Erasmus University Rotterdam

Erasmus School of Economics

Master thesis Urban, Port and Transport Economics

"Analysis of the market failures that obstruct circularity in the Dutch inland shipping sector"

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Abstract

The awareness of the importance of terms like 'sustainability', 'circularity' and 'innovation' has increased over the past decades. Complete sectors started to realise the potential of this matter to enhance their environmental performance, but also the potential of gaining competitive advantage. However, not every sector is as developed as the other. The aim of this paper is to analyse and discuss the Dutch inland shipping sector in terms of sustainable and circular performance and development, which is said to be relatively low compared to other sectors. This paper will analyse and discuss the relatively low development, which factors contribute to the issue and provide an overview and synthesis of these factors to gain a more thorough understanding of the separate factors and their interrelationships. This will be done through literature review and desk research to acquire theoretical information, followed by a conduction of interviews to eight relevant actors in the Dutch inland shipping sector for a more practical point of view. Combining the theoretical and practical information must provide a better understanding of the current state of play and development of the Dutch inland shipping sector. The research concludes that most of the discussed causes of market failures occur in the Dutch inland shipping sector, caused by a complex web of different factors that contribute to the obstruction of implementation of circular business models in the sector. The design phase and the ship operation phase of the ship life cycle turn out to be the most relevant in tackling these obstructions.

KEY WORDS: Dutch inland shipping sector, Ship Life Cycle Management, Circularity, Sustainability, Innovation, Cooperation, Market failures.

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Furthermore, I would like to acknowledge my supervisor, Maurice Jansen, for thoroughly and patiently guiding me through the process and providing me with new and often interesting insights, and my second assesor, Bart Kuipers, for assessing the thesis and providing additional remarks to finalise my research.

Preface

After finishing the rather broad BSc Economics and Business Economics at the ESE, I chose the MSc Urban, Port & Transport Economics because it is a more applicable form of economics. It was actually the only MSc that really interested me, also because of its applicable nature.

The subject of my thesis is partially stemmed from the subject of my BSc thesis, also supervised by Maurice Jansen, which was also focussed on sustainability and SDGs. As I enjoyed researching that matter, I decided to do my MSc thesis in the same direction. In the beginning I had some trouble narrowing down the subject, which resulted in a paper full of broad information on a variety of subjects. However, after several conversations with my supervisor the subject was more and more narrowed down.

The process of writing the thesis had its ups and downs. Periods in which I was highly motivated followed by periods that showed more of a lack of motivation. During the process I gained new knowledge on the different subjects of the thesis. Especially the conducted interviews interested me, as it provided practical insights of different companies that are active in the Dutch inland shipping sector. I had some fun and thorough conversations with different people that have an important position within the company. This made the process of completing my thesis more fun.

I hope the results and conclusions provided in my thesis will contribute to the existing literature and knowledge on the subject and will – in some way – help the Dutch inland shipping sector in its innovative and circular development.

Contents

1 Introduction

1.1 Relevance

Covering 60% of the total European inland shipping fleet, the Dutch inland shipping sector is considered to be the largest of Europe (Cirkellab, 2016). Several studies expect the inland shipping sector to grow in the coming decades, at least in the next 40 years (Ministerie van Infrastructuur en Milieu, 2015). This expected growth is due to the expected container transport and the construction of Maasvlakte 2, resulting in increased transport from the Port of Rotterdam into the hinterland. An article published by TNO (2014) argues that this increased transport flow cannot be handled exclusively by the road transport of the Netherlands and the rest of the hinterland, as this would result in too much congestion and pressure on the road network. Therefore, TNO mentions the importance of the growth of the Dutch inland shipping sector in order to cope with the expected transport growth.

The Dutch inland shipping sector could become more appealing through innovation. Cirkellab (2016) mentions the lack of innovation in the inland shipping sector, especially when compared to road transport. Inland shipping was argued to be a more sustainable mode of transport, but due to innovation of other transport modes, this gap is decreasing. Both Cirkellab (2016) and a report of Maritime by Holland (2011) mention the lack of intrinsic innovation in the Dutch inland shipping sector, causing this sector to lose its lead in terms of sustainable transport.

The Dutch inland shipping sector consisted of around 5000 ships, while seeing a decreasing trend in the number of ships due to economies of scale, resulting in smaller vessels being driven out of use (Nederland Maritiem Land, 2019). According to a research of Panteia (2019), two-thirds of the vessel engines of this Dutch fleet does not meet the CCR-2 emission requirements, which will be obligatory for all vessels by 2025.

However, this issue does not go unnoticed. Multiple programs regarding sustainable shipping have been initiated, both on national and international shipping levels. The European Green deal, initiated in 2019, recognises the contribution of shipping towards the global greenhouse gas emissions and strives to tackle this problem by involving all economical sectors in this mission and providing support to those sectors that suffer the most. The International Maritime Organization is another example of an organization that acknowledges the environmental issues and supports their 174 member states in achieving the implementation of the Sustainable Development Goals (IMO, 2015). On a national level, the "Green Deal Zeevaart, Binnenvaart en Havens" has been initiated. This program acknowledges the environmental progress that can be made. The deal includes goals, ambitions and actions that should contribute to a decrease of emissions caused by shipping. The Dutch government

will provide financial support to the actors that aim to implement a more sustainable business model but struggle with the financial feasibility (Green Deal, 2019).

Thus, there is awareness of the sustainable issues that are present in the current shipping sector, including the Dutch inland shipping sector. But still, there seems to be a lack of innovation and development in order to develop at the same rate as other sectors do. According to Cirkellab (2015) the Dutch maritime sector, including the inland shipping sector, could potentially learn from other sectors in terms of circularity. Other sectors, such as the automotive sector, show to be more circularly developed and have more circular initiatives and projects that results in higher revenue.

1.2 Research question

As it turns out that the Dutch inland shipping sector is lacking in terms of sustainable development and circularity compared to other sectors, the aim of this paper is to find a cause of this matter. What causes the sector to fail in keeping up with circular progression. This results in the main research question:

"What market failures exist in Dutch inland shipping sector that obstruct the implementation of circular business models?"

The main research question will be answered through both desk research and practical information acquired through interviewing relevant actors in the Dutch inland shipping sector. By analysing the answers to the sub questions and additional inside information provided by the interviewed actors, a conclusion and answer to the main research question will be formed.

1.3 Sub questions

The main question is supported by sub questions, which need to be answered in order to construct an answer to the main research question.

Sub question 1:
"What are the relevant actors in the shipping market that influence the circular performance of the Dutch inland shipping sector, and what is their role?"

Sub question 2:
"To what extent is every phase of Ship Life Cycle Management related to circularity in the Dutch inland shipping sector?"

Sub question 3:

"What forms of collaboration exist in the Dutch inland shipping sector and how effective are they in order to increase the circularity in inland shipping?"

The next chapter will be the methodology in which the manner of answering the separate questions. Besides, the methodology will elaborate on how the relevant actors for the interviews have been selected and how the interview is constructed. The methodology will be followed by a literature review to gain a better understanding of circularity, circular business models and collaboration. The next chapter aims to provide a better understanding of the concept of market failures, followed by a chapter elaborating the shipping market and Ship Life Cycle Management (SLCM). Now that the theoretical approach has been completed, the next segment focusses on the practical information derived from the interviews. Combining the interview results with the results of the theoretical desk research will result in a conclusion for the three sub questions and eventually the main research question. At last, the limitations of the research shall be provided.

2 Methodology

2.1 Introduction

In this segment the main research question and sub questions are further elaborated as to how they will be answered. The answers to the sub questions will help construct the answer to the main research question. Rationale for choosing these methods.

2.2 Research method

To answer the three sub questions and main research question discussed in chapter 1 this paper uses several research methods. The paper starts off with a literature review combined with desk research on sustainability and circularity, market failures, ship life cycle management and the Dutch inland shipping sector. The aim of this research method is to gain a better understanding of the different topics. The literature review will give an overview of what has already been found on the relevant topics, while the desk research will focus on the analysis of the found literature. Sustainability and circularity, market failures, Ship life cycle management and the Dutch inland shipping sector are important subjects that need to be elaborated through these research methods, as it will form a fundamental understanding on which more practical research and analysis can be conducted.

This more practical research is conducted through interviews with actors that are relevant for all three subjects that have been previously elaborated through both literature review and desk research. Conducting interviews will provide more in-depth information on the subjects, which can be combined with the previously acquired theoretical information. The practical information can either be in line with or contradictory to the theoretical information. This will help to find the eventual answers to both the sub questions and the main research questions.

The subjects that are analysed in the literate reviews, desk research and the interviews are selected based on the sub questions mentioned in chapter 1. Besides the answers to the sub questions, the practical knowledge acquired through the interviews could provide different points of view on the main research question that are just as important for the conclusion. Therefore, these potential insights will also be concluded in the answer to the main research question.

2.3 The interviews

As mentioned in segment 2.2, the research method utilises the conduction of interviews to relevant actors. This segment will aim to provide a better understanding as to how the interviews are set up and based on what criteria the relevant actors are selected.

2.3.1 Setting up the interviews

The construction of the interview is based on the theoretical framework of the paper. In general, four different subjects were used, with several questions for every subject. The subjects were:

- *Circularity in general*
- *Ship Life Cycle Management*
- *Cooperation within the Dutch inland shipping sector*
- *Relatively slow development of the innovation in the Dutch inland shipping sector.*

The subject *circularity in general* aims to gain a better understanding as to how the different companies interpreted and implemented the SDGs when these were introduced, which SDGs are the most relevant for them and how they are represented in the business models of the companies. By doing so, the mentioned SDGs can be linked to circularity using the framework in segment 3.3.4, which eventually gives an overview as to how circularity is represented within the companies.

The second subject, *Ship Life Cycle Management,* focusses on the relevant ship life cycle phases, described in segment 4.5, for the different companies. This way the interview strives to elaborate which ship life cycles are more relevant for the companies in the Dutch inland shipping sector so it becomes clear which problems in which phases should be tackled.

The third subject, *cooperation within the Dutch inland shipping sector,* aims to understand to which extent the current state of cooperation in the sector contributes towards the current state of circular innovation in the sector. Cooperation in the sector in general is elaborated in a theoretical way in segment 3.5, cooperation within the general shipping sector is discussed in segment 4.3 and cooperation in specifically the Dutch inland shipping sector is discussed in 6.3. The subject aims to elaborate how the different companies are related to the current cooperation, which factors are important for a successful cooperation and why some literature argues this cooperation to be lacking.

The final subject, *relatively slow development of the innovation in the Dutch inland shipping sector,* is more of a closing subject, where the general issue of the thesis is presented and their practical point of view on this issue is asked.

2.3.2 Selecting the relevant actors

In this step, the relevant actors are selected that are active in the Dutch inland shipping sector and are considered to play a significant role in the circular development in the sector. In order to gain a better understanding of the different points of view of the different actors, the selected actors must be from different markets within the sector.

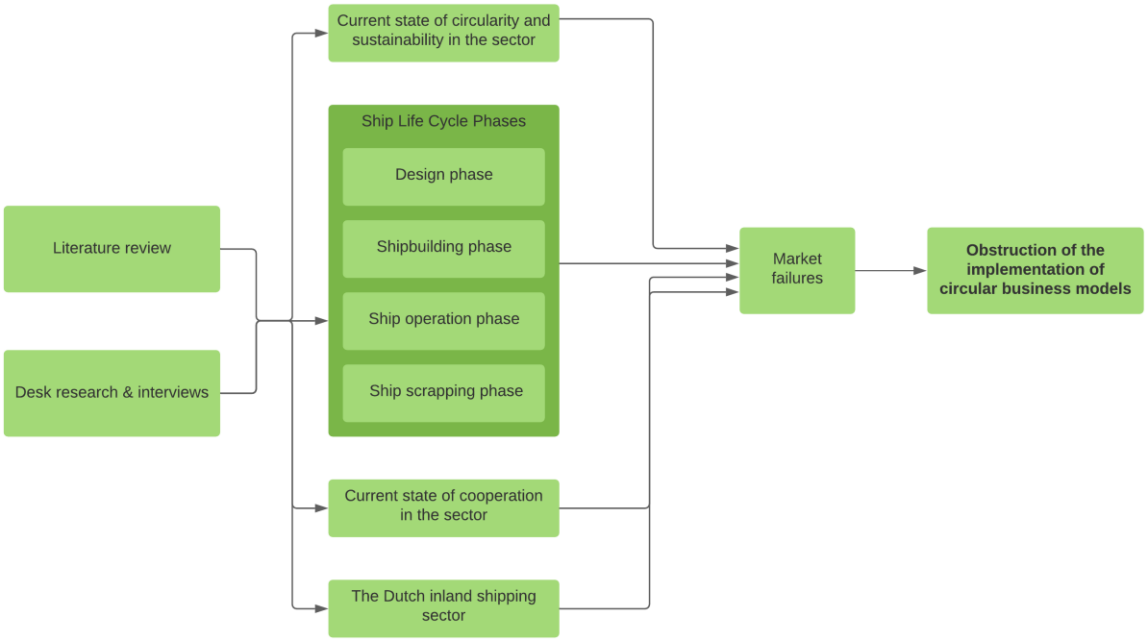
Selecting the different points of view is done through desk research. Segment 4.2 discusses the actors that are relevant in the shipping market in general. Important actors mentioned in this segment are shipowners, shippers and shipbrokers. This can be combined with the subject of Ship Life Cycle Management, discussed in chapter 4. The actors mentioned in the different phases of the SLCM should also be considered as potentially relevant actors which could be useful to interview. An overview of the eventually selected actors is given in segment 7.2. When an actor meets the two mentioned characteristics that were just discussed, it is considered to be a 'relevant actor' for this interview. The selection process and why the actors were included in the research will be discussed in segment 7.2.

2.3.3 Analysis

The answers to the interviews will be transcribed in Microsoft Word and then analysed using ATLAS.ti 9.0. The practical information derived that is acquired through the interviews will be referred to using the document numbers combined with the specific quotation number, for example: (3:12).

2.4 Conceptual framework

Table 1. Conceptual framework of the research method.



To gain a better overview of the research method, a conceptual framework is provided in figure X. This framework shows that the information is gathered through literature review, desk research and interviews. The information will be gathered on four different subjects: the current state of circularity & sustainability in the sector, the SLCM, the current state of cooperation in the sector and the Dutch inland shipping sector. These four subjects are very broad. Besides, there is a complex interrelationship between the subjects through various levels. Analysing and discussing the separate

subjects will result in an overview of these interrelations and can be identified as a specific cause of a market failure. The causes of market failures are discussed in chapter 5. Using the different causes of market failures derived from the analysed subjects, the paper can provide an answer to the main research question on the obstruction of circular implementation in the sector. The conceptual framework of the research method is depicted in Table 1.

3 Circularity

3.1 Introduction

This segment aims to provide a better understanding of the global urgency and rising awareness regarding sustainability and circularity. It mentions initiatives that strive to support the sustainable and circular development, the essence of a circular economy and corresponding circular business models that are implemented, and how collaborative action can improve the implementation of circularity.

3.2 Sustainable development goals

3.2.1 Global initiatives

In September 2015, the United Nations (UN) initiated the *"2030 Agenda for Sustainable Development".* This initiative consisted of 17 *Sustainable Development Goals* (SDGs). These goals are meant to categorise the global issues regarding the society, economy and biosphere, and help companies worldwide with their implementation of the SDGs into their business strategy (Kruiswijk, 2019).

Besides the 2030 Agenda for Sustainable Development, many other global initiatives have been constructed to enhance sustainability worldwide. Back in 2000, for example, the UN approved eight *Millennium Development Goals.* Nowadays, multiple programs are set up that are all driven by the SDGs. In 2015, the European Commission initiated the *European Union Action Plan for the Circular Economy,* which focusses on the transition from a linear towards a circular economy (Rodriguez-Anton, Rubio-Andrada, Celemín-Pedroche & Alonso-Almeida, 2019). In 2017, the International Association of Ports and Harbours (IAPH) started the *World Port Sustainability Program* (WPSP). This program was launched in 2018 and aims to create a better coordination of sustainable efforts of ports worldwide, through which they aim for a better co-operation between the ports. Another sustainable initiative in the port sector is the *"Agenda 2030"*, created in 2018 by the *Association Internationale Villes Ports* (AIVP). This program listed 10 'commitments' among which the 17 SDGs of the UN have been divided. This way the AIVP strives to ease the coordination of global initiatives that aim to tackle global sustainable issues within the port-city context (Kruiswijk, 2019).

3.2.2 Sustainable development goals

As described in section 3.2, the SDGs resulted in political institutions all around the world putting high priority on the increase of sustainability through programs and initiatives. To fully understand these initiatives and the actions that are taken, it is important to gain an overview of the Sustainable

Development Goals initiated by the UN back in 2015, which can be seen as a 'backbone' of the global initiatives. This overview is given in Appendix Table A

3.3 Circular economy

3.3.1 Definition of Circular economy

With the increasing need of a transition to more sustainable sociotechnical system, the concept of *Circular Economy* (CE) has become more important to global policymakers. Although the concept of CE is not new, the urgency of it has grown in the eyes of many to battle environmental, societal and economic problems. With the increased urgency of circular economy, it has become an important field of academic research, resulting in a high increase of the number of articles and journals discussing this topic (Geissdoerfer, Savaget, Bocken & Hultink, 2017). It is trending among both scholars and practitioners, which resulted in more than 100 articles about CE being released in 2016. This proves the growth of circular economy's urgency, considering the number of articles about CE published in 2014 being only 30 (Kircherr, Reike & Hekkert, 2017).

According to the research of Kircherr et. Al (2017), the concept of circular economy has become too vague. The increased urgency of CE has resulted in many different definitions being published. The research claims that a definition being vague could cause it to lose its importance. Therefore, Kircherr et al. gathered 114 circular economy definitions and analysed it through a coding framework. This way they strived to get a better understanding of the definition of circular economy. Their research resulted in the definition of circular economy being *"an economic system that replaces the 'end-of-life' concept with reducing, alternatively reusing, recycling and recovering materials in production/distribution and consumption processes. It operates at the micro level (products, companies, consumers), meso level (eco-industrial parks) and macro level (city, region, nation and beyond), with the aim to accomplish sustainable development, thus simultaneously creating environmental quality, economic prosperity and social equity, to the bene fit of current and future generations".*

3.3.2 Seven key elements of Circular Economy

According to Circle Economy (n.d.), there are 7 key elements that define circular economy. These elements are depicted in Figure 1. The first key element, *Prioritise Regenerative Resources*, aims at ensuring that renewable, reusable and non-toxic resources are prioritised, and efficiently utilised as materials and energy. The key element *Preserve and Extend What's Already Made* emphasises repairing, maintaining and upgrading resources that are being utilised. This way, the lifetime of the resources could be maximised and, if applicable, utilise the resources again and providing them with a 'second life'. *Use Waste as a resource* aims at using waste streams of production as a resource for

other production in order to minimise the waste. The key element *Design for the Future* states that products must be designed in a way that considers the lifetime of the product, the materials used for production and the potential future use of the product. This could involve the reuse of the material post-lifetime. *Collaborate to Create Joint Value* emphasises the increase in transparency throughout the supply chain and the increase of cooperation between organisations to create joint value. *Rethink the Business Model* looks at whether there are opportunities to gain value and align incentives by creating business models that build on interaction between products and services. An example of such an interaction is leasing a product. This way, the manufacturer retains ownership of the products and can efficiently reuse or recycle the products. The last key element, *Incorporate Digital Technology,* makes it possible to track resource use and strengthen the connections between organisations through digital platforms and other technologies that create more transparency and insights (Circle Economy, n.d.).

