ERASMUS UNIVERSITY ROTTERDAM

The Dutch innovation policy for the shipbuilding industry: a burden or a beacon?

An evaluation of the Dutch innovation policy for the shipbuilding industry

Master Thesis

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Abstract: The global financial crisis of 2008 severely hit the shipbuilding industry, which resulted in big excess capacity problems. Distinguishing through innovation seemed more than ever the way forward in the pressure that this overcapacity creates on Western shipbuilding nations. Governments try to support these innovation activities through the execution of a well designed innovation policy. Based on a comparison with the innovation policy of Germany and Norway, and based on interviews with experts in the Dutch shipbuilding industry, an attempt will be done to improve the Dutch innovation policy for the shipbuilding industry.

Preface

In the last seven months I devotedly plunged into the world of the shipbuilding industry. The time at Netherlands Maritime Technology (NMT) has been a very interesting and instructive period for me. With this thesis I do hope to directly or indirectly contribute to the development of the Dutch innovation policy for the shipbuilding industry.

I want to thank Ralph Dazert for his guidance during the writing process, and for all the information I received. I also want to thank the other colleagues at NMT that contributed to my thesis, by providing me with information, by introducing me to experts in the industry and several other ways. This made it quite a lot easier to get to know the shipbuilding industry, and to write the thesis.

It would not have been possible for me to write a proper thesis without the guidance of my supervisor Bart Kuipers. Thank you very much for the feedback during the writing of this thesis. The final word of thanks is for the second reader, Martijn van der Horst.

Executive Summary

The global financial crisis of 2008 severely hit the shipbuilding industry. The low levels of new order and the resulting overcapacity put the economic viability of the industry in some parts of the world in jeopardy. The result was a further emphasis on knowledge and innovativeness as competitive edge in western shipbuilding nations. In order to realise the best conditions for the Dutch shipbuilding industry to innovate in, Netherlands Maritime Technology (NMT), the industry organisation of the Dutch shipbuilding industry, would like the following research question to be answered: *How can the Dutch innovation policy for the shipbuilding industry be improved?*

In order to give an answer to the research question, two qualitative analyses will be done, namely case studies and interviews. The two subsequent sub-questions that will be answered by the two analyses are: *How is the Dutch innovation policy for the shipbuilding industry performing compared to those of Germany and Norway?* And: *How is the Dutch innovation policy for the shipbuilding industry performing according to experts from the Dutch shipbuilding industry?*

Because of the focus on companies innovation policy is defined as: *the set of government measures that attempt to stimulate innovation activities at companies*. Several reasons exist for a government to support innovation. Market failure is one reason. Another reason is to achieve long-term economic prosperity. The instruments of the innovation policies of The Netherlands, Germany and Norway have been analysed along a cyclical innovation model. Further, 6 interviews have been conducted with experts which represent the entire scope of firms in the industry.

Together, the analyses led to the following conclusions. The Dutch innovation policy can be improved by increasing generic financial instruments, by improving the legislative hurdle tackling through green deal, by providing a more structural innovation policy, by using a holistic view in innovation instruments on innovation, marketing and export, by actively contributing to particular innovation processes, by solving problem related with the open structure of innovation projects, by solving problems related to the loss of momentum, and finally, by improving the clarity and burden of proof.

The key recommendations for the Dutch government to practically solve the above mentioned issues are the following: (1) to make the tax instruments more accessible for SMEs, (2) to work on the structure by launching policy instruments with an initial scope of several years, (3) to adjust the requirements for certain instruments to increase the speed for SMEs, (4) to take into account the marketing and export aspect of innovation, (5) to create speed and direction in certain innovations by taking the lead, and not letting companies steer the boat, and (6) look into IP ownership from innovation projects, for example by creating an overarching brand for a region.

Content

Chapter 1: Introduction

1.1 Background and motivation

The global financial crisis of 2008 severely hit the shipbuilding industry turning years of high growth and record production into very low levels of new orders for practically all shipyards. The resulting excess capacity is one of the challenges that the global shipbuilding industry now faces and which will put the economic viability of the industry in some parts of the world in jeopardy. Persistent worldwide overcapacity may encourage governments to provide support through subsidies and other measures, as well as spur other market distorting practices, which can create major structural problems even in the most efficient shipbuilding industries (OECD).

International bodies and organisations like the European Union and the OECD try to control for protectionism by pleading for a level playing field. Because of the unique characteristics of the shipbuilding industry it is virtually the only industry without any type of effective protection against unfair trading practices (European Commission, 2003). The Jones Act[1] is one example of a protectionistic law which among other things determines that all goods transported by water between U.S. ports have to be carried on U.S.-flag ships, which are constructed in the United States, owned by U.S. citizens, and crewed by U.S. citizens and U.S. permanent residents.

While achieving a worldwide level playing field seems beyond reach for the OECD or the WTO for the moment, the EU is having a hard time enforcing similar agreements in its own territory. The Spanish Tax Lease (STL) is a famous example of level playing field disruptive government aid. On July 17th 2013 the European Commission decided that part of the fiscal measure was unlawful and that it partly had to be paid back. Even before the STL was partly rejected, Spain already issued STL2 from January first 2013 onwards (Sprundel van, 2015).

In this environment the Dutch shipbuilding industry is trying to stay competitive, and in this field innovation and innovation policy are addressed. The overcapacity that was the result of the financial crisis of 2008 put massive pressure on Western shipbuilding nations like Germany, Norway, Spain and The Netherlands. The labor costs of these countries are naturally higher than countries like China, Korea and Vietnam. For that reason increasingly work was flowing to these cheaper countries. The result was a further emphasis on knowledge and innovativeness as competitive edge in western shipbuilding nations. To keep the competitive advantage compared to countries like China and Korea, but also compared to the direct competitors like Norway and Germany, innovation is an absolute necessity for the Dutch shipbuilding industry. In order to realise the best conditions for the Dutch

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[1] The Merchant Marine Act of 1920 is a United States federal statute provided for the promotion and maintenance of the American merchant marine, and is often referred to as the Jones Act.

shipbuilding industry to innovate in, Netherlands Maritime Technology (NMT), the industry organisation of the Dutch shipbuilding industry, wanted to evaluate the Dutch innovation policy for the shipbuilding industry. NMT then approached me with the question if I could write my Master thesis about the Dutch innovation policy for the shipbuilding industry, with the purpose to come up with recommendations for improvement.

1.2 Research question

The importance of innovation is undisputed, and recognized by all actors in Western countries as explained in the introduction (OECD, 2011); as well as by leading authors like Schumpeter (1943) and Lundvall (1992). Market failure and other problems can however prohibit optimal innovation, interaction and knowledge sharing in an industry. There might be a role to play here for the Dutch government, namely through the execution of an effective innovation policy. Measuring innovation, and therefore measuring the effect and (cost) efficiency of innovation policy, is however very difficult, as can for example be seen from Velzing (2013). This has among other things to do with the long period between the implementation of the innovation instrument and the realisation of its objectives. In this long period variables like education policy and ups and downs in the (global) economy can affect the outcomes in the real world. This leads to the problem of the assumption of a causal relation between innovation instruments and the effect on the reality as it is observed after the implementation of those instruments. Because a proper quantitative evaluation of the effectiveness is not feasible, and a simplistic version does not do justice to the real effect of the innovation policy, the thesis will contain a qualitative evaluation of the Dutch innovation policy. In order to be able to give a proper qualitative evaluation a two-fold analysis will be conducted, namely case studies and interviews. In the case studies an attempt will be made to qualitatively evaluate the *effectiveness*[2] of the Dutch innovation policy. However, the contribution of the case studies will be wider, which will have to be covered by a more open sub-question to summarize the findings, as can be seen in the next paragraph. Details and other choices that have been made will be elaborated on in section 1.3. The qualitative assessment of the Dutch innovation policy eventually has to lead to an answer on the research question of the thesis: **How can the Dutch innovation policy for the shipbuilding industry be improved?**

8 sub-questions

In order to be able to answer the research question eight sub-questions have been formulated that build on each other and will eventually enable us to answer the research question. The answer to the first sub-question provides the innovation theory that is needed to understand the rest of the thesis.

[2] Effective is here defined as 'successful in producing a desired or intended result' (Oxford University Press, 2015)

The answers to sub-questions 2 and 3 explain the necessity of innovation and innovation policy. Question 4-6 will be used in the case studies that will be conducted of The Netherlands, Germany and Norway. The answer to question 7 will summarize the evaluation of the Dutch innovation policy for the shipbuilding industry based on the case studies. The answer to question 8 will finally summarize the evaluation of the Dutch innovation policy for the shipbuilding industry based on the interviews. Sub-question 7 and 8 have an open character. For sub-question 7 the reasons have already been explained in the previous paragraph; for sub-question 8 this will be done in section 1.3.

- What do we need to know about innovation theory?
- Why do we need innovation?
- Why do we need the government to intervene?
- How does the shipbuilding industry in the country look like?
- What are the objectives of the country's innovation policy (for the shipbuilding industry)?
- Which instruments does the country's innovation policy (for the shipbuilding industry) consist of, and what are their features?
- How does the Dutch innovation policy for the shipbuilding industry perform compared to those of Germany and Norway?
- How does the Dutch innovation policy for the shipbuilding industry perform according to experts from the Dutch shipbuilding industry?

1.3 Approach and methods

The aim of the thesis is to give a qualitative evaluation of the effectiveness of the Dutch innovation policy for the shipbuilding industry. The structure of the thesis will be an evaluating structure. As indicated, the analysis is two-fold. On the one hand a qualitative analysis of the overall effectiveness of the current innovation policy will be given by comparing it to two other prominent Western shipbuilding nations: Germany and Norway. The formulated goals of the nation's innovation policies serve as structure for the evaluation of the effectiveness of the nation's innovation policies. The other side of the analysis is the execution of six interviews with experts from firms in the Dutch shipbuilding industry. In the following paragraphs the used methods and approach will be explained.

The choice for the method of case studies

The choice for the method of case studies is based on three conditions, which are mentioned in the book Case Study Research by Robert K. Yin (2003). The three conditions are: the type of research question posed, the extent of control that the investigator has over actual behavioural events and the degree of focus on contemporary as opposed to historical events (Yin, 2003). The answer to the first question is that it is a 'how'-question. The answer to the second condition is 'no', and to the third condition is 'yes, on contemporary events'. The combination of these three answers selects 'case study' as the ideal research strategy for the analysis in this thesis. Data for the case studies have been collected through desk research, e-mail conversations and conversations with colleagues.

The approach of the case studies

Germany and Norway have been chosen as case studies because – according to experts in the shipbuilding industry – both countries are close competitors of The Netherlands with a comparable structure of the shipbuilding industry. Both countries possess and invest in a lot of technical know-how and knowledge development and therefore make for two representative cases. Further, for the sake of thoroughness the case studies have been limited to two. More specific features of Germany and Norway will be given in their case studies in respectively chapter 5 and 6.

The choice for the method of interviewing

The method of interviewing has been chosen for the added value that this method adds to the analysis. Interviews are believed to add a 'deeper' understanding of social phenomena than would be obtained from purely quantitative methods, such as questionnaires (Silverman, 2000). Interviews are most appropriate when detailed insights are required, which is conform with the purpose they serve here. The combination of the two methods is further appealing since the case studies mostly have an 'external' approach and the interviews an 'internal' approach of evaluating. Finally, the choice for these two qualitative methods has among other things been decided by the absence of or the non-specific nature of data.

The approach of the interviews

Six people have been interviewed for the internal analysis of the Dutch innovation policy for the shipbuilding industry. Specifically these six experts have been approached because the firms they work at together represent the entire scope of Dutch shipbuilding industry. Two interviewees are employees of major shipbuilding companies: Royal IHC and Damen Shipyards. Royal IHC has mostly expertise in highly technical (offshore) ships. Damen Shipyards complements the segments Royal IHC represent with its wider portfolio, contributing to the representativeness of the two major shipbuilders. Further, an interview has been taken with a representative of a major supplier in the shipbuilding industry (appendix B6). Finally, three interviews have been taken with SMEs in the shipbuilding industry, of which two have been taken with representatives of maritime suppliers (appendix B3 and B5) and one with a shipbuilder (appendix B6).Together the interviewees represent major and smaller shipbuilders, and major and smaller suppliers in the shipbuilding industry, hence representing the entire Dutch shipbuilding industry.

The approach of the internal evaluation through the interviews is a bit different than that of the case study; namely a choice has been made of the main criterion of evaluation: cooperation. The choice for this criterion and the link with innovation theory will be explained in section 2.4. Hence, the case studies are designed to give a more overall evaluation of the effectiveness of the Dutch innovation policy, where the interviews will focus more on the aim of cooperation of the innovation policy. However, due to the richness of the data that is gathered by the method of interviewing, the generic issues identified are much wider than that of issues related with cooperation. In order to be able to present these issues as well, the sub-question summarizing the findings of interviews has an open character (see section 1.2). Furthermore, the interviews can serve as support for issues identified in the case study of The Netherland, which will add strength to the evaluation and the consequent recommendations for improvement.

A focus on 'competitive cooperation'

A final demarcation is that the thesis will not focus on the entire innovation cycle, as it will be introduced in section 2.4, but only on the final stages; namely the actual innovation and the market implementation stage. While a lot of research has been done on cooperation in the earlier stages of innovation, not a lot academic writing exists about cooperation in the final stages, which is one reason for this choice of scope. Another reason is that small and medium sized enterprises (SMEs) are often not engaged in fundamental research (projects). Since Netherlands Maritime Technology represents any firm in the maritime industry, no matter the size of the company, this scope is very convenient as well. In appendix A the model has been described that will be used in the cases. In the upcoming chapters some more choices will be made and scopes will be defined. Those choices are however embedded in the context of those chapters, and can therefore not yet be given here. However, those choices will follow naturally from context of the chapters and will be well explained.

1.4 List of chapters

In order to structurally come to an answer of the research question the proceeding will be structured as follows. Chapter 2 will answer the first sub-question by introduce the theory about innovation that is required to understand the rest of the thesis. Chapter 3 will introduce innovation in practice, why it is needed, and why the government should intervene, by answering sub-question 2 and 3. In chapter 4 subsequently the Dutch shipbuilding industry, the objectives of the Dutch innovation policy for the shipbuilding industry and the instruments of that policy will be introduce. This will be done by answering sub-question 4, 5 and 6. Chapter 5 will do the same for the case of Germany, as chapter 6 does it for the case of Norway. Chapter 7 will then summarize the previous chapters by giving a general assessment of the Dutch innovation policy for the shipbuilding industry by answering sub-question 7. Chapter 7 will also provide an evaluation of the Dutch innovation policy for the shipbuilding industry based on the six interviews that have been conducted, by answering sub-question 8. Chapter 8 will then contain the recommendations for improvement of the Dutch innovation policy for the shipbuilding industry. Finally, chapter 9 contains the conclusion of the thesis, and the final recommendations.

Chapter 2: Innovation theory

An introduction

Innovation is as old as mankind itself. Already since prehistoric times people are constantly trying to make their lives easier, better and more comfortable. Innovation theory and beliefs about innovation and innovation policy are also already under development for quite some time now. This section will introduce this evolution of innovation theory. *Before we introduce three different innovation models innovation will be defined in section 2.1.* After that the linear innovation theory will be introduced. Subsequently the system innovation theory will be introduced. Thinking in innovation (eco)systems is nowadays more and more accepted. The theory further seems to have a logical relation with the topic of the thesis: the Dutch innovation policy. Next, the innovation cycle and the theory behind it will be introduced. This theory will be introduced because of its strong relation to the phenomenon of market failure that will be introduced in chapter 3. It further hands us the model with which the national innovation policies will mapped. The innovation theory section will be closed by introducing its connection with cooperation, and the introduction of the cooperation framework that will be used. Together these elements of innovation theory will enable us to answer the question: *What do we need to know about innovation theory?*[3]

2.1 Defining innovation

Innovation literally means: renewal. American Heritage (2011) defines innovation as "the act of introducing something new". More specifically focussed on companies innovation can be defined as "the introduction of something new with the aim of creating value for the company" (Velzing, Innovatiepolitiek, 2013). Many definitions of innovation have something to do with the introduction of something new. Although this is a rather vague definition, it covers all the different kinds of innovation, and it is therefore comprehensive. Innovation namely has a lot of different characteristics.

The different kinds of innovation

The OECD for example defines four categories of innovation in the Oslo Manual of 2005, namely: product, process, marketing, and organisational innovation (OECD, Eurostat, 2005). Innovations can be technical and non-technical. Innovation further differs with the degree of novelty of the innovation. Jacobs & Snijders (2008) for example use a fuzzy approach to novelty in which all innovations can be assigned along an axis from incremental to radical (Jacobs & Snijders, 2008). Albury & Mulgan (2003) define next to the categories incremental and radical the category of

[3] The theory of open innovation will, despite its relation with cooperation, not be explained in this thesis. The three theories that will be introduced, together with the information provided in section 2.1 and 2.5, adequately equip the reader with the knowledge that is needed to understand later decisions, models and theories used in this thesis, and are therefore comprehensive enough to answer the sub-question of chapter 2.

systematic innovations (Albury & Mulgan, 2003). Another dimension of innovation is in what kind of company or organisation it took place, thus being either public or private. Nowadays though, governments also actively try to stimulate innovations created in public-private partnerships, thereby creating a third category in this dimension: public-private innovations. The management style with which innovations are created is one other variable that is defined as innovation dimension. Two variables affect the management style: the size of the company and the (sometimes cohesive) stability of the environment in which the innovations are created. These two variable will however be left aside when deciding the scope of the thesis. Finally, social innovation has not been mentioned yet. Social innovation is defined as new ideas (products, services and models) that simultaneously meet social needs and create new social relationships or collaborations (Grisolia & Farragina, 2015). A social innovation is therefore any innovation that also serves a social purpose. Although the thesis will not directly focus on social innovations it will do this indirectly. As will become clear a lot of innovations nowadays (in the Dutch shipbuilding industry) also have a social aspect. Chapter 4 will further show that the Dutch innovation policy also has a social aspect to it, spurred on by organisations like the OECD.

Table 1: The different kinds of innovation. Adapted from Innovatieroutine, by Jacobs & Snijders, 2008: Table 1.1

	Product/service innovation			Process innovation	Transaction innovation
	Incremental	New concept, existing product	Totally new products		
Technical	New generation of tug boats	Fully hanging propulsion system[4]	Heave compensated gangway[5]	Entire supply chain in-house[6]	e-business
Non-technical	New aesthetic design	Offshore windfarm	Offshore seaweed cultivation[7]	Stock building[8]	leasing

[4] This innovation, called 'ship-in-ship' has been developed by Rubber Design BV. By hanging the entire propulsion system vibrations are reduced immensely, reducing the wear down of engine components and other ship components and improving the comfort of the crew and passengers. An interview with Rubber Design can be found in appendix B5.

[5] The heave compensated gangway has been developed by Ampelmann Company BV. With the innovation it is now possible to just walk from an offshore windfarm service craft onto an offshore structure, which revolutionizes the accessibility of these offshore structures.

[6] The example of the innovation of developing all components of the supply chain in-house in order for example speed-up a maintenance process has been given by Mr. Kooiman from the Kooiman Group. An interview with the Kooiman Group can be found in appendix B4.

[7] Noordzee Boerderij developed a buoy with which it is now possible to cultivate seaweed offshore. This product is totally new innovation which capitalizes on the (potential) future growth of demand for seaweed.

[8] Damen Shipyards engaged in stock building to reduce the costs and to reduce the building time. An interview with Damen Shipyards can be found in appendix B2.

The relation between the definition of innovation and the scope of the innovation policy

A summary about the kinds of innovation that exist has been provided by Jacobs & Snijder (2008), of which a to the shipbuilding industry adapted version is given in table 1. Innovation policy is from this perspective the set of policy instruments that tries to stimulate one or more aspects of innovation. This definition does match with the definition of Edquist (2011) and Lundvall & Borras (2005). Applied to companies, as this thesis will be, the definition is: *the set of government measures that attempt to stimulate innovation activities at companies*.

As can be seen from the definition of innovation policy, the definition that is used for innovation does determine the scope of the innovation policy. For a very long time innovation was identical to technical product innovation in the minds of policy makers. Until 1990 the Dutch innovation policy was in fact a technology policy, merely focussing on technical innovations (Velzing, Figure 7-2, 2013). Only in 2005 the OECD included marketing and transaction innovation in their definition of innovation (OECD, Eurostat, 2005). The choice of the type of innovation that is focussed on in this thesis does therefore have an effect on the instruments in the innovation policy that will be reviewed. However, the relation also works vice versa. The innovation policy is namely designed around the innovation that one tries to stimulate. In a highly technical industry like the Dutch shipbuilding industry the instruments that are designed are naturally very technology focussed. Not only does the selected definition decide the scope of innovation policy analysis, the innovation policy itself affects the selected definition, and therefore scope of the thesis as well.

The scope of the thesis

The focus of this thesis will be on technological innovations developed at companies. The decision to focus on technological innovations is based on three considerations. First, the shipbuilding industry has a clear manufacturing nature. The Netherlands is between the most technical shipbuilding nations in the world. This makes technical innovation important to stay at the forefront of the world's maritime industry. The second reason is the interaction of the nature of the Dutch shipbuilding industry and the innovation policy for the Dutch shipbuilding industry. As was mentioned in the previous paragraph, the current innovation policy for the shipbuilding industry is focussed around technical innovations. Since the current innovation policy will be analysed, the type of innovations that is analysed is naturally mainly technological. Third, the interviews, which form part of the analysis, emphasize on cooperation. Cooperation and knowledge sharing seems the most valuable in technical innovations. The decision to focus on privately developed innovations is based on the fact that the thesis is written for Netherlands Maritime Technology (NMT). NMT is an industry organisation for companies in the shipbuilding industry. Since the members of NMT are companies, the innovation policy for privately developed innovations is their main concern, and will hence be the focus of the thesis.

2.2 The linear model

It is often a long route to go from an invention to a successful innovation. The way to look at this route can be from different perspectives. The traditional perspective to look at it is the so called linear innovation process. The idea here is that innovation happens in a chain of independent and subsequent steps. This section will introduce this perspective in order to get familiar with the terminology, and to be able to show the path along which innovation process theory evolved in the past decades.

Until the mid-90's the linear innovation system was the dominant innovation paradigm. The innovation process in the perspective of the linear model is built up from several phases that one passes through one after another. The first phase is research at universities and research centres. Subsequently the technology and the prototype are developed, which are then tested. If these steps are executed successfully the market introduction and market diffusion are the next steps to undertake (Hekkert & Ossebaard, 2010).

Linear innovation thinking was the result of the Big Science period in the 50's and 60's of the 20th century (WRR, 2013). A science driven crash-project like the Manhattan project that led to the development of the atomic bomb appealed to the imagination and functioned as a seed for the science driven thinking. Soon after World War II the UK increased government expenses on R&D from 0,2 to 2 percent of the GDP, followed by the U.S.A. The success of science in the two decades after WO II would also mean the start of the prolonged controversy of the importance of science for innovation (WRR, 2013). End 2010 the international science journal Nature published a controversial review article about the economic efficiency of science. The various studies showed a wide range of outcomes. Measuring things like the cost efficiency of science on innovation is a difficult task, if only because the time between research outcomes and economic productivity is of the order of twenty years (Antonelli, Franzoni, & Geuna, 2011).

A problem with this model is that it suggests that an increase in research activities (as the result of an increase in investment in this early stage of the innovation process) automatically leads to an increase in successfully implemented innovations. This strategy is referred to as the 'technology push' strategy. The reasoning behind this strategy is that increasing research activities lead to an increasing amount of inventions, which are then turned into successfully implemented innovations by companies. The view in this strategy of a customer as simply adapting to the industry output was soon altered by adding the 'demand pull' strategy. The increased emphasis on the customer as the indicator of what had to be supplied by science and the industry was also not representative for the way that innovation processes actually happen. In reality it turned out to be too difficult for customers to clearly formulate their needs, since looking ahead and knowing what is technologically possible was indicated as being very difficult. On top of that it turned out to be very difficult to organise constructive interaction between society and science and the industry (Hekkert & Ossebaard, 2010).

The last version of the linear innovation model thinking was introduced by Kline and Rosenberg in 1986. This so called ‘chain linked’ model is still characterised by the typical linear innovation idea of the existence of different phases, but it also acknowledges the existence of feedback loops between the different phases. This meant that the model did for example leave room for the idea that problems in the upscaling phase can directly result in new research demands in the first phase of the innovation process. However, as can also be seen in Figure 1 (Kline and Rosenberg, 1986, p. 290) the model results in a rather complex way of thinking about innovation processes.

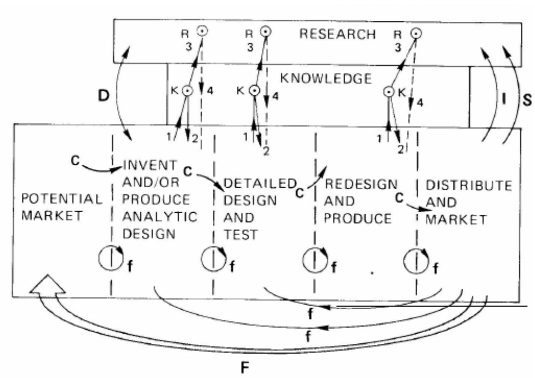

FIGURE 3 Chain-linked model showing flow paths of information and cooperation. Symbols on arrows: C = central-chain-of-innovation; f = feedback loops; F = particularly important feedback.

K-R: Links through knowledge to research and return paths. If problem solved at node K, link 3 to R not activated. Return from research (link 4) is problematic-therefore dashed line.

D: Direct link to and from research from problems in invention and design

I: Support of scientific research by instruments, machines, tools, and procedures of technology.

S: Support of research in sciences underlying product area to gain information directly and by monitoring outside work. The information obtained may apply anywhere along the chain.

Figure 1. Chain-linked model. Reprinted from ‘An Overview of Innovation’ (page 290), by S. J. Kline and N Rosenberg, 1986.

The linear model of science driven innovation turned out to be limited, and particularly from the 80s onwards the model was replaced by the idea that innovation was a complex combination of different elements that together formed something new. The innovation model of today is different in roughly five points from the linear innovation model. First, the model incorporates a broader knowledge concept. The linear innovation model emphasizes on scientific knowledge, while the model of today takes into account the importance of other forms of knowledge (see section 2.5). Second, the model emphasizes more on adaptive ability more than on knowledge creation. Third, the model acknowledges that innovation can occur at all places in the chain. Fourth, it assumes that innovation takes place in networks, and finally, it also assumes that the turnover time of innovation gets shorter and shorter (WRR, 2013). In the next section an innovation model will be introduced that emphasizes on the network requirements of innovations.

