FleetFlow

Circularity into every stage of the ship's lifecycle

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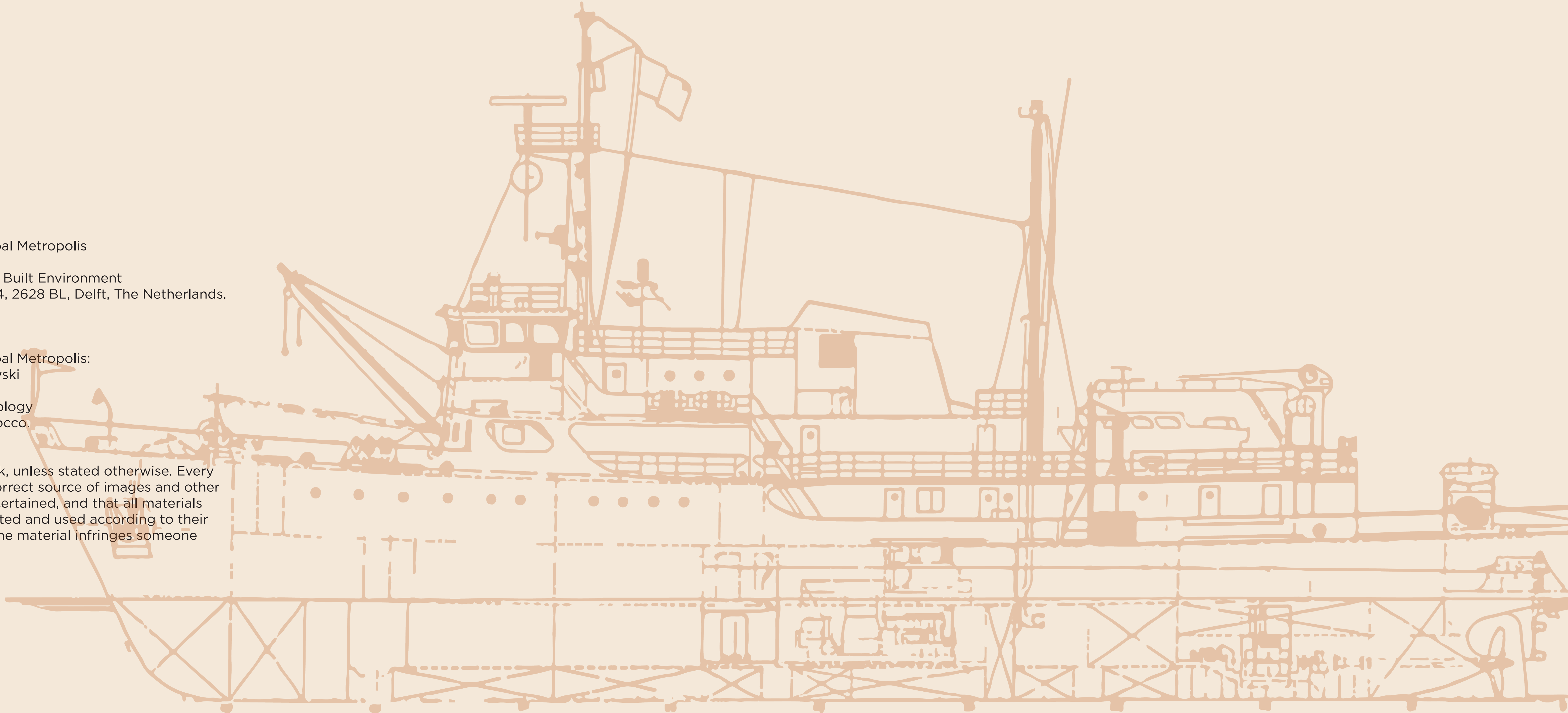

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PREFACE

FleetFlow is a proposal for a more circular ship manufacturing industry in the province of South Holland by 2050, which can be achieved by by linking and managing resources and material flows in innovative and smart ways. This proposal is made by Kim van Balken, Jinlai Song, Timo van Oorschot and Ziqi Xu during the 2021-2022 MSc2 courses AR2U086 *Spatial Strategies for the Global Metropolis* and AR2U088 *Research and Design Methodology for Urbanism*. These courses are part of the Master track of Urbanism at the Faculty of Architecture and the Built Environment, at Delft University of Technology.