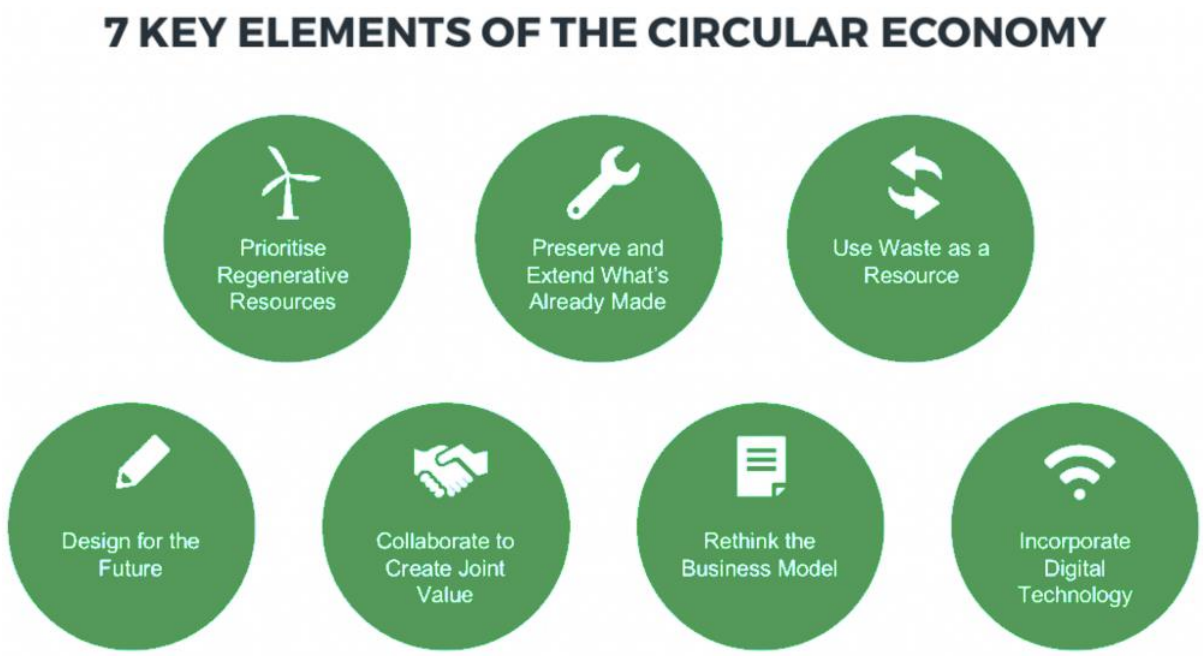


Figure 1. Seven key elemensts of the circular economy
Source: Circle Economy (n.d.)

3.3.3 The 'butterfly' diagram

The Ellen MacArthur Foundation define circular economy as *"an economy that is restorative and regenerative by design"* and argue that it is based on three principles. The first principle is to *design out waste and pollution,* where the negative consequences of economic activity causing damage to the environment and human health is designed out. Think of greenhouse gas (GHG) emission, pollution or structural waste resulting from for example traffic congestion. The second principle, *keep products and materials in use,* emphasises the importance of keeping materials, products and components circulating in the economy, by creating business models and design that focus on

durability, remanufacturing, recycling and reuse of resources. The last principle is to *regenerate natural systems,* which argues that we should not only protect but also improve the environment. A circular economy must preserve or enhance renewable resources in order to be able to utilise renewables in the future.

Besides defining circular economy, the Ellen MacArthur Foundation attempted to depict the essence of circular economy in a so-called 'butterfly diagram', shown in Figure 2. The two cycles in the diagram depict two fundamental flows of material: *biological and technical*. The biological cycle represents the materials that can return to nature after going through one or multiple use processes. These products will biodegrade and contribute to the environment. The technical cycle represents the materials that must be kept and reused within the production cycle as they cannot be re-introduced to the environment. In order to maximise the efficiency of such a product, it should be reutilised as much as possible. These two cycles were introduced in *"Cradle to Cradle: Remaking the way we make things",* a research by McDonough & Braungart (2002). The Ellen MacArthur Foundation states that *"the diagram tries to capture the flow of materials, nutrients, components, and products, whilst adding an element of financial value. It builds on several schools of thought, but is perhaps most recognisably influenced by Cradle to Cradle's two material cycles."*

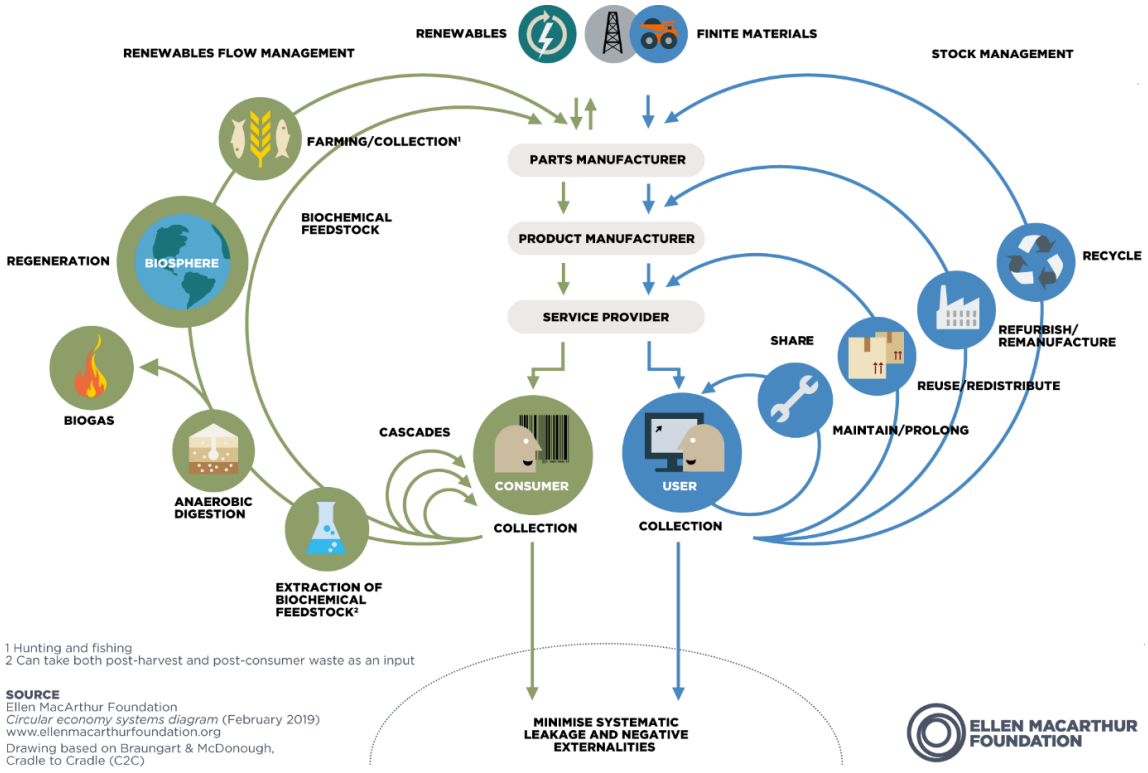


Figure 2: Diagram depicting the essence of the circular economy, nick named "butterfly diagram"

3.3.4 Relation between the SDGs and circular economy.

As mentioned in section 3.2.1, the European Commission initiated the European action plan for the circular economy. This action plan was in line with the SDGs and aimed at seeking a transition towards a more circular economy in which the generation of waste was minimised, focussing on production, consumption, waste generation and other measures to monitor the CE. The European commission stated that *"the circular economy will also need to develop globally. Increased policy coherence in internal and external EU action in this field will be mutually reinforcing and essential for the implementation of global commitments taken by the Union and by EU Member States, notably the U.N. 2030 Agenda for Sustainable Development and the G7 Alliance on Resource Efficiency. This action plan will be instrumental in reaching the Sustainable Development Goals (SDGs) by 2030, in particular Goal 12 of ensuring sustainable consumption and production patterns."* (Rodriguez-Anton et al., 2019). Thus, according to the European Commission, there should be a close relationship between CE and the SDGs. However, the term "circular economy is never mentioned in the 2030 Agenda for Sustainable Development (Einarsson, 2019). Then what are the links between the SDGs and CE?

In his research, Einarsson summarizes the direct and indirect relationships between CE and the SDGs, and the effect of the SDGs on the global uptake of CE that are mentioned in a study of Schroeder & Anggraeni (2018). This study considers circular economy to be a 'toolbox' for achieving many of the SDGs. The direct benefits of CE practices for achieving the SDGs are related to five SDGs and 21 of the 169 targets linked to these SDGs. These benefits are shown in Appendix Table B. The indirect benefits are related to 4 SDGs and 28 additional targets, as the indirect effect occurs through the direct effects. The indirect benefits are shown in Appendix Table C. Furthermore, there are 6 SDGs and 52 targets that positively contribute towards the global development of circular economy. These contributions are shown in

Appendix Table D. To gain a better understanding of the connection between circular economy and the SDG, the flowchart depicted in Figure 3 aims to provide a visualisation of the connections that were discussed in Appendix Table B, Appendix Table C and

Appendix Table D.

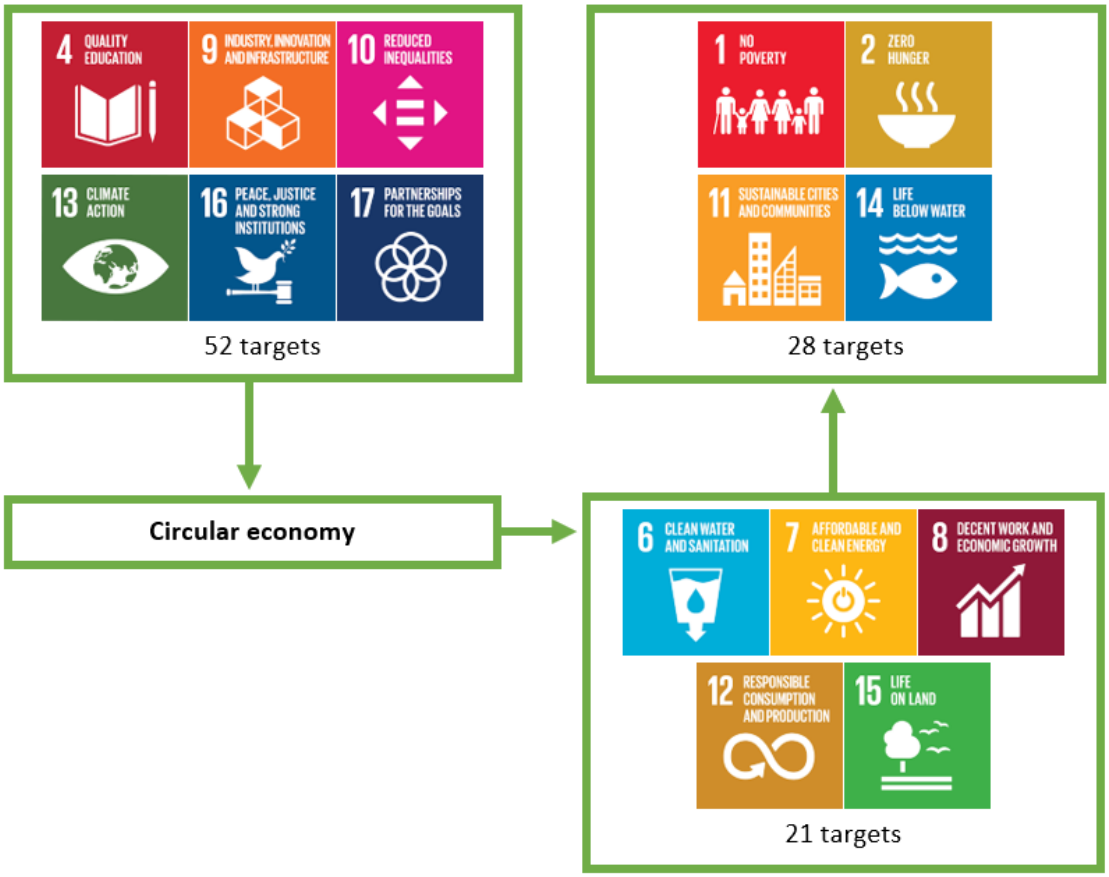


Figure 3. Summary of the connections between the SDGs and circular economy
Source: Information acquired from Schroeder & Anggraeni (2018).

The framework elaborated in this segment is an important link between the concepts of *sustainability* and *circularity*. Even though these concepts are closely related they do differ, and in order to better understand the goal of this research it is important to be able to distinguish them.

3.4 Circular business models

Having discussed the essence of circular economy, relevant models and the relation of circular economy with the Sustainable Development Goals, this segment aims to provide a better understanding as to how circular economy is implemented in business models both in general as in inland shipping.

3.4.1 General circular business models

A research of Osterwalder and Pigneur (2010) define a business model as a model that *"describes the rationale of how an organization creates, delivers and captures value".* The paper provides nine

elements that together form a business model. These elements are depicted in Figure 4. A research of Guldmann (2017) argues a circular business model combining these nine elements in an innovative way, striving for value creation in places which are usually neglected when operating in a linear manner. Guldmann mentions several ways to align the elements of Figure 4 with circular economy, with the previously mentioned *butterfly diagram* – depicted in Figure 2– being one of them. The loops in the diagram represent a possible area in which a company can improve in terms of resource efficiency. These loops can thus be utilised to find inspiration for new ways of value creation in normally neglected areas. Besides the butterfly diagram, the paper mentions two other frameworks which could help companies with value creation in a circular manner and setting up their circular business model: *Four value creation bases* and *five distinct business models of the circular economy.*

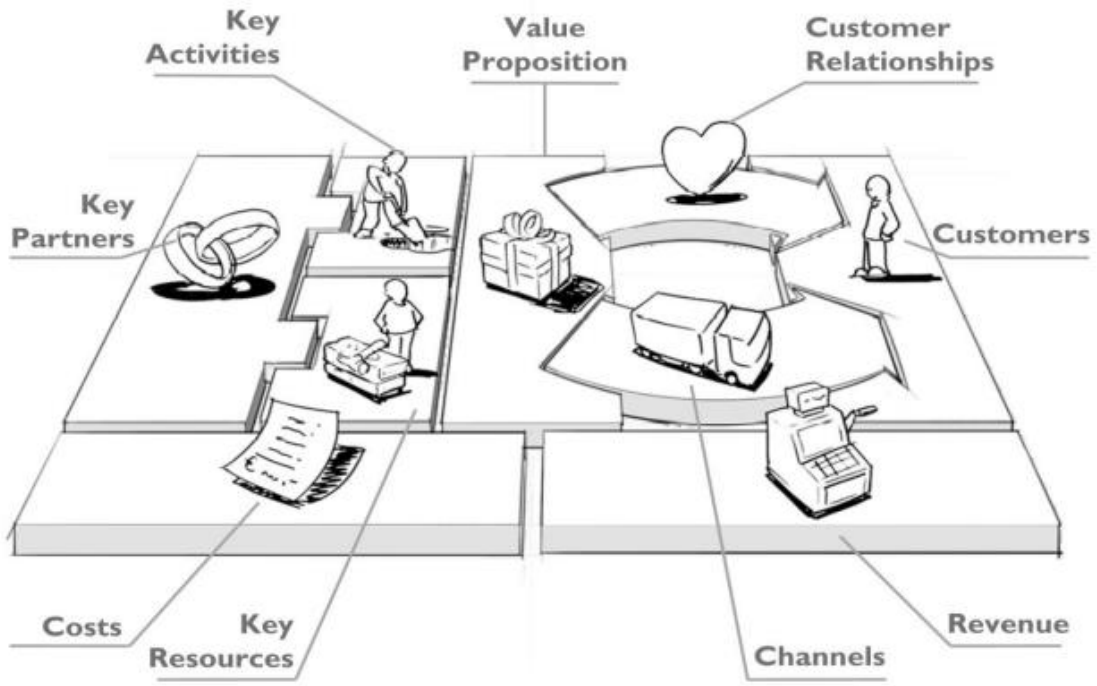


Figure 4. The nine elements of a business model
Source: Guldmann (2017)

The *four value creation bases* were elaborated by a report of the Ellen MacArthur Foundation (2013). They provide four ways of value creation in a circular manner. The first way is *'The power of the inner circle',* which aims at minimising material usage by utilising resources and materials as long as possible. The report argues that a tighter circle results in larger benefits from being circular, as the inefficiencies of a linear production are minimised. This strategy is comparable with the 'maintain/prolong' loop in the Ellen MacArthur Foundation's butterfly diagram. Circular product design and supportive business models are important in order to maximise the opportunities of this strategy. The second way of value creation is the *'power of circling longer'.* This strategy aims at keeping materials in as many cycles as

possible before labelling it as 'waste'. This can be achieved by keeping materials either in as many circles as possible or within a circle for as long as possible. This minimises the total input of new resources for the business process. The third basis of value creation provided by the Ellen MacArthur Foundation (2013) is the *'power of cascaded use and inbound material/product substitution'.* Here, the focus is mainly on diversifying the reuse of products in order to prolong the utilisation of the same input. Products could be used in a different way after their initial method of reusage is no longer efficient or possible. Products that are not usable in one production process could be used in another production process. The last value creation basis is the *'power of pure, non-toxic, or at least easier to separate inputs and design'.* The value creation of this basis lays within the enhancement of the potential of the other three value creation bases. Pure material usage contributes to the total created value of the bases. Quality of the products and components result inefficiency gains and the post-consumption materials that are reused for production will no longer be offered as a mixture of materials, but rather as pure materials that will be more efficient for reusing on production.

3.5 Partnership mechanisms

"The issues we face are so big and the targets are so challenging that we cannot do it alone" (Polman, 2012).

"It will be impossible to achieve the Sustainable Development Goals without accelerating and scaling private sector engagement and collective action by business, government and civil society. Action by individual companies is necessary but not sufficient to drive transformational and systemic change toward sustainable development" (Nelson, 2017).

"The SDGs can only be realized with strong global partnerships and cooperation. A successful development agenda requires inclusive partnerships — at the global, regional, national and local levels — built upon principles and values, and upon a shared vision and shared goals placing people and the planet at the centre" (United Nations, 2015).

These are just some quotes found in the academic literature regarding sustainable development and achieving the Sustainable Development Goals. Considering these quotes – which represent the line of thought of the academic literature on this subject – it can be derived that sustainable development will not be achieved by a single company or sector enhancing its sustainable performance. Such achievements will only be achieved through strong collaborations on governmental, organisational and societal level.

3.5.1 General partnership models

According to a report published by the Network for Business Sustainability (NBS) in 2013 collaboration is one of the key elements for increasing sustainability. This report substantiates this claim by providing an overview of the growth of both voluntary and public policy articles that mentioning the use of partnerships between 2000 and 2012. This is given in Figure 5.

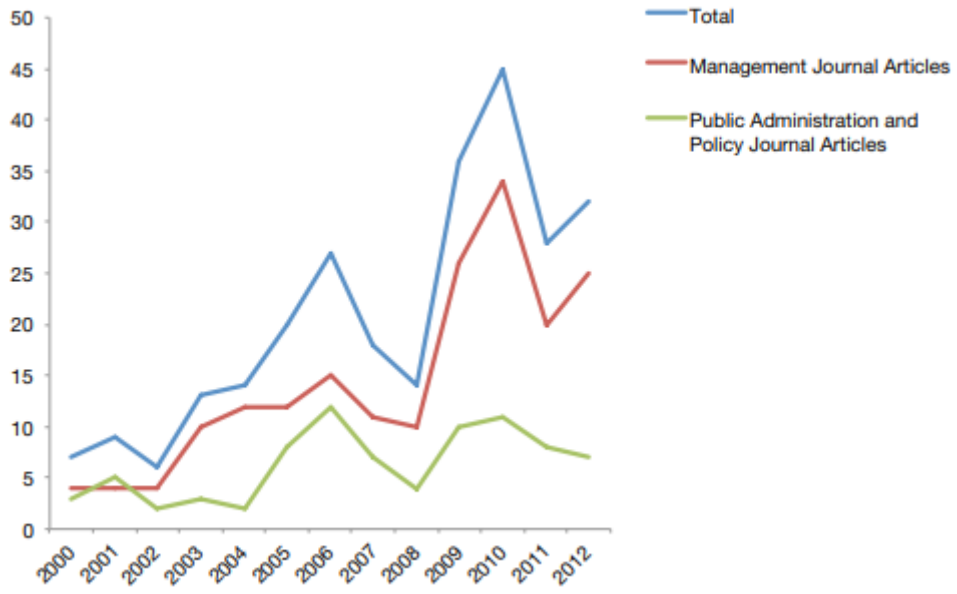


Figure 5. The number of published articles regarding partnerships. 2000-2012
Source: Network for Business Sustainability

The Partnerships Resource Centre (PRC) is an initiative by the Rotterdam School of Management that aims to create a platform for public and private collaborations in terms of sustainability and inclusive development. They argue that when Government, Business and Civil Society work together, this can result in collaborative and inclusive solutions for issues regarding the Sustainable Development Goals. The collaboration on the three levels will result in creation of knowledge, sharing of knowledge and the connection of knowledge.