2.3 The system innovation model

No single innovation takes place in a solitary place; all innovations take place within a social-economical context. This is the framework of rules, habits and cultures, organisations, parties (like producers and consumers), their interrelatedness via networks (like consultation and financial structures), usage possibilities, et cetera (Hekkert & Ossebaard, 2010). Thinking about innovation processes in an innovation system is nowadays widely accepted. According to Hekkert and Ossebaard (2010) the idea of innovation system theory is increasingly catching on with organisations and institutions like the OECD and the European Union when implementing innovation policies.

System innovation, the successor of linear innovation

The system innovation model is the successor of the linear innovation model. The model not so much focuses on the different phases that innovation goes through, but rather on the environment or system in which it takes place. In the often long period between invention and implementation of the innovation different actors from different knowledge backgrounds contribute to the so called innovation process. A strong and fast built-up innovation system in which this innovation takes place improves the chance and speed of a successful development, application, and diffusion of the innovation. Vice versa this also holds, very promising inventions or innovations also help building their own innovation system since people are eager to contribute in order to benefit from the success of the innovation (Hekkert & Ossebaard, 2010).

The origin of the system innovation model

The concept of a 'system of innovation' was introduced by Lundvall in 1985. The concept does however go back to 1841 when it was introduced by Friedrich List in his conception of "The National System of Political Economy", which according to Freeman (1995) might just as well have been called "The National System of Innovation". The innovation system framework stems from theories like interactive learning (Lundvall B.-A. , 1992), and evolutionary theories (Nelson & Winter, 1982).

The kinds of innovation systems

Innovation systems have been categorised into the following five categories: national, regional, local, sectoral and technical innovation systems. As mentioned in previous paragraphs the concept of innovation systems originates from one at a national scale. National Systems of Innovation (NSI) are therefore the starting point. Mostly for the reason of problems with the scale and complexity of these NSIs regional and local innovation systems were introduced. Regional Systems of Innovation (RSI) are systems that are larger than a city, but smaller than a country. Local Systems of Innovation (LSI) are smaller than RSIs and are defined as a spatial concentration of firms and associated non-market institutions that combine to create new products and/or services in specific lines of business (Corey & Wilson, 2006). A proposed definition of Sectoral Systems of Innovation is: "… *a set of new and established products for specific uses and the set of agents carrying out market and non-market interactions for the creation, production and sale of those products"* (Malerba, 2002). Technical Systems of Innovation (TSI) focus on the specific technology or innovation and not on territorial barriers. With more and more international activities and knowledge and data sharing this innovation system is perhaps the most accurate representation of the real world. Also WRR (2013) indicates that according to OESE[9], R&D is nowadays more international than production.

The functions of innovation systems

Several authors give different functions of innovation systems. The most basic function mentioned in many innovation system studies is the activity of 'learning' or 'interactive learning'. As Lundvall (1992) puts it: "The most fundamental resource in the modern economy is knowledge and, accordingly, the most important process is learning". The activity of learning therefore lies at the heart of the innovation system approach. Edquist and Johnson (1997) introduce three functions of institutions in innovation systems. First, institutions reduce uncertainty by providing information. Second, institutions manage conflicts and cooperation. Last, institutions provide incentives for innovation. Empirical work based on Johnson (2001) introduced five functions: create new knowledge, guide the direction of search processes, supply resources, facilitate the creation of positive external economies (in the form of an exchange of information, knowledge, and visions) and facilitate the formation of markets (Jacobsson, Sanden, & Bangens, 2004).

Shortcomings of the innovation system model

Two shortcomings exist when using the innovation system framework to understand technological change according to Hekkert (2007). First, as mentioned before the framework is based on theories such as interactive learning and evolutionary economics. Despite this the character of most analyses of innovation systems is quasi-static. To explain the difference in performance between innovation systems there is a focus on the social structure of the systems and less on the dynamics of the innovation systems. Second, the explanatory power of the framework lies mainly in the part of institutions (macro level), and less on the actions of the entrepreneur (micro level), even though the key idea behind the framework is that innovation is both a collective and individual act.

[9] OESO = Organisatie voor Economische Samenwerking en Ontwikkeling (Organisation for Economic Cooperation and Development)

The innovation system model that will be used in the thesis

In this thesis the perspective of a national system of innovation will be used to look at innovation in the Dutch shipbuilding industry for the following reasons. First, we will be looking at the innovation policy of the Dutch government. This does provide us with clear territorial boundaries, namely those of The Netherlands. This would not make it possible to look at it from a technical innovation system view. Second, and related to this, members of Netherlands Maritime Technology (NMT) are all established in The Netherlands with at least one office. It is therefore also useful for the members of NMT to look at innovation from a national perspective. Third, although we are looking at the shipbuilding industry a sectoral innovation system would not suit the entire purpose of the thesis, since it also includes cross-sectoral innovation. Despite a globalisation of economic activities Freeman (1995) argues that the perspective of national innovation systems and the networks of relationships on that scale are still necessary for any firm to innovate. *Whilst external international connections are certainly of growing importance, the influence of the national education system, industrial relations, technical and scientific institutions, government policies, cultural traditions and many other national institutions is fundamental* (Freeman, 1995). Although looking at an innovation system from a national perspective does have disadvantages, it does seem to be the correct perspective to analyse the Dutch national innovation system for the shipbuilding industry.

2.3.1 National innovation systems

No universal definition of national innovation systems exists, among other things because the concept is still emerging. Freeman (1987) defined a national innovation system as follows: "… the network of institutions in the public and private sector whose activities and interactions initiate, import, modify and diffuse new technologies". Nelson (1993) gave the following definition: "… a set of institutions whose interactions determine the innovative performance … of national firms". A very inclusive and clear definition of a national innovation system is given by Metcalfe (1995): "… that set of distinct institutions which jointly and individually contribute to the development and diffusion of new technologies and which provide the framework within which governments form and implement policies to influence the innovation process. As such it is a system of interconnected institutions to create, store and transfer the knowledge, skills and artefacts which define new technologies."

In The Netherlands a variation of the innovation system framework has been actively promoted and emphasized on, the so called 'golden triangle' or 'triple helix'. In the Maritime Monitor 2014[10] the triple helix between the industry, the government and leading knowledge and research centres like Deltares, Imares, Marin, NLDA, TNO maritime and offshore and specialised sections of the technical university of Delft is indicated as a strong promoter of innovativeness in the maritime industry. A

[10] Maritieme Monitor 2014 published by Nederland Maritiem Land

national innovation system is however often bigger than the three actors in the triple helix. A national innovation system model consists of companies, knowledge centres, financial organisations, governments, and intermediaries. An overview of the different actors in the national system of innovation is provided in figure 2.

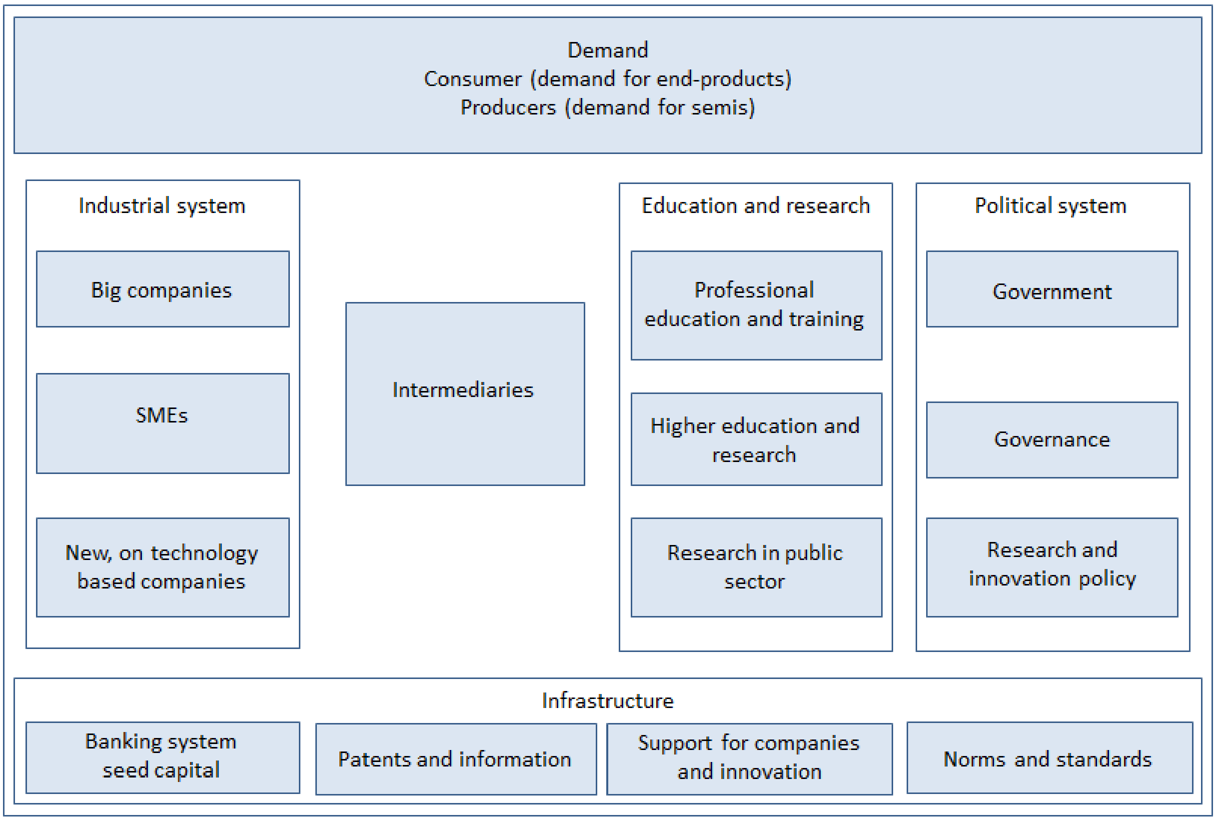

Figure 2: Different elements that together shape the National Innovation System. Adapted from De Innovatiemotor (page 49), by M. Hekkert and M. Ossebaard, 2010, Assen, The Netherlands: Van Gorcum. Copyright (2010) by Koninklijke Van Gorcum BV.

2.4 The innovation cycle

As thoroughly explained in the previous section, companies, institutions, and policy makers are more and more thinking in terms of innovation systems, and about ways to influence these systems, in order to have impact on the development, adaption and diffusion of innovations. However, as also mentioned, this approach has the problem of a quasi-static character by only looking at the structure of the environment in which the innovation takes place. This macro level perspective does not fit well with the micro level phases that a particular innovation at a company goes through. It is difficult then to identify the different (roles of) actors and different innovation policy instruments in each phase. Hence, one reason to introduce the innovation cycle is that a cyclical model will be used in the case studies. Another reason is that the model, and the idea of cyclical innovation, has a strong link with the theory of market failure, which will be introduced in chapter 3.

Everything should be as simple as possible, but not simpler. Einstein's quote is surely something that applies to innovation management models. Section 2.2 introduced linear innovation with the purpose to get familiar with the terminology. Section 2.3 introduced the successor of the linear model, the system innovation model. The central message of this framework is that an innovation is an individual and collective act that takes place in a context. This section will introduce the innovation cycle model, with the central message that innovation is a continuous process.

An innovation goes through different stages, whether it start with institutional research, industrial research, or it is the result of difficulties during the implementation phase, it has to go through different stages. However, while thinking about the different phases that an innovation goes through, one has to recognize that these phases have feedback loops, are not necessarily subsequent, and are characterised by the input of different actors.

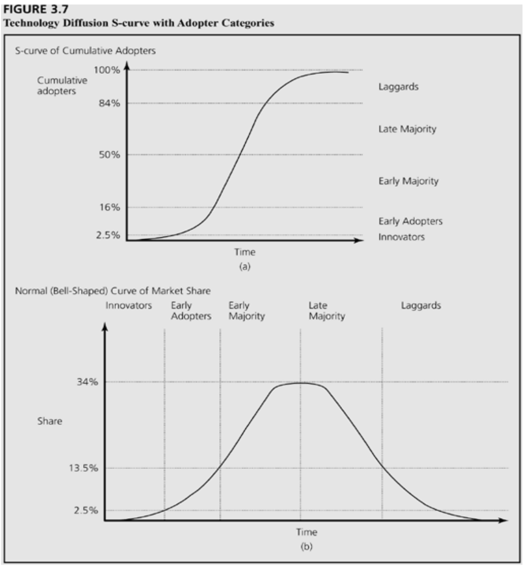

Figure 3: Technology Diffusion S-curve with Adopter Categories. Reprinted from Strategic Management of Technological Innovation (p. 47), M. A. Schilling, 2005, New York, NY 10020: McGraw-Hill/Irwin. Copyright (2005) by The McGraw-Hill Companies, Inc.

Several innovation theories are the foundation for the assumption that innovation is a cyclical process. The first theory is the innovation diffusion theory introduced by Jean-Gabriel Tarde (1890) in his *Les lois de l'imitation*. However, the theory only became famous with Everett Rogers' *Diffusion of Innovations* (1962). Rogers distinguished five stages, representing five different groups of adopters of an innovation. The innovators is the group of people first adopting the innovation, followed by the early adopters and the early majority. The innovation has matured, the biggest part of the market knows about it and is buying it. Sales will go down in this stage of diffusion. It is this stage that the late majority will adopt the innovation. The innovation is now in the stage of exiting the market, at which point the laggards will buy the product, for example because of a sale. Figure 3 shows the bell curve of market share, and the cumulative plotted version: the s-curve.

Another theory that shows an S-curve is that of the performance improvement of an innovation or technology. S-curves in technology performance and s-curves in technology diffusion are related. Technology improvements may result in a faster adoption and vice versa, a greater adoption may stimulate investments in development of the

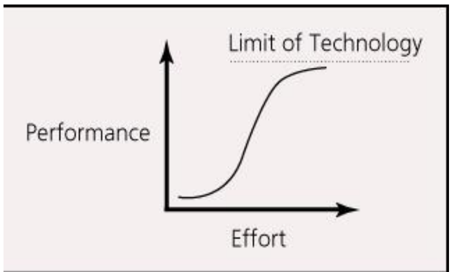

Figure 4: S-curve of Technology Performance. Reprinted from Strategic Management of Technological Innovation (p. 41), M. A. Schilling, 2005, New York, NY 10020: McGraw-Hill/Irwin. Copyright (2005) by The McGraw-Hill Companies, Inc.

innovation. Though the two processes with the two s-curves are related they are something entirely different.

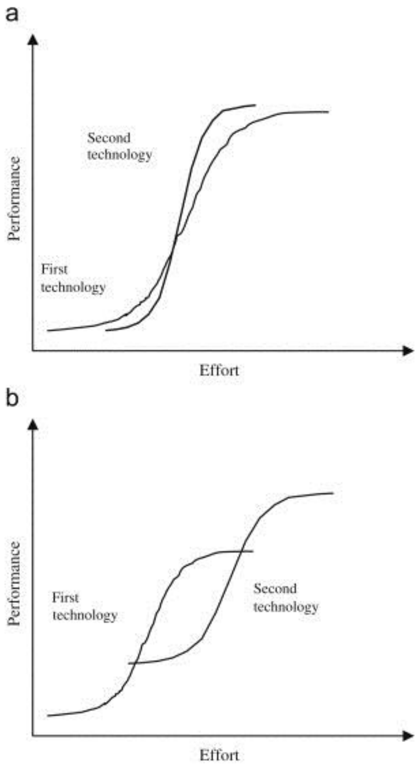

Figure 5: Technology S-curves - Introduction of Discontinuous Technology. Reprinted from Strategic Management of Technological Innovation (p. 44), M. A. Schilling, 2005, New York, NY 10020: McGraw-Hill/Irwin. Copyright (2005) by The McGraw-Hill Companies, Inc.

Many technologies exhibit an s-curve in their performance improvement over their lifetimes (Foster, 1986). Wijnolst & Wergeland (2009) provide several examples of technologies in the shipbuilding industry that developed along a s-curve, such as steam power, internal combustion power and alternative energy sources (Wijnolst & Wergeland, 2009). The logic behind the s-curve is that performance improvements are slow in the beginning because the fundamentals of the technology are poorly understood. Great effort and a lot of money have to be spent to gain this understanding. However, once scientists and firms do invest this time and money the technology improvements accelerate. At some point though, the cost of a marginal improvement starts increasing again. The technology is now reaching its inherent limits; the s-curve flattens.

Technologies do not always get the opportunity to reach their limits; they may be rendered obsolete by new, discontinuous technologies (Schilling, 2005). A new innovation is discontinuous when it fulfils a similar market need, but does so by building on an entirely new knowledge base. At first it might be possible that the new technology has a lower performance than the incumbent technology, but once knowledge about the new technology starts increasing among scientists and companies the technology starts improving fast. In early stages the return on investment for the new technology might be lower than that for the incumbent technology, but if the s-curve of the new one is steeper or reaches a higher limit there might come a time that this will switch around. Figure 5 shows this with two figures.

The two above introduced s-curves show that the development of a technology or (technological) innovation is a cyclical process an improvement or diffusion that is initially slow, then accelerated and then diminishing. Whether an incumbent technology or product or process is replaced because the market is satisfied or the technological limit has been reached, they will be replaced by new innovations and according to WRR (2013) at a faster and faster pace.

While the innovation cycle is deeply rooted in innovation theory there is also from a pure business perspective good reason to use the innovation cycle as management tool. For the viability of a company or country it is necessary to keep innovating. As will also be discussed in section 2.2 it is necessary for an economy to be continuously innovating to ensure a growing or a non-diminishing relative income, and to ensure a constant supply of work and jobs. Another reason to use it is that the central message of continuity of the innovation process is something that is easy to distract from the model. This makes the model very appealing to the imagination.

Several innovation cycles exists, with bigger or smaller steps and more or less phases to go through. A very descriptive cycle is one that is introduced by Berenschot (2009). The cycle describes eight steps and three major phases. Usually an innovation goes through the process from creation, to implementation, and finally, capitalisation. As can be seen in figure 6 the eight steps are sometimes 'transition steps' connecting two phases. Receiving incentives is for example the end of the capitalization phase, where companies will receive incentives from the market for the development of new or improvement of old products, processes, or services. This will subsequently lead to new ideas, which will then further be developed, ultimately resulting in utilization again. The existence of these 'transition steps' is added value that cyclical models give. Further, the comparison with reality is better, since new innovations often are improved old products, processes or services.

Received incentives are the end and the beginning of the innovation cycle. The incentives that are received are subsequently turned into new ideas, followed by the process of function creation (FCP). The end of the creation phase and the beginning of the implementation phase is characterized by the step of the production creations process (PCP). Subsequently the innovation will the introduce to the market, followed by the order realization process (ORP). This step will also herald the stage of capitalization. After the ORP the service realisation process is developed (SRP). Now finally the created value of the innovation has to be turned into money flowing to the company. After the utilization of the innovation incentives will rise from the market. There can for example be problems with the current product, process or service that have to be solved in a new innovation, or the innovation has to be optimized for another reason.

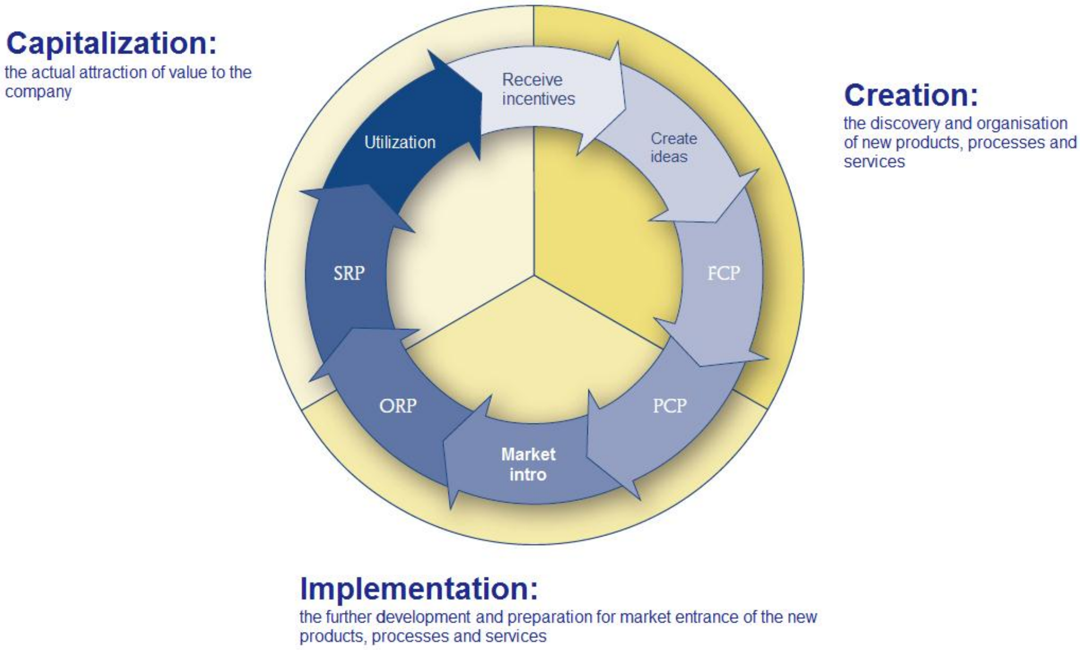

Figure 6: The Berenschot innovation cycle. Adapted from "Innovationmanagementmodellen", by J. Krebbekx et al. p. 10

2.4.1 The used innovation cycle

The innovation cycle that will be used in this thesis is a cycle of four phases. The precise model and an explanation of the model can be found in appendix A. The choice for these phases has been made since the Dutch government and the shipbuilding industry are familiar with this terminology, which makes it clear where the focus will be put on, and on what not. Below the different phases and steps will be explained.

1. Institutional knowledge creation

Institutional knowledge creation is the knowledge that is created in university and research centres. In the original science driven thinking of the linear innovation model, institutional knowledge creation was the starting point of every innovation. Nowadays this idea evolved to a more interactive model with the central belief that innovation can be the result of any interaction through the whole innovation cycle. In combination with the innovation system framework the origin of an innovation is harder to determine upfront than in the original linear innovation model. However, for the sake of simplicity we will take institutional knowledge creation as the first phase in the innovation cycle. In reality however this first phase is often already the result of market demand for particular research, incentives or signals after the implementation and utilization of an innovation, etc.

2. *Industrial knowledge creation*

The next phase is industrial knowledge creation. Although this phase does not necessarily have to be the subsequent step of institutional knowledge creation, it is believe, in heritage of the linear innovation thinking, that scientific knowledge is more often applied in an industry than vice versa. The previously discussed triple helix is however already a way of innovation system thinking that prevents these two phases of being too separate, by actively trying to stimulate interaction between knowledge institutes, the industry, and governmental organisations.

3. *Innovation*

The often subsequent step of the previous two steps that resulted in an invention, is the development of this invention into an innovation. In this phase all kinds of problems can be met. The invention can be too expensive, there can be no market for the invention, the invention can have problems meeting all kinds of environmental and legal requirements, etc. As explained in section 1.2 it depends a lot on the innovation system around the invention or innovation if and how fast it will make it to market implementation. Speed and direction are very much needed in this phase of development since competitive advantages get shorter and shorter, and innovations are overthrown by new ones faster and faster.

4. *Implementation*

Once the innovation is developed and it has been tested first on a pilot scale and later on a bigger scale the added value of the innovation has to be utilized. The faster an innovation can be turned into money, the more value a company will be able to capture with its short monopoly. Hence, also in this phase of the innovation process speed is required, which also here depends on the innovation system around the innovation. In the implementation the innovation often goes through a diffusion process of slow initial growth, followed first by fast growth, but later declining growth rates because of satisfaction of the market or the introduction of a so called discontinuous technology, as explained in above sections. After capitalisation the company will receive all kinds of reaction and feedback on it innovation, and new incentives will be received, resulting in a potential new innovation. To achieve the needed speed and direction in the innovation process cooperation, and an efficiently coordinating government where needed are absolute preconditions. Cooperation in the industry, and the role of the innovation policy of the Dutch government will therefore be the focus of this thesis on innovation. The focus will further be on the last two stages, namely on innovation and implementation.

2.5 Cooperation and innovation

The testing of innovation systems: functions of innovation systems

As mentioned in section 2.3 the innovation system model does have problems. One of these problems is the quasi-static nature of the model. However, by not look at the structure, but at the processes that are important for a well performing innovation system, this problem can be mitigated. Several propositions of frameworks have been made that focus on a number of processes that are highly important for a well-functioning innovation systems. These processes are called 'functions of innovation systems' (Hekkert, Suurs, Negro, Kuhlmann, & Smits, 2007).

Functions of innovation systems

According to Lundvall (1992) *the most fundamental resource in the modern economy is knowledge and accordingly, the most important process is learning*. He therefore identifies learning as the most fundamental function of innovation systems (Lundvall B.-A. , 1992). Learning accordingly happens in different ways: learning by doing, learning by using, and learning by interacting (Rosenberg, 1982). Another function proposition is done by Edquist and Johnson (1997): institutions reduce uncertainty by providing information, manage conflicts and cooperation, and provide incentives for innovation. Liu and White (2001) focus on 5 *activities,* not functions, since they say that the innovation system has a "lack of system-level explanatory factors". These activities are: research (basic, development, engineering), implementation (manufacturing), end-use (customers of the product or process output), linkage (bringing together complementary knowledge) and education (Liu & White, 2001).

Reasons to choose for cooperation

As can be seen from the statement made by Lundvall (1992), cooperation is highly related to the core idea behind the system innovation model and interactive learning theories. Further, as put forward by Edquist (2001) innovation is both an individual and a collective act. The focus of this thesis on cooperation is therefore well in line with up-to-date innovation framework theory and the functions of these frameworks. Further, cooperation is a concept that appeals to the imagination, both to that of the policy makers and companies. It is also something that is rather easy to appoint, much more than some other functions of innovation systems mentioned before, which is advantageous when gathering the data (by means of interviews). This is another strong reason why the function of cooperation is preferred over the other above mentioned functions. Below the three different dimensions of cooperation will be introduce that will function as framework of the analysis of cooperation. However, before this will be done some characteristics of innovation specifically related to the shipbuilding industry will be introduced that further clarify the choice in this thesis for cooperation in innovation.