During the preparation of the booklet, we have received a lot of valuable help from many people. Their comments and advice contribute to the accomplishment of the booklet. A special thanks goes out to our AR2U086 tutors: Dr. Marcin Dabrowski, Birgit Hausleitner, the course coordinators: Dr. Lei Qu and Dr. Verena Balz and to the AR2U088 tutors: Dr. Marcin Dabrowski and Dr. Roberto Rocco. All of them provided us with tools, insights and support.

ABSTRACT

With the growing world population and concerns about resource scarcity, environmental pressures, and social challenges more and more industries have a growing interest in transitioning towards a circular economy.

In South Holland, specifically in the port of Rotterdam, the ship manufacturing sector requires fundamental change. Circularity is currently hardly integrated into the ship manufacturing sector, as the lifecycle of most ships follows a linear path. The cycle starts with raw metals being extracted from the earth, ending with scrap steel being poorly recycled for other sectors in Asia. Because of the lack of a global regulatory framework, and the growing capacity and capability pressures on the ship recycling business in Europe, the business will not be able to process the increasing number of ships to be recycled in the future.

To generate a spatial vision and strategy to solve these issues, which helps transition to a more circular ship manufacturing sector, this research uses evidence-based design. Several methods are used including literature research, data analysis, site analysis, and research by design.

This is done to work towards the final goal: integrating spatial, technological, and regulatory solutions into the ship manufacturing business of South Holland, to build circularity into every stage of the ship's lifecycle. Essential in reaching this goal, is safeguarding the ship manufacturing sector, which is in a vulnerable position, in symbiosis with resilience, innovation, collaboration, and transparency.

In the end, the province of South Holland will be a world-leading example demonstrating more circular ship manufacturing in the port of Rotterdam. Spatially, this will result in a better port-city relationship, where ship manufacturing is embedded and mixed with other activities where possible, creating a synergy between different stakeholders. In addition, flows are connected by sustainable water transport.

By transitioning to a more circular ship manufacturing sector, the port of Rotterdam can contribute to the mitigation of the negative effects of climate change and resource scarcity. Additionally, the port of Rotterdam and its shipbuilding sector is of great international importance, which means the implementation of circularity can stimulate change and benefit people from the local to the global scale.

Keywords: ship manufacturing, circular economy, recycling industry, south holland, material flow

CONTENT

Figure 1.1: Prelude collage of FleetFlow

1 INTRODUCING FLEETFLOW

1.1. INTRODUCTION

Fleetflow is a proposal that brings a new social relation between circular ship manufacturing and the province of South Holland by 2050.

South Holland encompasses the large cities of The Hague and Rotterdam, and various other cities and villages. The area is roughly 3,400 km2 (including 600 km2 of water) and has a population of over 3.7 million people, making it the country's most populous province. Beside the dunes along the North Sea coast, the land is almost entirely flat and mostly consists of polders. The center of South Holland, and the area along the coast in the west, are mainly urban and part of the Randstad conurbation. One of the world's largest and Europe's busiest seaport, the Port of Rotterdam, is located in South Holland, providing approximately 385,000 jobs in 2021. With an added value of 45.6 billion Euro, it contributes to around 6% to the Dutch Gross Domestic Product (GDP) ("South Holland", 2022).

In order for South Holland, and the port of Rotterdam, to transition towards a circular economy, fundamental change is needed. Driven by a growing world population and concerns about resource scarcity and environmental pressures, industries and policy makers are exploring the switch from a linear to a circular economy. The Ellen MacArthur Foundation defines this circular economy as "an economy that is based on the principles of designing out waste and pollution, keeping products and materials in use, and regenerating natural systems. As a result, the economy is restorative and regenerative by design" (Ellen MacArthur Foundation, 2021). The manufacturing industry, plastics, consumer goods, construction and biomass & food are five sectors that are established within this transition (Province South-Holland, 2019).