Besides initiatives such as the PRC, other literature provides action plans which give recommendations for companies regarding partnerships and sustainable inclusive development. In the report *"Partnerships for sustainable development: Collective action by business, government and civil society to achieve scale and transform markets"* written by Jane Nelson (2017), an "Agenda for Action" is provided. This agenda aims to create a better understanding as to how companies could be able to make a difference through partnerships and collaborations. The paper concludes that partnerships are key in order to create a more responsible, inclusive and sustainable growth, and can help to identify market failure, trust deficits and governance gaps which obstruct the sustainable

development of companies and industries. It provides eight key factors for success, based on a research of over 40 academic studies exploring what is essential in building a partnership. The eight key factors for achieving efficient partnerships given by Nelson (2017) are given in Table 2.

Table 2. Key factors for achieving efficient partnerships

Success factors in building partnerships		
SHARED PURPOSE and **UNDERSTANDING OF THE ECOSYSTEM** and its **STAKEHOLDERS**	1	A compelling **agenda for change led by strong champions** who are leaders in their own organizations and are able to take decisions, allocate resources, motivate and mobilize others, and support a long-term commitment.
	2	Jointly agreed **public commitments and a strategic plan** for achieving them, based on rigorous consultation and relevant baseline evidence, with clearly defined roles and responsibilities for every participant.
	3	Understanding of the **full value chain or ecosystem required for transformation** and ability to either holistically coordinate activities or stakeholders across this system or target specific interventions that mutually reinforce those of others.
RIGOROUS PROCESS and **OPERATIONAL ALIGNMENT**	4	Effective **implementation capability**, enabled by dedicated and well-resourced 'backbone support', committed practitioners from participant organizations who have the necessary authority and skills to engage, and effective communication and conflict resolution processes that enable regular and rigorous dialogue and feedback.
	5	Strong alignment with and leverage of partners' **core competencies** and interests.
GOOD GOVERNANCE and **MUTUAL ACCOUNTABILITY** for **PROGRESS**	6	Mutually agreed **metrics and governance mechanisms to track performance and ensure rigorous oversight and accountability**, both within the partnership itself and externally with relevant stakeholders, including beneficiaries and vulnerable groups where relevant.
	7	**Participatory monitoring and independent evaluation** approaches that facilitate shared learning and better decision-making in addition to ensuring transparency and accountability.
	8	Flexibility to **"course correct" and be adaptive** based on evolving circumstances, disruptive events, failures, stakeholder feedback and lessons learned.

Source: Nelson (2017)

3.5.2 Coordination mechanisms

A research of van der Horst & van der Lugt (2011) defines coordination mechanisms as *"all modes of organising transactions, including operational transactions, informal agreements, contracts, incentives, alliances, introduction of new actors or markets, and vertical integration"*. The aim of coordination mechanisms is to solve coordination problems between actors. The paper of van der Horst & van der Lugt focusses on coordination mechanism that improve hinterland accessibility. It provides some examples of coordination mechanisms for hinterland accessibility, such as a terminal operator implementing arrangements with inland terminals to resolve the planning problems that occur for barges at the terminal.

Solving coordination problems between actors positively affects efficiency of cooperation within a market or between a certain group of actors. Therefore, coordination mechanism could benefit the Dutch inland shipping market in terms of improving circular performance.

3.6 Conclusion

Chapter 3 discussed multiple subjects that are important for answering the sub questions and the main research question. First, sustainability in general and related initiatives was discussed to emphasise the global awareness regarding sustainability. After the initiation of the SDGs by the United Nations, multiple programs arose that strive to help implement these SDGs on a large scale. Circularity turns out to have varying definitions, but the essence of the subject is properly depicted through the 'seven key elements of circularity' and the 'butterfly diagram'. Besides, circularity can be linked the previously discussed SDGs. These relations are depicted in Figure 3. Circularity can be translated in circular business models, but in order to achieve these models on a larger scale, the importance of collaborations and partnerships cannot be neglected. The awareness of the importance of collaboration in order to achieve goals, such as circularity, is growing.

Now that sustainability, circularity and the importance of collaboration have been elaborated, the next chapter will focus on Ship Life Cycle Management and its different life cycle phases.

4 Ship life cycle management

4.1 Introduction

This chapter elaborates on the general shipping market and its current state in terms of sustainability. Besides, Ship Life Cycle management and its corresponding phases are discussed, as it is an important subject for answering the sub questions and main research question.

4.2 The shipping markets

To be able to apply the discussed circularity models to the Dutch inland shipping sector, there should be a general understanding of what the shipping market includes. The book *"Maritime Economics",* published by Martin Stopford in 1997, delves into the organization and workings of the global shipping industry, with one chapter covering the four shipping markets that trade in different commodities. These four markets are the *freight market,* the *sale and purchase market,* the *newbuilding market* and the *demolition market.* Stopford argues the activities of actors in the four markets to be closely correlated as they all trade in the same four markets.

The *freight market* is described by Stopford as the marketplace in which sea transport is purchased and sold. The main actors of this market are the shipowner, the shipper and the shipbroker. The shipowner offers available cargo space on a ship. This cargo space is demanded by shippers. The shippers want to get their cargo from one point to another, and therefore demand a specific type of shipping, dependant on the type of cargo. The shipbroker is the mediator within this market and acts on behalf of his client. The shipbroker finds cargo space that fits the specific demands of the shippers.

In the *sale and purchase market,* shipowners put their ships for sale. This could be for several reasons, such as financial or technological reasons. On the other side is the ship purchaser, which is looking for a ship that fits his specific demands. Just like in the freight market, the actors tend to utilise the services offered by a shipbroker. The shipbroker mediates between the seller and the purchaser and matches the offered ships with the specific demands.

According to Stopford (1997), the *newbuilding market* and the sale and purchase market are closely related. Where the sale and purchase market deals in existing ships, the newbuilding market deals in ships that are still non-existent. This affects the complexity of the contractual administration, partially because of the specification of the demanded vessel. Besides, after the agreement, the manufacturing and delivery of the ship still takes several years. During this time, conditions could have changed significantly. The motives of the purchaser could be somewhat similar to the motives of the purchaser in the sale and purchase market. It could be the need of a new vessel with certain specifications which

is not available on the second-hand market, or a vessel that has to certain requirements for the specific cargo or operations that the shipper will perform.

Lastly, the *demolition market* is argued to be less glamorous but still an essential part of the market (Stopford, 1997). In this market, the purchasers are the scrap yards. Instead of another shipowner taking over the ship of a shipowner who wants to sell the ship, vessels that are no longer demanded by shipowners are sold to the scrap yards acting in the demolition market. The actors on this market also tend to utilise the services offered by shipbrokers. Some brokers even have departments specialised for the demolition market. Most of the buyers, which are the demolition yards, are located in the Far East. According to a research of Karlis and Polemis (2016), China, India, Bangladesh and Pakistan are among the leading countries in terms of shipbreaking. The research argues these countries to hold 82% of the ships that are demolished and 92% of the deadweight tonnage (DWT) demolished. These results are somewhat comparable to the results of a research of Reddy & Manoharan (2014, stating these countries to hold 75% and 93% of the demolished ships and DWT respectively. Such results could be caused by the cheap labour availability in these countries, with shipbreaking being labour intensive. However, this is mainly applicable for seagoing vessels. There is enough capacity in the Netherlands for the demolition of inland shipping vessels, with laws and regulations preventing these inland vessels being scrapped in a responsible manner. Therefore, the demolition market for the inland shipping sector does not compare to the demolition of seagoing vessels when it comes to environmentally friendly and responsible scrapping (Cirkellab, 2016).

4.3 Sustainable shipping

Now that the general shipping market has been discussed, this segment elaborates on the sustainable state of play in the shipping market. Several concepts will be discussed and analysed that will give an overview of to what extent sustainability and circularity currently play a role in transport and shipping. This way, the paper aims to provide a link between the Sustainable Development Goals and sustainability, discussed in segment 3.2, and the general shipping market.

4.3.1 International Maritime Organization (IMO)

The IMO is an active participant in the process of achieving the SDGs. They mention SDG 14 to be their central SDG but have provided linkages between their shipping activities and the other 16 SDGs too. They argue that most elements of the goals will only be acquired using sustainable transport and world trade. Therefore, the IMO argues to be an important actor in achieving them. They strive to support all their 174 member states in their process of implementing the SDGs (IMO, 2015). To do so, the IMO published a strategy to provide support to member states in their goal of implementing the SDGs.

4.3.2 UN Sustainable Transport

The UN, initiator of the Sustainable Development Goals, has mentioned that global transportation and mobility – including maritime shipping – are a central aspect for sustainable development. Since it was first argued to play an important role in 1992, it has developed continuously and is now considered to be contributing to many sustainable aspects globally. International sustainable transport can enhance economic growth and achieve economic integration while being environmentally friendly. Given the fact that transport contributes significantly to the global greenhouse gasses emission, sustainable transport is considered as a mainstream factor across all SDGs (United Nations, 2015).

4.3.3 European Green Deal

In 2019, the European Green Deal was initiated with the aim to utilise resources more efficiently by changing to a more circular economy and recovering the biodiversity by reducing pollution. All economical sector must be involved through investments, stimulating innovation, increasing energy-efficiency and international cooperation. The European Union will provide support to those who must make the most sacrifices. Transport is said to be responsible for 25% of the greenhouse gas emissions in the EU, of which 13,4% are caused by shipping. The Green Deal aims to reduce this emission with 90% by 2050.

4.3.4 Sustainable Shipping Initiative (SSI)

SSI, founded in 2010, is another international initiative aims to unite organisations with the same goal of improving the sustainability of shipping. SSI released their "Vision for 2040", in which their stakeholders publish their hopes for the shipping sector and which actions they take in order to achieve them. In general, achieving sustainable shipping is done through energy transition, enhanced work environments, financial rewards for sustainability, transparency and responsibility. 14 international members are currently participating in the achievement of their goals (SSI, 2010).

4.3.5 Emission pricing in shipping

With emissions of international shipping being responsible for 2.4% of the global annual greenhouse gas emissions between 2007 and 2012 (Kachi, Mooldijk & Warnecke, 2017), the initiatives mentioned in the previous segments are a logical response. According to the paper of Kachi et al. (2017) putting a price on greenhouse gas emissions could contribute to reaching the goal of having a decarbonised sector by 2050. The paper investigated three types of market-based measures. The first measure makes ships compensate their emissions through an offsetting scheme by buying emission reduction credits, the second measure places a cap on international shipping emissions and allows companies to buy and sell extra allowances, while the third measure includes a climate levy that sets a certain price on each tonne of greenhouse gasses emitted. According to a publication of the Global Maritime

Forum (2019), carbon pricing is not yet a significant factor of the strategy for GHG emission reduction in shipping initiated by the IMO, but will take some time to be implemented.

4.4 Ship Life Cycle Management

This segment will discuss the Ship Life Cycle Management, which is one of the subjects on which the interviews are based. Therefore, having a better understanding on the matter helps to better understand the practical information gained from the interviews. SLCM can be used to bridge the gap between circularity in general and circularity applied to the shipping market.

"Product Lifecycle Management (PLM) is the business activity of managing, in the most effective way, a company's products all the way across their lifecycles; from the very first idea for a product all the way through until it's retired and disposed of" (Stark, 2011). This definition describes PLM in general. This definition is backed by a research of Favi, Germani, Campi, Mandolini, Manieri, Marconi & Vita (2018), which argues life cycle management to be challenging for maritime transportation. Products which a large and complex production process, such as ships, require life cycle management that must also be adapted to the changing world during the life cycle. The implementation of new environmental regulations must be considered during the construction phase, but also during the phase in which the ship is used. Favi et al. (2018) mention two life cycle approaches that have been applied in the shipping market over the last decades. The first approach is the *life cycle assessment* (LCA), calculating the environmental performance of the product and the second approach is the *life cycle costing analysis* (LCCA), which assesses the total cost over the life cycle. Furthermore, the research mentions a large number of players to be involved in the production of ships due to the complexity of the product. With a large number of actors involved, data sharing should be managed in such a way that the production of ships becomes more efficient. This is implemented in maritime vessel designs through PLM combined with *product data management* (PDM).

4.5 Life cycle phases

The SLCM can be combined with different life cycle phases of a ship. A research of Gesellschaft für angewandten Umweltschutz und Sicherheit im Seeverkehr (2011) divides the life cycle of a ship into three phases: *shipbuilding phase, ship operation phase* and the *ship scrapping phase.* The research labels this view on the ship life cycle as the *cradle-to-grave perspective.* A paper of Cirkellab (2016) mentions the same phases but uses an additional phase in front: *the design phase.* Each phase accounts for a certain ecological impact. The aim of implementing and developing SLCM is to manage this impact in the most efficient way. Dividing the total life cycle in separate phases helps to distinguish which environmental impact is accounted for by which actor contributing to the life cycle of the ship.

Cirkellab (2016) mentions the design phase being responsible for 80% of the product-related environmental impact. The design of ships with a long life cycle is already happening, but circularity is not yet considered often during this design process. Gauss (2011) also mentions the importance of design for sustainability, as the design phase account for important decisions regarding future energy efficiency.

The shipbuilding phase focusses on minimising the environmental impact of the ship construction, while using materials that could be recycled or reused in the future. The choice of material takes place in the design phase. Shipbuilding requires a lot of raw materials and energy and causes emission and waste (Cirkellab, 2016). The production cycle should be transformed to a closed loop, using recyclable materials, clean energy and utilising the waste and emissions resulting from the production.

The main environmental concerns within the ship operation phase is the emission resulting from ship utilisation. Besides, the ship must meet the frequently changing environmental regulations of the area in which it is operating. Therefore, there must be adjustments to the ship that create a more environmentally friendly vessel. These adjustments to a ship could be considered to be obstructing newer innovative vessels from entering the market, which could cause a lack of innovation in the shipping market.

Lastly, the scrapping phase considers the way in which 'end-of-life ships' are being scrapped. Ship scrapping results in high energy use due to transport, welding of components and other steps that take place in the demolition of a vessel. Due to defective environmental laws in the countries in which scrapping takes place the most, demolition of vessels with a relatively low environmental awareness, causing air and water pollution and waste (Gauss, 2011).

4.6 Conclusion

This chapter showed the 4 different shipping markets and its corresponding actors. These actors are considered to be relevant for this research, as it helps to select the companies that will be interviewed. Whether a company is a relevant actor based on this explanation of the shipping markets will be one of the criteria in this selection. Furthermore, the chapter showed several global initiatives by the IMO, UN or the European Union regarding sustainable shipping, indicating the global awareness of the environmental impact of shipping. This environmental impact can be divided among the four life cycle phases that were discussed. This division makes it easier to oversee the different environmental impacts coming from the total life cycle of a product, which is of even more importance when the product has a longer life cycle, such as vessels. Potential environmental challenges for every life cycle phase are given in table X.

The essence of Ship Life Cycle Management, ship life cycle phases and its relation to sustainability are important subjects in this research, as it can help to find which phases face the most environmental challenges when it comes to shipping. Eventually, this can be narrowed down to specifically the Dutch inland shipping sector and included in the interviews with the relevant actors. The next chapter will discuss market failures, which is an essential term to understand in order to answer the main question.

Table 3. The environmental challenges of the different ship life cycles

Ship life cycle phase	Potential environmental challenges
Design phase	• Increasing the use of reusable materials • Decreasing the emissions coming from vessel engines
Shipbuilding phase	• Creating a closed-loop production cycle • Using reused raw materials • Maximising the energy efficiency of production
Ship operation phase	• Decreasing the total emission coming from ship operations • Opting to use more durable and recyclable materials • Increasing the shipping efficiency over the long life cycle
Ship scrapping phase	• Minimising energy-use during the scrapping activities • Enhance the laws and regulations regarding sustainable scrapping on a global level

5 Market failures

5.1 Introduction

In order to understand and answer the main research question properly, it is important to analyse the term 'market failures'. This chapter will provide the definition of a market failure, followed by the general causes of market failures to occur. This way, we can identify occurences in the Dutch inland shipping sector as market failure.

5.2 Definition and causes of a market failure

A market failure can be defined as *"the failure of the market to bring about results that are in best interests of society as a whole"* (Marciano & Medema, 2015). It is often used as a justification for the government to initiate interventions in order to control these failures and achieve the results that are in best interest of society. Such interventions include government spending, taxes and regulations. When market failures occur, the market seems to be unable to achieve the ideal outcome. This has caused a discussion, as the market is expected to meet idealised standards which is said not to be useful in a world that is dealing with imperfect knowledge and imperfect governments (Bourne, 2019). According to a research of Brian Andrew (2008), there are multiple causes of market failures. These causes are described in Table 4.

Table 4. Different causes of market failures

Cause of market failure	Explanation
Information problems	Unequal access of information results in an actor being able to make more profit compared to the other actor. An efficient market needs complete, unbiased and certain information. If that is not the case, those with limited information will make sub-optimal decisions.
Market power	An efficient market requires a large number of both sellers and buyers. When this is not the case, the side consisting of less actors acquires more market power. When there are only a few sellers, for example, they can set prices higher than the optimal price, resulting in market inefficiency.
External effects	External effects occur when the total costs for both the society as the individual are higher than the costs that are paid for by the producer. The costs that are not accounted for are the external effects. This results in an inefficient production because of the lower cost price.
Public goods	Can be defined as goods that provide benefits to people who have not paid for them. Because there are no or little costs for using public goods, they are often over-consumed.
Economies of scale	When companies do not produce at a volume at which they can benefit from economies of scale, they do not produce at the highest efficiency.

The 'second best' problem	This problem occurs when the optimum option cannot be achieved because only a few factors cannot be met, the impact of the factors that are already achieved for this optimum option changes. This change of impact can result in the current activity not being the second-best option, but maybe even worse.
The 'free-rider' problem	Occurs when some actors do not have to deal with laws and regulations. Laws and regulations could enforce restrictions on production. When certain actors do not have to deal with these restrictions, it causes a competitive advantage. Some industries are protected from restrictions because of their economic significance.

Source: Brian Andrew (2008)

5.3 Conclusion

This chapter elaborated on market failures and its various causes. It turns out that there are multiple causes of market failures, which have been described Table 4. However, the question is to what extent these different causes can be applied on the Dutch inland shipping sector, and how these market failures contribute towards the obstruction of circular business models in the sector.

6 The Dutch inland shipping sector

6.1 Introduction

While chapter 4 elaborated on shipping market in general, its current state regarding sustainability and circularity and the SLCM with its corresponding life cycle phases, this chapter zooms in on the Dutch inland shipping sector. As the main research question is based on this sector, it is important to gain a better understanding on the current size and composition, as well as some examples of sustainable initiatives within the sector.