Some forms of knowledge make spillover difficult

The previously introduced innovation system theory stems from theories like interactive learning. The central idea behind this theory is that knowledge is the most important determinant of innovativeness, which makes learning the most important activity. Knowledge however exists in different forms, which has an effect of the learning process and the difficulty of it. Michael Polanyi (1958) distinguishes *scientific knowledge* and *tacit knowledge*. The first one is often freely available. The latter one is however enclosed in someone's personal experience and understanding. According to Polanyi innovation is much more determined by tacit than scientific knowledge. Another distinction is made by Blackler (1995), who distinguishes between *embodied knowledge* and *embrained knowledge*. Embodied knowledge designates the kind of knowledge that resides in ones hands and fingers. Embrained knowledge includes cognitive skills like analytical and problem solving thinking and creativity. Both forms of knowledge are hard to specify, but can however be very productive in practical situations. There can be made a case that the shipbuilding industry contains a high degree of tacit and embodied knowledge. This can for example be seen by the fact that the Human Capital department of NMT is actively busy with the training and inflow of craftsmen. Knowledge spillovers are in this case a bit more complex, which makes it all the more necessary to explicitly cooperate and to for example share knowledge in specific projects.

Evidence that there is a lot of knowledge to share

Evidence that there is however a lot of knowledge to share, is provided by the maritime monitor 2014. This publication indicates that the maritime cluster spends on average 3.9% of their added value on R&D, this is considerably higher than the national average of 2%. This high percentage of R&D expenses indicates that a lot of knowledge is created inside the firm. If this knowledge could be share and combined in innovation projects, then cooperation could be the key to the creation of a strong Dutch shipbuilding industry.

2.5.1 The different dimensions of cooperation

Cooperation can take place in all kind of forms, and on all kinds of levels. The choice has been made here to focus on three kinds, namely horizontal, vertical and cross-sectoral cooperation. This choice has been made because these three forms of cooperation are generic and comprehensive. Further, since the maritime industry is central in the analysis it makes sense to focus on the three kinds of cooperation that are possible for a company, namely in the chain, with the competitor, and with actors from other industries.

Chain cooperation (vertical)

Cooperation in the chain is a well-known and straight forward way of cooperation. (Cost)efficiency in the chain, and hence cooperation, are things that have been studied much in academic fields like supply chain management. An advantage of chain cooperation is that it is rather easy to secure the sharing of confidential information compared to horizontal cooperation. The competitive power of competitors if often higher than that of the parties in the chain, like supplier and consumers. In general it therefore holds that the closer an innovation is to market entry – so the more it depends on company specific knowledge – the more chain cooperation happens compared to horizontal cooperation.

Competitor cooperation (horizontal)

Horizontal cooperation, or cooperation with competitors happens with the same logic as above more in the beginning or precompetitive phase of the innovation process. Although companies are generally more focussed on capturing value for themselves and are by nature not very much willing to cooperate with competition it is a very important kind of cooperation for a nation. It is in this kind of cooperation that equals can find each other to organise a strong lobby or to do fundamental research. Fundamental research is good for an economy to undertake since usually the degree of knowledge spillovers is rather high compared to chain innovation. Horizontal cooperation therefore contributes to a good environment for the companies and for innovation.

Cross-sectoral cooperation

Many successful innovations have been developed with the contribution of external know-how, so with knowledge and experience from a different sector. An example is the "iDrive" developed by BMW (Brunswicker & Hutschek). In hindsight the innovation often seems obvious, however in reality many companies have difficulties to open up intentionally and to identify potential solutions. Even if firms would like to work together this might not result in a success. So called market failures can sometimes prohibit fruitful cooperation. Section 3.2 will go deeper into market failures. It are issues like this that can justify government involvement in an economy.

Illustration 1 – How does the Dutch shipbuilding industry innovate?

The following two examples are examples of innovative SMEs in the Dutch shipbuilding industry that have been participating in Innovation Performance Contracts (IPCs), see chapter 4.3. Their story has been published in the book 29 SME successes, which represents 29 stories of successful Dutch SMEs in the shipbuilding industry. The two stories represented here give among other things an idea of the high technicality of the innovations, and the cooperation in innovation.

Mampaey Offshore Industries BV is a company with more than a 100 years of experience in approach and mooring systems for ships, among others in the oil and gas industry, as well as advanced tow hooks and the "Dynamic Oval Towing System" (DOT) for tugs. The DOT system has been jointly developed with IMC Corporate Licensing BV in Rotterdam, as well as with MARIN, TNO and the Technical University of Delft. Mampaey with its DOT system has been awarded most successful and innovative company by Syntens, the innovation network for entrepreneurs, and entrepreneur's magazine Bizz, in 2007 (HME, Scheepsbouw Nederland, 2009).

Rubber Design BV is one of the leading specialists for solutions in the field of vibration, sound, and shock. In the last 10 years, the company has also been recognized as specialist in propeller systems for luxury yachts. Rubber Design developed several innovations via IPC contracts. One innovation is a machine condition monitoring system for propulsion systems. With this system it is no longer necessary to dock the ship before the condition of the propulsion system can be checked. The innovation makes it possible to continuously measure the conditions of the propeller shafts, which makes it easier to plan maintenance of the ship, and reduces downtime by preventing damage (HME, Scheepsbouw Nederland, 2009). An interview with Mr. Van Sliedregt, technical manager at Rubber Design, can be found in appendix B5.

2.6 Conclusion

The purpose of this chapter was to give an introduction in innovation theory. To summarize the essential theory that is necessary to understand the rest of the thesis, and answer will be formulated to this chapter's sub-question: *What do we need to know about innovation theory?*

We need to know that the definition that one uses influences the scope of the innovation policy that one subsequently develops. We also need to know that a linear innovation model is too simplistic. We further need to know that innovation is an individual and joint activity that takes place in a context with different actors contributing and prohibiting in different phases. Finally, we need to know that the innovation process is cyclical and continuous and that it can start anywhere in the innovation cycle.

With this in mind we will focus on cooperation in the industrial system, and the relationship of the shipbuilding industry with the political system in the broader context of a national innovation system. In the innovation process we will focus on the two phases of innovation and implementation. The dimensions of cooperation that will be used to partly structure the interviews are horizontal, vertical, and cross-sectoral cooperation since all kinds have their own advantages and contributions for a strong national environment to innovate in. Finally, the focus will be on technological innovations because of the manufacturing nature of the shipbuilding industry.

Chapter 3: Innovation in practice

Why do we need it, and why do we need the government to intervene?

3.1 Why do we need innovation?

Ever since Joseph Schumpeter introduced innovation as the critical dimension of economic development in the early twentieth century, economists are stuck with this idea. Schumpeter emphasized that innovation does not only result in new opportunities, but it also destroys old ones through the process of '*creative destruction*'. The temporary monopoly that this creates for the innovator results in abnormal profits. Although these profits will disappear after a while because of the behaviour of competitors and imitators, it is an important trigger for companies to develop new products, services, and processes (Schumpeter J. , 1911).

Innovating to achieve higher profit margins

The rationale behind innovation is straight forward. If no company would be able to innovate then a lot of companies would be making the same product or would offer the same service. Competition would then only take place based on price, which would result in very small profit margins. Through innovation however companies are able extend the range of possibilities. Innovations make it possible for a company to offer a product to their customers that their competitors are not able to offer. If this new product results in added value for the customer, and the customer is willing to pay for that, the company is able to achieve higher profit margins than their competitors. According to Schilling (2005) in many industries companies rely for more than one-third of their sales and profits on products developed within the past five years. The development of successful innovations, often through Research & Development (R&D), is therefore an important matter for many companies (Hekkert & Ossebaard, 2010). The increased competition as the result of the globalisation of markets, and the increasing pace of innovation through the development in the information technology emphasize even more the importance of the creation of a competitive advantage through innovation (Schilling, 2005).

The important role of innovation is widely accepted

The importance of innovation is undisputed as was already mentioned in the introduction chapter. As the OECD puts it *"one of the important lessons of the past two decades has been the pivotal role of innovation in economic development"* (OECD). Rosenberg (2004) brings the growth in output of the economy back to two possibilities. Either one can increase the number of inputs that go into the productive process, or one can try to find ways to get more output with the same amount of inputs. He further mentions that several longitudinal studies measured a residual of 85 percent when trying to measure the effect of growth of input on growth of output of an economy[11]. This means that only 15 percent of the growth in output is determined by the growth in input. This enormous residual has led to the conclusion that technological innovation must have been a major force in the growth of output in highly industrialised economies. A report published by OECD in 2007 also stipulates the crucial importance of innovation, not least in relation to global challenges like climate change and sustainable development.

Finally, the WRR report (2013) states that innovation and speed of adoption are more than ever crucial determinants of the competitive position and the survival rate of companies. An example that is given is the rise and fall of Nokia. Naturally this means that companies can gain and lose market share very fast. Rosenberg (2004) underlines this idea by saying that *uncertainty is at the heart of all innovations*. A phenomenon like uncertainty as the root of all innovations might provide grounds for government support, but more on this in the next section.

3.2 Why do we need the government to intervene?

The invisible hand or the invisible foot[12]?

Not only companies but also countries are competing through innovation. Countries are different in the amount and kind of innovative companies, which results in different levels of growth and wealth. It is therefore very important for the national government of a country to keep innovativeness on a high level. Without innovation the relative wealth of a country will decline compared to other countries (Hekkert & Ossebaard, 2010). Also from a market failure perspective one can come up with arguments for government intervention, which has for example been done by Commissie Theeuwes (2012) in their expert report about measuring the effect of policy instruments. In the following sections the different kinds of market failures as well as other reasons for government support for the shipbuilding industry will be explained. However, before this will be done, the economic theory behind market failure will be shortly introduced.

3.2.1 Market failure

Adam Smith (1723-1790), probably the most famous economist of all time, claimed in his book *The Wealth of Nations* that efficient allocation of resources is best left to the market system. One of the biggest achievements of modern economics is to confirm this intuition by identifying the conditions

[11] Studies by for example Moses Abramovitx and Robert Solow measured a residual of 85% when measuring the effect of input growth on output growth of an economy (Rosenberg, Innovation and economic growth, 2004).

[12] The invisible hand describes the self-regulating mechanism of markets, and was introduced by Adam Smith in *The Theory of Moral Sentiment* in 1759. To oppose this idea of an invisible hand Hunt and d'Arge (1973) introduced the term *invisible foot* referring to the negative externalities that are the result of a free functioning of markets.

under which a market economy delivers the socially optimal allocation of resources[13] (Burda & Wyplosz, 2009). These conditions among other things comprise no uneven balance of power and enough competition, so that prices can adjust freely. Another condition is that no externalities are present. It is not surprising then that these ideal conditions are unlikely to be met in the real world. In this case of market failure governments can intervene to improve the allocation and use of resources in order to achieve a larger level of output in the economy.

Economic theory defines a market failure as a situation wherein the allocation of production or use of goods and services by the free market is not efficient. Market failures can be viewed as scenarios where individuals' pursuit of pure self-interest leads to results that can be improved upon from the societal point of view (Krugman & Wells, 2006). This idea has been traced back to the Victorian philosopher Henry Sidgwick (1838-1900) (Medema, 2004), but was only first mentioned by economists in 1958 (Bator, 1958).

There are three reasons why market failure might occur. First, one party might have power that prevents efficient transactions from happening. A famous example is a monopoly, which is therefore often actively contested. A second reason is that an efficient transaction can have externalities that reduce efficiency elsewhere in the market or the broader economy. Finally, market failure can occur because of the nature of certain goods or services (Farlex, Inc., 2011). The following three paragraphs will further elaborate on these three reasons of market failure.

Generally, a perfectly competitive market exists when no participant is big enough to set the prices of homogeneous goods, hence all participant are "price takers"[14]. When firms are competing they are under constant pressure to adapt the price and the design of the product to the wishes of the customers. If firms do not adjust they will eventually have to shut down. Firms therefore try to work as efficient as possible, and try to allocate resources optimally, just as society wants them to and just as Adam Smith predicted. However, firms will try to create a premier position for themselves at the expense of their competitors in order to escape this kind of position. Through differentiation or use of economies of scale firms will be able to capture more value through the earning of so called economic rents. Competition policy tries to increase competition and hence the economic output.

[13] In the 1950s Nobel laureates Kenneth Arrow of Stanford and Gerard Debreu of Berkeley showed how Adam Smith's intuition could be confirmed by identifying these conditions.

[14] All actors being price takers is the bottom line requirement of a perfectly competitive market. Specific characteristics might include: a large number of buyers and sellers, no barriers to entry and exit, perfect factor mobility, perfect information, zero transaction costs, profit maximisation, homogeneous goods, non-increasing returns to scale, property rights, rational buyers and no externalities.

Externalities are *activities that affect the welfare of economic agents not undertaking them directly* (Burda & Wyplosz, 2009). In other words, a third party, unrelated to the transaction, experiences the consequence of an economic activity. Externalities can be positive or negative. Pollution is an example of a negative externality. The polluter only reaps the benefits derived from polluting while imposing the costs of this pollution on others. Technology has positive externalities. A firm that invests in developing and implementing a new technology creates positive externalities for other firms and consumers, but incurs all the costs.

Some externalities arise because of the nature of some goods. These goods are referred to as public goods. Public goods are non-rival and non-excludable. Practically this means that if someone uses a public good like a beach or clean air, that it does not make it less available to other, nor does it prevent anyone else from using it either, since it is freely available to everyone. The problem here is that no one is to be charged for using these goods, and they should therefore be provided by the government.

Economists are divided in two camps when it comes to government intervention. The first camp believes that markets are naturally efficient, and see therefore no reason for the government to intervene. This view is known as the *laissez-faire* view. The other camp believes that the ideal conditions as described in Smiths theory of resource allocation are unrealistic and unattainable. They see a role for the government to intervene here. Government interventions should however meet two requirements. First, interventions should be limited to clearly identified market failures. Second, they should be targeted directly at these market failures to limit or mitigate additional distortion, also known as government failure[15] (Burda & Wyplosz, 2009).

Of the three reasons that can lead to market failure, externalities are probably the biggest problem that the shipbuilding industry faces, as will become clear in the next sections. Another argument for government involvement is the case of incomplete information or information asymmetries. Jaffe et al. (2005) give a clear overview of these market failures that both innovations and diffusion of new technology have to deal with. They divide the market failures in: knowledge externalities, adoption externalities and incomplete information. The following three sections will zoom-in on these three market failures stemming from economic theory, followed by a fourth section zooming in on more practical problems related to innovation in the shipbuilding industry.

[15] Government intervention to solve market failure can sometimes result in failure on its own by distorting the market, known as government failure.

3.2.2 Knowledge externalities

As explained above externalities can both be negative and positive. It is further explained that the positive externalities that are created by innovations are related with the public good nature of the development of knowledge. Firms cannot prevent other firms from benefiting from their developed knowledge, while they are the only ones incurring the costs. This is called the *freerider problem*. While intellectual property rights like patents are used to protect a firm's investment in innovations, such protection is inherently imperfect. A successful innovator will only capture a small to a very small part of the created value by their innovation. Hence, innovations create positive externalities in the form of "knowledge spillovers" for other firms, and spillovers of value or consumer surplus for the users of the new technology. Not only does a firm create positive externalities for companies that are geographically close, but with worldwide information flows and data sharing, a firm a several thousand kilometres away can benefit just as easily nowadays.

The unattractiveness of investing in innovation development and R&D has increased over the past decades. On the one hand the decreasing length of innovation cycles leads to high expenses, because a company has to invest more per unit of time to stay competitive. On the other hand shortening innovation cycles lead to less benefits, because the temporary monopoly period in which a company is able to earn back the invested money gets shorter and shorter. In short this means that innovation investments are getting riskier, and therefore increasingly unattractive. WRR (2013) establishes that the shorter and shorter innovation cycles demand for an increasing ability to adapt instead of to create knowledge.

3.2.3 Adoption externalities

The above discussed knowledge externalities, and the earlier mentioned environmental externalities of innovations are not the only market failures that may operate during the development and implementation of a new technology or innovation. Adoption externalities are another externality that is present during the diffusion of an innovation. Section 2.1.3 introduced the S-curve in order to explain the cyclical nature of innovation adoption and development. It can be seen from the s-curve describing the technology improvements that initial improvement of the technology is slow, and only starts to gain some momentum after significant investment of assets. The s-curve describing the adoption of the innovation shows that it takes a lot of time in the beginning to move from the innovators and early adaptors to the early majority. The innovation cycle theory is linked to the innovation systems theory here, since it might take some time in order for an innovation to reach a certain magnitude since the incumbent system is often deeply rooted and hard to replace also known as a *lock-in*. In other words, it is often not two products competing, but the product systems.

The interrelatedness of the two above mentioned S-curves can be seen by the phenomena "learning-by-doing" and "learning-by-using". The phenomenon of "learning-by-using" describes the positive externalities of the information that the innovators and early adaptors provide to others by adopting the innovation. This information reduces the risk of people that still have to adopt, or provide producers with information to improve the technology or innovation. The phenomenon of "learning-by-doing" is the supply-side counterpart, and is related to the s-curve presenting technology improvement. It describes how production costs tend to fall as manufacturers gain experience in production. The third and final adoption externality has to do with *network externalities*: the more people use a particular technology, the more valuable it becomes to others, which is partly captured by the adoption s-curve (Jaffe, Newell, & Stavins, 2005). An incumbent technology or product already went through all these processes, and already reaped all the benefits from for example "learning-by-doing" and "learning-by-using". A new technology or innovation can sometimes seem unattractive precisely for the reason that it is not yet optimised through such kinds of positive externalities. These three adoption externalities therefore provide clear grounds why it is hard to replace incumbent systems with new innovation systems, and hence explain why the breakthrough time of innovations is often very long. Government intervention to make it through the early stage of development would be desirable here.

3.2.4 Incomplete information

Finally, incomplete information is an additional reason why the market, or the so called *invisible hand*, underprovides research and development. The first reason why incomplete information can be a barrier to R&D and the development of innovations, is that the inequality in information often leads to high premiums on the investments that are needed to do R&D or develop this innovation. All investments carry uncertainty, but especially in the case of innovations the uncertainty about returns on investment are high. Further, information about the prospects of a certain innovation are asymmetric. It is the innovator, much more than the investor, that can estimate the potential of the innovation. Hence, an innovator is often faced with expensive investment capital, which might form a barrier. In combination with the above explained (increased) unattractiveness to invest in R&D yourself, this potentially results in underinvestment in R&D (Jaffe, Newell, & Stavins, 2005).

3.2.5 Additional arguments for government intervention

In the previous three sections three market failures have been described that constitute a substantial argument for government involvement in innovation management. In this section some additional arguments will be introduced. These arguments are sometimes less rooted in or derived from economic theory, but are more related to practice. The arguments have been explicitly mentioned by actors in the shipbuilding industry or are often recurring in academic literature. First the need for direction in innovation will be explained, including considerations regarding lock-in. Second, arguments from a level playing field point of view will be provided. Third, a special characteristic of the shipbuilding industry will be provided, namely that of very high switching costs, as an argument for government involvement. The section will be concluded by final considerations to take into account for the government when they think about innovation in the shipbuilding industry.

Speed and direction in innovation

Often recurring in academic literature about government involvement in innovation management is the need for speed and direction. Hekkert (2007) says: *"…there is a strong need to influence both speed and direction of innovation and technological change. Increasing the speed of innovation is important, since innovation is a key determinant for long term economic growth and development."* In one of his later writings he says that the government should try to push innovation in a certain direction in order to solve societal problems (Hekkert & Ossebaard, 2010). As the result of increasing insight from bad experiences in the past, governments are sometimes trying to avoid choosing particular technological areas for support[16]. There are however good reasons to give targeted support to certain innovations. For example, according to several interviewed actors in the shipbuilding industry, innovations in the shipbuilding industry are very often related to environmental gains. Since the environment can be seen as a public good, in which the government should provide, a targeted innovation or technology policy can be seen as a very effective environment policy. Subsidies and other forms of government support can in such a case lead to a much faster market introduction with society profiting much earlier from all the positive externalities. Further, with the rationale of the s-curve in mind, government support in the early stages will lead to faster steepening development curves, which leads to a fast maximisation of the innovation gains.

Illustration 2 – The European Commission selects 7 LNG projects under the TEN-T call 2012

The Trans-European Network for Transport (TEN-T) Call 2012 made 1.597 billion euros available to finance European transport infrastructure projects covering all transport modes – air, rail, road, and maritime/inland waterways – plus logistics and intelligent transport systems, and all EU Member States (TEN-T EA, 2013). From this budget 105 million euros has been granted to 7 LNG projects. In several projects the shipbuilding industry had a stake, but one was particularly interesting: *the LNG Masterplan for Rhine-Main-Danube*. For this project TEN-T funding in

[16] Read for example Ruben Rosseels' *Niets nieuws onder de zon. Overheidssteun voor de Nederlandse scheepsbouw van 1932 tot 1963* (2015)

the amount of 40.3 million euros has been recommended, covering 50% of the project's total costs. The aim of the project is to *provide a European strategy and pilot deployments both from LNG as fuel for inland vessels and as cargo transported on waterways and distributed via inland ports* (TEN-T EA, 2013). Actions to achieve this goal are: the execution of a set of feasibility tests, technical concepts, technical trials and pilot deployments of vessels and terminals. The project consists of 33 companies from 12 different EU Member States. One of the companies that were part of this project is the Kooiman Group from The Netherlands. An interview with Mr. Kooiman can be found in appendix B4. According to Kooiman a governmental body, like the European Commission (EC) in this case, is in a project like this indispensable. Without financial support from the EC it would not have been possible to build and develop a LNG network of providers and suppliers from scratch.

Level playing field

In commerce, a level playing field is a concept about fairness, not that each player has an equal chance to succeed, but that they all play by the same set of rules (Stanford University, 2002). A metaphorical playing field is said to be level if no external interference affects the ability of the players to compete fairly. Unilateral national subsidies are by principal contradicting the level playing field.

The shipbuilding industry has always been one of the industries that is protected by national governments for several strategic, economic and non-economic reasons. Economic reasons can be to sustain jobs and to create stability and wealth by doing so. Developing industries (e.g. Korea and Vietnam) often see the shipbuilding industry as the first or launching industry in order to establish a strong national manufacturing industry. By heavily supporting the development of the shipbuilding industry a country attracts all kinds of investments, investors, suppliers and related manufacturing activities, which makes it more of a strategic reason. Non-economic reasons are things like national pride or "regional drive", in areas like Kinderdijk.

Nowadays the shipbuilding industry is still an industry that is often supported by national governments. As mentioned in the introduction the USA still holds on to the Jones Act which is very favourable for their national shipbuilding industry. Also Spain is said to be supporting its national shipbuilding industry. On July 17th 2013 the fiscal policy for Spanish shipbuilders – in the market known as the Spanish Tax Lease – was partly rejected by the European Commission, because it was not compatible with the European state aid regime. On January 1st 2013 the Spanish government had already introduced the Spanish Tax Lease 2 though that has been approved by the European Commission, because it was not selective (Sprundel van, 2015). Although such fiscal policies help economic growth in Spain, it is the question if it contributes to a level playing field in Europe.

The European Union, the OECD and the WTO have made it their job to strive for a Europe wide and worldwide level playing field. As above examples might suggest, this is a fairly difficult job. In soccer, teams swop sides at halftime to control for the possibility of a sloping playing field. In business, unilateral subsidies resulting in a sloping playing field might provide a reason for counter subsidies and regulations. Although it is good to strive for a level playing field, reducing or abolishing support for your own industry while other countries are less committed to do so, can be harmful for your own economy by loosing orders.

High switching costs in the shipbuilding industry

The previous section mentioned that there are several economic and non-economic reasons for government support for the shipbuilding industry. One of the reasons for a government to support its national shipbuilding industry might be the significant vulnerability of it through its high switching costs. If a company is under high pressure, for example in an economic crisis, the company can decide to start producing a different product in order to stay in business by adjusting their plants, shops, service, etc. For the shipbuilding industry this is however a very difficult thing to do. It is for a shipyard near to impossible to change their facility to for example start building cars instead of ships. The economic crisis of 2008 and the resulting overcapacity led European (Dialogic, 2014) and non-European governments (Kalouptsidi, 2014) to support their national shipbuilding industry for this reason. From a level playing field point of view this could therefore also be a reason for the Dutch government to support its national shipbuilding industry.

Risk

While part of the risk that a company in the shipbuilding industry bears is covered by previously mentioned problems like knowledge externalities or high sunk-costs, there is still a part of the risk that is underexposed. A unique risk that shipyards face compared to other industries has to do with the size of the products that they are developing. Ships, compared to for example cars, are very big. In order to introduce some innovations it is therefore not possible to build a prototype, simply because it is too expensive. Hence, the testing of some inventions or innovations is very risky, which leads to a very slowly executed innovation process, and the loss of momentum. At the worst the innovation process is never undertaken. Also the European Union underwrites the uniqueness of the shipbuilding industry[17] and its resulting eligibility for state aid (Council Working Party on Shipbuilding, 2015).

[17] In the Council Working Party on Shipbuilding (WP6) published in June 2015 it is mentioned that: *Certain features make shipbuilding unique and distinguish it from other industries such as small production series, the size, value and complexity of the units produced as well as well as the fact that prototypes are generally used commercially. As a consequence, shipbuilding is the only sector eligible for innovation aid, as an incentive to technological risk-taking (EU Framework of state aid to shipbuilding). Modes of payment: 20 per cent gross*

3.3 Conclusions

This chapter answers two sub-questions. The answer to the first sub-question – Why do we need innovation? – is: innovation is necessary to realise long-term economic growth and prosperity. Through innovation it is possible to achieve higher profit margins, which is necessary for the wealth in a country to stay on the same relative level. The second sub-question is: Why do we need the government to intervene? The answer to this is because of market failure (knowledge externalities, adoption externalities, and incomplete information) as well as industry specific issues (speed and direction in innovation, the level playing field, the high switching costs, the unique risk in the shipbuilding industry).

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limited to expenditure on investments, design, engineering and testing activities directly and exclusively related to the innovative part of the project (Council Working Party on Shipbuilding, 2015).

