus, financial reasons seemingly have an important role amongst the drivers. Legislation development was seen as a strong contributor to the environmental focus. Interestingly, many commented that despite the challenging market conditions and restructuring in the companies, research and development resourcing is seen as valuable and reductions in that area are small or are not planned at all. The question also included a comparison of the importance of the environment with that of social aspects. It became clear that the environment gets a lot of attention, whilst social aspects matter less. All nine shipyards had examples of focus on the environment, but only two mentioned social aspects as a driver. One said that good ethics is important for their customers and they want to show it, and another said that whilst social aspects are important, the environment is more so.

Question 6. Is the environment important in new innovations in your company? Every shipyard responded that the environment is either important or very important as a driver for their innovations. Four shipyards combined the environment together with fuel consumption and cost as a common driver, whilst five treated the environment as a single important driver. Many foregrounded legislation as important driver for environmental focus and explained how long they had been developing their skills and competences in order to be able to respond to the upcoming requirements. One yard listed the new environmental technologies that they have installed as the first shipyard in the world, whilst another explained the measures they had been taking to reduce CO_2 emissions in their ships.

Question 7. Is there an increase or decrease in the importance of the environment in recent times? Seven out of the nine shipyards said that there had been no reduction in the importance of the environment despite the heavy focus on cost. Two shipyards, however, said that cost is now more focused on at the expense of

the environment. These two both then referred to the use of gas as a fuel in ships and emphasized that on such ships the cost needs to go down, whilst they both admitted that the use of gas is a consequence of the environmental focus in the world economy and also shipbuilding and thus is part of the drive for a better environment.

Question 8. How do you take the environment into account in your new innovations? Five out of eight responses (one did not respond to this) raised legislation as the starting point, which confirms the role of legislation as a driver of innovations. The focus on fuel consumption, nitrogen oxide (NOx) emissions, ballast water cleaning and selection of raw materials were mentioned as key drivers for innovations.

Question 9. Are the customers ready to pay extra for good environmental performance? Interestingly, the respondents here made a differentiation between customers coming from different parts of the world. Five of the nine shipyards responded that European customers are ready to pay extra for getting better environmental performance than the minimum and two shipyards specified North-European customers especially. Asian shipowners satisfy the needs to the minimum set by legislation. In the offshore business (oil exploration, drilling and production) the customers ask for better environmental performance than the minimum, but now when oil prices have declined a lot, the companies are no longer asking for more than the minimum set by legislation. Thus, some of the customers act as real drivers for the environmental focus in innovations.

Question 10. How do you measure your success in environmental performance? All the shipyards stated that their most important measurement is comparison of the performance of their new vessels with previous ones. The energy efficiency design index (EEDI) which has been a mandatory measure for all ships globally during the last four years was mentioned by five of the nine shipyards as an important parameter to show their innovation performance. Further advances in this parameter are also being used as a selling argument when selling ships to owners. This confirms that there are environmental parameters that can develop to be drivers that guide innovation for improving competitiveness.

Question 11. Is good social performance, = good citizenship important for your company? All eight of the nine shipyards that responded said that social aspects are very important for them. One did not want to comment on this at all. As examples were mentioned company owned hospitals, gymnastics exercises for personnel twice a day, training personnel in ethics and morale, including monthly reporting of these, and company reports on social responsibility. Safety was mentioned as a serious focus area that is also followed up by the customers. Co-

operation with universities was mentioned and also other collaboration with society.

Question 12. Are social aspects taken into account in new innovations? This was a more challenging question for the respondents, and only in four shipyards was an answer received. Two shipyards mentioned especially that new innovations are made in such a way that they give work to local workers and the local community. This driver is not there because they would like economically to focus on local workers, but social pressure is forcing them to keep a good balance between financial and social aspects. Therefore, some evidence was received that social aspects are important according to the triple bottom line principle.

Question 13. Do your customers value social aspects? Only five of the nine shipyards wanted to answer to this question. All these five confirmed that their customers care about social aspects as well. One shipyard also regularly reports on their ethical performance to customers. One shipyard mentioned that the big top-class customers put focus on social aspects, whilst the smaller customers do not. One respondent said that their customers ask to see the safety and environmental policies of the shipyard and therefore they have created their own internal health and safety training centre.