While this discussion is advancing quickly in many sectors, and circular economy principles are beginning to appear more commonly in regulation, this topic is still in its infancy for the shipping industry. Our project, Fleetflow, will focus on the sector of maritime manufacturing. Within this sector, we explore ship manufacturing (focusing on seagoing ships) in more detail, and think about how to built circularity into every stage of the ship's lifecycle.

The past two decades have seen continuous growth in the global fleet in terms of size and number. Global recycling volumes are expected to grow significantly, doubling by 2028 to 14 million light displacement tonnes (ldt) and near quadrupling by 2033 to 28 million (ldt) (Circular Shipping Initiative, 2019). Furthermore, ships can be designed with resource optimization in mind to reduce the amount of resources used, allow for greater reuse of components, as well as promote repair, refurbishment and, if needed, replacement of individual modules. For this reason, better traceability of materials during the ship's lifecycle can be a useful tool to enable better reuse, refurbishment and recycling activities.

One of the latest global shipbuilding industry trends has been the adoption of 3D-printing technology within the ship manufacturing process, to improve efficiencies and quality of the products. This is also a new sector we want to involve. In the end, our goal is to provide a strategy for spatial change, where a (more efficient) circular economy and a new social infrastructure are synergized, and benefit each other.

1.2. CONTEXT

The first impression of the fieldtrip

Our field trip mainly focus on five sites: Delfshaven, Lloydkwartier, Merwe-Vierhaven area (M4H), Rotterdamsche Droogdok Maatschappij NV (RDM) and Waalhaven.

Delfshaven was ever part of the port of Delft, but it shifted its municipal authorities to Rotterdam in 1886. The historic center was spared from War-II bombing runs and has been carefully preserved. Visitors like the versatile atmosphere, in which culture is mixed with leisure facilities, and a varied bustle occurs in the surrounding neighborhood.

As the old harbor area of Delfshaven, Lloydwartier plays a crucial role in transporting goods and slaves from 17th to 19th century. In the context of urban renewal, the former port area has been transformed into a contemporary living and creative working area. People like to visit there for the feeling of the raw harbor in combination with contemporary architecture.

The Merwe-Vierhaven area (M4H) was once one of the largest fruit ports in the world. Nowadays space is created for the establishment of new companies in combination with housing, catering and other urban functions, particularly for innovative manufacturing. This harbor is now changing into a new residential and working area, together with the RDM area on the other side of the Maas, referred to as “The Makers District”.

The Rotterdamsche Droogdok Maatschappij NV (RDM) was an important shipyard for shipbuilding, ship repair and machine building, which existed between 1902 and 1996. RDM now includes companies, education and research. RDM Innovative Dock is offered as a core place to introducing companies to build knowledge relationship with educational institutions.
Heijplaat originated as a residential area for workers of the then RDM, which started maintenance and construction of ships here in 20the century.

Until the 1990s, the Waalhaven served as a transshipment port for bulk goods and containers in particular. It is still a very important harbor now which is the perfect place for logistics, industrial, maritime and business services. In the future, there are plans to build a new metro line from Kralingse Zoom via Feyenoord stadium and Zuidplein to Waalhaven .

Figure 1.2, Field trip impression,
(a) RDM; (b) Lloydkwartier; (c) Delfshaven; (d) M4H

1.3. PROBLEM STATEMENT

Social and environmental dilemmas

With the growing world population and concerns about resource scarcity and environmental pressures, more and more industries have a growing interest in transitioning towards a circular economy (Hoezen & van 't Hoff, 2021). This phenomenon applies to the port area of Rotterdam, as the Port Authority of Rotterdam is investigating the possibilities for integrating a more circular system of flows (van Barneveld & Veldboer, 2019). Simultaneously, the port area is starting to adapt to the New Economy, for what the port explores the integration of a clean energy system, resilient high-tech solutions and radical innovation (Han & Hausleitner, 2018). These trends substantiate there is a demand for fundamental change in the making industry of the port.