Chapter 4: the Dutch innovation policy for the shipbuilding industry

4.1 Introduction

For several hundreds of years The Netherlands has been active in the shipping and shipbuilding industry. Nowadays The Netherlands is still amongst the most advanced and innovative shipbuilding nations. The shipbuilding industry is therefore still an important industry in The Netherlands, also because of its facilitating role towards other industries. In the next paragraph more details about the Dutch shipbuilding industry will provided, followed by an introduction of the ministry responsible for the Dutch innovation policy, the Dutch innovation policy (for the shipbuilding industry), and its objectives. The subsequent sections will then describe the individual innovation instruments in the Dutch shipbuilding industry that fall within the scope of the thesis.

The Dutch shipbuilding industry

In 2014 the shipbuilding industry (shipyards and suppliers) realised a total revenue of 7.5 billion euros, and provided 31,680 fte of work. The revenue of the entire Dutch industry is 277.2 billion (Netherlands Maritime Technology, 2015). The revenue of the Dutch maritime cluster therefore represents 2.7% of the total revenue of the Dutch industry.

On 31st of December 2014, the order portfolio of the Dutch shipbuilding industry comprised 156 ships, representing a total of 436,000 gross tonnage (GT)[18]. The compensated gross tonnage (CGT)[19] of the order portfolio is 698,000, comprising 8.1% of the total CGT of the European Union. The total European order portfolio is estimated at 702 ships (Netherlands Maritime Technology, 2015). The Netherlands therefore represents 22.2% of the entire European order portfolio in terms of amount of ships.

The Ministry of Economic Affairs (EZ)

The ministry responsible for execution of the Dutch innovation policy is the Ministry of Economic Affairs (Dutch: Ministerie van Economische Zaken (EZ)). EZ is one of the eleven ministries of the Dutch government. The mission of EZ is to promote a sustainable way of doing business, as well as a good business climate and a strong international position for Dutch enterprises (Rijksoverheid). The State Agency for entrepreneurial Netherlands (Dutch: Rijksdienst Voor Ondernemend Nederland (RVO)) is an agency of EZ, which executes the schemes and instruments that are particularly relevant for this thesis.

[18] Gross tonnage is an index expressing a ship's overall internal capacity. Gross tonnage is a convenient measure when one wants to express the size of a group of heterogeneous ships, for example when one wants to express the size of a nation's shipbuilding industry.

[19] Compensated gross tonnage (CGT) is an indicator of the amount of work that is necessary to build a particular ship. It is calculated by multiplying the GT of a ship by a coefficient which is determined according to the type and the size of that particular ship.

EZ's strategy and the Dutch innovation policy

Derived from key words and formulations that have been used repeatedly throughout governmental websites, the strategy behind the Dutch innovation policy seems to be two-fold. On the one hand the innovation policy should enforce and improve the competitiveness of Dutch companies. On the other hand the innovation policy is seen as key to the development of innovations that solve problems of a global scale, also known as 'social innovations', as introduced in chapter 2 (Rijksoverheid, 2014). This is confirmed by EZ itself, which summarizes its mission as: "... for sustainable and enterprising Holland" (Rijksoverheid).

In order to realise the innovation climate in which these two goals are realised, the Dutch government believes that it should create *room* for companies to create these innovations. Practically the Dutch government therefore provides *better financing, simplified rules, and new foreign markets*. Eventually, this should lead to more income and more jobs (Rijksoverheid, 2014). The strategy that has been developed in order to achieve this mission comprises several components. One component is a targeted policy for innovation and entrepreneurship, aimed at supporting companies in issues where this is absolutely necessary. Another component that is related to innovation is the intended target of a competitive business environment, for example by reducing and improving legislation and establishing an entrepreneurial fiscal policy. A final component in the strategy that is related to innovation is that EZ wants to support business that also takes into account nature and animal welfare, trying to establish a balance between economy and ecology (Rijksoverheid).

The Netherlands innovation policy is characterised by a generic and a specific part. As can be seen in Velzing's *Innovatiepolitiek* (Figure 7-2, p. 187) the financial support for both generic and specific innovation policy has been upward trending in the past four decades. Around 2009 however the financial support via generic innovation policy increased heavily, and the financial support for specific innovation policy dropped (Velzing, Figure 7-2, 2013). Currently the specific innovation policy comprises the Top Sector policy. The generic innovation policy mostly consists of fiscal benefits through WBSO, RDA and the Innovation Box.

EZ's specific objective towards innovation

The specific goal regarding innovation is: *realising a stronger innovative capacity of the Dutch economy.* This objective has been translated in three targets. First, The Netherlands has to be among the top 5 knowledge economies in the world in 2020. Currently The Netherlands is on the eighth place, according to the World Economic Forum. Second, 2.5% of the Dutch GDP has to be spent on

R&D by 2020. Third, the ambition of the so-called 'business policy' (Dutch: bedrijvenbeleid) is to achieve a participation of public and private parties worth at least 500 million euros in TKI[20] in 2015.

To realise these three targets EZ formulated four things that it will stimulate. First, EZ will stimulate extra investment in R&D and innovation in a generic and specific way regarding the top sectors, by all companies, including the SMEs. Second, it will stimulate public-private cooperation between institutions and companies, like the top consortia for knowledge and innovation (TKI). Third, EZ will stimulate the access to (risk) capital for companies, through the SME+ fund. Fourth, EZ will stimulate cooperation in European and international R&D and innovation projects. The role and responsibility of EZ have been formulated in more detail in the State Budget 2014[21].

EZ's innovation policy for the Dutch shipbuilding industry

No specific goal or aim has been formulated related to the shipbuilding industry. The industry is however part of the Top Sector Water, under 'Maritime Technology'. For the subdivision 'Maritime Technology' four goals have been formulated: winning at sea, clean ships, smart and safe sailing and an effective infrastructure (Schultz Haegen van, 2014). These four objectives are however very abstract, so in order to be able to say anything about the effectiveness of the Dutch innovation policy these objectives have to be translated in measurable variables.

Difficult to measure the effect of innovation policy

In 2011 the Dutch general Accounting Office (Dutch: Algemene Rekenkamer), published a report about the Dutch innovation policy. The main conclusion of the report was that it was not possible to determine the effectiveness and efficiency of the innovation policy between 2003 and 2010. It is not clear if the increase of government investment in innovation from 1.8 billion euros in 2003 to 3.7 billion euros in 2010 led to an increase of the innovative capacity of Dutch firms. The report further mentioned that the coherence between policy and goals is missing. In most evaluations the essential information to determine the effectiveness and efficacy is missing (Algemene Rekenkamer, 2011).

Since then EZ developed the 'business innovation policy' that is currently operative. In the monitor of this 'business policy' executed in 2014 however EZ mentions that *harsh statements about the impact of the business policy and the achievement of its goals are not (yet) possible at the moment*. *The measurability of the effects of the company policy on so-called "outcome" variables such as economic*

[20] TKI stands for 'Topconsortia voor Kennis en Innovatie', which translates with 'Topconsortia for knowledge and innovation'

[21] The more detailed role and responsibility of EZ can be found here: http://www.rijksbegroting.nl/2014/verantwoording/jaarverslag,kst208202_8.html

growth and productivity is methodologically complex and the effects will be visible only in the medium term (Ministerie van Economische Zaken, 2014).

Outline of the cases

The difficulty with measuring the effect of (the relatively new Dutch) innovation policy, together with the kinds of analysis that the research question actually asks for, demands for a different approach. The individual instruments of the Dutch innovation policy will therefore be qualitatively analysed and compared to those of the German and Norwegian innovation policy. The subsequent sections of this chapter will therefore describe the instruments in the Dutch innovation policy, and chapter 5 and 6 will do the same for subsequently Germany and Norway. However, this will not be done before the final scope down will be introduced, together with the model along which the policy instruments in the three cases will be mapped.

The used model

The following model represents the financial and fiscal instruments in the Dutch innovation model for the shipbuilding industry. It can both be specific or generic instruments, as long as the shipbuilding industry can claim it. The model that has been used has been adapted from a model used by the Australian government to describe their innovation policy, which can be found in appendix A. The model corresponds with the innovation cycle theory as explained in section 2.3. Although the model is drawn as a linear one, it should be read as a cyclical one. More information about the used model, and the values in the model (technology readiness level and commercial readiness level), can be found in appendix A.

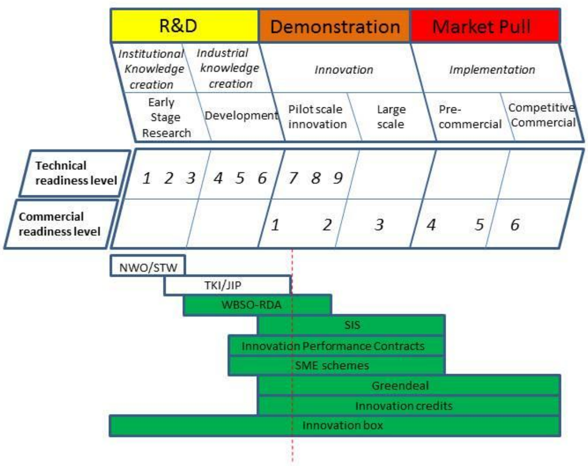

Figure 1: National instruments in Dutch innovation policy for the shipbuilding industry

4.2 Subsidy Innovative Shipbuilding (SIS)

Summary
Name (in Dutch): Subsidieregeling Innovatieve Scheepsbouw (SIS)
Budget per year (in euros): 7 million (for the years it was available)
Period available: 2007-2012, 2014
Nature: specific
Focus: big companies

The subsidy for innovative shipbuilding (SIS) is a subsidy for companies in the shipbuilding industry for order related innovation projects. The innovation projects should be industrial applications of technologically new or significantly improved products and processes related to the construction or renovation of a ship, or the construction of a floating and moving offshore-construction (Rijksdienst voor Ondernemend Nederland). The SIS is mostly beneficial to shipbuilding companies.

When in 2002 South-Korea disturbed the world wide shipbuilding industry by heavily supporting its shipbuilding industry, the European Union reacted by founding the Temporary Defensive Mechanism (TDM) (Cierna, 2004). This TDM enabled member states to support their own shipbuilding industry. Under the TDM the Dutch government issued the TROS[22], which is the predecessor of the SIS. However, the European TDM turned out to be conflicting with international trade agreements which lead to the creation of a new framework of guidelines in 2005. The new framework states that government support is only permissible if it relates to innovative projects. In order to help national governments to implement the new policy a model was developed, which formed the basis for the in 2007 introduced Dutch SIZ[23] (Dialogic, 2014).

In 2012 new European guidelines were introduced, which had to be incorporated in the Dutch SIZ. This led to the introduction of the expanded SIS, which not only focussed on sea ships, but also on inland ships. An additional alteration to the original framework was the possibility to reimburse up to 30% of the cost of innovation resulting in environmental benefits. The SIS was terminated in 2013, but at the end of 2013 the Dutch House of Representatives[24] adopted an amendment for reintroduction. This led to the continuation of the subsidy with one year in 2014 (Dialogic, 2014). The annual committed budget – in the years that it was available – was on average about 7 million euros (Dialogic, 2014).

[22] TROS stands for 'Tijdelijke Regeling Ordersteun Scheepsnieuwbouw' (English: Temporary Regulation Order support new Ship construction)
[23] SIZ stands for 'Subsidieregeling Innovatieve Zeescheepsbouw' (English: Subsidy Innovative Sea ship construction)
[24] The House of Representatives is the English equivalent of the Dutch 'Tweede Kamer'

4.3 SME schemes

Summary   Name (in Dutch): MKB regelingen (Innovatie Fonds MKB+)   Budget per year (in euros): 125 million   Period available: 2012-current   Nature: generic   Focus: SMEs

SME schemes represent several policies which support the activities of SMEs. A couple of these schemes have an innovation scope, which will therefore be handled in this section. Among the handled schemes are both generic and specific ones. Before specific instruments will be explained, the umbrella instrument SME+ Innovation Fund (Dutch: Innovatie Fonds MKB+) will be explained.

The SME+ Innovation Fund enables entrepreneurs to easier and faster develop ideas into profitable new products, processes and services. With Innovation fund SME+ the Dutch government supports fast growing, starting entrepreneurs directly or via investment funds to finance innovation plans. The development of new products or technologies is expensive. Companies further have to deal with problem related to *imperfect information* as introduced in section 3.4. This means that it is often difficult for companies to find investors, which results in loss of momentum, and a much later or no introduction of the product. Support through the fund can convince potential financers to contribute as well. In the period between 2012 and 2015 a budget of 500 million euros has been made available (Rijksdienst voor Ondernemend Nederland).

Funding from the SME+ Innovation Fund can happen through three instruments: Innovation Credit, the SEED Capital-arrangement and Fund-of-Funds. The focus of the three instruments is mostly on the phase in which knowledge is turned into a product. The Dutch government uses the formula knowledge-skills-cash (Dutch: kennis-kunde-kassa), in which these three instruments focus on the phase from knowledge to money. Section 4.7 will be dedicated to the funding instrument Innovation Credit; however the other two instruments will be discussed here (Rijksdienst voor Ondernemend Nederland).

The SEED Capital-arrangement is an instrument that helps investors, technological starters and creative starters to turn their technological and creative knowledge into applicable products or services. The scheme improves the risk-return ratio for investors and increases financing opportunities for 'technostarters' and creative starters. The instrument is focussed on closed-end venture capital funds, and is a specific instrument since it is targeting the technological and creative industry, two of the nine Dutch top sectors[25]. Fund-of-Funds is an instrument that improves the

[25] To see all the nine top sectors see: http://topsectoren.nl/

accessibility to venture capital for fast growing innovative enterprises. This instrument is currently being developed (Rijksdienst voor Ondernemend Nederland).

Participation in one of the instruments of the SME+ innovation fund is not without its own set of terms. The condition for the entrepreneur and investor is that financing has to be repaid once the development of the innovative product or service from a technical perspective has been executed successfully. The money will be put back in the innovation fund enabling the development of a new innovative product or service (Rijksdienst voor Ondernemend Nederland).

4.4 Innovation performance contracts

Summary
Name (in Dutch): Innovatie Prestatie Contracten
Budget per year (in euros): 18.7 million
Period available: 2007-2013, 2015
Nature: generic
Focus: SMEs

Innovation performance contracts are subsidies for SMEs cooperating in the same region, chain or industry in a multiannual innovation project. The subsidy was available from 2007 to 2013. In 2014 the IPC was merged to become one instrument with the MIT support scheme (Dutch: MKB Innovatiestimulering Topsectoren). In 2015 a new support scheme, namely the SME Regional and Top Sector innovation support, was introduced in which the IPC is no longer available as an isolated instrument. The IPC will however be available again under the new scheme, although details are thus far not given yet (Rijksdienst voor Ondernemend Nederland). The IPC instrument is generic, and not industry specific.

In order to get an IPC awarded the following requirements have to be met. First, under an IPC project 10 to 20 SMEs are working together on innovation projects. Second, the period of cooperation should be up to 2 years maximum. Third, the SMEs are supported by a so called secretary, which represents the interests of the SMEs. The predecessor of Netherlands Maritime Technology – Holland Marine Equipment – has been the secretary under an IPC project in 2012. The SMEs are working on individual and collective innovations in an IPC. The annual budget for IPC is estimated around 18.7 million euros.

4.5 R&D tax credit (WBSO) and Research and Development Allowance (RDA)

Summary Name (in Dutch): Wet Bevordering Speur- en Ontwikkelingswerk (WBSO) en de Research en Development Aftrek (RDA) Budget per year (in euros): 794 million + 238 million (2015) (Rijksdienst voor Ondernemend Nederland) Period available: open Nature: generic Focus: generic

The R&D tax credit and R&D Allowance are fiscal schemes that lower R&D costs for companies who perform R&D projects. The R&D tax credit decreases labor costs. The R&D Allowance is a fiscal scheme which compensates for other R&D costs and expenses, such as prototypes and research equipment. The RDA functions as additional deduction for profit tax payable, and can for that reason only be requested in combination with the WBSO (Rijksdienst voor Ondernemend Nederland, 2015). Self-employed individuals can make use of a fixed deduction, while companies pay less income tax and national insurance contributions. With these two schemes the ministry of Economic Affairs aims to stimulate entrepreneurs to increase their research investments in order to improve the innovative power and thus the competitiveness of Dutch companies (Rijksdienst voor Ondernemend Nederland). Any company, with any size from any industry, can appeal to this instrument.

Obligations for users

When a company uses the WBSO/RDA schemes there are certain obligations to fulfil, which roughly fall apart in two categories. First, a person who uses the WBSO/RDA schemes is required to keep records of the R&D projects executed under the two schemes. A proper way of keeping records of the R&D projects is to give a simple and clear overview of the nature, content, progress and the extent of the work performed. The administration can take several forms, for example: several (digital) documents, reports of meetings, drawings, photos of prototypes, test results, test reports, calculations. In the R&D records a company should also keep track of which days and how many hours per day an employee worked on the R&D project[26]. Second, a company using the WBSO/RDA schemes should provide the RVO with the records kept of the actual R&D hours, costs, and expenses realised. When a company uses the RDA on the basis of costs and expenses and not on the basis of a flat rate, then the company is also required to keep track of the realised costs and expenses and the corresponding payments per R&D project. The company is allowed to report the costs, expenses and payments in the way that is common in the company. Examples of the RDA administration are:

[26] The webpage of the following link provides a model form for the track keeping of R&D hours (model timesheet): http://www.rvo.nl/subsidies-regelingen/verplichtingen-wbso

various (digital) documents, tenders, order confirmations, invoices and receipts (Rijksdienst voor Ondernemend Nederland, 2015).

Reward for users

When the RVO acknowledges a R&D project as a project for which a company can receive fiscal benefits through the WBSO/RDA schemes, the benefits are the following. When a company uses the WBSO/RDA schemes for the first time, or only used the schemes in 2014 for the first time, the costs related to R&D hours will be calculated based on a flat rate of 29 euro multiplied by the total acknowledged R&D hours of the project by RVO (Rijksdienst voor Ondernemend Nederland, 2014). In the first bracket, which goes up to a maximum of 250,000 euro 35% of this sum can be deducted from the wage tax payable. In the second bracket from 250,000 to 14 million euro this percentage is 14% in 2015. For start-ups[27] the percentage of the first bracket is 50%. The fiscal benefit of self-employed individuals the fiscal benefit is a fixed amount of 12,421 euro. Starting self-employed individuals are eligible for an additional fixed deduction of 6,213 euro. The RDA percentage is 60%, based on the costs and expenses incurred in the R&D projects or based on a flat rate of 15 euro per approved WBSO hour (Rijksdienst voor Ondernemend Nederland, 2015). When the total amount of invested WBSO hours exceeds 150 it is not possible to calculate the RDA based on the flat rate as explained above. In this case the RDA will be calculated based on the estimated costs and expenses (Rijksdienst voor Ondernemend Nederland, 2014). The total available budget for WBSO-RDA in 2015 is 1,032 million euro (Rijksdienst voor Ondernemend Nederland, 2015).

4.6 Green deal

Summary
Name (in Dutch): Greendeal
Budget per year (in euros): n.k.
Period available: open
Nature: generic
Focus: generic

Green deal is a service provided by the Dutch government through the RVO to solve problems related to (potential) sustainable projects and activities of companies, social organisations and other governments. Green deals are agreements between the Dutch government and other parties, with the aim of supporting the execution of sustainable plans. In practical terms the role of the government can take several forms, depending on the problems or bottlenecks that the organisations in the green deal face. The four different ways in which the government contributes in a green deal are the following. First, the government can commit itself to adapt laws and regulations.

[27] A starter is defined here as an enterprise that in the past five years only had people employed to a maximum of four years. For a self-employed individual this means that he or she has been self-employed for a maximum of four years in the past five years.

In this way the government can decrease the administrative burden that the other parties face. Second, the government can be a mediator, for example in negotiations or by bringing together different parties. Third, the government can (help to) solve problems related to financing. As explained in section 3.4 financing can be very difficult in the introduction phase of an innovation. An example of a tool that the government uses is the SME+ innovation fund. Fourth, the government can help companies to develop a market for their sustainable technology, for example by helping a company to enter a foreign market (Rijksdienst voor Ondernemend Nederland).

4.7 Innovation Credits

Summary
Name (in Dutch): Innovatie kredieten
Budget per year (in euros): 60 million
Period available: open
Nature: generic
Focus: SMEs

Innovation credits are direct loans supplied by the Dutch ministry of Economic Affairs that enable entrepreneurs to finance part of the project costs of projects that are promising but technologically risky and for that reason also financially risky. The aim of this particular innovation supporting instrument is to fill the gap in the capital market in a phase where entrepreneurs are busy developing the innovation, but are not yet generating returns (Rijksdienst voor Ondernemend Nederland). This phase in which an entrepreneur is mostly only spending money, and not yet receiving it, results in cash flow problems. Because of the market failure of incomplete information as introduced in section 3.4 it is further hard to find external financers, since the success of the innovation is still hard to predict. These two problems in this phase can slow down the implementation of the innovation tremendously, or can even put the entire market introduction in jeopardy. An innovation credit can help to give the diffusion process a kick, and can further convince external investors to invest as well since a government loan makes the investment less risky.

The innovation credits are paid out of the SME+ innovation fund. In 2015 there is a budget of 60 million euros available. Innovation credits under this scheme are only awarded to projects that are technologically innovative and unique in the Netherlands, Bonaire, St. Eustatius and Saba. The entrepreneur is therefore required to explain in detail what the technical challenge involves. The project should further be approached systematically and according to a plan. Its technical feasibility needs to be established and all activities up to and including the testing of prototypes must be able to be supported. The instrument is focussed on innovative SMEs with a financing need, and is therefore generic (Rijksdienst voor Ondernemend Nederland).

4.8 Innovation box

Summary
Name (in Dutch): Innovation box
Budget per year (in euros): n.k.
Period available: 2010 - current
Nature: generic
Focus: generic/big companies

The innovation box is a special tariff box in the company tax for companies that generate profit with innovative activities. The company tax that is usually charged over profit amounts up to 20 to 25%. With this tariff box the tax payable over profit generated from an innovation activity is 5%, which results in a substantial fiscal benefit. The aim of the Dutch government with the innovation box is to promote innovation in The Netherlands (Rijksdienst voor Ondernemend Nederland, 2014). The innovation box was introduced January 1st, 2010. The innovation box is a generic instrument which can be used by any company in any industry (Rijksdienst voor Ondernemend Nederland, 2014).

There are however a few conditions or requirements that should be met in order for a company to use the innovation box. In order for a company to use this policy the company should be obligated to pay company tax, usually meaning that a company is a Private Limited Liability Company (BV) or a Public Limited Liability Company (NV). Second, a company should have spawned intellectual property. The company should have received a patent for this intellectual property, and the generated profit with this innovation (at least 30%) should be due to this patent. Further, before a company is allowed to post the profit of this innovation in the 5% company tax box, the production costs should be fully offset by the generated profit. This requirement functions as a financial threshold[28]. (Rijksdienst voor Ondernemend Nederland, 2014)

4.9 Conclusions

Table 3 summarizes the 7 innovation instrument of the Dutch innovation policy that have been analysed. Several things can be said when looking at the features of the instruments in the Dutch innovation policy. First, the amount of instruments in the innovation and implementation stage compared to the instruments in the fundamental and industrial research stage is rather high, especially compared to Germany. Second, the balance between fiscal and non-fiscal instruments is striking. The fiscal innovation climate is good in The Netherlands. A third observation is that in two cases instruments have been temporarily suspended.

[28] If a company for example invested 100,000 euros in the first and second year, and only starts generating a profit of 200,000 euro per year from year three onwards, then only from four onwards the company is allowed to put the profit generated with this innovation in the special tariff box, in year three fully offsetting the costs.

As explained in section 4.1 it is difficult to measure the effectiveness of an innovation policy. No harsh statements can therefore be made about whether or not *the innovation policy should enforce and improve the competitiveness of Dutch companies*. Neither can be confirmed that *global scale problems* have been solved yet. However, according to experts, a lot of innovations in the shipbuilding industry are sustainable innovations. Encouraging this kind of innovation does therefore result in positive externalities regarding the environment. It further seems that *the SME+ fund successfully provides access to (risk) capital*, via the credits that it provides. Other statements about the effectiveness of the Dutch innovation policy cannot be made, which can be caused by the abstract formulation of the objective, for example: "...*realising a stronger innovative capacity of the Dutch economy".* Another reason can be that the objectives do not match the scope or the nature of the analysis conducted in the case study.

Table 2: A summary of the analysed instruments in the Dutch innovation policy and their features

Instrument	Budget (million euros)	Nature	Period available	Focus industry	Focus companies
WBSO-RDA	1,032	Fiscal	Open	Generic	Generic
Innovation box	n.k.	Fiscal	2010-current	Generic	Large
SME+	65	Credit	2012-current	Generic	SME
IPC	10	Grant	2007-2013, 2015	Generic	SME
Innovation credit	60	Credit	Open	Generic	SME
SIS	7	Grant	2007-2012, 2014	Specific	Large
Greendeal	n.k.	Grant	open	Generic	Generic

Chapter 5: CASE Germany

5.1 Introduction

The maritime industry is a high-technology industry that is among the main and most advanced sectors in the economy of Germany. The industry counts for approximately 400,000 employees and has an annual sales volume of more than 54 billion euros (Projekttrager Jülich). Expressed in compensated gross tonnage the estimated German order portfolio on the 31st of December 2014 is the second biggest in Europe, after Italy (Netherlands Maritime Technology, 2015). Combining this with the fact that Germany was the third most innovative country in Europe according to the European Union's Innovation Union Scoreboard of 2014, where The Netherlands took place six, makes the German shipbuilding industry an interesting case for review (European Commission, 2014). This is what will be done in the next sections, in the following order. First, the German shipbuilding industry will be introduced in more detail, followed by an introduction of the ministries responsible for (the execution of) its innovation policy. Next, the objectives of the German innovation policy will be given, followed by the description of the three policy instruments that fall inside the scope of the thesis.

The German shipbuilding industry

The relative size of the shipbuilding industry in Germany is almost equal to that of The Netherlands, namely about 2.8%. The entire German industry is however about seven times bigger, which ten logically also holds for the shipbuilding industry. The total revenue of the German industry amounted about 1,920 billion euros[29]. However according to NMT's annual report of 2014, the German shipbuilding industry had an order portfolio of 28 ships, 1,491,000 gross tonnage and 1,444,000 compensated gross tonnage, representing 16.8% of the European Union total CGT on December 31st, 2014. Although these numbers also show that the German shipbuilding industry is bigger than the Dutch one, the difference in size seems to be smaller than what was suggested by the previous measurement. The German GT is only about 3.5 times bigger than the Dutch GT, and with the CGT the difference is only about 2 times the Dutch CGT.