6.2 Size and composition of the Dutch inland shipping sector

6.2.1 Size and economical importance

According to Nederland Maritiem Land (2019) the Dutch inland shipping sector is one of ten different sectors within the Dutch maritime cluster. In 2018 the sector produced a direct added value of €1440 million and an indirect added value of €639 million. Since 2008, the inland shipping fleet consists of more than 5000 vessels, but this number is slowly declining. This is caused by economies of scale, forcing smaller vessels out of the market.

6.2.2 Composition

While the total number of vessels in 2018 was 4989, the number of companies acting in the Dutch inland shipping sector was 4010 (Nederland Maritiem Land, 2019). This is because of the high number of relatively small family business acting in the sector, which is a characteristic of the Dutch inland shipping sector according to NML (2019). Because of the individualised character, the sector is said to be hard to organise (Maritiem Nederland, 2020). Besides, the sector faces problems in terms of succession if the high number of different businesses. The decrease of the succession rate in the could even drive some businesses out of the market (NML, 2019).

48% of the inland shipping fleet consists of motorized vessels used for transporting dry bulk or containers, 22% consist of pushing barges, 16% of the fleet are tankers and then there is another 14% of remaining ships. Since 2008, the type of goods transported mostly on the Dutch inland waterways is dry bulk, followed by liquid bulk, and lastly containerised goods (NML, 2019).

6.2.3 Relevant actors

The relevant actors of the Dutch inland shipping sector can be derived from the elaboration of the general shipping market in segment The shipping markets4.2. The types of actors discussed in that framework are also applicable for this sector. These types of actors are also considered during the selection of relevant actors for the interviews.

6.3 Innovation in the Dutch inland shipping sector

As discussed in the introduction, the inland shipping sector of the Netherlands sees a lack of innovation implementation in terms of circularity and sustainability. However, there are initiatives that strive to support the innovation of the Dutch maritime sector. Sustainability in shipping has already been discussed. The initiatives in this segment are mainly applicable on the Dutch inland shipping sector.

6.3.1 Maritime innovation contract

The maritime innovation contract, initiated by TKI maritime, is an agreement within the Dutch maritime sector which aims to support innovation. The contract is built based on four innovation themes:

- *'Material extraction at sea'* focusses on clean extraction of energy and raw materials on sea.
- *'Clean ships'* aims at saving fuel and materials and reducing emissions.
- *'Smart and safe shipping'* strives to increase safety and reduce costs of shipping in an innovative manner.
- *'Effective infrastructure'* is needed to provide essential and more effective support to the whole transport chain through the port.

For this paper, *'clean ships'* seems to be the most relevant as the aim is to analyse the reason why circular innovation is not implemented effectively into the Dutch inland shipping sector.

6.3.2 Joint industry projects

Joint industry projects (JIP) are collaborations between government, knowledge institutes and companies to enhance innovation in a certain industry. There are various JIPs that are relevant to the Dutch inland shipping sector. This segment will discuss several of these projects to gain an overview of the relevant sector for the innovation in the Dutch inland shipping sector when it comes to sustainable circular and sustainable innovation. An overview of these projects is provided on the website of Netherlands Maritime Technology (NMT).

RAMSSES

Realisation and Demonstration of Advanced Material Solutions for Sustainable and Efficient Ships (RAMSSES) is a European innovation project that strives to improve the life cycle performance of ships built in Europe. Through the enhanced environmental performance, the project aims to increase the competitiveness of the industry, as it lacks intrinsic innovation when compared to other sectors. RAMSSES argues that "*the use of lightweight and other advanced materials in the maritime sector is lagging behind the potential"* (RAMSSES, 2017).

The project team of RAMSSES consists of various companies such as technology centres (Netherlands Maritime Technology), shipyards (Damen) and research institutes (TNO). Their mission corresponds with the circular business models discussed in the literature review, as they strive for product life extension (RAMSSES, 2017).

NAVAIS

New Advanced Value Added Innovative Ships (NAVAIS) strives to enhance the sustainability in ship design. Even though NAVAIS mainly focusses on passenger/road ferries and multi-use workboats, their innovative ideas and initiatives could be used as an example for other sectors – such as the Dutch inland shipping sector – as to how innovation could be implemented into the business models. The project is aimed to result in constant quality and better supply chain integration, creating competitive advantages for the European shipbuilding industry. The project is based on six *'project workspaces'* which together form the complete progression that is strived for.

Multiple organisations work together in this partnership. The project is coordinated by Damen Shipyards in collaboration with NMT. They collaborate with 14 other partners, varying from engineering companies to knowledge institutes (NAVAIS, 2018)

6.3.3 Maritime Innovation Impulse Projects

The Maritime Innovation Impulse Projects (MIIP) is an initiative by Nederland Maritiem Land (NML) in collaboration with the Dutch Ministry of Economic Affairs. These projects are aligned with the four innovation themes as stated in the maritime innovation contract mentioned in 6.3.1 and are aimed to fulfil the goals of this contract. MIIP are projects that qualify for financial support. After ranking the projects that applied for the subsidy, only the best projects will receive the financial support.

RODEO

Raamwerk Operationele Data in Engineering en Ontwerp (RODEO) is an MIIP that strives to provide a framework for companies and research organisations to analyse a large amount of data of ships during their life cycle. Using this data, actors on different levels of the production chain can improve their efficiency of future production. Sharing data between all actors can result in an increased profit for these actors, indicating this MIIP to be of high potential (NML, 2020). Thus, the relevant sectors for this MIIP are spread across the four phases of the ship life cycle that were elaborated in segment 4.5.

6.3.4 Zero Emission Services

Zero Emission Services (ZES) is an initiative of ING, ENGIE, Wärtsilä and the Port of Rotterdam that Is focussed on the increase of sustainability in inland shipping. The initiative introduces a system in which vessels can transport with zero emission using a battery-container which are charged with sustainable energy. ZES provides an accessible infrastructure with 'open access charging points', where the batteries are replaced.

The program makes use of a 'pay per use' system. This means that the shipowner that wants to transport using ZES only pay energy utilization and the rent of the battery container. This way, ZES aims to avoid large investments for shipowners that strive to transport in a more sustainable way. The only condition is that the vessel needs to be compatible with the battery-containers.

Ever since the build-up of ZES, Heineken has been involved in the process. Heineken strives to contribute to the development of sustainable shipping and aims to achieve a complete zero-emission supply chain.

ZES is an example of an initiative that strives to enhance the sustainability of the Dutch inland shipping sector. The involved actors recognised the importance of collaboration in order to achieve certain goals. Besides ING, ENGIE, Wärtsilä and the Port of Rotterdam, the initiative has been made finically feasible through subsidies coming from the Ministry of Infrastructure and Watermanagement as well as the Netherlands Enterprise Agency. This relates to the importance of collaboration discussed in segment 3.5.

6.4 Conclusion

This chapter mentioned size and economical importance of the Dutch inland shipping sector as well as its composition and actors. It stated the fragmentation and the individualised character of the sector which often leads to a difficult collaboration. However, there is no lack of initiatives regarding sustainability and circularity. Various programs have been initiated that aim to enhance the sector's sustainability, such as the Zero Emission Services program.

However, these finding somewhat contradict the issue of this paper, which argues the relative lack of circular implementation in the business models. This begs the question whether these initiatives regarding sustainability and circularity are successful or sufficient Therefore, the next chapter aims to gain a more practical understanding of the current state of play in the Dutch inland shipping sector regarding the most important subjects of this paper: circularity, sustainability, market failures and SLCM.

7 Interview findings

7.1 Introduction

This chapter describes the practical information that is derived from the interviews. Until now, theoretical information has been gathered regarding sustainability, circularity, market failures and SLCM, together with an understanding of the current state of the Dutch inland shipping sector. Now, the more practical point of view, derived from the interviews, is added to this theoretical information in order to gain a better understanding of the different subjects. Segment 2.3 has shown how these interviews have been constructed.

The chapter will describe the selected companies for the interviews, discuss which phases of the ship life cycle are the most relevant for sustainability and circular innovation in the Dutch inland shipping sector, how the different actors implemented circularity in their business models – solely based on their link with the SDGs –, what the current state of cooperation is within the sector and what other aspect are relevant for answering the main research question.

7.2 The selected companies

Considering the actors mentioned within the general shipping market and the different SLCM phases, eight companies have been selecting which will be interviewed to gain a more in-depth knowledge on the current state of play in the Dutch inland sector regarding the circular and sustainable developments. The connection between the companies and the phases of the ship life cycle are depicted in Table 5.

Centraal Bureau voor de Rijn- en Binnenvaart (CBRB) – *Robert Kasteel*

The CBRB is one of the branch organisations for the Dutch inland shipping sector. They represent the largest part of all the subsectors, and the members vary from small transport businesses to large international logistic companies. Their main goal is to "*strengthen the position of their members and of the Dutch inland shipping sector in general"* (binnenvaart.nl, n.d.).

The interviewee is Robert Kasteel, the director of the CBRB. They represent businesses and companies that are active in all the different subsectors of the inland shipping sector. During the interview, they could be able to provide a more general point of view on the developments in the sector as they represent the interests of different actors described in both the general shipping market in segment 4.2 and the ship life cycle phases in segment 4.5, such as shipowners, shipbrokers and active players in different phases of the ship life cycle. Therefore, they are considered to be a relevant actor to be interviewed for this thesis.

Binnenvaart Kredietunie Nederland (BKN) – *Jaco Baars & Elbert Visser*

The BKN is an organisation that finances businesses that act in the Dutch inland shipping sector. They acquire capital by issuing bonds to other entrepreneurs that act in the sector and have the financial capacity to do so. This cashflow can be used to finance other business in need of financial support for investments. This financial support is for relatively small investments, which are not financially interesting for banks but still of high importance (Binnenvaart Kredietunie Nederland, n.d.)

Eventually there were two interviewees for the BKN. The first interview was with Jaco Baars, the treasurer of BKN. However, during this interview it turned out he was not able to provide in-depth information regarding the subject. Therefore, he referred to Elbert Visser, the chairman of the BKN. He would have enough experience on the subject to thoroughly answer the questions of the interview. The BKN is considered to be a relevant actor to interview, as they can provide in-depth information on their point of view in the Dutch inland shipping sector. They finance investments of shipowners, which is one of the relevant actors mentioned in segment 4.2, and is also connected to the companies that are active in different phases of the ship life cycle.

Expertise- en InnovatieCentum Binnenvaart (EICB) – *Khalid Tachi*

The EICB argues to be the centre of innovation in the Dutch inland shipping sector. They aim to create a smarter and more sustainable environment for the inland shipping transport. The EICB cooperates with different actors in the inland shipping sector as described in segment 4.2 and is thus connected to several phases of the ship life cycle as described in segment 4.5. Their provided services vary. From project management based on years of national and international experience, to consultancy regarding financial support for innovations and investments, to the publication of studies on different subjects relevant within the sector in order to provide a platform of knowledge and expertise (Expertise- en InnovatieCentrum Binnenvaart, n.d.). Therefore, the EICB is expected to be able to provide inside information about the current state of innovation and development in the Dutch inland shipping sector.

As the EICB is involved with the business activities of different actors and therefore linked to several phases of the ship life cycle, they are considered to be a relevant organisation to interview. The interviewee is Khalid Tachi, the managing director of the organisation.

Binnenvaart Centre of Excellence (BCE) – *Cees-Willem Koorneef*

Although the BCE is no longer in existence, the aim of the initiative was to bring different actors in the Dutch inland shipping sector together. They offered a platform on which these actors were able to share their knowledge and initiatives, hopefully resulting in more innovation and development (Maritime Delta, 2018). The interviewee, Cees-Willem Koorneef, was the manager of the organisation and was able to offer broad insights in the process of the initiative and the attitude of the participants.

These participants varied from shipowners to manufacturers to shipbuilders, therefore the connected participants were actors described in segment 4.2 and are related to multiple phases described in segment 4.5. As the BCE has such a broad view on the process of cooperation and knowledge-sharing between the varying participants of the initiative, it is considered as a relevant organisation involve in the interviews.

Concordia Damen – *Paul Cornet*

Concordia Damen aims to design and build vessels for the offshore, seagoing and inland shipping market with an innovative state of mind. The company focuses on the European and South American market and strives to foresee changes and implement these expectations in their provided services (Concordia Damen, n.d.). As Concordia Damen provides services for shipbuilding, brokerage and shipping, which link to the different types of actors as described in segment 4.2, this company has inside information on many levels of the shipping market. Considering their business activities, they can also be linked to multiple phases of the ship life cycle. Combined with the fact that they manage a fleet of inland shipping vessels, this company is considered to be relevant for this thesis. The interviewee is Paul Cornet, acting as a shipbroker for Concordia Damen and has years of experience in the shipping market.

Kennisinstituut voor Mobiliteitsbeleid (KiM) – *Martijn van der Horst*

The KiM acts for the Dutch ministry of Infrastructure and Water Management. Their aim is to provide information to the ministry in order for them to develop policies based on sufficient knowledge. These publications are carried out for all forms of mobility, including transport by water, and are focused on subjects like sustainability and safety (Kennisinstituut voor Mobiliteitsbeleid, n.d.). The interviewee, Martijn van der Horst, is one of the researchers of the KiM. Therefore, he can provide inside information on the point of view of the KiM on the subjects discussed in this thesis. Besides his role as a researcher for the KiM, he has a broad experience in research and consultancy and expertise regarding product transport, logistics, sea shipping, rail transport and the inland shipping market. As Martijn has a broad understanding of the inland shipping market and mobility over water, he is considered to be a relevant person to include for the interviews.

ABN AMRO – *Bart Banning*

The ABN AMRO is a financer of many sectors, including the Dutch inland shipping sector. They provide financial support to various actors within the shipping market. During this process of financial support, the ABN AMRO strives to communicate with their clients on important subjects, such as sustainability, social impact, circularity and the labour market. The interviewee, Bart Banning, is the Sector banker of Transports and Logistics, which includes the inland shipping sector (ABN AMRO, n.d.). Therefore, Bart could provide in-depth information on their business activities and financial support within this

sector. They finance various actors within the shipping market and are therefore linked to multiple phases of the ship life cycle. This makes the ABN AMRO a relevant actor to include in the interviews.

MVO Nederland – *Mieke Bakker-Mantjes*

MVO Nederland aims to create a network of partners that strives to innovate on subjects such as circularity and climate change. The interviewee, Mieke Bakker-Mantjes, is a former Maritime sector manager of IMVO (Internationaal Maatschappelijk Verantwoord Ondernemen). Although she is no longer active for the organisation, she will still be able to provide inside information regarding the process of setting up projects on an international level. She communicated with many different organisations in order to set up a cooperative network, which results in her having a broad knowledge on the different points of view of the different partners. Therefore, her knowledge could be linked to several actors within the shipping market. However, she was not able to provide information on the SLCM of the Dutch inland shipping sector, as this did not work out in their business activities.

Table 5. Connections between the relevant companies and the different phases of the ship life cycle

Organisation	Relevant ship life cycle phases for the companies			
	Design phase	*Shipbuilding phase*	*Ship operation phase*	*Ship scrapping phase*
CBRB	✓	✓	✓	
BKUN		✓	✓	
EICB	✓	✓	✓	
BCE	✓	✓	✓	
Concordia Damen	✓	✓	✓	
KiM	✓		✓	
ABN AMRO		✓	✓	
(I)MVO Nederland			✓	

7.3 Circularity of the relevant actors

7.3.1 Introduction

After interviewing multiple companies active in the sector, this segment elaborates the current state of circular economy in the Dutch inland shipping sector. They were asked questions regarding the extent of relevancy of the SDGs for their company, how they reacted to the introduction of the SDGs and how they were or were not implemented in their business models, and what the different companies think of these SDGs. This segment will analyse the answers of the different companies and eventually provide an overview of the state of circularity in the different companies and therefore the different points of view in the sector, by linking the SDGs that are said to be directly affecting circular economy as described in the framework in segment 3.3.4 to the *seven key elements of circular*

economy as described in 3.3.2. It is important to note that there can be other SDGs that are related to the business models of the companies, but as the thesis uses the framework of segment 3.3.4 the analysis is limited to those SDGs. Therefore, this segment only aims to create an overview of the extent of circularity of the companies based on the familiarity with the SDGs.

7.3.2 Linked SDGs of the relevant actors

Centraal Bureau voor de Rijn- en Binnenvaart

The CBRB emphasises the fact that they are not an active entrepreneur within the inland shipping sector, but a branch organisation (1:7). In the end, they do not decide which innovations and SDGs are implemented in the business models of the actors in the shipping market. They mention the fact that they follow laws and regulations that are given by the government (1:13). Then it is their task to guide the actors that are a member of the CBRB towards the implementation of these new laws and regulations. A large proportion of the shipping market actors represented by the CBRB are said to be small businesses because of the Dutch inland shipping sector being highly fragmented. This results in a large proportion of these actors not being interested in such concepts as the SDGs.

The interviewee said not to be familiar with the SDGs (1:5), but he did mention the closure of a Green Deal with the Ministry of Infrastructure and Water Management in which multiple goals were included (1:4). This Green Deal included several goals that could be related to SDGs, which are in their turn related to circular economy as described in the framework of segment 3.3.4. An overview of the relevant SDGs of the framework is given in Table 6.1

Table 6.1. Relevant SDGs for CBRB

SDG	Explanation
9: Industry, Innovation and Infrastructure	Focus on solving the congestion in container terminals, integrating a more efficient infrastructure based on IT and want to stimulate the development of new innovations.
13: Climate action	Focus on reduction of CO2 in the inland shipping sector, aim to upgrade motors in inland vessels and want to stimulate the development of new innovations
17: Partnerships for the goals	The Green Deal that has been accepted is a form of collaboration between different actors to achieve certain goals.

Binnenvaart Kredietunie Nederland

When asked about the introduction of the SDGs, the interviewee of BKN stated that they barely reacted to it (2:1). The BKN follows the demand of the market, and if their clients do not demand certain innovations that are based on the SDGs, then neither do they (2:6). When their clients do

demand financial support for a sustainable innovation the BKN will always cooperate, provided that their goals are financially achievable. It always comes down to the business model. The interviewee mentions that the demand for financial support for sustainable innovation is low, as shipowners view such innovations as not being lucrative. Thus, as the BKN mainly follows the demand of their clients, the SDGs are not highly represented in their business model simply because of the low demand for sustainable innovations based on the SDGs.

Table 6.2. Relevant SDGs for BKN

SDG	Explanation
17: Partnerships for the goals	When demanded, the BKN cooperates with the clients and other included actors in order to achieve the financial support of a sustainable innovation

Expertise- en Innovatie Centrum Binnenvaart

The interviewee for the EICB states that the SDGs implemented by the UN are 'a bridge too far'. They are only indirectly related to the SDGs, as these are first translated in European and national laws and regulations before they are applicable for the EICB (3:3). They have three different main themes in the business model, which are *being zero emission by 2050, creating a modal shift towards transport on water* and *digitalisation* (3:1). Their goal is to create a more sustainable Dutch inland shipping sector by acting as more of a facilitator of financial support, knowledge and networks (3:5).

The three themes that were mentioned during the interview, along with the other goals that were mentioned, are linked to some of the SDGs that are said to be affecting the circular economy according to the framework. These SDGS are in their turn linked to key elements of circular economy.

Table 6.3. Relevant SDGs for EICB

SDG	Explanation
9: Industry, Innovation and Infrastructure	The *Digitalisation* theme contributes towards a more efficient infrastructure.
13: Climate action	By aiming to *be zero emission by 2050*, the EICB contributes towards a more environmentally friendly and limiting the wastes and emissions resulting from the inland shipping sector.
16: Peace, Justice and Strong Institutions	The provision of a knowledge sharing platform and acting as a facilitator will increase the transparency and knowledge sharing in the Dutch inland shipping sector.
17: Partnerships for the goals	Just like SDG 16, this goal is linked to the provision of a knowledge sharing platform which is offered through partnerships and collaboration.