One of the sectors in the port of Rotterdam that requires fundamental change, is the ship manufacturing sector. The port of Rotterdam is a key actor in this sector, as it accommodates the biggest share of large ship manufacturing businesses in the Netherlands, which generate more than half of the total revenue of the 50 largest Dutch ship manufacturers (Dun & Bradstreet, 2022).

However, circularity is currently hardly integrated in the ship manufacturing sector, as the lifecycle of most ships follow a linear path ending with scrap steel being recycled for other sectors. With a view on the lack of a global regulatory framework, and the growing capacity and capability pressures on the ship recycling business, the business will not be able to process the increasing number of ships to be recycled in the future. To add to that, there is currently a low transparency and openness of the material flows, which limits the opportunities for pursuing circularity (Hoezen & van 't Hoff, 2021).

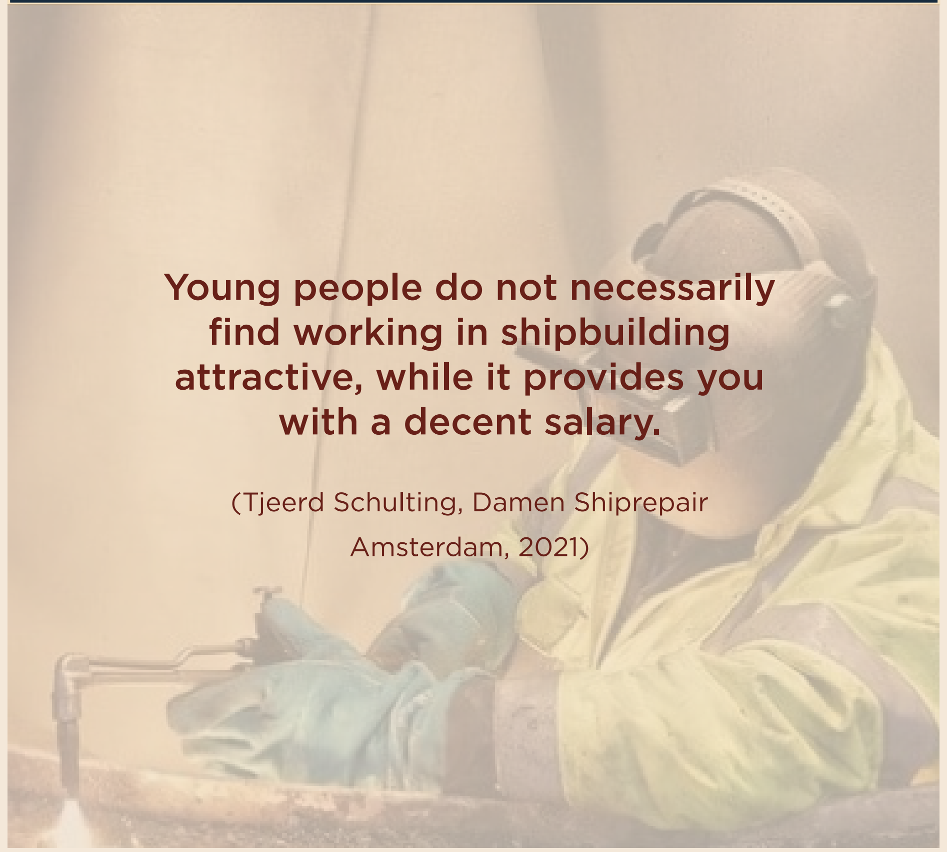
By solving these issues and transitioning to a more circular ship manufacturing sector, the port of Rotterdam can contribute to the mitigation of the negative effects of climate change and resource scarcity. Additionally, the port of Rotterdam and its shipbuilding sector is of great international importance, which means the implementation of circularity can stimulate change on a large scale. On a more local scale, the shift towards circularity can result in an innovative and efficient collaboration between stakeholders, which can benefit local businesses.