The German Government

The German government consists of 14 ministries. Of those 14 ministries three are important regarding innovation instruments for the shipbuilding industry. The Federal Ministry of Economic Affairs and Energy is the most important ministry, since it administers/administered 7 of the 10 instruments that have been found to support the German shipbuilding industry. 2 of those 7

[29] The revenue of the car industry of Germany in 2014 was 384 billion euros, which was about 20% of the total German industry (Bitonto Di, Stefan; Trost, Rico, 2015). The revenue of the entire German industry is therefore about 1,920 billion euros.

instruments fit the scope of the thesis and will therefore be explained in this chapter. Another Federal Ministry that is of importance is that of Education and Research, which administers 2 of the 10 schemes, of which one fits the scope. Finally, the Federal Ministry of Transport and Digital Infrastructure administers one scheme that is interesting for the shipbuilding industry (Bundesministerium fur Wirtschaft und Energie, 2014). This scheme however falls outside of the scope of this thesis and neither the ministry nor the scheme will therefore be incorporated in the main text (Fiedler, 2014).

The German innovation policy

No overarching list of objectives of the German innovation policy has been found. In order to get an idea of these objectives though, the innovation objectives of the two ministries that will be reviewed in this case will be introduced.

The central task of the Federal Ministry of Economic Affairs and Energy (BMWi) is to reinvigorate the social market economy, stay innovative in the long term and strengthen the social fabric in Germany. Different objectives have been established, which form a guideline for concrete political action. Regarding innovation these guidelines are formulated as follows: *we are deploying an active industrial policy. Our approach is to focus on the lead markets and lead technologies of the 21st century, to provide the scientific infrastructure needed to support these, and to improve the way in which innovation is brought to the market* (BMWi, 2015). The primary objective of the technology policy of BMWi is to improve the policy environment for research and innovation within German businesses. The framework consists of nine components. A striking component is public procurement. The total volume of public-sector contracts in Germany is estimated at about 300 billion euros per year. This could therefore very well be the potential driver of innovation (BMWi, 2015).

The Federal Ministry of Education and Research (BMBF) wants to realise five objectives: (1) more equity in education, (2) career opportunities, (3) strengthening innovativeness, (4) German science must continue to be the world’s best and (5) funding research. Two objectives are therefore related to innovation, of which one is related to the scope of the thesis. *BMBF has an annual budget of approximately 15.3 billion euros*, of which about 300 million will be invested in basic research, and 250 million in technology and innovation funding. In order to achieve the goal of strengthening innovativeness an interdepartmental High-Tech Strategy has been developed as comprehensive national innovation strategy (BMBF, 2015). The aim of the High-Tech Strategy is to speed up the transfer of scientific findings into marketable products, processes and services, as well as on improving the overall environment for innovation. To achieve this, the German government invested 14 billion euros in 2014, and will do the same in 2015 (BMWi, 2014).

A summary of the instruments of the German innovation policy

The different instruments that fit in the scope of the thesis will be described in a top-down manner in the following sections. However, before describing the instruments individually an overview of the fiscal and financial generic and specific instruments in the German innovation policy for the shipbuilding industry has been provided in figure 2:

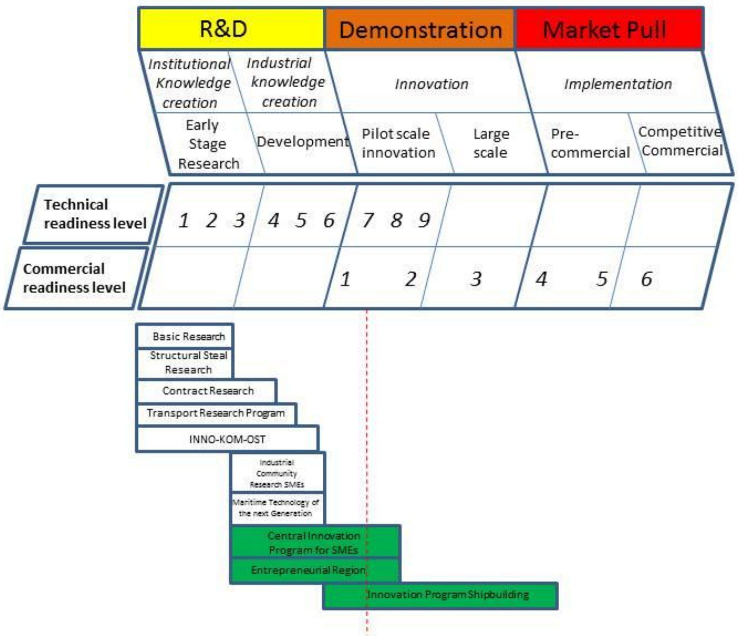

Figure 2: National instruments in German innovation policy for the shipbuilding industry

The Federal Ministry for Economic Affairs and Energy

The Federal Ministry for Economic Affairs and Energy (in German: Bundesministerium für Wirtschaft und Energie), abbreviated BMWi, is a cabinet level ministry of the Federal Republic of Germany, which is responsible for most of the innovation policy execution of Germany. The BMWi is organised into 9 departments[30] and one central department (Bundesministerium für Wirtschaft und Energie, 2015). It is not retraceable which department is responsible for which innovation instruments, but BMWi offer two instruments that fall within the scope of this thesis.

[30] The 9 departments are: Political Staff and Policy Planning, European Policy, Economic Policy, Energy Policy: Heating and Efficiency, Energy Policy: Electricity and Grid, Industrial Policy, External Economic Policy, Innovation, IT and Communications Policy, SME Policy. The central department is called Central Administration.

5.2 Central Innovation program for SMEs

Summary
Name (in German): Zentrales Innovationsprogramm Mittelstand (ZIM)
Budget per year (in euros): up to 350,000 per project (Fiedler, 2014) with an average annual budget of 500 million (European Commission, 2012)
Period available: 2008-2014 (Fiedler, 2014)
Nature: generic
Focus: SMEs

The Central Innovation Program (ZIM) for SMEs is a nationwide, technology and market open funding program issued by the Federal Ministry of Economics and Technology (BMWi). The purpose of the program is to support SMEs and cooperating research institutes, in order to create more research, development and innovation. The speed of the development and implementation of an innovation resulting from R&D findings should be increased. The innovation program further encourages the expansion and improvement of entrepreneurial innovation, cooperation and network management, the cooperation between SMEs and research institutions (Die Bundesregierung, 2015). Practically these goal are to be achieved by providing SMEs with grants and low-interest loans so they can finance research and innovation projects (Bundesministerium für Wirtschaft und Energie, 2015).

Three kinds of projects can get funded through the Central Innovation Program for SMEs. First, individual projects in which a company develops in-house innovation capabilities. Second, cooperation projects in which R&D is undertaken with several SMEs as well as SMEs and research institutes to develop innovative products, processes or technical services, not limited to particular technologies or industries. Third, cooperation networks can get supported through network management services and funding for the development of projects of the network. The network should consist of at least six SMEs as well as possible other partners like research institutes, large companies and other institutions (Die Bundesregierung, 2015). Cooperation with research institutes is especially encouraged in order to realise or speed up the conversion from new scientific findings to marketable products (Bundesministerium für Wirtschaft und Energie, 2015).

The Central Innovation Program for SMEs is the most successful funding program designed to support the innovative medium-sized companies in Germany. 4500 R&D projects are approved every year (Bundesministerium für Wirtschaft und Energie, 2015). 25% to 55% of the costs eligible for support, up to a maximum of 350,000 euro per sub-project can be co-financed for companies. For research institutes this is 90% to 100% up to a maximum of 175,000 euros or 350,000 euros for collaborative projects. The maximum amount of co-financing for an entire collaborative R&D project is 2 million euros. Services and consulting related to innovation can be co-financed for 50% of the eligible costs up to a maximum of 50,000 euros or 75,000 euros in the special case of international or export oriented projects[31] (Federal Ministry of Economics and Technology (BMWi), 2012).

5.3 Innovation program Shipbuilding

Summary
Name (in German): Innovationsprogramm Schiffbau
Budget per year (in euros): ca. 12 million (Fiedler, 2014)
Period available: 2011-2015 (Fiedler, 2014)
Nature: specific
Focus: generic/big companies

The Innovation program Shipbuilding, issued by BMWi, is created to stimulate industrial applications of results achieved in research and development, as well as applications of new ideas or ideas that are new to the shipbuilding industry. Research and development comprises basic research, industrial research or pre-competitive development. Ideas that are new to the industry can be applications of concepts, products or processes from another industry, and where risks and technological or economic failures are given, due to previous application in the other industry (Bundesamt für Wirtschaft und Ausfuhrkontrolle).

Shipbuilding innovations that can be awarded with a subsidy under this program are innovations that are industrial applications of innovative concepts, products or processes that are new if compared to the technical state of the shipbuilding industry in member states of the European Union. There are three categories of eligible shipbuilding innovations: new vessel types, new ship component and systems and new methods in the shipbuilding industry. Support for new vessel types can be received if the ship is the first ship of a potential new batch. The rationale behind support for the development of this ship is the potential gains of this development for other ship constructions and the development of new components or procedures for this ship. The development of new components and systems for ships and the development of new methods in the shipbuilding industry are also potentially subsidized itself (Bundesamt für Wirtschaft und Ausfuhrkontrolle).

The Innovation program Shipbuilding is the German equivalent of the Dutch SIS. Since there is a European framework behind this subsidy the characteristics of the subsidy are the same as the SIS. Up to 20% of the gross development costs are eligible. The new directive in 2012 made it possible that the development costs of environment improving innovations are eligible for 30%. The new directive further opened the subsidy to barges and floating and moving offshore structure too, just as in The Netherlands.

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[31] Further details about co-financing under this program can be found in the following document: http://www.bmwi.de/English/Redaktion/Pdf/central-innovation-programme-sme,property=pdf,bereich=bmwi2012,sprache=en,rwb=true.pdf

The Federal Ministry of Education and Research

The Federal Ministry of Education and Research (German: Bundesministerium fur Bildung und Forschung (BMBF)) is responsible for the education and research policy of the German government. The Ministry is organised in 7 departments and one central department. The scheme that, although generic, might be interesting for the shipbuilding industry is the Entrepreneurial Regions scheme, which will be discussed in the next section.

5.4 Entrepreneurial Regions

Summary
Name (in German): Unternehmen Region – Die BMBF-Innovationinitiative für die Neuen Länder
Budget per year (in euros): open budget (Fiedler, 2014)
Period available: 1999-2015 (Fiedler, 2014)
Nature: generic
Focus: generic

The Entrepreneurial Regions initiative stands for the building and expansion of special technological, scientific and economic competences in East German regions. The goal is to translate the competences that exist in the region into innovations, economic growth and employment. This initiative is therefore the basis for the creation of regional economic clusters (Bundesministerium für Bildung und Forschung). In order to achieve long-term success of regions in the New German Länder the Federal Ministry of Education and Research developed several programs[32] since 1999. The reasoning behind the programs is that most innovative products and applications are almost entirely the result of highly specialised and internalised knowledge and skills that exist in people and organisations. Entrepreneurship is therefore pivotal in the philosophy of the programs (Bundesministerium für Bildung und Forschung).

There are four guidelines behind the philosophy of “Entrepreneurial Regions”. First, the initiative promotes the strengths in the region as outstanding potential for innovation. Innovation is key to successful economic development, and the initiative is therefore based on ‘only the best from the region’. The second guideline is that of joint, creative and strategic action. The innovation potential from the regions strengths is developed in a network of industrial, scientific, academic and administrative actors in the region. Third, innovations should be marketable. From the development stage onwards this entrepreneurial approach should be incorporated. Practically this demands for strategically designed concepts and a long-term marketing strategy. The final guideline, which is

[32] The programs that were introduced by BMBF are: Innovative Regional Growth Cores (German: Innovative regionale Wachstumskerne, since 2001), with GC Potential (German: WK Potenzial, since 2007), Centres for Innovation Competence (German: Zentren für Innovationskompetenz, ZIK, since 2001) InnoProfile (since 2005), ForMaT (since 2007), Twenty20 – Partnership for Innovation (German: Zwanzig20 – Partnerschaft für Innovation, since 2012) and InnoRegio (1999-2006) (Bundesministerium für Bildung und Forschung).

more like an umbrella guideline, is that the BMBF wants to achieve *regions with clear profiles based on outstanding technological platforms* (Bundesministerium für Bildung und Forschung).

An example of a regional innovation sub-project in the maritime industry is that of Maritime Safety Assistance developed in Rostock-Warnemünde between 2006 and 2009. The common goal of the project is to develop and market assistance systems for secure maritime transport. The project was a further step to promote Rostock as a recognized problem-solving area for ship safety (Bundesministerium für Bildung und Forschung).

5.5 Conclusions

Table 4 summarizes the three innovation instruments that have been analysed. The first observation is that the German innovation policy is very much focussed on fundamental research. Only 3 of the 10 innovation instruments that have been found fitted the scope of the thesis; 7 were too fundamental in nature. BMWi's objective of *providing the scientific infrastructure needed to support the lead markets and lead technologies of the 21st century*, seems therefore to be well support by the German innovation policy. What is further interesting about the German innovation policy is that all three instruments provide grants, and that Germany does not use any fiscal innovation incentive. Another interesting observation is the striking size of the public-sector contracts in Germany, worth about 300 billion euros per year. Although it is no direct innovation instrument, the effect can be the same as an innovation credit or government support for access to risk-capital, because it might help companies through the difficult initial stage of implementation of their innovation. Mostly because of the abstract formulation of other innovation objectives, like 'strengthening innovation', no further statements can be made about the effectiveness of the German innovation policy.

Table 3: A summary of the analysed instruments in the German innovation policy and their features

Instrument	Budget (million euros)	Nature	Period Available	Focus industry	Focus companies
ZIM	500	Grant	2008-2014	Generic	SME
Entrepreneurial regions	Open	Grant	1999-2015	Generic	Generic
Innovative shipbuilding	12	Grant	2011-2015	Specific	Large

Chapter 6: CASE Norway

6.1 Introduction

Norway is known for its fjords, fish and its long maritime tradition. The relation with the marine industry and the owning of (fishing) ships seems therefore natural. Norway further possesses huge oil and gas reserves. The country therefore also has natural ties with the maritime and offshore industry. Despite being recognised as a "high cost" country, Norway has been able to build up a successful shipbuilding industry. The choice for Norway as a case study seems logical then. The case study will be structured as follows: first, the Norwegian shipbuilding industry, the Norwegian government, and the (objectives of the) innovation policy will be introduced. After that the individual policy instruments that fit the scope of the thesis will be described.

The Norwegian shipbuilding industry

The turnover of the Norwegian shipbuilding industry in 2013 was 62.5 billion euros. The industry employed in that year 112,227 people. The order portfolio on the 31st of December 2014 consists of 42 ships, a total of 195 GT and 313 CGT, hence comprising 3.6% of the total European order portfolio CGT. This measurement suggests that the Dutch shipbuilding industry is more than twice as big as the Norwegian shipbuilding industry. However, in term of total turnover the story is quite different. The Dutch shipbuilding industry realised a turnover of 6.4 billion euros in 2013 and 7.5 billion euros in 2014. According to an adviser at the Norwegian Ministry of Trade, Industry and Fisheries the Norwegian shipbuilding industry realised a total turnover of 499.7 billion NOK, or about 60 billion euros[33] (see Appendix C2). This means that the turnover of the Norwegian shipbuilding industry is about 10 times bigger than that of the Dutch shipbuilding industry in 2013.

The Norwegian government

The Norwegian government is organised in 15 ministries[34]. The ministries of particular interest for the thesis are the Norwegian Ministry of Trade, Industry and Fisheries and the Ministry of Education and Research. The reason why the Ministry of Education and Research will be handled is that the Ministry also administers instruments that a company can claim in later phases than the fundamental and industrial research phases.

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[33] For calculations in this chapter a conversion rate of 1 euro equals 8.5 Norwegian Crowns has been used. The Norwegian exchange rate fluctuated around 8.5 NOK per euro the last year. However, for the calculation of this figure an exchange rate of 1 euro equals 8 NOK has been used, because in 2013 the exchange rate fluctuated around 8 NOK per euro (XE Currency Converter, 2015).

[34] Information about the other 14 ministries and other information about the structure of the Norwegian government can be found on: https://www.regjeringen.no/en/dep/id933/

The Norwegian innovation policy

The Norwegian national budget of 2015 formulates the purpose of innovation as follows: *Innovation can enhance the competitiveness of the business sector via new or improved products and processes, or via organisations that work better and compete in new markets* (Royal Ministry of Finance, 2015). It is further stated there that innovation is knowledge-intensive and often based on R&D. For that purpose the budget proposal of the Government is that it will allocate 32.4 billion NOK to R&D in 2015. Finally it is mentioned that in Norway most of the innovation policy measures at the enterprise level are under the administration of Innovation Norway (Royal Ministry of Finance, 2015). According to Oleynik & Toivonen (2012) the Norwegian government published a political steering document in 2003 called: *The Plan from Idea to Value*. The overarching objective of this document and the subsequent policy changes is to facilitate increased wealth creation across the country (Oleynik & Toivonen, 2012).

No other general statements about innovation policy and its objectives have been found, so the objectives of the Norwegian innovation policy will be composed from the individual goals of the leading innovation institutes, agencies and instruments. As mentioned in the previous section two Norwegian ministries will be analysed to map the Norwegian innovation policy (that falls within the scope of the thesis). The Ministry of Trade, Industry and Fisheries administers the leading instrument Innovation Norway (IN), and the Ministry of Education and Research administers the Research Council of Norway. The mission of IN is however only related to the instrument itself, and will therefore only be handled in the section about IN. The mission of the Research Council of Norway is however more comprehensive. The main strategy of The Research Council for the period 2015-2020 consists of two overarching challenges: Society must expand its private and public innovation capacity, and it must enhance sustainability in all areas (The Research Council of Norway, 2015). The mission of The Research Council is therefore very similar to that of the Dutch Ministry of Economic Affairs.

Also the European Commission's Platform of Research and Innovation policies and systems (ERAWATCH) identified the Norwegian Research Council as important contributor to the Norwegian innovation policy. Although they might be a bit out-dated, ERAWATCH summarized 11 policy priorities[35] for the Research Council of Norway in the period 2011-2014. 5 of these policy priorities fit the scope of the thesis: (1) increased funding for pilot, verification and demonstration projects; (2) improved selection and closer monitoring of innovation projects; (3) better use of the SkatteFUNN

[35] The list of policy priorities can be found here: http://erawatch.jrc.ec.europa.eu/erawatch/opencms/information/country_pages/no/policydocument/policydoc_0007

tax deduction scheme; (4) more innovation in key areas of knowledge and (5) greater value creation in strong areas of industry (ERAWATCH, 2012). No explicit innovation policy towards the Norwegian shipbuilding industry has been formulated or could be found.

A summary of the policy instruments of the Norwegian innovation policy

Before the two previously explained ministries will be described and the policy instruments they administer, a summary of the individual policy instruments of the Norwegian innovation policy has been provided in figure 3. As note 30 explains an exchange rate of 8.5 NOK equals 1 euro will be used for calculations in the upcoming sections.

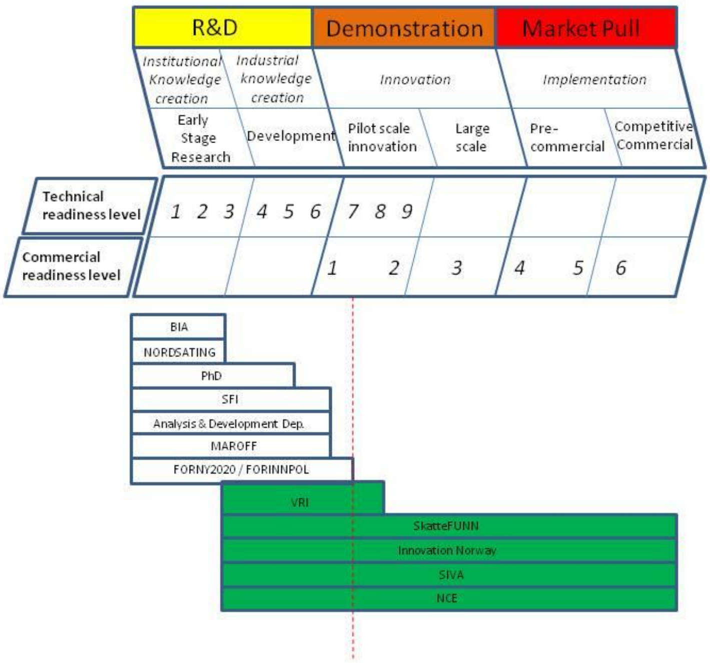

Figure 3: National instruments in Norwegian innovation policy for the shipbuilding industry

The Ministry of Trade, Industry and Fisheries

The Ministry of Trade, Industry and Fisheries is responsible for the design of industrial and marine policy with a future scope. This encompasses involvement in any policy area that has an effect on value creation. Value creation is what determines the long-term prosperity of Norway, and the objective of the Norwegian government's industrial and seafood policy is therefore to maximise value creation in the Norwegian economy. It is for that reason that the Ministry promotes trade, research, innovation and entrepreneurial spirit (Regjeringen, 2014).

The Research and Innovation Department

The Ministry of Trade, Industry and Fisheries is organised in 8 departments[36]. The department that is particularly interesting is the Research and Innovation Department. The Department of Research and Innovation is subsequently divided in four sections: research policy, innovation policy, institutes and marine research and Innovation Norway, the Industrial Development Corporation of Norway (SIVA) and financial instruments. The section of Institutes and marine research falls outside of the scope of this research and will therefore not be investigated. Further, research policy will be tackled in the section about the Research Department of the Ministry of Research and Education. Part of the innovation policy is handled by the Innovation Division of the Research Council of Norway, which is administered by the Ministry of Research and Education. This part of the innovation policy will therefore be handled in the section of the Ministry of Research and Education. This leaves only part of Norway's innovation policy for discussion here, namely the part through the instruments: Innovation Norway, SIVA and the financial instruments.

Innovation Norway, SIVA and financial instruments

The fourth section is among other things responsible for the overall management and funding of Innovation Norway. The next paragraph will be dedicated to Innovation Norway. Tasks of the fourth section further comprise the management and funding of Industrial Development Corporation of Norway (SIVA) as well as financial instruments. These instruments are a form of aid provided by the Norwegian government through Innovation Norway. The financial support takes the form of grants, innovation loans, guarantees, seed capital funds and commercial low-risk loans. Finally, the fourth section also manages the funding of the commercial venture fund investor Investinor, a subsidiary of Innovation Norway (Viken, Trond). Investinor invests in promising unlisted companies aiming for international growth and expansion. This is outside of the scope of the thesis and will therefore not be handled in subsequent sections, as opposed to Innovation Norway and SIVA.

6.2 Innovation Norway

Summary
Name (in Norwegian): Innovation Norway
Budget per year (in euros): 718 million
Period available: open
Nature: generic
Focus: generic

Innovation Norway (IN) is the most important instrument of the Norwegian Government for innovation and development of Norwegian companies and industry. The mission of IN states that *by*

[36] Information about the other 7 ministries can be found here: https://www.regjeringen.no/en/dep/nfd/organisation/Departments/id736/

combining local industry knowledge and international networks with the business ideas and the motivation of entrepreneurs, the foundation for new successful business is created (Innovasjonnorge). IN supports enterprises in developing their competitive advantage and to engage with innovation in order to grow and find new markets (Innovasjonnorge). To that end presence in the foreign market is seen as crucial[37]. IN is therefore the Norwegian government's official trade representative abroad (Innovasjonnorge). 51% of IN is owned by the Ministry of Trade, Industry and Fisheries. The remaining 49% is owned by the provincial authorities (Innovation Norway, 2015).

IN has a broad and complex social assignment. Central to the assignment is the expectation of value creation by stimulating to the growth within profitable business development throughout Norway. The organisation website of IN gives the four themes that IN support, which are: growth companies and clusters, internationalisation, start ups and sustainability (Innovasjonnorge). To support growth companies and clusters IN provides the following programs and services: FRAM[38], Strategic Positioning[39], Design Service[40], IPR[41] and InnovFin[42]. These programs and services fall outside of the scope of this thesis, either because of their non-financial or non-fiscal nature or their international nature, and will therefore not be discussed extensively in the main text. The other three themes, which are internationalisation, start ups and sustainability do also not provide instruments that fall within the scope of the thesis.

The contribution of IN – more on an activity basis – is described in their annual report of 2014, identified by the abbreviation 'IFCA'. "I" stand for the Internationalisation assistance that it provides through market advisory service and promotional services. "F" stands for Funding in the form of loans or grants. "C" stands for Cluster of which the enterprise can be a member. This is a networking service provided by Innovation Norway. Finally, "A" stands for Advisory capturing any advisory service or expertise areas not covered by any of the three earlier contributions (Innovation Norway, 2015). Funding is an important part of IN's activities since it comprises a big stake of their annual budget. The financial services of IN comprise: low risk loans, innovation loans, grants and guarantees.

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[37] Innovation Norway is present in 30 countries worldwide and all Norwegian counties.
[38] FRAM is a program for SMEs to upgrade their business and management skills.
[39] The Strategic Positioning service is offered by IN for companies to best differentiate from other firms. Although it is possible for individual firms to get this service, IN prefers to offer the service to clusters and networks with umbrella brands, because it makes it possible to realise cluster/network wide projects, which immediately helps to develop/strengthen this umbrella brand and the cooperation in the cluster/network.
[40] The Design Service helps a company to position strategically, to build a strong brand and to use design strategically in order to realise a competitive advantage.
[41] The IPR service of IN helps to create a map of the IPR in a company in order for the company to make better decisions with regards to protection and commercial use of this IPR.
[42] InnovFin is EU Finance for Innovators. The instrument is part of the EU framework Horizon 2020 and is a joint initiative of the European Investment Bank (EIB), the European Investment Fund (EIF) and the European Commission.