Binnenvaart Center of Excellence

The BCE was set up to provide a knowledge-sharing platform which would eventually create more transparency and efficiency in the Dutch inland shipping sector. The interviewee mentioned the lack of awareness of the SDGs among a large number of actors in the sector. Therefore, it turned out to be hard to cooperate with such actors in the creation of a knowledge platform (5:4). According to the interviewee, there are several important subjects for the BCE that are relevant to the SDGs: *Energy Usage, collaboration* and *knowledge-sharing* (5:17). These subjects can be linked to the SDGs, which can consequently be linked to key elements of circular economy.

Table 6.4. Relevant SDGs for BCE

SDG	Explanation
9: Industry, Innovation and Infrastructure	This SDG can be linked to the BCE's aim to provide a knowledge-sharing platform, as this can contribute towards a more efficient sector
13: Climate action	This goal can be linked to the subject of energy usage, which is regarded to be an important subject for the BCE.
17: Partnerships for the goals	The BCE's main goal was to achieve collaboration between relevant actors in order to share knowledge and tackle sustainable problems in the sector.

Concordia Damen

Concordia Damen mentions that, as the inland shipping sector is relatively small, the SDGs are not much represented. The fact that it is a relatively small market results in their focus being on where the demand is (6:6). They do need to comply to laws and regulations, but the more intrinsic implementation is found within Damen. Concordia Damen acts in a smaller market. So, just like the BKN, they follow the demand of the clients. When a client does ask for a sustainable innovation in a vessel and it is financially achievable, then Concordia Damen will try to realise the demand. But the main focus is not on the SDGs.

Table 6.5. Relevant SDGs for Concordia Damen

SDG	Explanation
17: Partnerships for the goals	When the client demands a certain innovation, Concordia Damen collaborates with the several relevant partners to realise the wishes of the client.

Kennisinstituut voor Mobiliteitsbeleid

The interviewee of the KiM mentions that they follow the demand of the ministry they work for. Their research is dependent on certain policies that need to be researched for the ministry. Sometimes these SDGs are represented in the research, but it is not the main issue (7:3). According to the interviewee, there are four themes which are often represented in mobility which can be linked to the

SDGs: *Safety, Sustainability, Accessibility* and *Liveability* (7:4). These are themes for mobility in general, but also applicable for inland water transport.

Table 6.6. Relevant SDGs for KiM

SDG	Explanation
9: Industry, Innovation and Infrastructure	This SDG can be linked to the *Accessibility* theme as accessibility is improved through better infrastructure, creating more efficiency in the sector
13: Climate action	As *sustainability* is one of the four relevant themes for mobility, this SDG is considered to be relevant for the KiM.
16: Peace, Justice and Strong Institutions	As they provide knowledge on which the new policies of the ministry can be based, they contribute towards a more transparent and efficient construction of those policies
17: Partnerships for the goals	To some extent, this SDG can be linked to their provision of information to the ministry in order for them to create policies based on a broad knowledge.

ABN AMRO

The interviewee mentions three important themes that can be linked to the SDGs: *Sustainability, Circular Economy* and *Social Impact* (8:6). These themes are also considered in their strategy and their cooperation with clients. When a certain client is not likely to fit within the strategy of the ABN AMRO, the cooperation or financial support will not be achieved (8:8). This way, ABN AMRO also aims to get a message across to their potential clients. If they do not meet the standards of the ABN AMRO, the probability of becoming a partner is low.

As one of their themes is *Circularity*, they are directly linked to all key elements of the circular economy. They mention circularity to be constructed by the 9 R's: *Refuse, Reduce, Reuse, Repair, Refurbish, Remanufacture, Repurpose, Recycle, Recover.* In order to achieve their goals regarding the circular economy, all the SDGs that directly affect circularity are considered to be relevant for the ABN AMRO

Table 6.7. Relevant SDGs for ABN AMRO

SDG	Explanation
10: Reduced inequalities	With *Social Impact* being one of their themes, they strive to reduce inequalities with their clients. They set a certain social standard for their clients and if these are not met, a cooperation is unlikely.
13: Climate action	Sustainability and Circularity are other themes mentioned to be important. Through these themes they strive to reduce the environmental impact coming from their clients.

16: Peace, Justice and Strong Institutions	Justice is important aspect of their Social Impact theme, which is an important theme in their business model.
17: Partnerships for the goals	Whether or not the ABN AMRO cooperates with a potential client is based on to what extent this client can reach their standards. ABN AMRO focusses on cooperation with clients that are capable of reaching these standards.

MVO Nederland

The interviewee of MVO Nederland mentioned that the SDGs were very relevant for their organisation. The most important ones were *Life Below Water, Partnerships for the Goals* and *Affordable and Clean Energy* (9:3). SDGs were always included in the projects of MVO Nederland, and they preferred to cooperate with companies and organisations that also implemented SDGs in their business models (9:6).

Table 6.8. Relevant SDGs for (I)MVO Nederland

SDG	Explanation
17: Partnerships for the goals	MVO focusses on collaboration to achieve goals regarding sustainability and circularity and are therefore not directly related to other SDGs

7.3.3 Link to circularity

Now that all relevant actors have been analysed in terms of relevant SDGs of the framework, they can be linked to the key elements of circularity as discussed in 3.3.2. Table 7 first provides an overview of the relevant key elements of circularity for every actor based on the SDGs. Afterwards, Table 8 provides an overview of which key elements turned out to be the most relevant according to the interviews.

Table 7. Relevant key elements of circularity for every actor based on the SDGs

Organisation	Relevant SDGs	Linked Key Elements of the Circular Economy	Notes
Centraal Bureau voor de Rijn- en Binnenvaart	9, 13, 17	• Preserve and Extend What's Already Made • Collaborate to Create Joint Value • Incorporate Digital Technology	
Binnenvaart Kredietunie Nederland	17	• Collaborate to Create Joint Value	The BKN follows the demand of their clients. They argue the demand for financial support for sustainable innovation to be low.
Expertise- en InnovatieCentrum Binnenvaart	9, 13, 16, 17	• Preserve and Extend What's Already Made • Collaborate to Create Joint Value • Incorporate Digital Technology	
Binnenvaart Center of Excellence	9, 13, 17	• Collaborate to Create Joint Value	The BCE mentioned the lack of awareness among the actors with whom they tried to create a partnership, which resulted in a low representation of the SDGs.
Concordia Damen	17	• Collaborate to Create Joint Value	Concordia follows the demand of the relatively small market in which they are active. When demanded, they aim to achieve sustainable innovations.
Kennisinstituut voor Mobiliteitsbeleid	9, 13, 16, 17	• Collaborate to Create Joint Value	The KiM researches a large number of different issues, which makes it hard to see which sustainable and circular key elements are directly related.
ABN AMRO	10, 13, 16, 17	• Prioritise Regenerative Resources • Preserve and Extend What's Already Made • Use Waste as a Resource • Design for the Future • Collaborate to Create Joint Value • Rethink the Business Model • Incorporate Digital Technology.	As circularity is one of the key themes of the ABN AMRO, all key elements are considered to be relevant.
(I)MVO Nederland	17	• Collaborate to Create Joint Value	For MVO Nederland it is also dependent on the type of collaboration which SDGs and key elements of circular economy are directly related.

Table 8. Overview of which key elements turned out to be the most relevant according to the interviews

Key element of circular economy	Related companies
Prioritise Regenerative Resources	ABN AMRO
Preserve and Extend What's Already Made	ABN AMRO, CBRB, EICB
Use Waste as a Resource	ABN AMRO
Design for the Future	ABN AMRO
Collaborate to Create Joint Value	ABN AMRO, CBRB, EICB, BKN, BCE, Concordia Damen, KiM, MVO Nederland
Rethink the Business Model	ABN AMRO
Incorporate Digital Technology	ABN AMRO, CBRB, EICB

7.3.4 Conclusion

Table 8 shows that every relevant actor that was interviewed was linked with the key element *Collaborate to Create Joint Value*. Furthermore, the key elements *Preserve and Extend What's Already Made* and *Incorporate Digital Technology* are mentioned by three actors. As it turns out, these actors are a knowledge institute, a branch organisation and a bank. These actors are active on a more collaborative level when it comes to circularity. The four mentioned key elements of circular economy turn out to be the most important key elements for the Dutch inland shipping sector. The only outlier is the ABN AMRO, being linked to all the key circular elements. This was the only interviewed actor that mentioned circularity in itself being one of their key themes in the business model.

These results only show the key circular elements that are relevant for every company solely based on which SDGs were said to be relevant during the interviews. Besides, only the SDGs that are directly affecting circularity are used, according to the framework of segment 3.3.4. Based on the additional in-depth information given during the interviews and analysed in the other segments of chapter 6.4, more key elements could turn out to be relevant for the Dutch inland shipping sector.

7.4 Relevance of the ship life cycle phases

7.4.1 Introduction

In segment 7.2, an overview was given of which phases were relevant for the different companies. It turned out that none of the companies thought of the scrapping phase as a relevant phase for their organisation. This segment aims to provide a more in-depth understanding of which phases of the ship life cycle are the most relevant for sustainable and circular innovation according to the interviewed companies.

The interviewees were asked which phase or phases they thought sustainability to be the most important. The results are depicted in Table 9. It turns out that the design phase is the most important, followed by the ship operation phase, the shipbuilding phase and finally the ship scrapping phase.

7.4.2 Design phase

In theory, the design phase turns out to be the most relevant when it comes to the implementation of innovations. The general explanation of the interviewees is that the design of a ship creates the fundament of the other phases. The design decides the lifespan of ships, the amount of waste generated in the shipbuilding phase, the emissions of the ship operation phase and the amount of waste generated in the scrapping phase. This is in line with the research of Cirkellab (2016) arguing that the design phase is responsible for 80% of the product-related environmental impact, which is mentioned in segment 4.2.

However, there is a sidenote. It is important to keep in mind that the innovative ideas coming from actors in the design phase must be financially achievable. It all comes back to the business model of actors in the shipping market and their capability to implement the innovations of the design phase (6:8; 8:15). Besides, this is related to laws and regulations on national and international level. Sometimes actors in the market are simply forced to implement a certain innovation before a deadline, but some laws and regulations then turn out to be demotivating innovation as it results in a competitive disadvantage due to postponement of these deadlines. This is further elaborated in segment 7.6.2.1.

7.4.3 Ship operation phase

The second most relevant phase for sustainability turns out to be the ship operation phase. There were multiple reasons for this statement. One reason is the fact that, due to the lifespan of inland ships being multiple decades, the overall environmental impact can add up significantly. Therefore, tackling these problems regarding the overall emission through proper maintenance and use of sustainable materials and innovations can decrease the environmental impact over the total lifespan of vessels.

This is, of course, strongly related to the design phase. However, this phase only includes the innovations that turn out to be acquirable for the actors in the shipping market and can actually be used in the operation phase. Again, some interviewees mentioned the importance of the financial feasibility of the innovations.

7.4.4 Shipbuilding phase

This phase turns out to be the third most important phase regarding sustainability according to the interviewed companies. A reason for this conclusion is the fact that the shipbuilding phase is in between the design phase and the ship operation phase. The shipbuilding phase does have an environmental impact, but this impact is actually "decided" in the design phase. Besides, the environmental impact of the shipbuilding phase is often exceeded by the total environmental impact of the ship operation phase due to its long lifespan. Therefore, the sustainable relevance of the shipbuilding phase is considered to be relatively low.

7.4.5 Ship scrapping phase

This phase was said to be the least relevant phase regarding sustainability and innovation. It was mentioned by one interviewee, with the explanation that every phase has its own sustainable relevance in its own way (7:16). The relatively low relevance of the phase could be explained by the fact that, according to Robert Kasteel, the scrapping phase of inland shipping vessels cannot be compared to the scrapping phase of seagoing vessels. The inland shipping vessels are mostly scrapped

in Europe with proper guidelines, unlike some seagoing vessels being scrapped in Bangladesh with no proper guidelines.

7.4.6 Overview

Table 9 provides an overview of the relevance of the ship life cycle phases according to the relevant actors that were interviewed.

Table 9. Overview of the relevance of the ship life cycle phases according to the relevant actors that were interviewed

Organisation	Relevant ship life cycle phase according to the companies			
	Design phase	*Shipbuilding phase*	*Ship operation phase*	*Ship scrapping phase*
CBRB	✓	✓		
BKUN	✓			
EICB	✓		✓	
BCE			✓	
Concordia Damen	✓		✓	
KiM	✓	✓	✓	✓
ABN AMRO			✓	
(I)MVO Nederland	✓			
Total	**6**	**2**	**5**	**1**

7.4.7 Conclusion

As the design phase turned out to be the most important phase regarding relevancy to sustainability, this indicates that key element *Design for the Future* is also relevant for the Dutch inland shipping sector, besides the key elements that were already mentioned in segment 7.3.The ship operation phase turned out to be the second most relevant phase, mainly because of the long ship life cycle of most inland shipping vessels. Next was the shipbuilding phase, which turned out to be less relevant as it is mostly a phase in between the design phase and the ship operation phase. Lastly, the ship scrapping phase turned out to be the least relevant for the Inland shipping sector, as most vessels within this sector are scrapped in a relatively responsible manner.

7.5 Cooperation in the Dutch inland shipping sector

7.5.1 Introduction

Having discussed the importance and essence of cooperation in segment 3.5, this segment discusses the practical information given during the interviews. The relevant actors were asked how the sector was organised to cooperate, if the cooperation is efficient and what they think are elements that stimulate or obstruct the cooperation.

7.5.2 State of the cooperation within the sector

According to every interviewee, the cooperation within the Dutch inland shipping sector is insufficient. Segment 6.2.2 already discussed the difficulty to cooperate in the sector. The main reason for this issue is the fragmentation of the sector. A high level of individuality results in many different points of view and interests (2:32). Besides, individuality results in competitiveness, decreasing the will of individual shipowners to cooperate with other actors, as the knowledge sharing in such a cooperation could give the competitors an advantage (5:41). A high number of actors is relatively small. Their focus is mainly on having a lucrative business model. Transparency is an important factor in cooperation, which could be acquired through digital platforms that stimulate knowledge sharing.

Besides cooperation among shipowners, lack of cooperation with the shippers turns out to be an important factor for the current state of the cooperation within the sector as well. As will be further discussed in segment 7.6.2.2, the role of shippers in the development of sustainable innovations is just as important as the role of shipowners. The lack of long-term contracts results in financial uncertainty for the shipowners, decreasing the level of innovation. Furthermore, the unwillingness of most shippers to pay a higher price for their shipments also decreases the motivation of shipowners to invest in innovation, as it increases their market price.

Because of the high fragmentation and lack of cooperation between shipowners and shippers, the main cooperation takes place on the level of branch organisations, knowledge institutes and governments. The different branch organisations represent different types of actors, varying from the smallest and most vulnerable actors to the big inland shipping entrepreneurs, and cooperate to find the best solutions for relevant issues. However, because they represent actors with different interest, this cooperation does not always come easy (2:35). Knowledge institutes, like the EICB, and the government are also often included in the cooperation with branch organisations to discuss the latest innovations and laws and regulations.

Thus, the branch organisations, knowledge institutes and government are said to be the leading actors in terms of cooperation. There are, of course, other actors that are leading in terms of cooperation, however, these are often the bigger companies with higher entrepreneurial and financial abilities (8:44). Besides, the position of the actors in the supply chain is also an important factor to explain to what extent one is motivated to cooperate. The closer an actor is to the consumer, the more emphasis is put on their sustainable image, which can be enhanced through cooperation.

7.5.3 Conclusion

This segment has shown the current state of cooperation within the Dutch inland shipping sector derived from the interviews. Several reasons for this current state, such as high fragmentation of the

market, were mentioned besides an analysis of which actors in the shipping market tend to be more leading in terms of sustainable initiatives.

7.6 Market forces

7.6.1 Introduction

The previous segments mainly discussed subjects that were already theoretically discussed in chapters 3 and 4. The goal was to provide additional practical and in-depth information for a better understanding of these subjects. The interviews did not only provide in-depth practical information on those subjects, but also on other subjects that turned out to be just as important for answering the main research question. One factor that was said to be obstructing the development of innovation in the Dutch inland shipping sector was the presence of several *forces within the market*.

7.6.2 Relevant forces

The forces that could be derived from the interviews were:

- Laws and regulations
- The shippers within the shipping market
- High fragmentation of the sector
- The suppliers of technology and innovation
- Market power of the shipowners

7.6.2.1 Laws and regulations

During the interviews, the *laws and regulations* within the shipping market are often mentioned during the interviews to be an obstructing factor in the innovative development in the shipping market. Two aspects are highlighted: *demotivational laws and regulations* and *motivational laws and regulations.*

Demotivational laws and regulations are said to be demotivating shipowners from implementing innovations in their ships or business models. Postponement of deadlines, insufficient enforcement of obligatory innovations in ships and defending the shipowners that have insufficient entrepreneurial abilities are examples of factors demotivating shipowners. When the deadline of a certain obligatory innovation is postponed, it disadvantages the shipowners that have made the investment to implement the innovation as these shipowners now have a higher market price compared to the shipowners that have not yet invested in the innovation. This will make them averse of future investments (2:25). Besides postponement of deadlines, the insufficient enforcement of these obligatory innovations is also demotivating, and for the same reason. When shipowners have not yet invested in sustainable innovations, but this is not checked upon by law enforcement, these shipowners have a market price advantage to those who have invested in the innovation because

shippers currently select their transport based on the market price (2:27). Lastly, there are organisations that strive to defend the shipowners with insufficient entrepreneurial capabilities by, for example, asking for postponement of deadlines (2:20). However, these organisations obstruct the efficiency in the shipping market as they prevent the inefficient actors from being driven out of the market.

Besides demotivational laws and regulations, *motivational laws and regulations* are also mentioned during the interviews. In general, the interviews stated that laws and regulations, when enforced sufficiently, motivates shipowners to invest in innovation. If they fail to do so, they can be excluded from certain activities (6:13). This is in line with the Dutch inland shipping sector being mainly extrinsically motivated to innovate, as mentioned in the introduction.

Altogether, demotivational laws and regulations do not reward the shipowners that invest in innovation. Motivational laws do reward shipowners meeting the sustainable requirements through innovation, provided that these requirements are enforced sufficiently.

7.6.2.2 The shippers within the shipping market

The shippers play a significant role in the sustainable innovation in the shipping market. An important statement coming from the interviews is that the *"inland shipowners are not responsible for the sustainable innovation on their own, the role of shippers in this issue is just as important"* (8:9). There is a general agreement on this issue from all the interviewees. Across all interviews, shippers giving a *negative incentive* for sustainable innovation has occurred 15 times, while shippers giving a *positive incentive* has occurred 8 times.

Shippers giving a negative incentive is mainly related to the unwillingness of shippers to pay a higher price for their cargo (5:24). As long as this is the issue, it will demotivate shipowners to invest in innovation as it will only increase their market price. Due to the higher market price, the shippers will select other shipowners to ship their cargo.

The positive incentives from shippers are said to be related to the position of the shipper in the supply chain. When a shipper closer to the consumers, sustainability is more important as this positively affects the image of the shipper (3:45). These shippers show a more intrinsic attitude towards these innovations and are therefore more willing to pay a higher price for a more sustainable shipping of their cargo.

Another role that shippers can play in stimulating the innovative development of the shipping market is the provision of more *long-term contracts* with shipowners that ship their cargo. A long-term

contract results in financial assurance for the shipowner, which gives him the opportunity to acquire a loan for an investment (8:10).

7.6.2.3 High fragmentation of the sector

The Dutch inland shipping sector sees a high number of smaller individual businesses and shipowners. Each individual shipowner has its own interests, resulting in a high fragmentation in the sector. The result of such a fragmentation can be seen in the cooperation of the sector, the attitude of the shipowners towards innovation and the power of the shipowners in the market.