The final goal of this research is integrating spatial, technological and regulatory solutions into the ship manufacturing business of South Holland, to built circularity into every stage of the ship's lifecycle. This can be a circular flow of materials, where materials and facilities are shared and managed in a efficient and innovative way, creating a hybrid synergy between different stakeholders. A secondary goal would be creating awareness on circularity, to inspire other industries by showing how a traditionally very linear product lifecycle can transition into a more circular system.

In exploring the opportunities and barriers within ship manufacturing, the dilemma of transformation can be concluded into the following four aspects: job vacancies, housing pressure, importance to maritime cluster and the need for circularity.

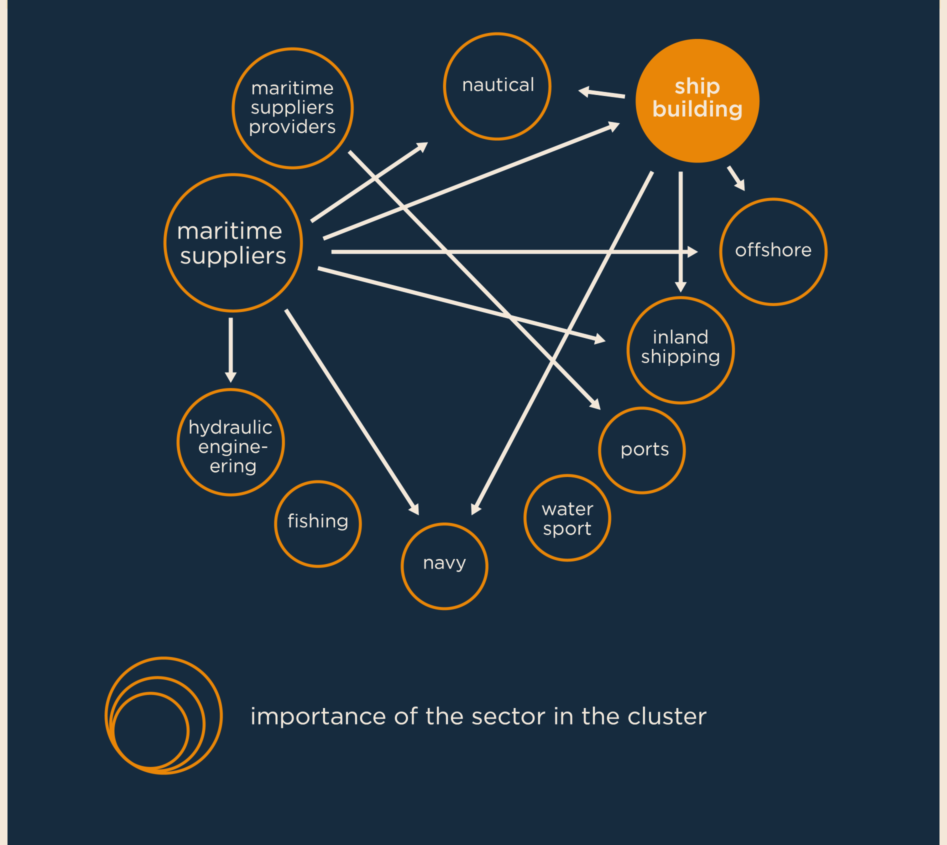
As Tjeerd Schulting, the managing director of Damen Shiprepair Amsterdam, said: "Young people do not necessarily find working in shipbuilding attractive, while it provides you with a decent salary". This means that while a lot of jobs can be provided directly and indirectly, they are less attractive to the younger generation. Secondly, the Damen Group, a Dutch defence, shipbuilding, and engineering conglomerate company, has been fighting for its survival in Amsterdam for years. This is representative for ship manufacturing, that has been getting pushed away because of housing pressure. Ship building is actually an essential part among other maritime industries, playing an important role in clusters. Finally, the demand for circularity is growing around South Holland.