Question 14. Are they ready to pay extra for it? Six responses were received for this question. Those who responded were very clear that they are not able to obtain any extra financial compensation from their customers for the improvements in social performance and achievements that they strive for. The matter was recognised to be important for the customers as well, but not so much that customers would be the main drivers for improvements in the social element.

Question 15. How do you measure your success in social performance? This was obviously the most difficult question for the respondents since only two responses were received. Obviously, there are no clear measurements in place and the definition of "social" is also seen as a little difficult. The two who responded commented that measurement happens via the management system and that the target is on a par with the local country level but did not specify the measurement indicators or parameters.

Question 16. Is it difficult to balance between financial/social/environmental aspects? Here, all nine shipyards gave their responses. Four of them were of the opinion that finding a balance is difficult. The reasons regarded the customer push for optimisation causing imbalance and about the difficulty to add the social dimension since the financial and environment aspects are easier to balance. Four shipyards responded that it is not difficult. One practical example showing the

balance on the triple bottom line was that the welders at the yard are trained to minimise the use of welding gas. That gives cost benefits, is good for the environment and the training gives the welders a good understanding of these impacts so that they feel good about their own achievements. One shipyard highlighted the importance of their owners and management in deciding the balance between the three triple bottom line aspects and even mentioned the role of government via rules and regulation. In conclusion it can be said that all shipyards recognise the three elements of sustainability and need to actively make decisions in order to find the best balance that is possible for their own situation.

Question 17. Have you been able to create processes to make it easier? Seven out of nine shipyards gave a response to this question. They all responded that they have been able to create processes that support sustainability development. The focus has been on manuals and processes including environmental aspects but less on the social dimension. Training was mentioned as an important element in practise. The responses given were, however, not well argued and the indication of content remained weak; thus, the credibility of the actual existence of processes supporting the drive towards sustainability was left weak.

Question 18. Do you have design/system/other tools to help being sustainable? This question was finally rather similar to question no 18, but only six responses were received. No clear evidence was received that showed the existence of tools or systems or designs that guide towards sustainability. Obviously, internal processes and guidance exist to some extent, but the sustainability is partly in-built into those in a way that does not receive focus in itself. This obviously indicates a weakness: these kinds of drivers for innovation are not strongly used in practice in the move towards sustainability

Question 19. Do your personnel care about sustainability? Eight responses were received and in seven of those the response was that their people do care about sustainability. Only one response was that their ‘people do not especially care’. Some said that the workers care more about society than the environment, whilst some said that their people understand that without a focus on the environment they would not have a business soon anymore. In general, the responses indicated that the people themselves do care a lot about the environment, even more than they are able to focus on in their work since the other boundaries cause a compromise at work. With matters regarding ethics and morale, the people follow the company policies. The responses show that the people do care and are willing to take on training and adapt their skills at work within the boundaries set by the management.

Question 20. Are you training them to be better in these aspects? Eight responses were received and seven of them told that training is given in sustainability related matters. Training is given by their own internal departments, by classification societies and by component and system suppliers. Both social aspects and environmental matters (starting from waste separation in offices) are included. Only one responding shipyard stated that there is no focus on sustainability in their training plans (that was a different shipyard than the one that responded in question 19 to the effect that their employees do not especially care about sustainability). In general, training was seen as important and a focus area for improving overall performance.

Question 21. How many ships have you delivered last year? This question was used as a ramp-down question from the more challenging discussions back to the operational activities of the shipyards. Every company had their own capacity and focus areas and thus the range of annual production varied a lot. The most specifically focused shipyards produced around two drilling rigs, together with ten ships per year, and the most active volume-producer delivered more than 70 ships per year.

Question 22. How many employees approximately do you have? This is the second wind-down question like question 21. The responses varied a lot, starting from 800 own persons and additionally some outsourced work done by external personnel, up to the biggest shipyards with about 30,000 employees. Altogether the nine interviewed shipyards employed more than 130,000 persons at the time of interview, own and outsourced personnel included.