Due to the high fragmentation and the high number of individual interests, the cooperation within the sector has been insufficient (5:41). There are several explanations for this issue. It is hard to bring such a highly divided sector together. Because of the different interests, many shipowners are not prepared to share knowledge with one another. The high fragmentation results in high competition, and sharing knowledge is often seen by the shipowners as 'providing the competitor with additional knowledge' (5:41).

Due to the high fragmentation and the high competition in the sector, combined with demotivating laws and regulations discussed in segment 7.6.2.1. shipowners tend to be averse of innovations. It could give them a competitive disadvantage in the market and with the current negative incentives of the shippers, discussed in segment 7.6.2.2, this could drive them out of business. The high fragmentation also results in a lower bargaining power of the shipowners.

7.6.2.4 Suppliers of technology and innovation

The interviews state that there is a lack supply of innovative technology in the inland shipping sector. When compared to other industries, the Dutch inland shipping sector is a relatively small sector. Looking at the supply of innovative vessel engines, the engine producers are not only active in the inland shipping sector. Therefore, these producers focus on the bigger markets, as is results in more revenue (6:37). This causes the lack of supply of innovative technology in the inland shipping sector. The producers are more focussed on the bigger markets, decreasing the amount of research and development (R&D) invested into inland shipping technology (1:14).

Because of the lower R&D invested into inland shipping technology, the level of new technology is relatively low and also expensive. The high price of these investments therefore withholds shipowners of doing so.

On the other hand, however, it is stated that the current rate of innovation demotivates shipowners as an innovation in which they invested could be outdated within a few years (3:41). This contradicts the statement of the relatively low R&D in the inland shipping sector to some extent.

7.6.2.5 Market power of the shipowners

The occurrence of this factor in the interviews has been lower compared to the other factors, but it is still considered to be important. Related to the importance of shippers in the sustainable development in the shipping market is the market power of shippers compared to the market power of shipowners. Due to the Dutch inland shipping sector being highly fragmented there are a lot of individual shipowners. Therefore, the individual shipowner has little negotiation power when dealing with a shipper (8:23).

7.6.3 Conclusion

Segment 7.6 has shown that there are several market forces within the shipping market which are obstructing innovative development in the sector. Laws and regulations and the shippers acting in the shipping market are factors that could demotivate shipowners to invest in innovation. The high fragmentation of the sector also contributes to the obstruction of the innovative development, as it results in high competition and many different interests. This causes shipowners to be averse from cooperation and knowledge sharing. Besides, the high fragmentation of the sector decreases the bargaining power of shipowners towards shippers. Lastly, the lack of supply of innovative technology, resulting from the Dutch inland shipping market being relatively small and therefore not the most lucrative to invest in, is another factor obstructing the innovative power in the sector.

7.7 Entrepreneurial abilities

7.7.1 Introduction

Another aspect that was found during the interviews that obstructs innovation and development in the Dutch inland shipping sector could be described as the *entrepreneurial ability* of the shipowners. This segment will first elaborate on the quantitative results that were found regarding the entrepreneurial abilities, followed by a more quantitative analysis of the in-depth information that was derived from the interviews.

7.7.2 Factors of entrepreneurial abilities

Based on the answers given in the interviews an overview can be constructed showing different factors that together create an overview of the entrepreneurial abilities of the shipowners. These factors are whether shipowners have a *negative attitude* or a *positive attitude* towards innovation according to the interviewee, whether the shipowner shows *sufficient entrepreneurial abilities* or *insufficient entrepreneurial abilities* according to the interviewee, whether shipowners are *more extrinsically motivated* or *more intrinsically motivated* and to what extent there is a potential *financial obstruction.*

This paper argues that characteristics of a *negative attitude* of shipowners towards innovation could be:

- A lack of awareness in terms of innovation, circularity and sustainability
- Financial inability that causes the negative attitude
- A conservative state of mind with regards to innovation
- Shipowners do not want to be "All talk, no action"

Shipowners with a *positive attitude* towards innovation see the potential value that innovation can bring. They think in the long term and acknowledge that the current state of the inland shipping sector needs a change. They show awareness of the problem. These shipowners are often also the shipowners showing *sufficient entrepreneurial abilities.* They see the potential competitive advantages that sustainable innovation can bring and strive to acquire such innovations. However, a positive attitude towards innovation does not always mean that the business case of the shipowner is considering innovative development, which this paper argues to be an important characteristic of good entrepreneurial abilities. In contrary, shipowners with *insufficient entrepreneurial abilities* fail to see this potential and therefore do not strive to innovate. They have a conservative mindset and focus on the most lucrative business case, without really considering the long term. These actors only innovate when it is forced by laws and regulations.

A research of Cirkellab (2016), Maritime by Holland (2011) and an initiative by RAMSSES (2017) argue the inland shipping sector to be more extrinsically motivated. Therefore, two factors are included to analyse the interviews on this concept. A shipowner could be *more extrinsically motivated* or *more intrinsically motivated.*

All these factors are related to the final aspect, which is the *financial obstructions* for the shipowners. This paper sees four different forms of financial obstruction. The first obstruction is based on the business case of the shipowner, where the used business case causes certain financial limitations making it impossible to innovate or there are just not enough financial assets in the first place to implement innovation investments into the business case. The second obstruction could be caused by laws and regulations which demotivate shipowners to innovate. The third obstruction used in this paper is the current rate of innovation technologies, which also demotivates shipowners to implement innovative technologies. The fourth and final obstruction comes from market forces that demotivate the implementation of innovation.

7.7.3 Quantitative analysis of the entrepreneurial abilities

The amount of times each factor has been mentioned by the interviewee has been analysed. The analysis shows that shipowners having a negative attitude has been mentioned 26 times, while

shipowners having a positive attitude has been mentioned 15 times. Furthermore, shipowners having bad entrepreneurial abilities is mentioned 22 times, while shipowners having good entrepreneurial abilities is mentioned only 9 times. Lastly, the occurrence of a financial obstruction has been mentioned 37 times, which are divided into three forms of obstruction, as previously mentioned.

Furthermore, the data provided in Table 10 shows the co-occurrence between entrepreneurial factors and financial obstructions. The table shows a relatively high number of co-occurrences between a *positive attitude of shipowners and financial obstructions* – 12 co-occurrences – and *a negative attitude of shipowners and financial obstructions* – 15 co-occurrences –.

Table 11 shows a relatively high number of co-occurrences between bad entrepreneurial abilities and a negative attitude of the shipowners towards innovation. This co-occurrence is relatively low between good entrepreneurial abilities and a positive attitude of shipowners towards innovation.

Based on the results so far, one would expect the inland shipping sector to be more extrinsically motivated rather than intrinsically motivated. However, when analysing the number of occurrences of shipowners being more intrinsically motivated and more extrinsically motivated, it turns out there is not much of a difference in occurrences. This is shown in

Table 12.

Table 10. The number of co-occurrences between entrepreneurial abilities and financial obstructions. (Number of occurrences between parentheses).

	Financial obstruction (34)
Sufficient entrepreneurial abilities (9)	3
Insufficient entrepreneurial abilities (22)	5
Positive attitude (15)	12
Negative attitude (25)	15

Table 11. Number of co-occurrences between negative and positive factors. (Number of occurrences between parentheses).

	Entrepreneurial abilities	
	Sufficient (9)	*Insufficient (22)*
Positive attitude (15)	1	1
Negative attitude (25)	2	11

Table 12. Number of occurrences regarding shipowners being more intrinsically motivated or extrinsically motivated.

	Occurrences
More intrinsically motivated	9
More extrinsically motivated	10

Table 13. The different forms of financial obstruction and the number of occurrences per form. (Number of occurrences between parentheses).

	Financial obstruction (34)
Related to the business model	26
Related to (de)motivating laws & regulations	2
Related to market forces	3
Related to the innovation rate	3

When analysing the results, a variety of findings can be distinguished:

(1) The interviewees put more emphasis on a negative attitude of shipowners towards innovation combined with bad entrepreneurial abilities. This is shown by the number of occurrences of the factors depicted in Table 11.

(2) There is a relatively high number of co-occurrences between both negative attitude of shipowners and financial obstructions and positive attitude and financial obstructions. This is depicted in Table 10. The form of financial obstruction that occurred the most was the financial obstruction resulting from the business model, as depicted in table 2.

(3) There is a relatively high number of co-occurrences between bad entrepreneurial abilities and a negative attitude towards innovation, when compared to the number of co-occurrences between good entrepreneurial abilities and a good attitude towards innovation. This is depicted in Table 11.

(4) The number of occurrences of shipowners being more extrinsically motivated is almost equal to the number of occurrences of shipowners being more intrinsically motivated. This is shown in

Table 12.

7.7.4 Qualitative analysis of the entrepreneurial abilities

The results from the interviews show with regards to the entrepreneurial abilities of shipowners acting in the Dutch inland shipping market show many similarities between the different interviewees. It becomes apparent that many shipowners acting in the Dutch inland shipping sector still show a negative attitude towards sustainable innovation and show insufficient entrepreneurial abilities to implement such innovations. There are multiple reasons for both the negative attitude and the insufficient entrepreneurial abilities mentioned in the interviews.

The negative attitude of shipowners could be a result of the high fragmentation of the Dutch inland shipping sector. There are a lot of individual actors within the sector, with each of them having their own interests. Many of these shipowners are thus a relatively small business with limited financial capacity, which demotivates many shippers to even consider a sustainable innovation of their ship. These shipowners want to make a living out of their business activities and when the implementation of an innovation would result in them making less or even no profit, they are no longer interested in doing so. In the interviews a distinction is made between "regular shipowners" and "inland shipping entrepreneurs". The regular shipowners show no awareness of the advantages of innovation and do not think in the long term, while entrepreneurs do acknowledge the importance of innovation and the fact that changes need to be made regarding sustainability in order to keep competing with other modes of transport. Furthermore, the negative attitude could be a result of 'unfair' laws and regulations that punish inland shipping entrepreneurs for their innovations. When, for example, a certain deadline is set before which a certain innovation must be implemented by shipowners but eventually this deadline keeps getting postponed, the shipowners that did implement the obligatory innovation are disadvantaged. Often a significant investment is needed to implement such an innovation, especially for the smaller shipowners. Such an investment reflects in the costs of the shipowners, which is subsequently reflected in their shipping price. When the shippers are not prepared to pay this higher price to the "innovative shipowners", which they are mostly not, the shipowners that have not made the investment yet gain the advantage of being able to set a lower price. This way, laws and regulations create a disadvantage for innovative shipowners, which will negatively affect the attitude towards such innovations. Lastly, the rate of the current innovation in the inland shipping sector could demotivate a shipowner to invest in an innovation. An innovation that is implemented this year could be outdated in 5 years, after which the shipowner's potential 'competitive advantage' resulting from the sustainable innovation is already gone, while the investment has not been fully paid off by then.

As finding (1) shows, a negative attitude towards innovation often co-occurs with bad entrepreneurial abilities. Having insufficient entrepreneurial abilities is often because of the same reasons of shipowners having a negative attitude towards innovation. The high fragmentation of the sector results in many different interests, and small shipowners focussing on making profit and keeping their business running. Regular shipowners with insufficient entrepreneurial are often only driven by laws and regulations when it comes to innovating, simply because forced upon them.

Finding (2) shows a relatively high co-occurrence for both a positive attitude and a negative attitude with financial obstructions. Both a positive attitude by shipowners and a negative attitude by shipowners have been mentioned relatively many times, but it comes down to having financial

obstructions for both attitudes. This means the financial obstructions of the shipowners could result in them having a negative attitude towards sustainable innovation, as it simply costs too much and could still cause a competitive disadvantage in terms of price as previously discussed. On the other hand, there are shipowners that do acknowledge the importance of sustainable innovation for the future of the sector, but do not have the financial capacity or the entrepreneurial ability to achieve these innovations. Finding (3) also shows that a negative attitude often co-occurs with insufficient entrepreneurial abilities, while having a positive attitude barely co-occurs with sufficient entrepreneurial abilities. Thus, whether they want to innovate or not, shipowners often fail to do so because of financial obstructions.

These financial obstructions related to finding (2) and (3) are divided into four forms, as shown in Table 13. The different forms of financial obstruction and the number of occurrences per form. (Number of occurrences between parentheses).. The most common form of financial obstructions for innovative investments was based on the business case. Shipowners could have a very positive or negative attitude towards innovation, but in the end, it is all about maintaining their business. When such an innovation does not fit into their business models or results in lower or no profit, they are no longer interested. Another form of financial obstruction is based on the market that the shipowners operate in. As previously discussed, an investment would result in higher cost and market price, resulting in losing the interest of shippers that aim for the lowest shipping price. Another form is the 'unfair' laws and regulations, demotivating sustainable innovations by postponing deadlines for certain innovations. The final form of financial obstruction is based on the high rate of innovation in the current inland shipping sector, which demotivates shipowners to innovate, as the innovation could be outdated within a few years, resulting in them losing their competitive advantage.

The financial obstructions are also an explanation for finding (4). Some shipowners do feel intrinsically motivated to innovate, but their financial capacity withholds them from doing so. Besides the financial obstructions, the occurrences of shipowners being more intrinsically motivated were about inland shipping entrepreneurs with more financial capacity which also put more emphasis on their sustainable image.

7.7.5 Conclusion

This segment concludes that entrepreneurial abilities of the shipowners are another important factor in the obstruction of the circular development in the Dutch inland shipping sector. Having analysed the results from the interviews, it turns out that financial obstruction is an important factor. These financial obstructions can be divided in four different forms: related to the business model, related to market forces, related to laws and regulations or related to the rate of innovation in the sector.

7.8 Synthesis

Now that the practical information gathered from the interviews is analysed, several factors appear to be important in the process of answering the main research question:

- The extent of circular activities of the relevant actors
- The relevance of the ship life cycle phases
- The state of cooperation in the sector
- Market forces that influence innovation
- The extent of entrepreneurial abilities of shipowners

However, these subjects are interrelated to each other. This segment aims to summarise and link the different findings of both the practical and the theoretical research in order to be able to come with a conclusion for the sub questions and the main research question.

7.8.1 Circular activities of the relevant actors

Segment 7.3 provided an overview of to which extent and in what way every actor that was interviewed is linked to circularity, solely based on the answers acquired through the interviews. It turns out that *Collaborate to Create Joint Value, Preserve and Extend What's Already Made* and *Incorporate Digital Technology* were the most relevant key elements of circular economy for the Dutch inland shipping sector. The key elements are described in segment 3.3.2. However, based on other practical information given by the interviews, more key elements relevant for the sector could potentially be derived.

7.8.2 Relevance of ship life cycle phases

Segment 7.4 focussed on elaborating which of the four ship life cycle phases was the most relevant for sustainability and circularity. Based on the answers given in the interviews, the prioritisation of the four phases is *design phase, ship operation phase, shipbuilding phase* and the *ship scrapping phase.* The design phase being the most relevant phase is in line with a paper of Cirkellab (2016), mentioned in segment 4.5. The ship operation phase followed up the design phase in terms of importance, mainly because of the long life cycle of ships. Besides, the ship operation phase includes the innovation that is actually financially feasible to implement, whereas the design phase is not. Therefore, the ship operation phase does not see as much innovation.

With the design phase being interpreted as the most relevant, the key element of circular economy *Design for the Future* is considered as another relevant key element for the Dutch inland shipping sector.

7.8.3 The state of cooperation in the sector

Segment 7.5 discusses the current state of cooperation within the Dutch inland shipping sector. According to segment 7.3, *Collaborate to Create Joint Value* is the most relevant key element of circular economy for the interviewed actors. This indicates the relevance of collaboration in the sector. Segment 6.2 already mentioned the high fragmentation and individuality of the sector, which is only confirmed by the practical information provided by the interviews. Due to this high individuality, the companies are relatively small, which causes them to focus more on themselves rather than cooperating with the competitor. Besides, the high fragmentation causes lots of different interests, making cooperation even more difficult.

Cooperation could be achieved through knowledge sharing and transparency. This could be stimulated through creating technological knowledge platforms. However, shipowners are averse towards sharing their knowledge with the competitors. This is not in line with the key element of circular economy *Incorporate digital technology,* which is discussed in segment 3.3.2.

Besides shipowners, shippers also play an important role in the development of innovation in the sector. The lack of cooperation between shipowners and shippers results in financial uncertainty among shipowners through a lack of long-term contracts between the two actors and the unwillingness of shippers to pay a higher price for their cargo shipments. This decreases the financial feasibility and motivation of shipowners to implement sustainable innovation, obstructing the development of the sector.

The most cooperation takes place on the level of branch organisations, banks, governmental institutes and knowledge institutes. These actors represent certain smaller actors within the sector, such as the shipowners, who hardly collaborate on an individual level. There are other actors that actively participate in collaborations and innovation, but these actors are often of larger scale with higher financial capabilities and closer to the consumer in the supply chain.

7.8.4 Market forces that influence innovation

Segment 7.6 discussed several market forces that, according to the interviews, turn out be affecting the rate of innovation in the sector.

The first market force are *laws and regulations* that could be either motivating or demotivating shipowners in the sector. Demotivational laws and regulations make shipowners averse of innovative investments, as it only causes competitive disadvantages in the market. This could be caused by postponement of investment deadlines, insufficient enforcement of regulations or organisations that defend the organisations with insufficient entrepreneurial capabilities. Motivational laws and

regulations could motivate shipowners as it could exclude them from business activities in the sector when certain innovations are not implemented, provided that these are enforced correctly.

The second market force that affects innovation are *the shippers within the shipping market*. Shippers could provide either positive or negative incentives to the shipowners, but negative incentives turn out to be more frequent according to the interviews. Negative incentives include the unwillingness to pay a higher price for cargo shipment or the lack of setting up long-term contracts with shipowners. This decreases the financial feasibility for shipowners to implement innovations, which has already been discussed in segment 7.6.2.2. The positive incentives are mainly provided by shippers that value a more sustainable image due to their position in the supply chain. These actors are willing to pay a higher price for their shipments as it will be compensated through their enhanced sustainable image.

For the third market force, the Dutch inland shipping sector turns out to be *highly fragmented,* with lots of individual and small businesses. This has also been discussed in segment 7.6.2.3. Due to the high level of individuality, the shipowners have many different interests, are averse of cooperating and largely have a negative attitude towards innovation. The high fragmentation of the market is therefore linked to the current state of cooperation in the sector. Besides, the aversity towards innovation can be linked with the demotivational laws and regulations. Shipowners do not want to innovate if it only causes a disadvantage compared to the large number of individual competitors.

The fourth market force concludes *the level of technological and innovative supply*. Because of the Dutch inland shipping sector being relatively small, many developers and producers put more focus on other sectors that are more lucrative. The R&D investments for the trucking market is much higher compared to the investments in inland shipping, simply because of its size. This can be linked to the long life cycle of ships compared to trucks. The lifespan of trucks is roughly a decade, after which a new technology can be implemented. For inland shipping vessels, this cycle takes much longer, resulting in being a less interesting sector for developers. Due to the lower level of R&D, the innovations are more expensive too, once again demotivating shipowners to innovate.

The last market force that was derived from the interviews was *the market power of shipowners* in the sector. The shipowners have little negotiation power compared to the shippers due to the high fragmentation of the sector. The shippers can rather easily replace a shipowner, which is not the case the other way around.

7.8.5 The extent of entrepreneurial abilities of shipowners

As discussed in segment 7.7, the entrepreneurial abilities of shipowners play another important role in the innovative development of the Dutch inland shipping sector. Derived from the interviews, it turns out that a negative attitude towards innovation still prevails in the sector. This could be a result

of the high fragmentation of the market, lack of entrepreneurial abilities, demotivating laws and regulations. The high fragmentation and demotivating laws and regulations have already been discussed, thus it could be linked to the lack of cooperation in the sector as well as the discussed market forces that affect the innovative development.