A specific innovation related financial service is that of R&D contracts. These contracts are offered to companies that have an innovative idea with international potential that they want to develop in close cooperation with the public or private sector. Annually 300 million euros in grants is awarded to R&D contracts in the industrial and public sectors to alleviate risk and to encourage start-ups of demanding development projects (Innovation Norway).

The joint amount of funding provided by the Norwegian Parliament (Storting) and the province councils for value-adding business development activities all over Norway in 2014 is equal to 2.8 billion NOK, which equals 330 million euros. Together with loan schemes the total amount of funds made available is 6.1 billion NOK or 718 million euros. Of the 6,091 million NOK in funds provided to Norwegian companies, 474 million NOK or 55.8 million euros was invested in the maritime industry (Innovation Norway, 2015). The percentage of Innovation Norway funds invested in the maritime industry is therefore 7.8%.

One of the key figures in the annual report of 2014 is the percentage point higher growth in annual turnover three years after Innovation Norway provided support, compared with similar companies which did not receive such help. This figure was 9.7% higher for companies which received support (Innovation Norway, 2015). This makes for an interesting measure, and emphasizes the importance of value creation for Innovation Norway and the Norwegian Government.

6.3 SIVA

Summary
Name (in Norwegian): Selskapet for industrivekst
Budget per year (in euros): n.a.
Period available: 1986-current
Nature: generic
Focus: generic/start-ups

SIVA (Norwegian: Selskapet for industrivekst) is the Industrial Development Corporation of Norway. This state enterprise owned by the Norwegian Ministry of Industry, Trade and Fisheries was founded in 1968. SIVA works closely with Innovation Norway, the Norwegian Research Council and the Norwegian Patent Office (SIVA, 2015). The aim of SIVA is to develop strong regional and local industrial clusters through ownership in key components like infrastructure, investment and knowledge networks and innovation centres. Ultimately the development of regional and local industrial clusters should improve the national infrastructure for innovation. SIVA has a special task in looking after the achievement of the Norwegian government's policy goals in remote areas. In doing this regional innovation capabilities should be unleashed and increased wealth creation should be realised throughout the entire country of Norway (Regjeringen).

SIVA is divided in three pillars. The organisation defines it as follows: *We facilitate innovation by building, owning and developing infrastructure for industry, start-ups and research environments* (SIVA, 2015). The first pillar of 'building' includes the investments of the organisation in real estate and commercial property in order to reduce the risk for new entrants where market mechanisms makes this particularly demanding. Real estate operations are executed by a subsidiary of SIVA Siva Eiendom Holding (SHE)[43]. The 'own' pillar comprises the ownership that SIVA has in over a 100 innovative companies across Norway at this moment. These companies are important innovation agents in their environment, and ownership helps to realize their potential through connections with entrepreneurs and research environments. The third pillar – 'develop' – stands for the knowledge development and the development of start-up environments, and the connection to regional, national and international networks (SIVA, 2015). This is realised through innovation programs in which companies are enlisted that are Norway's finest business developers. Each year these "Siva partners" supports 2000 start-ups and businesses (SIVA, 2015).

The Ministry of Education and Research

The Ministry of Education and Research is responsible for research as well as for *primary and secondary school, upper secondary and tertiary vocational education and higher education sectors, as well as kindergartens and cultural schools* (Regjeringen). Of all the responsibilities of the Ministry only a part of their responsibility for research falls within the scope of this thesis. Only one out of seven departments of the Ministry is therefore interesting for further investigation, namely the Department of Research.

The Department of Research

The Department of Research has strategic responsibility for research policy. These responsibilities comprise preparing white papers on research, and coordinating research policy across ministries (Regjeringen). Since the Research Department has a coordinating role concerning the research policy, this topic will be discussed here instead of under the Research and Innovation Department of the Ministry of Trade, Industry and Fisheries. The aim in writing about the research policy is to make a list of the instruments that serve this policy.

As mentioned in the previous paragraph the key role of the Department of Research is their responsibility for the research policy. The activities of the department therefore revolve around this key task. One activity is the preparation of white papers, material that describes how government policy, a technology or a new product, solves a certain problem. This serves as decision material for

[43] SEH is a commercial company seeking profit and dividends, but its purpose is to contribute to innovation and economic development. SHE is for that reason different from other real estate companies. Sivas investments should always trigger private capital investments (SIVA, 2015).

the Norwegian government on how to take action and which researches the fund. Complementary to this task is the coordination of research policy across ministries. The department further has an administrative responsibility for the Research Council of Norway, which will be discussed in the subsequent section. Further responsibilities, via the Research Council, comprise of awarding grants for basic research, strategic projects and research infrastructure.

Next to responsibilities for the national research policy and collaboration, the Research Department also plays a role in (funding of) international research collaboration, research organisations and programmes. The most important international research program here is the EU framework, Horizon 2020. Other activities are of a more fundamental (research) nature and fall therefore outside of the scope of the thesis (Regjeringen).

The Research Council of Norway

The Research Council of Norway is a national strategic and funding agency for research activities. The council is the government's main source of advice on and contributor to their research policy, as well as for the central government administration and the overall research community. The main objective of the council is to make sure that Norway invests its money in R&D adequately (The Research Council of Norway, 2012). The Research Council is funded by the 16 ministries that the Norwegian government exists of. The three largest contributors are the Ministry of Education and Research, the Ministry of Trade and Industry, and the Ministry of Petroleum and Energy (Forskningsradet, 2013).

The Research Council defined four key challenges that it should deal with in order to achieve its goal. First, it should improve the capacity and quality of Norwegian research. Second, it should strengthen the research in areas that are of key importance for research, trade, industry and the entire Norwegian society. Third, it should promote constructive cooperation, structures in the research system and distribution of responsibility in this system. Finally, research should be translated into action (The Research Council of Norway, 2012). In order to achieve their goals adequately the council is divided in five divisions. Of those five, only the Division for Innovation falls within the scope of this thesis.

The Division of Innovation

Responsibilities of the Division of Innovation comprise the mobilisation and funding of research within and for Norwegian industry and trade. In order to do so the division performs analyses and develops strategies for thematic areas related to industry and trade as well as for the innovation system as a whole (The Research Council of Norway, 2014). The division is divided in five themes or objectives. Two of these themes and the corresponding generic and specific instruments will be discussed in the next sections. The Department of Technologies and Industries will not be discussed because of its focus on fundamental and industry research, and therefore its mismatch with the scope of this thesis[44]. The Department of Analysis and Development will not be discussed in this thesis because the department solely has responsibilities for the strategy of the activities of the Research Council without a relation to fiscal or financial innovation schemes or instruments[45]. The third department that will not be discussed here is the Department for Innovation in Industry. This Department for Innovation in Industry is responsible for several industry-oriented funding programs. The focus of these programs is on the specific needs on individual companies, not on that of a particular branch of industry or a specific thematic area (The Research Council of Norway, 2012). The Department is responsible for five funding programs, however none on the instruments fall within the scope of national financial or fiscal instruments, either because they are instruments issued by the European Union, or because their nature it too much pre-competitive or fundamental.

Regional Research and Innovation

The responsibility for coordination of the Research Council's regional research and innovation activities is in the hands of the Department for Regional Research and Innovation. These activities *range from promoting new regional research and innovation and encouraging networking measures to the provision of funding* (The Research Council of Norway, 2014). The department stimulates cooperation between industry, research and regional partnerships in order to develop new knowledge about innovation processes in a regional context. The department coordinates three instruments that aim to achieve this goal: the Programme for Regional R&D and Innovation (VRI), the Regional Research Funds and the Research Initiative for Northern Norway, which will subsequently be worked out in the next sections.

6.4 Program for Regional R&D and Innovation (VRI)

Summary
Name (in Norwegian): Virkemidler for Regionale FoU og Innovasjon (VRI)
Budget per year (in euros): 7.2 million
Period available: 2007-2017
Nature: generic
Focus: generic

[44] Research relevant for the maritime industry happens in the so-called MAROFF (Maritime activities and offshore operations) project of which more information can be found on: http://www.forskningsradet.no/servlet/Satellite?c=Page&cid=1228296528774&p=1228296528774&pagename=maroff%2FHovedsidemal

The Program for Regional R&D and Innovation (Norwegian: Virkemidler for Regional FoU og Innovasjon (VRI)) is a national program. The initial timeframe of the program is ten years (2007-2017). The precise work program is open for revision and development throughout the program period (The Research Council of Norway, 2004). VRI is run jointly by the Research Council of Norway and Regional Authorities. The program consists of a set of tools and helps regions to focus, to develop their own R&D strategy and to innovate (A film about VRI, 2009).

The program is designed to promote regional collaboration between R&D institutions, government authorities and trade and industry. It should further establish closer ties to other national and international network and innovation instruments. Examples are the Arena program, Norwegian Centres of Expertise (NCE) and the Regions of Knowledge initiative. In the end the goal of VRI is to create more innovation, knowledge development, and added value. The Fundamental components of the VRI program are research activity, exchange of experience, learning and cooperation across scientific, professional and administrative boundaries (The Research Council of Norway, 2004). A further criterion for eligibility for financial support from the Research Council, is that the VRI initiative must take place within a regional partnership. The partnership has to contribute 50 percent of the project funding (The Research Council of Norway).

6.5 SkatteFUNN Tax Deduction Scheme

Summary
Name (in Norwegian): SkatteFUNN
Budget per year (in euros): upto 18% (big companies) or 20% (SMEs) with a maximum of 2 million (individual projects) or 4 million (joint projects) per project with a budget of 277 million euros in 2015
Period available: open
Nature: generic
Focus: generic

The primary responsibility of the SkatteFUNN department is to administer the SkatteFUNN Tax Incentive Scheme. This responsibility comprises application assessment, project follow-up, and measures to encourage new actors from industry to start research and innovation activities. The SkatteFUNN scheme is among the most widely used instruments to support R&D in Norwegian industry and trade because of its generic nature. The scheme is open to any type of company active in any industry, not depending on the size of the firm or the geographical location that it is located in (The Research Council of Norway, 2012).

Companies that have to pay tax in Norway are eligible to apply for tax relief. Approved projects may namely receive a tax deduction of up to 20 percent (Forskningsradet, 2014). Not only should a company be incorporated in Norway and liable to pay tax there, the dedicated R&D project for which the scheme is requested must seek to develop a new or improved product, service or production process. SMEs can receive a tax deduction up to 20 percent, while large enterprises can receive this tax deduction up to 18 percent of the project costs. The cost ceiling for R&D projects using in-house R&D resources is 15 million NOK (almost 2 million euros). The cost ceiling for R&D projects with pre-approved external R&D resources is 33 million NOK (about 4 million euros) (Forskningsradet, 2014)[46].

6.6 Norwegian Centres of Expertise

Summary
Name (in Norwegian): Norwegian Centres of Expertise
Budget per year (in euros): 19 million
Period available: open
Nature: specific
Focus: generic

The Norwegian Centres of Expertise scheme (NCE) encourages industrial innovation in a regional context, through cooperation between companies, researchers, university colleges and the public authorities (The Research Council of Norway, 2009). The Blue Maritime Cluster is part of the Norwegian Innovation Clusters program. It is organized by Innovation Norway, and supported by SIVA and the Norwegian Research Council. The Ministry of Industry, Trade and Fisheries and the Ministry of Local Government and Modernization finance the program. Innovation Norway allocated about 19 million euros for financing and development of the cluster program in 2014 (see Appendix C2).

6.7 Conclusions

Table 5 summarizes the 5 instruments of the Norwegian innovation policy that fitted the scope of the thesis, and that have therefore been analysed. About the instruments it can be said that in this part of the innovation cycle the range of kinds of innovation instruments is rather wide. It can further be said that the industry focus of the instruments and the company focus is predominantly generic. The company focus of SIVA is unique compared to Dutch and German instruments, because it is the only instrument that focuses mostly on start-ups.

About the effectiveness of the innovation policy in terms realisation of it objectives no harsh statement can be made. The governments overarching objective of *facilitating increased wealth creation across the country* cannot be confirmed. No traces of instruments have been found that realise the objective of *increased funding for pilot, verification and demonstration projects.* Not the analysis of the instrument itself, but another source confirmed that the objective of *better use of the*

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[46] More details about the SkatteFUNN taks incentive scheme can be found here: http://www.skattefunn.no/prognett-skattefunn/Funding_Opportunities_and_Eligibility/1254001716647?lang=en

SkatteFUNN tax deduction scheme has been realised (Oleynik & Toivonen, 2012). Because of the abstract formulation of the objectives, or because of the nature of the analysis used in the case, no other statements about the realisation of the objectives of the innovation policy can be made.

Table 4: A summary of the analysed instruments in the Norwegian innovation policy and their features

Instrument	Budget (in million euros)	Nature	Period available	Focus industry	Focus company
VRI	7.2	Grant	2007-2017	Generic	Generic
Innovation Norway	55.8	Grant	Open	Generic	Generic
SIVA	-	Service	1986-current	Generic	Start-ups
SkatteFUNN	277	Fiscal	Open	Generic	Generic
NCE	19	Grant	open	Specific	Generic

Chapter 7: Evaluation of the Dutch innovation policy for the shipbuilding industry

In chapter 1 it has been explained that the thesis consists of two analyses. One analysis is done in chapter 4 to 6, the case studies. The evaluation of the Dutch innovation policy for the shipbuilding industry by comparing it to the innovation policy for the shipbuilding industry in Germany and Norway is an external approach to evaluate the policy of the Dutch government. An internal evaluation is done by a couple in-depth interviews with people representing several kinds of companies in the Dutch shipbuilding industry. Details about the selection of the interviewees can be found in section 1.3. These interviews can be found in appendix B. First the external analysis will be provided, followed and complemented by the internal analysis.

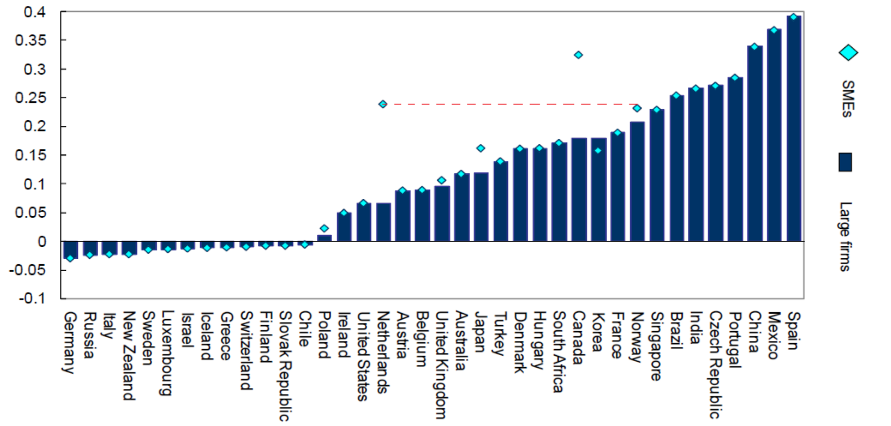
7.1 How does the Dutch innovation policy perform compare to that of Germany and Norway?

7.1.1 How much money is there?

Comparing innovation budgets is very difficult. The reason for this is the diversity of instruments, schemes and credits that exist. Some innovation stimulating instruments are fiscal, some financial; others are credits. Moreover, plenty of innovation stimulating instruments are not even mainly monetary at all. The main criterion in analyzing the three innovation policies in chapter 4 to 6 was that the national government had to be at the root of it. The innovation support further had to be clearly identified as instrument, so support through institutions, universities or other forms of support will be left aside. In order to be able to say anything about budgets several distinctive categories of innovation instruments had to be made. The categories that will be used are: fiscal instruments, specific financial instruments, generic financial instruments and others instruments, where the last category covers all instruments not covered by one of the previous three categories.

Dutch fiscal innovation subsidy is substantial

The Netherlands and Norway both have fiscal innovation instruments. Germany does not have such instruments, although the German government is considering them according to Palazzi (2011). According to a graph in the same OECD publication (see figure 4) Norway and The Netherlands are close regarding fiscal support per invested dollar in R&D for SMEs. Norway is in terms of fiscal innovation instruments significantly more attractive for big companies though. This was however before the introduction of the Dutch innovation box. Although it is often not the primary objective, such a policy could *attract MNEs headquarters and IP holding companies by providing incentives on the income side* (Palazzi, 2011). Germany is of all the countries represented in the OECD measure the least attractive country for fiscal R&D compensation.



Source: OECD Science, Technology and Industry, Scoreboard 2007. Note that in Figure 2 the index does not account R&D incentives provided at the provincial/state level in case of federation system, such as Canada or U.S.

Figure 4: Rate of tax subsidies for USD 1 of R&D investment, large firms and SMEs, 2006-2007. Adapted from "Tax and Innovation", by P. Palazzi (2011), p. 27

Although figure 1 shows that Norway is more attractive for firms, taking SMEs and large firms jointly, in terms of fiscal R&D subsidy, the schemes that have been found suggest that The Netherlands is more attractive. The Netherlands has two major tax schemes, namely WBSO-RDA and the innovation box. WBSO-RDA has a budget of 1,032 million euros in 2014 (Rijksdienst voor Ondernemend Nederland). The innovation box has and open budget. The estimated 'payout' has however not been retrieved. The tax scheme that is available in Norway is SkatteFUNN, with a budget of 277 million euros in 2015. Although the shipbuilding industry is quite a lot bigger in Norway than in The Netherlands, this does not hold for the entire national industries. In fact, the Dutch industry is about 1.4 times bigger in terms of created value. The Dutch industry may be 1.4 times bigger than the Norwegian one[47]; the generic fiscal instruments found have a much bigger budget in The Netherlands than 1.4 that of Norway. *Although the OECD publication might suggest otherwise, the case studies show that The Netherlands is the most attractive country in terms of tax subsidies on private R&D investments. Germany is of the three cases by far the least attractive country from the above-mentioned perspective.*

Dutch generic financial instruments are poor

Table 2 shows the generic financial instruments of each of the three countries reviewed, including their budget. For the German instrument 'entrepreneurial regions' the annual budget is an open budget; no precise comparison can therefore be done. The Netherlands *seems* to do quite well compared to Germany and Norway. Unlike the instruments in Germany and Norway however,

[47] The Dutch GDP in 2014 is 880.4 billion USD. 22.3% of the GDP is created by the Dutch industry, comprising 147 billion euros at an exchange rate of 0.75 euro per 1 USD. The Norwegian GDP is 339.5 billion USD, of which 41.8% is generated in the nations industry (Central Intelligence Agency, 2015). The created value in the Norwegian industry at the same exchange rate is therefore 105 billion euros. Hence, the Dutch industry is 1.4 times bigger than the Norwegian industry.

funding via the SME+ fund (which mostly consists of innovation credits) has to be paid back upon successful execution of the innovation project. Only in case of failure of the project the obligation to repay may be waived. The SME+ fund does solve the problem of imperfect information as can be found in chapter 4, which practically means that (risk) money is easier attainable. However, the Dutch government does not contribute to innovation like Germany and Norway do, in the form of grants. *In terms of generic financial instruments to support innovation the Dutch innovation policy is rather poorly equipped compared to Germany and Norway.*

Country	Instrument	Annual budget (in million euros)
The Netherlands	*SME+ fund*	*65*
	Innovation performance contracts	10
	Innovation credits	*60*
Germany	Central innovation program SME	500
	Entrepreneurial Regions	open budget
Norway	VRI	7.2
	Innovation Norway	55.8

Table 5: Generic financial instruments and their annual budgets of The Netherlands, Germany and Norway

Dutch specific financial instruments for the shipbuilding industry are mediocre

Table 3 shows the financial instruments in the nation's innovation policies specifically dedicated to the shipbuilding industry. The Dutch SIS and German Innovation Program Shipbuilding are both subsidies originating from a European framework policy. In the report by Dialogic (2014) the Dutch SIS was available from 2007 to 2014, apart from 2013. The Dutch equivalent subsidy was available from 2011 to 2015. Although the annual committed budget of the SIS was 7 million euros in the years that it was available, the average committed budget was much lower in the period from 2011 onwards, averaging about 3.9 million euros. *Compared to the size of the German shipbuilding industry however, the Dutch committed budget under the SIS does not seem to lag behind. Compared to Norway however, the Dutch innovation policy for the shipbuilding industry seems spare. The Norwegian government invests 19 million euros in the development of the Blue Maritime Cluster in 2015.*

Country	Instrument	Annual budget (in million euros)
The Netherlands	SIS	7
Germany	Innovation Program Shipbuilding	12
Norway	NCE	19

Table 6: Industry specific financial instruments and their annual budgets for The Netherlands, Germany and Norway

Greendeal it not living up to its potential

Finally two instruments are left that cannot be put under the previous categories of innovation instruments. With the innovation instrument 'greendeal' the Dutch government wants to provide a service to the Dutch industry. With greendeal it is among other things possible to discuss removal of obstructive legislation with the Dutch government. In the conducted interview the instrument was however not valued very important. Greendeal in funded from the SME+ fund, but the annual budget is not known. The second instrument that could not be categorised is the Norwegian SIVA. The goal of the organisation is defined as: facilitating, owning and developing infrastructure for industry, start-ups and research environments. The annual budget of SIVA is 18.5 million euros. *Although greendeal is a nice gesture from the Dutch government, the instrument should be optimised. Legislation can still be an immense burden in an innovation process, according to several interviewees,* for example according to Van Terwisga in the development of the LNG inlandship, the eco-liner developed by Damen Shipyards and partners (see Appendix B2).

7.1.2 How does that correspond to the size of the industry?

Now that the absolute budgets that are made available by the national government of The Netherlands, Germany and Norway have been established, the next step is to compare this to the size of the shipbuilding industries. As can be seen in the previous section it was difficult to compare the instruments, because of the diversity of the instruments, and the no-specific budgets that were provided with these instruments. This is however only one side of the difficulty faced. Retrieving figures with which the sizes of the three shipbuilding industries could be compared was a difficult task as well.

However, the following figures have been retrieved, which are summarised in table 4. The table shows that the size of the Germany shipbuilding industry is about 7 times bigger than the Dutch shipbuilding industry and that the Norwegian shipbuilding industry is 8 times bigger than the Dutch one in terms of turnover. The size of the entire German industry is also about 7 times bigger than the Dutch industry. The Dutch industry is however 1.4 times bigger than the Norwegian industry, in terms of created value. *Given this information, the same conclusions hold for the previous section. The Netherlands is mostly fiscally attractive, also in relative terms. Generic financial instruments are underequipped in The Netherlands. The budget of specific financial instruments compare well to Germany, but bad to Norway.*

	The Netherlands	Germany	Norway
Annual turnover in billion euros (year)	7.5 (2014)	54 (2014)	62.5 (2013)
Employment (year)	31,680 (2014)	400,000 (2014)	112,227 (2013)
Percentage of total national industry	2.7	2.8	13.5[48]

48 Because of the missing figure of the entire size of the Norwegian industry, the relative size of the Norwegian shipbuilding industry compared to the entire Norwegian industry has been calculated based on the created value. The given created value by the Norwegian shipbuilding industry is 175 billion NOK (2013). The Norwegian GDP is in the same year 3,069.8 billion NOK. 42,3% of this GDP is created by the nation’s industry (Central Intelligence Agency, 2015), which comprises an amount of 1,298.3 billion NOK. 175/1,298.3 is about

Relative size of the shipbuilding industry in terms of turnover compared to the Dutch shipbuilding industry	1	7	8

Table 4: Key figures of the shipbuilding industries of The Netherlands, Germany and Norway

7.1.3 What is the scope of the funds?

Table 5 summarises the scope of the available innovation instrument in The Netherlands, Germany and Norway based on two dimensions. The first dimension is whether the instrument is focussed on the entire national industry or on a specific industry. The second dimension is on which kind of company the instrument is focussed: small and medium sized enterprises, large enterprises, start-ups or all enterprises. *As can be seen in table 5 the instruments in The Netherlands have been divided rather well over the kinds of enterprises, with a focus on SMEs. For the industry specific scope The Netherlands is comparing well to Germany and Norway, with one specific instrument.*

	The Netherlands	Germany	Norway
Number of instruments in the scope	7	3	5
Instrument focus on industry: generic vs. specific	6 / 1	2 / 1	4 / 1
Instrument focus on company: SME/large/start-up/generic	3 / 1 /0 / 3	1 / 1 / 0 / 1	0 / 0 / 1 / 4

Table 5: Number of available innovation instruments and their focus on industry and company

7.1.4 How structural are the innovation instruments?

Structure is seen as very important in innovation policy. With structure a government can create clarity, and companies are able to anticipate on the available instruments. Especially when instruments are designed to create a multiplier effect, where additional government investment creates more additional private sector investment, predictability is valuable. Therefore the question heading this section is asked. Table 5 provides the several instruments that are available in The Netherlands, Germany and Norway and the period in which they were available.

As can be seen from table 6 The Netherlands is the only country of the three which has intermitted instruments. As can be also seen from the table and can be read in the cases, especially in the case of Norway, the governments of Norway and Germany set out instruments for a long period of time. Several instruments in Norway are introduced with an initial timeframe of 8 to 10 years. Especially in the case of SIS it is noteworthy that the Dutch government stopped the subsidy in 2013 and 2015, while it is a European framework subsidy, allowing a nation's government to support it industry in a way that would normally be illegal. Also several interviewees addressed problems like clarity and

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13.5%. This means that about 13.5% of the value created by the Norwegian industry is created by the shipbuilding industry.

structure. *Summarizing then, it is advised to actively pursue a structural and clear innovation policy, which creates as much stability as possible for the Dutch industry.*

The Netherlands		Germany		Norway	
Instrument	Period available	Instrument	Period available	Instrument	Period available
WBSO-RDA	Open	ZIM	2008-2014	SkatteFUNN	Open
Innovation box	2010 – current	Entrepreneurial regions	1999-2015	VRI	2007-2017
SME+ fund	2012 – current	Inn. prog. Shipbuilding	2011-2015	Innovation Norway	Open
IPC	2007-2013, 2015			NCE	Open
Innovation credits	Open			SIVA	1986-current
SIS	2007-2012, 2014				
Greendeal	open				

Table 6: Innovation instruments of The Netherlands, Germany and Norway and the period in which they were available

7.1.5 How effective is the Dutch innovation policy?

Harsh statements about the effectiveness of the Dutch innovation policy are not possible, for reasons expressed in section 1.2 and 4.8. However, the goal of EZ's innovation policy of the development of social innovations can be positively associated with successful government involvement in radical innovation (such as the LNG-project). Further, the Dutch government successfully provides access to (risk) capital through the SME+ fund, therewith fulfilling one other goal of its innovation policy.