Whether a shipowner has a positive or negative attitude towards innovation, it always comes down to the financial obstructions, according to the interviews. A negative attitude could be caused through innovations costing too much and potentially causing competitive disadvantages in the market. For positive attitudes, the shipowner may see the long-term potential of innovation, but simply cannot afford such innovations. These financial obstructions could be in the form of infeasibility of the business model, the unwillingness of shipowners to pay a higher price for their cargo shipment, demotivating laws and regulations and rate of innovation. These forms are once again linked to other subjects affecting the innovative development, such as the highly fragmented market, laws and regulations and the role of shippers. The form *rate of innovation* is to some extent contradicted by the statement of the inland shipping sector having a relatively low R&D.

The final finding of this segment shows the rather equal distribution of the inland shipping sector being either intrinsically motivated or extrinsically motivated to innovate. This finding also comes down to the financial feasibility of these innovations. Some shipowners do feel intrinsically motivated to innovate, but do not have the financial capacities.

7.8.6 Interrelationship diagram

Based on the different subjects that affect the innovation in the Dutch inland shipping sector, a diagram can be constructed that gives an overview of the interrelationships. The diagram is shown in Figure 6, where the different subjects are based off the subjects discussed in chapter 6.4. The diagram shows the complexity of the interrelationships between the subjects. It depicts the interrelationships as described in chapter 6.4, and the relations between the findings and the causes of market failures as described in 7.9. The weight of the market failure causes for the Dutch inland shipping sector has been depicted using the colours red, orange and green, indicating high weight, medium weight and low weight respectively.

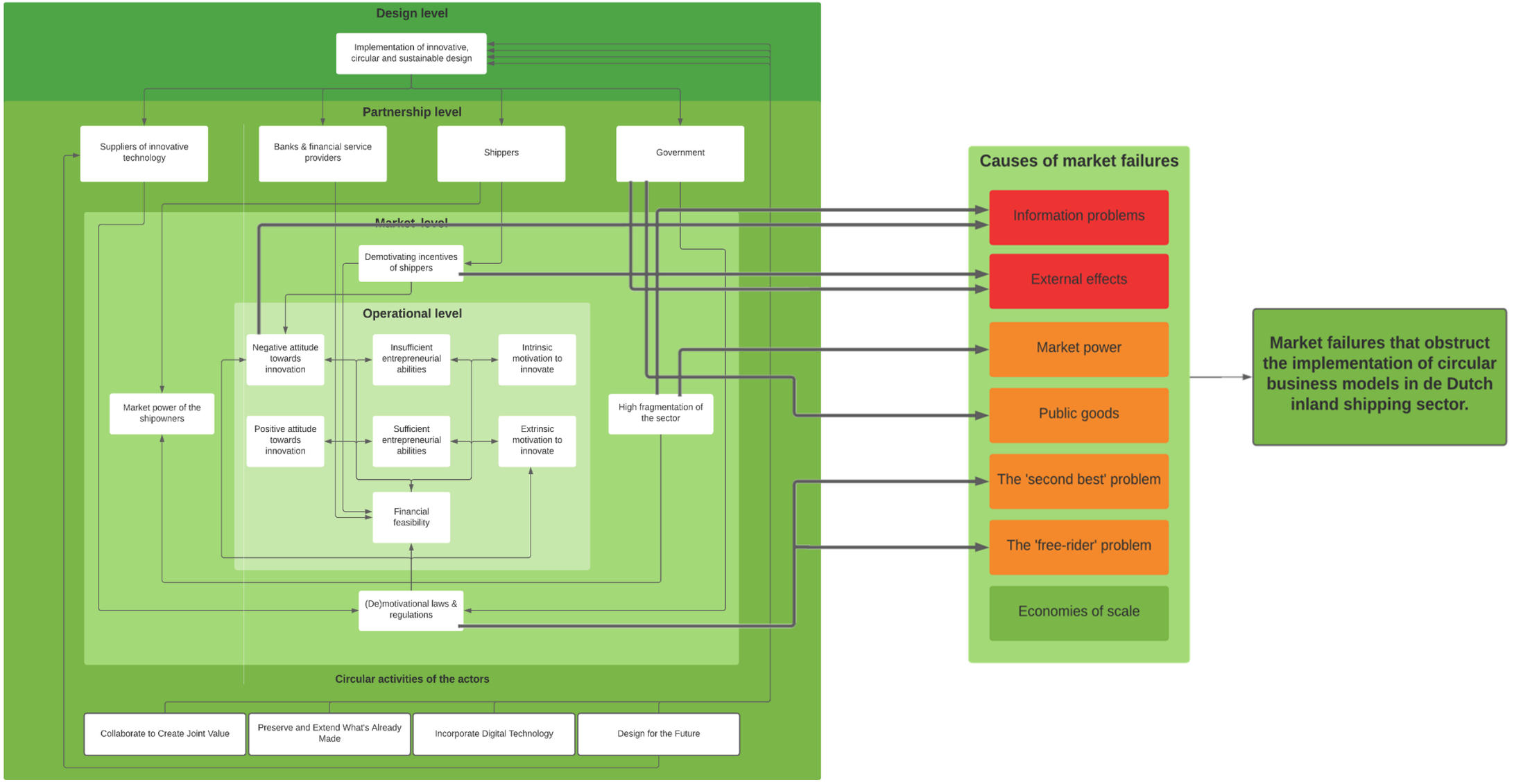


Figure 6. Interrelationship diagram of the theoretical and practical findings

7.9 Causes of market failures in the Dutch inland shipping sector

Lastly, in order to answer the main question this segment will look back at Table 4 and find links between the various causes of market failures and the mentioned causes of obstruction of circular business models in the Dutch inland shipping sector. This way, an overview can be given of the most occurring causes of market failure in the sector. This overview is provided in Table 14.

Table 14. The causes of market failures in the Dutch inland shipping sector.

Cause of market failure	Application to the Dutch inland shipping sector
Information problems	• The fragmentation of the market and the unwillingness of shipowners to collaborate and share information • The insufficient enforcement of the laws and regulations in the sector results in a lack of information for the government, who then provide laws and regulations that demotivate shipowners • The negative attitude towards innovation of shipowners can results in lack of interest in the subject, causing them to make sub-optimal decisions regarding sustainability • Unfamiliarity of shipowners with sustainability
Market power	• Fragmentation of the market and the relative power of the shipper to be unwilling to pay a higher price for more sustainable shipping
External effects	• The emissions coming from shipping has not been given a market value, which causes unwillingness of shippers to pay a higher price for their shipment
Public goods	• The environment and the waterways can be observed as a public good. They can be used without additional costs, as there is no pricing for externalities. The unlimited access to these public goods results in zero to limited caution while using them
The 'second best' problem	• When laws and regulations regarding sustainability are not enforced sufficiently, it provides a competitive disadvantage to those who do obey to them. To acquire the desired optimum, which is a circular shipping market, all factors must be achieved. This is not the case when insufficient enforcement of laws and regulations causes shipowners to create a negative attitude towards circular innovation. When some factors are not achieved, a sub-optimal situation will follow
The 'free-rider' problem	• Insufficient enforcement of the laws and regulations results in a competitive disadvantage for the shipowners that do obey to the rules compared to those shipowners that have not yet made the investment for a sustainable innovation
Economies of scale	• No issues identified

7.10 Conclusion

Chapter 7 discussed the practical results that were derived from the interviews and combined them with the theoretical results from chapter 3, 4, 5 and 6. It turns out that the answer to the main question is not straightforward, but more of a complex issue consisting of multiple factors. Various subjects have been discussed, varying from the circularity of companies and the ship life cycles to the entrepreneurial abilities of shipowners. These subjects are interrelated, which makes the overall understanding of the subjects even more complex. The complexity has been depicted in Figure 6. Furthermore, the causes of market failures that were introduced in chapter 5 were linked to the findings from both the theoretical and practical information that was gathered. Now that all subjects and results have been discussed, both practical and theoretical, an answer to the sub questions and the main question can be constructed.

8 Conclusion and discussion

8.1 Introduction

This chapter will answer the sub questions and the main research question. Each sub question will be discussed separately that will eventually, combined with the additional practical knowledge derived from the interviews, provide an answer to the main research question:

"What market failures exist in Dutch inland shipping sector that obstruct the implementation of circular business models?"

Afterwards, the limitations of the research will be discussed and doubtful findings are addressed. Finally, potential future research will be discussed.

8.2 Findings of the sub questions

8.2.1 First sub question

The first sub question was:

"What are the relevant actors in the shipping market that influence the circular performance of the Dutch inland shipping sector, and what is their role?"

In order to select the relevant actors that can influence the circular performance of the Dutch inland shipping sector, the paper analysed the general shipping market in segment 4.2 together with the ship life cycle phases of 4.5. These two subjects were used to select the different companies. The general shipping market elaborated on the four submarkets: the *freight market,* the *sales and purchase market,* the *newbuilding market* and the *demolition market.* Discussing these submarkets, several types of actors were said to be relevant, such as the *shipowner, shipper, shipbroker* and the *ship purchaser.* Being one of these types of actors was one of the criteria that had to be met in order to labelled as a relevant actor for this paper. The other criterion was linked to the ship life cycle phases. When an actor was an active player for one of the four ship life cycle phases – the design phase, shipbuilding phase, ship operation phase or the ship scrapping phase – it would be considered to be a relevant actor. These two criteria led to the selection of the different actors that have been interviewed in order to acquire more practical information. This selection was described in segment 7.2, and the connection between the organisations and the different life cycle phases is shown in Table 5. The eventual selection of companies covers many different points of view and have varying roles within the Dutch inland shipping sector which creates a thorough overview of the differences between the actors. This is necessary for an efficient analysis of the factors that obstruct the circular implementation in the sector.

8.2.2 Second sub question

The second sub question was:

"To what extent is every phase of Ship Life Cycle Management related to circularity in the Dutch inland shipping sector?"

In order to provide an answer to this sub question, the subject of Ship Life cycle management, together with the different ship life cycle phases have been discussed through both literature review and interviews. The theoretical analysis of SLCM mentioned the importance of Product Lifecycle Management in general, as it contributed to tackling the different environmental problems of products with a large production and life cycle, including ships. Through dividing the lifecycle in multiple phases, the problems linked to those phases are clearer and more comprehensible. The different life cycle phases of ships were divided in the *design phase, shipbuilding phase, ship operation phase* and the *ship scrapping phase,* each having their own environmental challenges. The design phase has to focus on creating an innovative and circular design for ship. The design phase was said to be responsible for a large part of the sustainable and circular performance of the ship in the other phases. The shipbuilding phase has to deal with production problems, such as minimising the emissions and wastes coming from production of ships. The total waste coming from production is affected by the design phase. The ship operation phase also sees an emission problem. Vessels often have a lifespan of multiple decades, which results in high cumulated emissions. Therefore, this phase must focus on minimising these emissions, which is also affected by the design phase. The last phase, the ship scrapping phase, must focus on minimising emissions and wastes coming from the demolition of ships. Especially larger vessels that are being demolished on, for example, the shores of Bangladesh, generate a high environmental impact that needs to be tackled. The environmental impact of this phase is also affected by the design phase.

So far, the analysis of the SLCM has been general, without applying it on the Dutch inland shipping sector specifically. To gain a more specified and practical understanding, the interviews were conducted. During these interviews, the actors were asked about the relevance of the different phases for their business activities and the Dutch inland shipping sector and which phases had the most pressure of the society and laws and regulations. It turned out that, as depicted in Table 9, the design phase was the most relevant for the circularity and sustainability in the inland shipping sector, followed by the ship operation phase, then the shipbuilding phase and lastly the ship scrapping phase. This was in line with the theoretical framework mentioning that the design phase was the most important. The ship operations phase turned out to be important mainly because of the long lifespan of vessels, combined with the current use of engines that are still emitting. But, through innovation, this emission of engines is seeing a decline. The shipbuilding phase and the ship scrapping phase were

said to be the two less relevant phases. The shipbuilding phase was said to be more of a phase that is in between the design phase and ship operation phase. Although the shipbuilding phase does have its environmental challenges, the emission of this phase is dependent on the design phase, and often overruled by the operation phase because of the long lifespan of ships. Lastly, the scrapping phase turned out to be almost irrelevant for the Dutch inland shipping, as most of the scrapping is done in a responsible way with proper guidelines.

There must be an emphasis on the long life cycle of vessels operating in the Dutch inland shipping sector. The long life cycle results in a contradiction regarding the circularity of the sector. On one hand, a vessel that lasts multiple decades without having to be replaced indicates a strong circular performance. Multiple interviewees mentioned that, because of the lifespan, inland shipping – but also sea shipping – is to some extent already circular. On the other hand, however, the long lifespan of inland shipping vessels results in a relatively slow technological development and innovation in the sector. As mentioned in 7.8.4, the sector sees a lower interest of developers of such technologies, resulting in less innovative development, and the innovation that is developed being more expensive. Thus, the relatively long lifecycle of vessels results in a trade-off between the sector already being circular and obstructing innovative circular research & development. Furthermore, several interviewees mentioned the potential of modular ships in order to tackle these different points of view regarding the lifespan of vessels resulting in the sector being less or more circular.

8.2.3 Third sub question

The third sub question was:

"What forms of collaboration exist in the Dutch inland shipping sector and how effective are they in order to increase the circularity in inland shipping?"

To answer this sub question, theoretical information was gathered of collaboration forms in general, collaboration for sustainability in general shipping and collaborative action for sustainability in specifically the Dutch inland shipping sector, followed by practical information of the current state of collaboration in the Dutch inland shipping sector according to the interviewed relevant actors. The theoretical information.

The theoretical analysis showed the growing awareness of the importance of collaboration in order to tackle environmental challenges, and the increased research on the subject. It turns out that we cannot do it alone. This growing awareness is also present in the general shipping market. Sustainable shipping is a growing term that forms the base of multiple collaborative initiatives that strive to combat climate change, tackle environmental challenges and other challenges that are stated in the SDGs through realising global cooperation of companies. The IMO, UN Sustainable Green Deal,

Sustainable Shipping Initiative and the term 'emission pricing in shipping' are all examples of such collaborative initiatives and are discussed in segment 4.3. Besides these global initiatives, the theoretical analysis showed the current state of awareness in the Dutch inland shipping sector. It turns out that multiple initiatives are set up in the inland shipping sector that strive to tackle environmental challenges through collaboration, such as the Maritime Innovation Contract, Joint Industry Projects and Maritime Innovation Impulse Projects. These are all projects in which partnerships are formed. Thus, there is awareness of the importance of cooperation in the Dutch inland shipping sector, and there are forms of collaboration.

This theoretical analysis is followed by acquiring practical information on the matter through interviewing the relevant actors for their insights and point of view. During the interviews, they were asked what forms of collaboration they mainly experienced and whether this collaboration is sufficient. It turns out that the existing collaboration mainly takes place on the level of branch organisations, knowledge institutes, governmental institutes and banks, rather than on an individual level. Branch organisations represent the interests of their members in general and discuss with other branch organisations and institutes to tackle problems such as environmental and circular innovation in the sector. However, the sector sees a high fragmentation resulting in lots of individual shipowners and, thus, lots of different interests. This causes the collaboration to be difficult. The high individuality of the sector results the sector being very competitive, making the realisation of partnerships even more difficult.

So, the theoretical analysis showed awareness of the importance of collaboration in order to tackle environmental issues. The practical analysis, however, has shown the difficulty of actually realising an effective collaboration to increase innovation and circularity in the sector. Furthermore, when the collaboration would be realised, the second issue is to implement the innovations coming from the partnerships. The individuality of the sector means a lot of relatively small actors with limited financial capacity, limited entrepreneurial abilities and many negative attitudes towards innovation. Combined with the fact that the shippers acting in the Dutch inland shipping sector are not willing to pay a higher price for a more sustainable transport of their cargo and insufficiently set up long-term contracts with shipowners to provide more financial stability, the realisation of actual innovation is an issue\, even after the partnerships have been realised.

8.3 Conclusion of the main research question

The aim of this paper is not to call out the Dutch inland shipping sector and all its actors for the lack of initiatives or development in terms of circular and sustainable innovation. As described in the paper, there are multiple initiatives on this matter, and many organisations, knowledge institutes,

governmental institutes and branch organisations are working hard to tackle the issues regarding the development. Its purpose is solely to point out the potential fields and market failures cause by which the relative lack of development in innovation could be caused, and which ship life cycle phases are most important in order to solve the most relevant environmental challenges.

The answers to the sub questions made clear that there is an awareness regarding sustainable and circular innovation in the Dutch inland shipping sector and that collaboration is needed in order to realise such innovations and development. The challenges that must be tackled through this collaboration vary for the different phases of the ship life cycle, with the design phase and ship operation phase turning out to be the most relevant for the main research question. However, the collaboration in the sector turns out to be insufficient, which obstructs the development of the sector in terms of innovation. This lack of collaboration is only one of the factors that are said to be obstructing the development. Based on the theoretical and practical information, laws and regulations, the shippers, the high fragmentation, entrepreneurial abilities, the negative attitude towards innovation, financial infeasibility of shipowners, unfamiliarity with sustainability and the circular awareness and activities of the relevant companies are just some other examples of factors that could be contributing to the lack of innovation and development. Another important factor is the fact that profitability always overrules implementation of innovations. If focussing on a certain development or innovation results in less profit or even losses, the deal is off. These factors can be seen as causes of the market failures that currently occur in the Dutch inland shipping sector. Table 14 has shown that almost every cause of market failure as discussed in chapter 5 occurs in the sector and also describes in what way.

It is difficult to pinpoint the specific factors that could be obstructing the implementation of circularity in the sector. Based on both the theoretical and the practical information, it turns out that there are multiple different subjects and subfactors that altogether, in a complex 'web' of interrelationships as depicted in Figure 6, form the obstruction of the circular and sustainable development of the sector and cause the relative lack of development the sector is currently confronted with. But the phases of the ship life cycle that turn out to be the most important in terms of obstructions to tackle are the design phase and the ship operation phase.

8.4 Discussion and limitations

8.4.1 Disputable findings

There are some findings that could be further discussed. First, due to the exclusion of the point of view of the shippers, which is also a limitation of this paper, several potential causes of the relatively slow development of the sector that regarded the shippers could be doubtful as their point of view is not

taken into account. Furthermore, the circular activity of the interviewed companies discussed in 7.3 could be incomplete due to the framework that is used in order to analyse their circular activity. Only some SDGs are used and were linked to the key elements of circularity. It could be that the use of another framework for the same analysis results in a different or more thorough outcome.

8.4.2 Limitations

There are limitations to this research. First, the selection process of the relevant actors, discussed in segment 2.3.2, was based on theoretical research and lacked the practical information and expertise. This could have led to potentially excluding actors that turn out to be relevant as well, which could cause a certain bias. There are two types of actors that were excluded from the interviews and analysis which could have potentially added relevant points of view to the thesis: the shippers and the ship repair yards. The exclusion of these points of view to some extent results in a bias However, the actors that were included still provide a representative image of the sector. Second, choice of actors to interview was limited. It was dependent on the response and availability of the companies that were approached. Some organisations did not answer to the request of being interviewed, and some companies denied the request. The third limitation is the potential bias coming from the interviews. Interviewees might not have given a neutral response to the questions because of self-interest. Although this bias is tackled to some extent as the paper aimed to compare the different points of view, some bias might still be included. The fourth limitation argues that the approach of this research to analyse to which extent the relevant actors implemented circularity as discussed in segment 7.3 is limited to only some SDGs and only the key elements of circularity, which might form an incomplete image on their full implementation of circularity. Lastly, I would argue that the selection process of the relevant actors should have resulted in the inclusion of more specific and innovative companies rather than mainly larger organisations. Although larger companies are able to provide a broad analysis of the sector, including smaller and younger companies could have provided more specific and thorough points of view that would add value to the thesis.

8.5 Potential future research

As mentioned in the limitations, this paper failed to include the point of view of the shippers on this matter, which turns out to be an important point of view. Thus, future research could focus on the point of view of the shippers and either compare it to or combine it with my current findings. The potential causes of the relative lack of innovation in the sector could be contradicted or complemented through the addition of the shipper's point of view. The other excluded actors were the ship repair yards. Adding their point of view could result in new insights. Furthermore, this paper only analysed the potential areas and factors by which the relative lack of development of the sector

could be caused. The paper provides an overview, but these factors and areas could be analysed further in order to gain a more thorough understanding of why these factors are relevant. A more thorough analysis could also be applied to the question why the design phase and ship operation phase turned out to be the most relevant.

9 References

ABN AMRO. (n.d.). *Global Transport & Logistics.* Retrieved from https://www.abnamro.nl/nl/zakelijk/corporates-institutionals/sectoren/global-transportation-logistics.html

Accenture. (2014). *Circular Advantage.* Retrieved from https://www.accenture.com/t20150523T053139__w__/us-en/_acnmedia/Accenture/Conversion-Assets/DotCom/Documents/Global/PDF/Strategy_6/Accenture-Circular-Advantage-Innovative-Business-Models-Technologies-Value-Growth.pdf

Andrew, B. (2008). Market Failure, Government Failure and Externalities in Climate Change Mitigation: The Case for a Carbon Tax. *Public Administration and Development, 28*(5), 393-401. Retrieved from https://onlinelibrary-wiley-com.eur.idm.oclc.org/doi/abs/10.1002/pad.517

Binnenvaart Kredietunie Nederland. (n.d.). *Over de Binnenvaart Kredietunie Nederland u.a.* Retrieved from https://www.binnenvaartkredietunie.nl/over-bkn

Binnenvaart.nl. (n.d.). *Over het CBRB.* Retrieved from https://www.binnenvaart.nl/over-het-cbrb

Bourne, R. (2019). *How "Market Failure" Arguments Lead to Misguided Policy.* Retrieved from https://assets.realclear.com/files/2019/02/1175_marketfailure.pdf

Circular Economy. (n.d.). *Making Sense of the Circular Economy: the 7 key elements.* Retrieved from https://www.circle-economy.com/circular-economy/7-key-elements

Cirkellab. (2015). *Blog: Breng circulariteit in de maritieme sector!* Retrieved from Blog: Breng circulariteit in de maritieme sector! – Cirkellab

Cirkellab. (2016). *Circulaire kansen in de Maritieme Topregio.* Retrieved from Kansenkaart-Circulaire-Kansen-in-de-Maritieme-Topregio_20160615_RAPPORT.pdf (cirkellab.nl)

Concordia Damen. (n.d.). *Whatever the challenge, Concordia Damen will find the best solution.* Retrieved from https://www.concordiadamen.com/bedrijfsprofiel

Duurzaam-ondernemen.nl. (2020). *Sleutelspelers ontwikkelen emissieloos varen voor de binnenvaart.* Retrieved from https://www.duurzaam-ondernemen.nl/sleutelspelers-ontwikkelen-emissieloos-varen-voor-de-binnenvaart/

Einarsson, S.F. (2019). *What is the link between Circular Economy (CE) and the Sustainable Development Goals (SDGs)?* Retrieved from https://www.linkedin.com/pulse/what-link-between-circular-economy-ce-sustainable-goals-einarsson#:~:text=The%20strongest%20indirect%20relationships%20are,and%20agriculture%2C%20also%20build%20resilience.

Ellen MacArthur Foundation. (2013). *Towards the Circular Economy.* Retrieved from https://www.ellenmacarthurfoundation.org/assets/downloads/publications/Ellen-MacArthur-Foundation-Towards-the-Circular-Economy-vol.1.pdf

Ellen MacArthur Foundation. (n.d.). *The Circular Economy in Detail.* Retrieved from https://www.ellenmacarthurfoundation.org/explore/the-circular-economy-in-detail

Expertise- en InnovatieCentrum Binnenvaart. (n.d.). *Over EICB.* Retrieved from https://www.eicb.nl/over-eicb/

Favi C., Germani M., Campi F., Mandolini M., Manieri S., Marconi M. & Vita A. (2018). Life Cycle Model and Metrics in Shipbuilding: How to Use them in the Preliminary Design Phases. *Procedia CIRP, 69,* 523-528. Retrieved from

https://www.researchgate.net/publication/324638295_Life_Cycle_Model_and_Metrics_in_Shipbuilding_How_to_Use_them_in_the_Preliminary_Design_Phases

Geissdoerfer, M., Savaget, P., Bocken N.M.P. & Hultink, E. (2017). The Circular Economy – A new sustainability paradigm? *Journal of Cleaner Production, 142,* 757-768. Retrieved from https://www-sciencedirect-com.eur.idm.oclc.org/science/article/pii/S0959652616321023

Gesellschaft für angewandten Umweltschutz und Sicherheit im Seeverkehr. (2011). *Ship life cycle assessment and management.* Retrieved from http://archive.northsearegion.eu/files/repository/20140303142113_D3.5.5_ship_life_cycle_management(ed).pdf

Global Maritime Forum. (2019). *Carbon Levy Evaluation.* Retrieved from https://www.globalmaritimeforum.org/content/2019/10/Could-a-carbon-levy-in-shipping-be-an-effective-way-to-help-reach-the-IMO-greenhouse-gas-reduction-goals-DNV-BW-BHP-DNB.pdf

Green Deal. (2019). *Green Deal Zeevaart, Binnenvaart en Havens.* Retrieved from https://www.greendeals.nl/green-deals/green-deal-zeevaart-binnenvaart-en-havens

Guldmann, E. (2017). Best Practice Examples of Circular Business Models. Retrieved from https://www.researchgate.net/publication/321764939_Best_Practice_Examples_of_Circular_Business_Models

International Maritime Organization. (2019). *Strategy, Planning and Reform.* Retrieved from https://www.imo.org/en/MediaCentre/HotTopics/Pages/SustainableDevelopmentGoals.aspx

Kachi, A., Mooldijk, S. & Warnecke, C. (2017). *Carbon pricing options for international maritime emissions.* Retrieved from https://newclimate.org/2019/03/19/carbon-pricing-options-for-international-maritime-emissions/

Karlis, T. & Polemis, D. (2016). Ship demolition activity: A monetary flow process approach. *Multidisciplinary Scientific Journal of Maritime Research, 30*(2), 128-132. Retrieved from https://www.researchgate.net/publication/316937357_Ship_demolition_activity_A_monetary_flow_process_approach

Kennisinstituut voor Mobiliteitsbeleid. (n.d.). *Over het KiM).* Retrieved from https://www.kimnet.nl/over-het-kim

Kircherr, J., Reike, D. & Hekkert, M. (2017). Conceptualizing the circular economy: An analysis of 114 definitions. *Resources, Conservation & Recycling, 127,* 221-232. Retrieved from https://www.sciencedirect.com/science/article/pii/S0921344917302835

Kruiswijk, W. (2019). *An analysis of the global implementation of sustainable development in the corporate objectives of ports, in particular for the Port of Rotterdam, the Port of Amsterdam and the Port of Antwer* (BSc Thesis). Retrieved from https://thesis.eur.nl/

Marciano, A. & Medema, S. (2015). Market Failure in Context: Introduction. *History of Political Economy, 47*(1), 1-19. Retrieved from https://www.researchgate.net/publication/287151244_Market_Failure_in_Context_Introduction

Maritiem Nederland. (2020). *De binnenvaart in Nederland.* Retrieved from https://www.maritiemnederland.com/vakgebieden/binnenvaart

Maritime by Holland. (2011). *Innovatie in de zee- en binnenvaart.* Retrieved from Innovatie in de zee- en binnenvaart.pdf (rvo.nl)

Maritime Delta. (2018). *Binnenvaart Centre of Excellence.* Retrieved from https://www.maritimedelta.nl/portfolio-item/binnenvaart-centre-of-excellence/

McDonough, W. & Braungart, M. (2002). *Cradle to Cradle: Remaking the Way we Make Things.* Rodale Press.

Ministerie van Infrastructuur en Milieu. (2015). *Naar een duurzamen zee- en binnenvaart in 2050.* Retrieved from (PDF) Naar een duurzame zee- en binnenvaart in 2050 (researchgate.net)

NAVAIS. (2018). *Challenge New Advanced Value Added Innovation in Ship Building.* Retrieved from https://www.navais.eu/

Nederland Maritiem Land. (2019). *Maritieme Monitor 2019.* Retrieved from https://www.maritiemland.nl/maritieme-sector/publicaties/maritieme-monitor-2019/

Nederland Maritiem Land. (2020). *Maritieme Innovation Impuls Projecten.* Retrieved from https://www.maritiemland.nl/innovatie/projecten/maritieme-innovatie-impuls-projecten/

Nelson, J. (2017). *Partnerships for Sustainable Development.* Retrieved from http://s3.amazonaws.com/aws-bsdc/PartnershipsforSD.pdf

Network for Business Sustainability. (2013). *Sustainability through Partnerships.* Retrieved from https://www.nbs.net/articles/sustainability-through-partnerships-a-systematic-review

Osterwalder, A. & Pigneur, Y. (2010). *Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers.* Wiley-Blackwell.

Panteia. (2019). *Op weg naar een klimaatneutrale binnenvaart per 2050.* Retrieved from Panteia-rapport-Op-weg-naar-een-klimaatneutrale-binnenvaart-per-2050.pdf (verbrandingsmotor.nl)

RAMSSES. (2017). *Our Mission at Ramsses Project for Sustainable and Efficient Ships.* Retrieved from https://www.ramsses-project.eu/mission/

Reddy, N. and Manoharan, N. (2014). Ship Recycling: An Important Mile Stone for India. *Indian Journal of Science and Technology, 7*(6), 15-21. Retrieved from http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.878.7999&rep=rep1&type=pdf

Rodriguez-Anton, J.M., Rubio-Andrada, L., Celemín-Pedroche, M.S. & Alonso-Almeida, M.D.M. (2019). Analysis of the relations between circular economy and sustainable development goals. *Internation Journal of Sustainable Development & World Ecology, 26*(8), 708-720. Retrieved from: https://www.researchgate.net/publication/335966505_Analysis_of_the_relations_between_circular_economy_and_sustainable_development_goals

Schroeder, P. & Anggraeni, K. (2018). The Relevance of Circular Economy Practices to the Sustainable Development Goals. *Journal of Industrial Ecology, 23*(1), 77-95. Retrieved from https://onlinelibrary-wiley-com.eur.idm.oclc.org/doi/full/10.1111/jiec.12732

Stark, J. (2011). *Product Lifecycle Management.* Springer.

Stopford, M. (1997). *Maritime Economics.* London: Routledge

Sustainable Shipping Initiative. (2010). *About the SSI.* Retrieved from https://www.sustainableshipping.org/about-the-ssi/

The Guardian. (2012). *Unilever's Paul Polman: challenging the corporate status quo*. Retrieved from theguardian.com/sustainable-business/paul-polman-unilever-sustainable-living-plan

TNO. (2014). *Innovaties in de Binnenvaart.* Retrieved from Innovaties in de binnenvaart (tno.nl)

United Nations. (2015). *Goal 17: Revitalize the global partnership for sustainable development.* Retrieved from https://www-un-org.eur.idm.oclc.org/sustainabledevelopment/globalpartnerships/

United Nations. (2015). *Sustainable transport.* Retrieved from https://sustainabledevelopment-un-org.eur.idm.oclc.org/topics/sustainabletransport

Van den Bossche, M., de Jong, O. & Janse, R. (2019). *De Nederlandse Maritieme Cluster.* Retrieved from Maritieme Monitor 2019 - Nederland Maritiem Land

Van der Horst, M. & van der Lugt, L. (2011). Coordination mechanisms in improving hinterland accessibility: empirical analysis in the port of Rotterdam. *Maritime Policy & Management, 38*(4), 415-435. Retrieved from https://www-tandfonline-com.eur.idm.oclc.org/doi/full/10.1080/03088839.2011.588257

10 Appendix

Appendix Table A. Overview of the SDGs and their related goals

SDG	Goal
	• Promote inclusive growth for sustainable jobs and equality. • Implement social protection systems to protect from great economic risk.
	• Nourish 815 million people who are hungry through investment in agriculture and sustainable food production systems.
	• Eradicate diseases and other health issues through funding health systems, improved hygiene and reduced pollution.
	• Help impoverished families to gain access to quality inclusive education through investments.
	• Providing women with equal rights and access to education, healthcare, jobs and politics, and eradicate harmful events against women.
	• Clean, accessible water and sanitation must be achieved through investments in infrastructure and freshwater ecosystems.
	• Ensure access to affordable and reliable energy and improve renewable energy technologies.
	• To achieve sustainable economic growth there should be decent job opportunities, financial services and commitments to trade.

	• Achieve sustainable development, increased productivity, health and education by investing in infrastructure.
	• Reduce the inequality of access to health and education services for the less developed communities.
	• Create efficient urban planning and management to deal with increasing urbanization. Cities must provide opportunities for everyone.
	• *"Doing more and better with less"*. Increasing welfare gains with less resources, pollution and degradation while increasing quality of life.
	• Work together to stop climate change and limit the global temperature rise.
	• Actively manage marine areas and implement regulations to reduce overfishing, pollution and ocean acidification.
	• Protect and manage forest and battle desertification to protect the ecosystem on land.
	• Achieve more peaceful and inclusive societies through government investments and regulations.
	• Successful sustainable development requires partnership between governments, the private sector and the community.

Source: An analysis of the global implementation of sustainable development in the corporate objectives of ports, in particular for the Port of Rotterdam, the Port of Amsterdam and the Port of Antwerp (Kruiswijk, 2019)

Appendix Table B. Direct benefits of circular economy practices for achieving the SDGs

SDG	Direct benefit from circular economy
	CE practices like water purification, wastewater treatment, water reuse and recycling can result in an increased access to safe drinking water and sanitation and could improve the water quality
	Renewable energy systems contribute towards *Affordable and Clean energy.* This can be concepts like energy and heat recovery, industrial symbiosis or second-generation biofuels.
	Circular business models have a high potential of increased resource efficiency and effectiveness and waste valorisation. According to the Ellen MacArthur Foundation (2015), CE implementation has multi-trillion-euro opportunities in a global aspect.
	As CE practices are mainly focussed on reducing resource use of economic activity and the resulting environmental and social impacts. This is equal to the moral of this SDG.
	CE practices aim to reduce the use of resources. Use of resources is known to affect the environment and reduce the natural resources of the Earth. CE practices like regenerative processes that protect the biodiversity are fundamental for restoring ecosystems.

Source: information acquired from Schroeder & Anggraeni (2018).

Appendix Table C. Indirect benefits of circular economy practices for achieving the SDGs

SDG	Indirect benefit from circular economy
	Adaptation of circularity can generate extra employment, which in its turn contributes to reduction of poverty.
	Implementation of circularity in agriculture or farming practices could improve the soil, increasing productivity of farming. Together with increased circularity in food production and consumption, this could indirectly affect food scarcity and hunger.
	With the expectation of three quarters of the world population living in cities by 2050, circularity could contribute to the reduction of environmental impact of cities.
	Waste management for land-based activities will reduce the amount of waste that ends up in the ocean. Besides, the acidification of oceans will be reduced through the effect of circularity on climate change.

Source: Information acquired from Schroeder & Anggraeni (2018).

Appendix Table D. Contributions of SDGs towards the global development of circular economy

SDG	Contribution towards the uptake of circular economy
	This SDG has the aim to improve education quality and provide equal access to technical, vocational and tertiary education. When this is combined with circular economy or other subjects which enhance the development of circular economy, this development could further enable circularity.
	Creating new infrastructure for, for example, renewable energy and water and waste management and constant innovations in an industry regarding CE contributes to the uptake of CE.
	By reducing inequalities between developed and developing countries and providing equal access to technical support and financing for CE, developing countries could enhance their performance in CE
	Through achieving targets that contribute to international, national or local climate related policies, increasing awareness of climate change and incentives to be more environmentally friendly, this SDG facilitates the development of CE.
	Achieving stronger institutions, reduction of corruption or enhance transparency will contribute to the development of circular economy. These achievements create a healthy and stable situation in order to practice circularity.
	Reducing debt of developing countries, increasing macro-economic stability, enhanced global environmental policies and increased access to technical support for developing countries all contribute towards and uptake of global CE.

Source: information acquired from Schroeder & Anggraeni (2018).

The conducted interview

Duurzaamheid in z'n algemeenheid (SDGs)

1. In 2015 zijn de SDG's geïnitieerd door de VN.

a. Hoe zijn jullie met deze SDG's omgegaan?
b. Welke SDG's zijn voor jullie met name relevant?
c. Waar in de bedrijfsvoering komen deze duurzaamheidsdoelstellingen terug?

Ship life cycle management

Ship Life Cycle Management (SLCM) verdeelt de totale levenscyclus van een schip in 4 fasen: de *ontwerpfase, bouwfase, gebruiksfase* en de *sloopfase.* Elke fase heeft bepaalde uitdagingen op het gebied van duurzaamheid.

2. In hoeverre is elke fase voor jullie bedrijfsvoering van toepassing? En wat doen jullie per proces om bij te dragen aan een zo duurzaam mogelijk schip?

3. In welke fase van SLCM manifesteert duurzaamheid zich volgens jullie het meest?

4a. Welke druk merken jullie vanuit de samenleving om te verduurzamen?

4b. Welke druk merken jullie vanuit de nationale en internationale wet- en regelgeving om te verduurzamen?

4c. Welke fase kent de meeste maatschappelijke druk en regelgeving op het gebied van duurzaamheid en hoe gaan de bedrijven binnen deze fase (dus ook eventueel jullie) er mee om?

Samenwerking binnen de binnenvaart

5a Hoe is de Nederlandse binnevaart georganiseerd om zich te verduurzamen? Welke samenwerkingsverbanden vinden bijvoorbeeld plaats en welke partijen zijn hier dan bij betrokken?

5b Hoe zijn jullie betrokken bij deze organisatie? Met welk soort bedrijven werken jullie voornamelijk samen ?

5c Wat voor initiatieven vinden er in de binnenvaartsector plaats op het gebied van verduurzaming en wie zijn dan de leidende partijen?

6a Wanneer er samenwerking op het gebied van duurzaamheid plaatsvindt met de Nederlandse binnenvaartsector en andere relevante sectoren, hoe verloopt dit en hoe wordt dit geinitieerd?

6b Wat is essentieel voor een succesvolle samenwerking en ontbreken deze factoren soms?

6c Wat is volgens u een "bottleneck" in de samenwerking om de binnenvaart te verduurzamen?

7a Volgens meerdere onderzoeken is de motivatie om duurzaam te innoveren in de binnenvaart meer extrinsiek dan intrinsiek, terwijl verduurzaming kan zorgen voor bijvoorbeeld competitieve voordelen. Hoe ziet u dit in de praktijk?

7b Aansluitend op de vorige vraag. Welk van de bedrijven waar u voornamelijk mee samenwerkt tonen vaak een meer pro-actieve houding op het gebied van duurzaamheid, en binnen welke fase van SLCM valt dit bedrijf? Zelfde vraag voor de meer reactieve bedrijven binnen jullie samenwerkingsverbanden.

8a. De probleemstelling van mijn onderzoek gaat over het feit dat de Nederlandse binnenvaartsector volgens meerdere onderzoeken relatief langzaam innoveert en ontwikkelt op het gebied van duurzaamheid en circulariteit. Sluit volgens jullie deze in theorie langzame ontwikkeling aan op wat jullie in de praktijk waarnemen?

8b. Wanneer jullie dit in de praktijk ook waarnemen, komt deze ontwikkeling dan voor uit de samenwerking tussen bedrijven? Wat is volgens jullie de reden van deze relatief langzame ontwikkeling.