7.2 How does the Dutch innovation policy for the shipbuilding industry perform according to industry experts?

This section will discuss the internal evaluation of the Dutch innovation policy for the Dutch shipbuilding industry with a focus on cooperation. Although the main focus of the internal evaluation is on cooperation, the methodological richness of interviews will not be nullified, so other generic conclusions will also be presented in this section. The rationale behind the selection of these six interviewees has been explained in section 1.3. As can be seen in appendix B, the interviews have been structured in three parts. The first part was to identify the extent to which a company engaged in innovation. Part B of the interview consisted of questions to identify a company's opinion about cooperation in innovation. In part C we reach the core interest of the interviews, namely a company's opinion about government support in (cooperation in) innovation. Several generic observations have been made, which will be discussed in a paragraph per observation.

The government is facilitating

Throughout several interviews it became clear that the government is often seen as facilitating. What the Dutch government should facilitate is to bring people together. In the interview with Peter van Terwisga (appendix B2) Mr. Van Terwisga stated that financial support of the government works like a lubricant. It brings people together and it gets them talking. The financial support further serves as a final push to commit (financially) for a company, since it takes part of the risk of investing away. Others were however more sceptical about the added value of government support. In order to make generic claims there has to be made a distinction in the kind of projects in which government support is potentially value adding for any company in the shipbuilding industry.

Government support in radical innovation projects is successful and necessary

This distinction that has to be made is that between projects in which incremental innovation is realised and that in which radical innovation is realised. An example of a successful innovation program, provided by Rinus Kooiman (appendix B4) initiated by government bodies is that of the LNG-project. The fact that the entire network of LNG suppliers as well as the entire network of LNG users had to be built up from scratch demanded for an overarching party that could put different parties together to initiate the development of those two networks. The government being the overarching party here resulted in an immense speed-up of this process. Without government involvement it can even be doubted whether the market would have realised this at all. The effect of government support in projects which are less radical is slightly harder to pinpoint as will become clear in the next paragraphs.

The open structure of Dutch innovation projects does not lead to the optimal outcomes

Cooperation in innovation in projects with an open structure, as innovation projects initiated or supported by the Dutch government are characterised, do not lead to the optimal solutions for several reasons. The first reason, as indicated by interviewees, in random order, is that the intellectual property that results from the innovation project is not fully yours. This can lead to the undesirable outcome in which companies in the project are only allowed to sell their innovation to other parties in the project, not to other Dutch or international companies. For companies that are heavily depending on export, these kinds of projects are not interesting. The second and third reason, which are slightly related to the first, have to do with the kind of parties that are involved in such an innovation project. Theoretically anyone can join a project, which leads to the following two problems. First, when two unequal companies (in terms of power and size) are together in a project, this can lead to uneven balance of power in the project itself, and can put pressure on the inferior company. Second, since anyone can join, it can also happen that two equal companies both take part in a project. When the two companies are eventually competing for the job, both are logically not willing to share a lot of information in the project. Only when both companies can gain something from the project they might be willing to share information. The fourth reason why Dutch innovation projects do not lead to the optimal solution is that the outcome is often open to anyone. The competitive edge gained by participating companies is therefore immediately lost. This leads to a potential *free-rider problem*. Finally, the last reason that came forward in interviews is that the customer is often missing in innovation projects. Where for several companies the customer, "the sponsor", is indicated as the most important innovation partner, this crucial party is missing around the table of government initiated innovation projects.

The Dutch innovation policy leads to loss of momentum (for SMEs)

As can be seen in chapter 4 The Netherlands has several innovation instruments specifically for SMEs within the scope of the thesis. The Netherlands has three innovation instruments for SMEs compared to one and none for respectively Germany and Norway. Comparing the three countries would suggest that the Dutch innovation policy is attractive for SMEs. According to several interviewees the instruments through which SMEs can receive funding lead to loss of momentum. At the same time it has been indicated by several interviewees that specifically for SMEs speed is of crucial importance. If as a small company you depend for more than half of your income on export, and the competition from abroad is as intense as it is nowadays, it is not possible for the company to wait for the Dutch government to support or subsidize. When your competitive edge only lasts for several months the path often chosen is to not use these instruments at all. Van Leeuwen (Corrosion - appendix B3) and Van Sliedregt (Rubber Design - appendix B5) indicate that they do not use innovation instruments (anymore), because the application processes take so much time, that by the time they might receive the subsidy their competitor already put the product in the market. This inflexibility of the Dutch innovation policy also comes forward with changing market conditions. Especially SMEs have to react fast on a changing market condition, and they cannot wait for the government to follow with support then. In order to increase innovation through the instruments that exist now, the instruments have to be optimized to comply with the need for speed in development and implementation of innovations.

The Dutch innovation policy can be improved by increasing the clarity and reducing the requirements

Throughout several interviews it was brought forward that the instruments in the Dutch innovation policy should be clearer and should not have immense lists of criteria. The long road from application for a subsidy to actually getting the subsidy awarded, not only takes out the speed that is necessary in innovation and implementation of the innovations, as mentioned before. It also makes the instruments inaccessible. Because of their size SMEs indicate that they don't have the manpower to complete subsidy applications. A second problem that SMEs run into because of their size is that many do not have people working fulltime on innovation or innovation projects. The resulting problem then is that it is not possible to substantiate invested man hours in innovation, which is required by the Dutch government in order to receive subsidies or tax alleviation. However, not only SMEs plead for a clear and less burdensome innovation policy, also representatives of big firms indicated that subsidies should not lead to more regulation, but rather that a form of innovation support is to reduce regulation. Finally, in a letter to the Dutch Lower Chamber also FME – the association for the entire Dutch technology industry – also pleaded for less 'tasks' for example for the WBSO-RDA (FME, 2015).

Chapter 8: Conclusions

8.1 The answer to the research question

This final chapter will answer the research question: **How *can the Dutch innovation policy for the shipbuilding be improved?*** In order to answer this question, two analyses have been done. In the previous chapter the following sub-questions have been answered: How does the Dutch innovation policy for the shipbuilding industry perform according to industry experts? And: How does the Dutch innovation policy perform compare to that of Germany and Norway? The answer to the research question is then rather straight forward, namely by taking away the things that are performing badly according to the case studies or the interviews. The following issues have been identified as burdensome in the Dutch innovation policy for the shipbuilding industry:

- First, from the case studies it has become clear that generic financial instruments are rather scarce. The Netherlands does, compared to Germany and Norway, not provide many grants in innovation.
- Second, from the interviews it became clear that green deal is not living up to its potential. Where it could potentially take away legislative hurdles, in practice it does not work well, and is not used very often.
- It further became clear from the cases that The Netherlands was the only country of the three where policy instruments have been temporarily intermitted. For the sake of structure the innovation policy can be improved upon from this point of view as well.
- What finally became clear from the case of Norway is that Norway actively promotes export and marketing through what they define as their most important innovation instrument (Innovation Norway). Potentially, the Dutch innovation policy can be improved upon by also using a more holistic view towards innovation.
- It was further mentioned in the interviews that government support in radical innovation projects is successful and necessary. The example that has been provided by an interviewee is that of the LNG-project initiated by the European Commission. This innovation is a fundamental (social) innovations, so by taking an active role in such innovation processes, the government can also realise the objective of *developing social innovations*.
- A issue that became clear from the interviews is that the open structure of Dutch innovation projects does not lead to the optimal outcomes. Problems with IP ownership, sharing information with competitors, and uneven power balances between participators in a project, because of the size of the firms they represent, lead to non-optimal outcomes. Solutions to solve this open-structure problem of innovation project would definitely improve the Dutch innovation policy.

- Another issue that came forward in the interviews was that SMEs lose a lot of momentum when they try to get funding from an instrument or scheme. Since speed is especially important for SMEs, this is something that can be improved upon.
- A final issue that became clear from the interviews is that the Dutch innovation policy can be improved upon by increasing the clarity and reducing the requirements.

The above mentioned issues with the Dutch innovation policy for the shipbuilding industry have become clear from the two methods that have been used for analysis. Based on these methods, in based on the approach that has been take in the thesis the answer to the research question is: The Dutch innovation policy can be improved by increasing generic financial instruments, by improving the legislative hurdle tackling through green deal, by providing a more structural innovation policy, by using a holistic view in innovation instruments on innovation, marketing and export, by actively contributing to particular innovation processes, by solving problem related with the open structure of innovation projects, by solving problems related to the loss of momentum, and finally, by improving the clarity and burden of proof. Recommendations how to solve these issue in practice will be handed in the next section.

8.2 Recommendations

In this section practical recommendations will be provided to solve the issues that have been summarized in section 8.1. For some recommendations observations from the cases and interviews have been clustered. The recommendations do therefore not match one-on-one with the bullets in the previous section, however they are based on them.

Make the tax instruments more accessible for SMEs

The first conclusion of the external analysis was that The Netherlands has an attractive fiscal innovation compensation scheme. This is good news; however in the interviews it was mentioned that for SMEs with a lot of people working only part of their time, and in a non-structured way on innovation (projects), that the burden of proof is that is required to get the tax discount is too difficult, and hence not accessible for these companies. In order to make instruments approachable and clear the RVO could for example provide small instruction movies on its website. There could further be a task here for NMT to provide their members with clear information, or as representative of the SMEs in the shipbuilding industry when discussing alteration of the requirements of the WBSO-RDA and the innovation box to make it truly accessible for any company.

Create clarity and stability, and no 'push-and-shove' policy

Other conclusions of the external analysis were that The Netherlands has relatively small budgets for generic and specific financial instruments which are provided in the form of a grant. The government solve some of the problems related to innovation; it namely reduces the risk of the company and the potential investor, and does with this provide a solution to imperfect information in innovation. The incentive that government support in form of a grant rather than a credit could achieve is however not realised with such a policy. Together with the conclusion that the Dutch innovation policy is the least stable of the three cases, this does suggest that the Dutch government is using a policy of 'push and shove', where one can only receive more if someone else receives less. Although EZ does have a ceiling to its budget, which does demand for a bit of push and shove, the starting point should always be structure and stability. If then it would be the case that the money has to come from somewhere, maybe the compelling comparison drawn by Jaffe et al. (2005) between innovation and environmental pollution could serve as inspiration, especially since innovation in the shipbuilding industry is often a sustainable innovation according to industry experts.

Let NMT represent the SMEs in the shipbuilding industry for project development

The first conclusion of the internal analysis was that many interviewees saw the government as facilitating. The current way of cooperation between government and industry in which policies are developed with the companies in the lead has been experienced as positive. However, this holds more for large enterprises than SMEs. Regarding policy development as well as the initiation of innovation projects it has been addressed that a party like NMT would be better, since they truly know what is going on in the industry, and what SMEs in the shipbuilding industry would want. This decentralised approach potentially leads to fewer 'project partner problems', where companies have to work together that do not want to. It further increases the chance for a better fit of innovation projects and ongoing developments in the industry.

Change the requirements to generate speed in innovation (for SMEs)

The second conclusion of the internal analysis was that government support in radical innovation projects is successful and necessary. The issue of 'speed and direction' brought up in section 3.2.5 as argument for government support has been confirmed here. However, as was also a conclusion of the internal analysis, in non-radical innovation project government support can also lead to loss of momentum. Clarity and structure of the innovation policy, as recommended earlier, is an important starting point then. However, in consultation with companies, mainly SMEs, RVO could also try to adapt the conditions and requirements for application for innovation support to the needs of the companies. Innovation is often a messy process and the competitive edge (for example through changing market conditions) that SMEs have last only for a couple of months. Requirements like working with an ex-ante planning, with structured steps slow down the innovation process tremendously.

Reduce the investment and increase the gains, or create a cluster brand

Another conclusion of the internal analysis was that the open structure of Dutch innovation projects did not lead to the optimal outcomes. The open structure with any company that can participate (competitor or customer, large or small), no clear agreements about intellectual property ownership, the often long-term commitment that has to be made, and the uncertain gains for the company, result in uncertainty, mainly for SMEs. Several things can be done to reduce this uncertainty. The solutions go in two directions: either increase the gains, or decrease the investment. Increasing gains can be done by making clear agreements about IP ownership, clearly sketching the potential orders to be expected, etc. Reducing the investment can be done by shortening the project period, making it possible to only participate part of the time, demanding less financial investment of the company, etc. However, a transcending solution to the above established problem is for example to create a cluster brand, region brand or project brand, as is done by Innovation Norway. This could encourage companies to not look at innovation and innovation projects from a purely transactional perspective, but more from relational angle. This brings us to the last recommendation.

Define different innovation policies for different kinds of innovation

Making statements about the effectiveness of the Dutch innovation policy for the shipbuilding industry is hard, as can be seen in the previous chapter an in section 4.8. However, government involvement in radical (social) innovations was valued as positive and necessary. In the development of such innovation the government should be in the driver seat, not the passenger seat (as it now does with the 'business innovation policy'). This finding does not make the current innovation policy obsolete though, but it demand for a different approach for different kinds of innovation.

Innovation policy and export policy go hand in hand

A very big part of the tasks of Innovation Norway, the innovation instrument that is indicated as Norway's most important one, is to help companies and clusters with design, IP, and branding. Innovation Norway is further Norway's most important export promoter, by representing Norway in over 30 countries worldwide. Although innovation is important, the marketing of your innovations is at least as important. Also several interviewees indicated that the biggest mistake in Dutch innovation projects was the missing customer. Selling your innovations is crucial and innovation policy can and should therefore not be seen separate from export policy.

8.3 Concluding remarks

The thesis answered the research question by providing evidence from case studies and interviews that the Dutch innovation policy for the shipbuilding industry can be improved, as well as the key issues that can or need to be improved. The thesis therefore produced a viable answer to the research question.

However, this does not mean that the thesis does not have limitations. The first shortcoming of the thesis results from the last recommendation. This innovation policy analysis is only one side of the coin, since the marketing of your innovations is at least as important. The scope of the case studies has been on innovation instruments in the innovation and implementation phase, which is naturally more related to marketing than fundamental R&D and industrial R&D. Government however tend to overemphasise the importance of the early stage of the innovation cycle, with Germany being the clearest example of the three cases. As the WRR report (2013) says, adaptive ability is much more important than knowledge creation. A recommendation for further research would therefore be to analyse the innovation policy together with a country's export policy.

Another limitation of the thesis is the potential over completeness of the coverage of the Dutch innovation policy compared to the German and Norwegian innovation policy. This can lead to underestimation of the German and Norwegian innovation policy compared to the Dutch innovation policy.

Further, the core of the current Dutch innovation policy is the Top Sector policy. Because this part of the Dutch innovation policy is pre-competitive, it has not been review, for the reasons mentioned in section 1.3. However, one should take into account that a significant part of the Dutch innovation policy has not been review, although the same hold for Germany and Norway.

Finally, because of difficulties with measuring the effectiveness and efficiency of the Dutch innovation policy, as explained in section 1.2, the choice has been made to do a qualitative evaluation. The issues that came forward from the two analyses that have been conducted subsequently served as framework for answering the research question. These issues have namely been translated in recommendations for improvement. However, for the sake of structure the choice could also have been made to predefine criteria for improvement, for example from theory, as has been partly done by focussing the interviews on cooperation.

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Appendix

Appendix A: Explanation of the used model in the case studies

The model that will be used in the case studies has been adapted from Figure 7. Figure 7 is a reprinted version of the model that has been used by ARENA, the Australian Renewable Energy Agency, to *structure its funding support to best reduce risks and barriers at the various stages of the innovation chain* (Australian Renewable Energy Agency, 2014). The Technology Readiness Level (TRL) index is a globally accepted benchmarking tool for mapping progress and supporting development of a specific technology through the early stages of the innovation chain, for example by the European Commission. This is from 'blue sky' research (TRL1) to the system test, launch and operations (TRL 9). Although most technological risk is retired in between TRL 1-9, there is often significant commercial uncertainty/risk remaining in the 'demonstration' (innovation) phase and 'deployment' (implementation) phase (Australian Renewable Energy Agency, 2013). In order to also support companies in those phases of the innovation process, ARENA maps its policy instruments along a combined model, representing the entire innovation cycle (see figure 7).

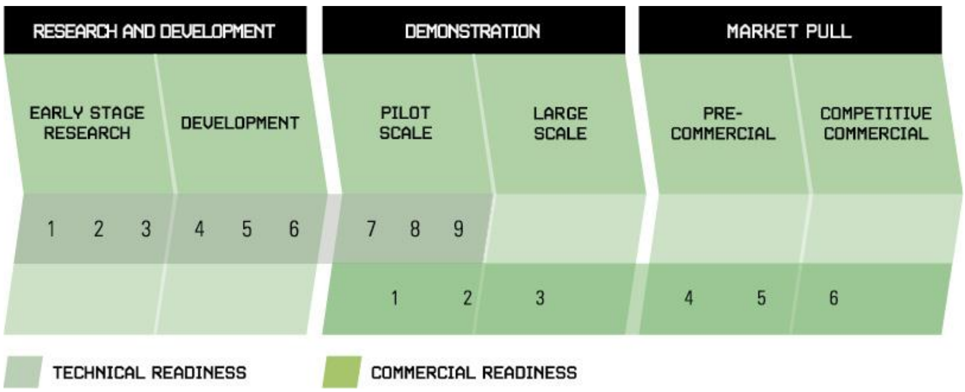

Figure 7: Technical Readiness Level and Commercial Readiness Index on the innovation chain. Reprinted from "ARENA Annual Report 2013-14", by the Australian Renewable Energy Agency, 2014

As Figure 8 shows the Commercial Readiness Index begins once the technology is at the stage where it can be trialled and demonstrated in the field (e.g. TRL 7). Further details about the model, and the different stages in the TRL and CRL can be found in Figure 8.

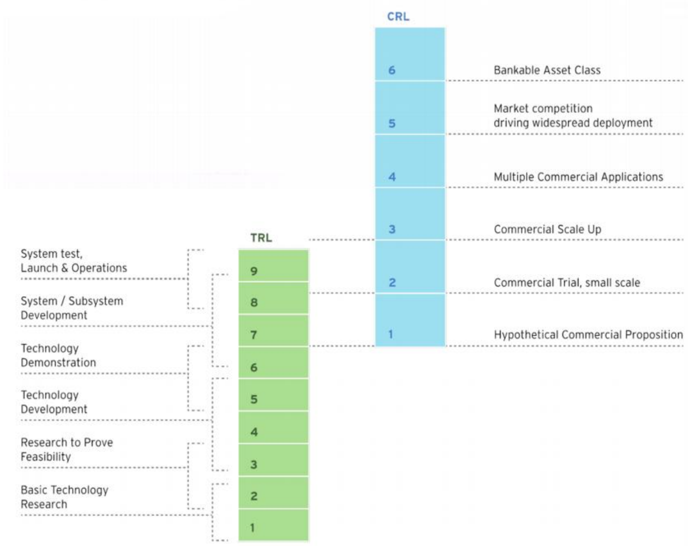

Figure 8: TRL and CRL Indexes. Reprinted from "Self-Assessment tool for the Accelerated Step Change Initiative: the Commercial Readiness Index" by the Australian Renewable Energy Agency, 2013

Appendix B: Interviews

Appendix B1: Interview with Marjolein van Noort

Manager Public Affairs at IHC Merwede

A) To identify to what extend a company is engaging in innovation:

1. Is your company actively busy with innovation? Yes, innovation is a continuous process, and in a lot of cases it starts at our company. Innovation happening in the chain (with suppliers and customers) could perhaps be increased. A challenge in that case, among others, is the fact that when SMEs (suppliers) innovate this should be carried/supported by the rest of the chain. In other words: which question does the (end) customer have and can the innovation be offered at a good price? The balance in this can be improved.
2. Is innovation important for your company, and do you have a structured innovation process/approach? Yes, among other things to reach quality target and standards set by a legislator, for example related to the environment. We further have to innovate in order not to become too expensive. In the choice to engage in innovation there is always a split. On the one hand you can innovate to be ahead of the competition. On the other hand, you can innovate in order to be able to offer a certain standard, a certain price-quality ratio, to the customer. In the second case explicitly not as the leader in the market.
3. What percentage of your turnover did you invest in R&D last year? Around 3 percent.
4. How many of your employees are busy with innovation? -

B) To identify a company's opinion about cooperation in innovation:

5. Did you use knowledge or competencies of other companies or institutions in your innovation process in the past years? Yes, with research institutions, customers like Van Oord and suppliers, but it would be desirable to increase cooperation.

6. Are the companies with which you cooperate mostly suppliers, competitors, or companies from a different sector? *Horizontal, vertical or cross-sectoral cooperation.* In the chain we are already cooperating. Companies like Boskalis and Van Oord are from a certain perspective also our competitors, namely when they are dredging at a certain location where we could have otherwise supplied vessels. However, they are also our customers, so we are also cooperating with them. Cross-sectoral innovation is interesting because you can learn from one another by looking from a different perspective. An example in which this happens is the initiative 'Maritime meets aerospace'.
7. On which basis do you cooperate with these actors, is there a structured way of working together? *Fe. In a project, group, cluster*. The way in which we cooperate is flexible, as it has to be. Cooperation differs with the size of the order, the client, the market and the level of innovation (standardised or custom work).
8. Do you share confidential information with the companies that you cooperate with? We do not share a lot of confidential information in cooperation. Some companies choose to share a lot of confidential information with the idea that they will stay ahead of competition anyway. This however demands for a lot of adaptive capabilities and a lot of flexibility. However, when you cooperate it is necessary to share information to a certain extend (for example technical information).
9. What is important when you decide to share or not share this information? -
10. Is cooperation a necessity to come to (certain) innovations, and do you see shortcomings or missed opportunities because of a lack of cooperation? It could be more, but overall the people that need each other will find each other.
11. Which form of cooperation is the most value adding for your company? Horizontal, vertical, cross-sectoral. This is hard to tell. Cooperation is necessary at all levels in order to achieve different things. Cooperation with competitors is necessary in order to get norms to be raised and standards to be improved at a national level. A strong national policy is good for all the companies in a country. Cooperation in the development of products happens more in the chain.

C) To identify a company's opinion about government support in innovation:

12. Do you see an (intermediary) role for the government regarding cooperation in an innovation process? In my opinion the role of the government is mostly facilitating.
13. Did you make use of innovation and research and development subsidies and support, and if so: which? Yes, NWO/STW, TKI/JIP, SIS, WBSO-RDA.
14. What is the rationale behind the choice for certain subsidies and others not? We used certain schemes because they fitted with the projects or activities that we did. This is therefore the selection mechanism.
15. Have some project been made possible by government support? This is not known.
16. Has there been more cooperation in innovation due to government policy and measures? The reward has to be substantial. It further has to be predictable; conditions have to be clear, and there should not be an immense list of criteria. Also, the innovation that has to be created should be more important than what is contributed by which party.
17. How can regulations and measures facilitate your needs regarding cooperation in innovation better? -

18. Do you see shortcomings in the market regarding cooperation in innovation in which the government should play a role? Regarding sustainability there sure is some work to do.

Appendix B2: Interview with Peter van Terwisga

Director Group's Research at Damen Shipyards Group

A) To identify to what extend a company is engaging in innovation:

1. Is your company actively busy with innovation? Yes
   a. Can you please describe your most important innovations? We are market leader in high speed ships, for example through innovations like the axe bow. Many of the innovations in high speed ships have been developed together with the Technical University of Delft. Other examples of innovations and innovative ships are the KNRM NH1816 and the air lubricated, LNG fuelled inland ship the *EcoLiner*.
   b. Are you only developing technological innovation, or are you also developing other forms of innovation? We mostly develop technological innovations, but we also apply other forms.
   c. Can you please give examples of non-technological innovations? The introduction of the concept of building stock and standardized building. This is not new, but it was new to the industry, and it has been a very important innovation for us.
2. Is innovation important for your company, and do you have a structured innovation process/approach? Yes. We have different processes for different kinds of R&D. The project portfolio consists of a mixture of (R&D) processes that are of short-term, mid-term, and strategic importance.
3. What percentage of your turnover did you invest in R&D last year? 1%
4. How many of your employees are busy with innovation? Hard to tell. Innovation is dispersed over different departments and operating companies, this is in particular the case for the development activities.

B) To identify a company's opinion about cooperation in innovation:

5. Did you use knowledge or competencies of other companies or institutions in your innovation process in the past years? Yes, absolutely. We worked with TU Delft, TNO, Marin, customers and suppliers.
6. Are the companies with which you cooperate mostly suppliers, competitors, or companies from a different sector? *Horizontal, vertical or cross-sectoral cooperation.* We do a lot of cooperation in the chain. An example is the E3 Tug Project that we jointly developed with our supplier (Alewijnse Marine Technology) and our customer (Smit international LLC). With competitors we mostly develop pre-competitive project or research. Cross-sectoral cooperation is more difficult. At first glance companies in other industries seem to deal with the same technological issues, but when you dig deeper the problems that are faced are often not the same. Cross-sectoral innovation happens most often through suppliers that supply to different industries.

7. On which basis do you cooperate with these actors, is there a structured way of working together? Cooperation happens often on a project basis, but Damen also strategically cooperates with important suppliers/co-makers.
8. Do you share confidential information with the companies that you cooperate with? Yes, we then often sign confidentially agreements. This happens most easy in chain cooperation.
9. What is important when you decide to share or not share this information? The sharing of confidential information is necessary to reach certain goals. Hence, the goal is decisive.
10. Is cooperation a necessity to come to (certain) innovations, and do you see shortcomings or missed opportunities because of a lack of cooperation? Yes. However, the cooperation is not always a success. Sometimes you underestimate the competitive forces between partners, sometimes you overestimate the potential input of the partner or the cooperation is just not working out.
11. Which form of cooperation is the most value adding for your company? Horizontal, vertical, cross-sectoral. The cooperation with knowledge institutes like TU Delft is very fruitful and the results are rather easy to pinpoint. This is different when it comes to for example the incremental chain innovation which is the result of customer feedback on Damen standard designs. Over time this form of innovation leads to significant quality an competitiveness improvements , but it is less obvious or eye catching, not less important though..

C) To identify a company's opinion about government support in innovation:

12. Do you see an (intermediary) role for the government regarding cooperation in an innovation process? Yes. The effect of subsidies is facilitating, and it can therefore be seen as a 'lubricant'. Subsidies bring people together because the subsidies cover part of the efficiency costs that companies have to invest by participating in a project. By bringing people together a sector organises itself, talks about an innovation agenda, etc. First, subsidies speed up the development of certain innovations, by providing additional assets to reach the goal. Second, it deepens an innovation climate, because subsidies can sometimes have significant effects on the willingness of companies to spend money on the innovation process.
13. Did you make use of innovation and R&D subsidies/support, and if so: which? Yes: NOW/STW, TKI/JIP, SIS, EU RTD (Research and Technological Development), WBSO-RDA , innovation box.
14. What is the rationale behind choosing particular subsidies and others not? Projects are developed to pursue a certain goal, sometimes subsidies will follow then, but it is always this order of events. Subsidies in The Netherlands are never a 100% covering the project, so we will have to invest something ourselves as well. This makes sense, but it does emphasise the need for vision.
15. Have some project been made possible by government support? Yes, some projects have definitely been made possible by the government. Government support generates speed in an innovation process. If a company does not provide certain subsidies and policies a company can decide to move their R&D abroad.
16. Did cooperation in innovation occur more often due to government policy and measures? Yes, absolutely. The former 'key area policy' under PM Balkenende and the current Top Sector policy definitely result in more cooperation in innovation. Subsidies are less in the current policy, but the demand driven nature of the policy is still positive.

17. How can regulations and measures better facilitate your needs regarding cooperation in innovation? The amount of subsidy has to be increased. In the past percentages amounted up to 40%, nowadays it is barely half that. The SIS-policy was very interesting because it helped in the tough part of market introduction, in that sense the policy was adapted to the unique innovation process of the maritime sector. Furthermore, environmental factors are not good. For example, for the LNG ship it took years and years to change the regulations, this could have been achieved in a shorter period. There is also a severe unbalance in incentives to introduce environment friendly technology. The emission savings of one hybrid tugboat are equal to the savings of changing 80 normal cars into hybrids. It is hard to tell then why there are significant financial incentives for car owners to do so and not for the purchaser of a tugboat. Incentives should be equivalent to the effect on air quality and climate effects. Also from a level playing field point of view it is hard to justify why the SIS-policy has been ended. In the shipbuilding industry it is very expensive and for most actors not possible to build prototypes. In the car industry companies are able to receive financial support on prototype development since they are able to count expenses as R&D expenses. This is not possible in the shipbuilding industry and the development of new innovations has to be done on the orders itself.
18. Do you see shortcomings in the market *regarding cooperation in innovation* in which the government should play a role? –

Appendix B3: Interview with Koen van Leeuwen

QHSE manager at Corrosion & Water Control

A) To identify to what extend a company is engaging in innovation:

1. Is your company actively busy with innovation? Yes

   Can you please describe your most important innovations? Process innovations are mostly internal optimisations. Product innovation is often a continues process of fine tuning (incremental innovation). Sometimes product innovations are derived from other products, or they are a combination of two products. Finally, some disruptive innovations are the result of changing laws and regulations.

2. Is innovation important for your company, and do you have a structured innovation process/approach? Yes, the approach is partly structured in that I structurally attend meeting and projects related to innovation. However, innovation often just means establishing creative connections that lead to better products or more efficient processes. Further, some innovations are the result of a question of a customer at our service desk or sales department.
3. What percentage of your turnover did you invest in R&D last year? Between 3.5 and 4.5% of our turnover. It roughly includes man hours, although the estimation of this is difficult.
4. How many of your employees are busy with innovation? People contribute to projects or processes where they can (approximately 10 fte; 10-15% of their time). However, with about 45 employees in total it is not possible to employ people to only work on innovation.

B) To identify a company's opinion about cooperation in innovation:

5. Did you use knowledge or competencies of other companies or institutions in your innovation process in the past years? Fe. *Customers, suppliers, universities, industry organisations, research institutes, competitor-colleague.* Yes, on a continuous basis. We mostly work with TNO, providers of software applications, and prototype builders.
6. Are the companies with which you cooperate mostly suppliers, competitors, or companies from a different sector? *Horizontal, vertical or cross-sectoral cooperation.* We mostly cooperate with companies that are complementary in what we do, as you can see from the previous question. The suppliers that we cooperate with are more like partners or family to us. Some suppliers we are already working with for 15 years. This certain dependency on each other sometimes results in a smooth relation, and sometimes in friction.
7. On which basis do you cooperate with these actors, is there a structured way of working together? *Fe. In a project, group, cluster.* We do have meetings and we do have a planning, but cooperation (in innovation) is mostly approached on a project basis.
8. Do you share confidential information with the companies that you cooperate with? Yes, you have to in order to create a complete innovation. However, this is not problematic, since that is why nondisclosure agreements exist. Trust is however preferred over NDAs.
9. What is important when you decide to share or not share this information? Trust in the person you are sharing information with.
10. Is cooperation a necessity to come to (certain) innovations, and do you see shortcomings or missed opportunities because of a lack of cooperation? Yes. If in some innovations projects we would have looked for (the correct) partners sooner or in an earlier stage innovations would have been developed faster, more smoothly, and with less mistakes. For SMEs speed is absolutely crucial, so the creation of momentum in an innovation process is a necessity. The competitive advantage that SMEs have through an innovation lasts for a couple of months, for MNEs and other big companies a project can take years, which makes speed less important.
11. Which form of cooperation is the most value adding for your company? Horizontal, vertical, cross-sectoral. Cooperation in the chain is the most important. With competition we almost never work together with the rare exception of having a common enemy like a legislator.

C) To identify a company's opinion about government support in innovation:

12. Do you see an (intermediary) role for the government regarding cooperation in an innovation process? No. The problem with many innovation subsidies is that the cooperation that is sometimes required is a cooperation between non-equals in the chain. This is the reason that the initial goal of this requirement, namely the creation of an open sharing environment and an equal relationship between actors in the chain is often not realised. Furthermore, the shipbuilding industry is transaction focussed industry, not relation focussed. Not the government, but an industry organisation should play an intermediary role in an innovation process, since they know that the industry really wants.
13. Did you make use of innovation and research and development subsidies and support, and if so: which? We used some TKI and European innovation subsidies (under the seventh framework program) In order to use a subsidy your project has to fit with the requirements of the subsidy. Because of the size of our firm we are not able to have multiple running projects, which makes it hard to have matching projects with available subsidies. Further, with changing market conditions subsidies are often not flexible enough. Changing market

conditions need to be acted on fast in order to cease the opportunity. SMEs cannot wait for the government to follow with the appropriate subsidies because of the short time scope that SMEs have.

14. What is the rationale behind the choice for certain subsidies and others not? Subsidies are too hard to acquire, too complicated, do not fit, or only apply to applied knowledge. It would be interesting for us for example to get subsidies for demonstration projects, however this is difficult because it is very close to market implementation.
15. Have some project been made possible by government support? No, we do all projects on our own.
16. Has there been more cooperation in innovation due to government policy and measures? No.
17. How can regulations and measures facilitate your needs regarding cooperation in innovation better? No, they are not flexible enough. A suggestion for a better innovation policy is to take off the tax pressure through a more structural policy. This can for example be done by letting a company invest a percentage of its tax payable in R&D. This can further be complemented with gradual tax advantage for cooperation, contribution to research project, etc. The current burden of proof that the tax authority requires is a true burden. With small companies where people only partly work on innovation(projects) it is hard to pinpoint the labour costs invested in innovation.
18. Do you see shortcomings in the market regarding cooperation in innovation in which the government should play a role? No, this should be left to the industry organisation.

Appendix B4: Interview with Rinus Kooiman

CEO at The Kooiman Group

A) To identify to what extend a company is engaging in innovation:

1. Is your company actively busy with innovation? Yes

   Can you please describe your most important innovations? We have all kinds of innovations. We for example developed the trailing suction hopper dredger (TSHD)[49], which was nominated for the ship of the year award in 2013. We further developed a multipurpose work ship[50] which was equipped with all kinds of innovations (that were new to us). We further developed the Omega pin which was the result of a question of a customer. Some innovations have a more strategic purpose. We for example built a new slipway at one of our firms, at the site of Hoebee in Dordrecht. The much bigger size of the slipway meant a big investment, that we directly are still paying back. Indirectly however it opened the possibility of developing a whole new market for us: short-sea shipping. We further invested in a CNC-lathe, which makes it possible for us to shorten the maintenance or repair of a ship drastically.

[49] More information about the TSHD on: http://dekooimangroep.nl/en/nieuws/reimerswaal-nominated-for-knvts-ship-of-the-year-award/

[50] More information about the multipurpose work ship on: http://dekooimangroep.nl/en/nieuws/handover-bnr-192-zwerver-iii-coming-close/

2. Is innovation important for your company, and do you have a structured innovation process/approach? We try to be in the top end of the market, so innovation is very important for us. Once people know that you are innovative and that you are actively developing (products in) new markets, they will come to you with more and more questions. Further, when you can offer speed through the presence of the entire development chain in-house, combined with equipment like a CNC-lathe, makes it possible to be a bit more expensive, and hence to be in the top end of the market.
   The design and advisory bureau of Kooiman is the key component in the innovation process. Here the design, work preparation, procurement and sales are combined into an incorporated process. We provide customer specific solutions.
3. What percentage of your turnover did you invest in R&D last year? This is about 1%, comprising mostly of man hours. The inventing of the new solutions and innovations takes the most time. This inventing is mostly done at our design and advisory bureau.
4. How many of your employees are busy with innovation? 2 to 3% of our fte, so about 3 to 6 full time employees on a total of 180.

B) To identify a company's opinion about cooperation in innovation:

5. Did you use knowledge or competencies of other companies or institutions in your innovation process in the past years? Yes, for example in the LNG project that we developed, we needed the knowledge of (potential) suppliers to solve some problems.
6. Are the companies with which you cooperate mostly suppliers, competitors, or companies from a different sector? Companies with whom we work are partly suppliers, because the combination of what you can create together is very successful. However, in the group the entire chain is represented, which makes it less necessary to work with other parties. In the LNG project we for example used knowledge from Shell in London. Cooperation with competitors happens for example when there are issues with the legislator.
7. On which basis do you cooperate with these actors, is there a structured way of working together? On a project basis.
8. Do you share confidential information with the companies that you cooperate with? Yes you have to. Whether we use a nondisclosure agreement or not depends on the stake that is at risk and the familiarity with the other party.
9. What is important when you decide to share or not share this information? Sometimes you share some of your knowledge to make the other party curious, sometimes you deliberately decide to share only a part of the story to not give it away entirely. Sharing knowledge is inescapable and it is always a bit of trading.
10. Is cooperation a necessity to come to (certain) innovations, and do you see shortcomings or missed opportunities because of a lack of cooperation? Yes, and yes. We for example participated in the inbiship[51] project. The purpose of the project was to develop a lightweight inland ship, which made it possible to transport more. The project however never led to real demand from the market.
11. Which form of cooperation is the most value adding for your company? Horizontal, vertical, cross-sectoral. This is difficult to tell. Some innovation activities are not profitable at all at

[51] Inbiship stands for 'innovatief binnenvaartschip' which translates with 'innovative inland ship'. More information about the project on: http://cordis.europa.eu/project/rcn/43299_en.html

first. The first ship is usually very expensive. Only once you can start building the second, third or fourth ship you start making money. Innovation is therefore a long-term strategy. You have to invest money as long as you have it. Once you are out of money you are too late to start investing in innovation, and you will lose your position in the top end of the market. Not undertaking innovation means that in the long-run you will have to close your company.

C) To identify a company's opinion about government support in innovation:

12. Do you see an (intermediary) role for the government regarding cooperation in an innovation process? Yes. The Ten-T EA LNG project[52] is an example of a situation in which the intermediary role of a (supra-national) government is crucial. The development of an LNG network (both bunker stations and consumers) would not have been possible without government involvement. Subsidies can then make it interesting for parties to enter this process. Subsidies can help people to cross a threshold, because you need innovators (people very early in the development of an innovation) to solve teething problems to make it more attractive for early and late adopters.
13. Did you make use of innovation and research and development subsidies and support, and if so: which? SIS, EU Innovation, WBSO-RDA, Innovation box
14. What is the rationale behind the choice for certain subsidies and others not? It has to fit, and you have to know about it. For the SIS for example you have to be eligible for using it. A subsidy lowers costs and improves your chances.
15. Have some project been made possible by government support? Yes, the previously stated Ten-T EA LNG project.
16. Has there been more cooperation in innovation due to government policy and measures? Yes, mostly cooperation between parties that through cooperation can create something, that otherwise would not have been possible. Cooperation in the LNG project was absolutely necessary, because of the special characteristics of LNG that we were not familiar with (for example the temperature of LNG of about -162 degrees Celsius). Whether people really start to innovate more from a subsidy is not clear. You only start innovating when it saves you money.
17. How can regulations and measures facilitate your needs regarding cooperation in innovation better? The role of the government in radical innovations in big. The government can play a key role here by putting together parties with entirely different backgrounds. Sometimes however you are put together with parties that you don't want to share information with, the competition for example. When you are tendering for the same contract in a project companies do not share knowledge up to such a level that the project is executed optimally. Cooperation in such a case is not effective.
18. Do you see shortcomings in the market regarding cooperation in innovation in which the government should play a role? The LNG project is an example of something where the market failed. Although it is a cheaper fuel (especially if you take into account the negative externalities of other fuels) the market would not have been able to bring about the network.

[52] More information about the Ten-T EA LNG project on: http://www.ngvaeurope.eu/european-commission-selects-7-lng-projects-as-winners-in-ten-t-call-2012

Subsidies can however also slow down the development of an innovation. The time that if often takes before you get a subsidy awarded is very long. Abuse on the other hand makes for a good argument for thorough screening of projects.
Further, the WBSO-RDA is different for every official. Sometimes you get the WBSO-RDA awarded by one official, while a couple of month later a different official does not award the application.

Appendix B5: Interview with Jaco van Sliedregt

Technical Manager at Rubber Design

A) To identify to what extend a company is engaging in innovation:

1. Is your company actively busy with innovation? Yes

   And can you please describe your most important innovations? One of our famous and revolutionary innovations is the so-called 'ship-in-ship' (bootje-in-een-bootje) innovation, where the entire propulsion unit of a ship has been hung up flexible, resulting in less vibration. This results in more comfort for passengers (of river cruise ships) in their cabins. Nowadays, the innovation is standard in the industry.

2. Is innovation important for your company, and do you have a structured innovation process/approach? We have an R&D unit which develops the ideas of our business units, and specific question from the customer.
3. What percentage of your turnover did you invest in R&D last year? 1,5%
4. How many of your employees are busy with innovation? The R&D unit consists of 6 fulltime employed persons. Additionally we have about 12 people who contribute part of their time to innovation projects.

B) To identify a company's opinion about cooperation in innovation:

5. Did you use knowledge or competencies of other companies or institutions in your innovation process in the past years? Fe. *Customers, suppliers, universities, industry organisations, research institutes, competitor-colleague.* Nowadays not much. The last couple of years we made less and less use of institutions like TNO. In order to reduce costs and to develop knowledge in the company we are more testing ourselves. However, we sometimes indirectly pay for TNOs knowledge and service, for example when they give trainings at our (production) site. We further jointly develop products with our suppliers.
6. Are the companies with which you cooperate mostly suppliers, competitors, or companies from a different sector? *Horizontal, vertical or cross-sectoral cooperation.* We cooperate in the chain, with our customers, and with suppliers. In this production chain cooperation with the customers is the most important, in order to achieve efficient production and marketization. With the competition we never work together. Cross-sectoral cooperation only happens very rarely, mostly via our suppliers.
7. On which basis do you cooperate with these actors, is there a structured way of working together? *Fe. In a project, group, cluster*. We cooperate on a project basis.

8. Do you share confidential information with the companies that you cooperate with? We do share knowledge, but always in combination with nondisclosure agreements (NDAs), also with our suppliers.
9. What is important when you decide to share or not share this information? A relationship with your partner is very important. With some companies we are already working for 10 to 15 years. This makes cooperation easier, and NDAs less heavy.
10. Is cooperation a necessity to come to (certain) innovations, and do you see shortcomings or missed opportunities because of a lack of cooperation? This is absolutely necessary, and this is also something that I promote in our company. Although we want to develop a lot of knowledge and processes internally, external knowledge can be very valuable. In order to be sure that the innovation can be marketed it is essential that we involve our customer in an early stage.
11. Which form of cooperation is the most value adding for your company? Horizontal, vertical, cross-sectoral. Good cooperation with our customer is the most valuable for our company. In doing this we also involve our suppliers, which makes chain cooperation the most important for our company.

C) To identify a company's opinion about government support in innovation:

12. Do you see an (intermediary) role for the government regarding cooperation in an innovation process? A potential role for the government could be to inform SMEs, or to provide trainings on how to file for subsidies. A couple of years back I attended a knowledge sharing training on 'innovation in your organisation'. This can function as a mirror on how well you are actually performing regarding innovation, which is very valuable. Via HME (currently NMT) we made use of an Innovation Performance Contract (IPC) a couple of years back, which was successful for our company. Nowadays however we are not participating in any big project. This has to do with uncertainty related to the sharing of confidential information and the generation of sales.
13. Did you make use of innovation and research and development subsidies and support, and if so: which? We use, used or tried to use the following subsidies: JIP, MKB regelingen, IPC, WBSO-RDA. The two JIPs we applied for have never been executed (with our support).
14. What is the rationale behind the choice for certain subsidies and others not? We try to make use of the subsidies for which we think we can apply. We do apply for these subsidies because we believe it is trigger for our innovation process. The paperwork that is involved does sometimes form a barrier to apply.
15. Have some project been made possible by government support? Yes, the WBSO-RDA results in product development. Through this policy we are able to employ 2 to 3 people more in our R&D department. The effect of this subsidy is therefore significant.
16. Has there been more cooperation in innovation due to government policy and measures? No, not enough yet. Because of the uncertainty that comes with cooperation we did not use it much so far. How do you make sure that the knowledge and product that is jointly developed stays your property? How big is the chance that we will make money with this project in order to earn back the invested money and time? Further, you can expose yourself, because there might be a (potential) competitor attending the project as well. Finally, project are often very big and with a long scope, which make them less attractive.

17. How can regulations and measures facilitate your needs regarding cooperation in innovation better? More information about the possibilities would be welcome. Further, clearer agreements about intellectual property right could be very helpful to take away some uncertainty.
18. Do you see shortcomings in the market regarding cooperation in innovation in which the government should play a role? More cooperation can lead to more speed in the innovation process. A shortcoming in the market could be that the developed knowledge in an institution such as TNO is not yet optimally applied to practice. In order to close the gap between theoretical knowledge, and the practical application the government could play a role. Finally, through innovation vouchers the government could make it less expensive to test innovations with TNO.

Appendix B6: Interview with Anonymous

Director Global sales at a big supplier in the maritime industry

A) To identify to what extend a company is engaging in innovation:

1. Is your company actively busy with innovation? Yes, very important.
   And can you please describe your most important innovations? We are innovating in several ways: product innovation (example: instead of hydraulic cylinders we now offer electronic cylinders), systems/applications (example: active heave compensation to control an objects position/ motion), innovation in turn-key projects and innovation in different markets (example: motion simulators are originally from the aviation industry, but are now applied in the offshore industry).
2. Is innovation important for your company, and do you have a structured innovation process/approach? Yes, if you want to be at the forefront of the industry you will have to innovate. For product innovation and development we have a structured approach, which subsequently entails market research, prototype development, product development and product diffusion. Innovation as in the development of standard applications is often simply combining what you already have. The previous two kinds of innovation are based on calculated market potential. Innovation in turn-key projects has to be earned back in the project itself, since the project is often its own prototype, and will not be repeated after.
3. What percentage of your turnover did you invest in R&D last year? Average 2-5% including man hours.
4. How many of your employees are busy with innovation? 5 dedicated persons and about 50 people who work on innovation between several hours to several days per week.

B) To identify a company's opinion about cooperation in innovation:

5. Did you use knowledge or competencies of other companies or institutions in your innovation process in the past years? A lot of innovation happens internally, without help from other parties. However, sometime we work with suppliers, and we do work a lot with our customers in innovation. An example is the development of the ceramic piston rod cover that was jointly developed with a coating developer.

6. Are the companies with which you cooperate mostly suppliers, competitors, or companies from a different sector? Suppliers (for example in electronics and mechatronics). We barely ever work with our competitors.
7. On which basis do you cooperate with these actors, is there a structured way of working together? Mostly in projects with customers and suppliers. We do not work in projects issued by the Dutch government.
8. Do you share confidential information with the companies that you cooperate with? Yes, and we cover that with non-disclosure agreements (NDAs) in order to protect our intellectual property.
9. What is important when you decide to share or not share this information? NDAs. Everyone is the same, so also with people that we already work with for several years we sign NDAs.
10. Is cooperation a necessity to come to (certain) innovations, and do you see shortcomings or missed opportunities because of a lack of cooperation? In innovation projects you need 'a sponsor' (a customer, a market) because if you don't have a sponsor you are not sure whether you will ever sell the innovation, nor will you have the financial assets to execute the innovation process. When your market is growing, anticipation in innovation projects is sometimes justifiable, but without a customer 'around the table' in an innovation project, the project is unnecessarily risky. This is also what goes wrong in government issued innovation projects: the end-consumer is missing.
11. Which form of cooperation is the most value adding for your company? Horizontal, vertical, cross-sectoral. There where you complement each other and you do not overlap with the other party, for example in a field of expertise that you are totally not familiar with. Further, partners from particular regions are interesting, regions that you are not familiar with, and your partner is.

C) To identify a company's opinion about government support in innovation:

12. Do you see an (intermediary) role for the government regarding cooperation in an innovation process? There could maybe be an intermediary role, but the government often demands for an open structure, which makes the innovation project and the outcome of the project accessible for everyone. It is the question if you would want that. The competitive edge that is gained in the project is then directly gone. Further, partners should find each other, and the relation between the two parties should be good. Getting partners assigned in a government issued project does not work, or does at least not lead to the optimal outcome. Innovation is further part of the entrepreneurial mind-set of the company. Once the word is out people will approach you with questions, and you will be invited for innovation projects.
13. Did you make use of innovation and research and development subsidies and support, and if so: which? Only WBSO/RDA, the rest is paid from our own assets
14. What is the rationale behind the choice for certain subsidies and others not? We do not use other subsidies or do not take part in projects for the following reasons. First, the intellectual property that is developed now is fully owned by our company. Second, the bureaucratic burden is too big. Third, a lot of innovation is done in-house, which makes us less eligible for government subsidies.
15. Have some project been made possible by government support? No, government support is never decisive, and this applies to all firms that have more than 500 employees.
16. Has there been more cooperation in innovation due to government policy and measures? No

17. How can regulations and measures facilitate your needs regarding cooperation in innovation better? Subsidies often directly lead to regulations. The Dutch government can improve the current environment for innovation in two ways: a reduction of regulations, and a stimulation of technological inflow. A lot of employees of technological firms like us are employing people from abroad. This is dangerous when it comes to keeping the knowledge in The Netherlands, and is in the long-run dangerous for the pre-existence of technological firms in The Netherlands. Finally, what we would be interested in is when the government could play an intermediary role in international innovation projects, for example with high-end companies in China or Korea.
18. Do you see shortcomings in the market regarding cooperation in innovation in which the government should play a role? The only problem that is arising now is education (and therefore Dutch technological inflow). If you have to employ a lot of foreign people the knowledge will be easily spread to other countries and companies once people get a job there.

Appendix C: e-mail conversations

Appendix C1: An e-mail from Grete Pettersen, Deputy Director of the Maritime Department of theMinistry of Trade, Industry and Fisheries, Norway.

(1) What generic and specific instruments exist in Norway to stimulate innovation in the shipbuilding industry?

With regards to instruments to the shipbuilding sector we report to OECD every year, see the attached report from OECD 2015.

(2) Is this list exhaustive or is/are there more innovation schemes and instruments?

In Norway instruments for research, development and innovation in general is managed by Innovation Norway;http://www.innovasjonnorge.no/en/start-page/ and The Research Council of Norway; http://www.forskningsradet.no/en/Home_page/1177315753906. The cluster programme Norwegian Centres of Expertise , like for instance http://www.bluemaritimecluster.no/default.aspx?menu=291, is of special interest to the shipbuilding industry.

For innovation on environmental friendly shipping and shipbuilding, see also https://www.nho.no/Prosjekter-og-programmer/NOx-fondet/The-NOx-fund/ and Enova, http://www.enova.no/about-enova/about-enova/259/0/.

(3) Could you please indicate if the following schemes are still available: BIA, Industrial Ph.D. Scheme and SFI?

These schemes are still available.

(4) Could you further please provide me with the annual budgets of VRI, BIA, FORNY2020 and the Industrial Ph.D. Scheme?

In 2015 the budget for these schemes are:

VRI – 61 mill NOK

BIA – 578 mill NOK

FORNY2020 – 172 mill NOK

Industrial Ph.D – 52 mill NOK

Appendix C2: An e-mail from Rouzbeh Rasai, Adviser of the Ministry of Trade, Industry and Fisheries, Norway

Question 1

Total annual turnover in 2013 in Norway for shipyards, repair yards and suppliers was 499,7 billion kroners. The maritime industry had a value creation of NOK 175 billion in 2013. We do not have data for 2014.

Question 2

GDP Norway
2014 – 3.149,681 billion kroners
2013 – 3.069,801 billion kroners

Question 3

Total employees in 2013 in Norway for shipyards, repair yards and suppliers was 112.227. We do not have data for 2014.

Question 4

GCE Blue Maritime Cluster is part of the Norwegian Innovation Clusters program, which is a government supported cluster program. It is organized by Innovation Norway, and supported by Siva (The Industrial Development Corporation of Norway) and the Norwegian Research Council. The Ministry of Industry, Trade and Fisheries and the Ministry of Local Government and Modernization finance the program. Innovation Norway allocated 159,8 million NOK for financing and development of the cluster program in 2014.

Question 5

SkatteFUNN does not have a budget. The taxation authorities through a tax relief cover the research expenses. For 2015, these expenses have been estimated at 2.35 bill. NOK.

SIVA receives in 2015 allocations of 96 mill. NOK from the Ministry of Local Government and Modernisation, 54 mill. NOK from the Ministry of Trade, Industry and Fisheries and 5 mill. NOK from the Ministry of Agriculture and Food.

Nordsatsing has an annual budget of approx. 35 mill. NOK according to the Research Council of Norway, which combines funding from various Ministries in order to finance this program.