Job vacancies



Housing pressure

Importance to maritime cluster



Need for circularity

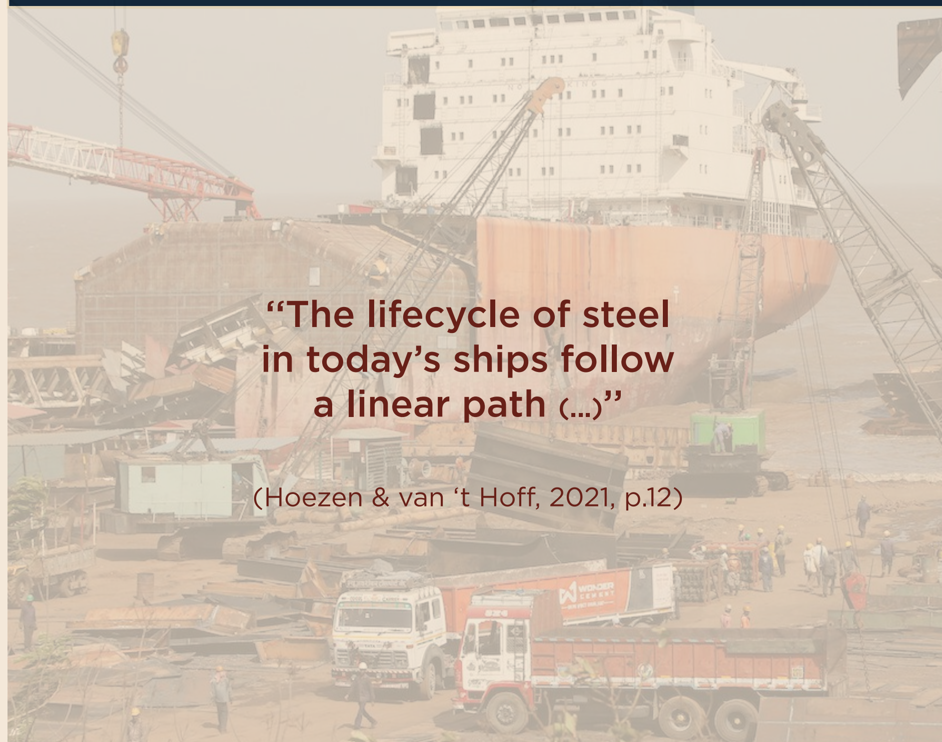


Figure 1.3, Problem statement, (Damen, 2021; NH-nieuws, 2021; Kuipers, 2014; Hoezen & van 't Hoff, 2021; Schuler, 2018)

1.4. GOALS

1.4.1. Sustainable development goals

In 2050, the province of South Holland will be a world leading example demonstrating more circular ship manufacturing in the port of Rotterdam, in order to mitigate the effects of climate change and resource scarcity. The ship manufacturing sector, which is in an vulnerable position, will be safeguarded in symbiosis with resilience, innovation, collaboration, and transparency. This will all happen in a way that is socially, spatially and ecologically just.

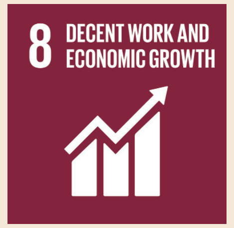
This correlates with the 17 sustainable development goals set by the United nations in the 2030 Agenda for Sustainable Development (United Nations Publications, 2020). These goals reflect a beautiful vision for a sustainable environment, reflecting on the social structure of public sectors, private sectors and civil society. There are 8 dominant goals which are relevant for the process of circular ship manufacturing.

Figure 1.4, Sustainable Development Goals, (UN, 2021). * icons will be used in pages 14, 128-129

1. No Poverty
A more diverse, flexible and qualitative working environment will be provided, in collaboration with a complete-cycle and profession education and training in the industry. This will provide more jobs and diversify the labor market.

3. Good Health and Well-being
Only industries with low to medium nuisances can be mixed with other activities such as living. We will smartly design so that residents do not experience noise, air pollution, etc.

4. Quality Education
Updated manufacturing and a more learning-by-doing education will help to adapt to the new shifts. There should be a better connection between knowledge education and final practice. This will provide people with a chance to grow personally, along with the needs of the new economy.



8. Decent Work and Economic Growth
The new strategy promotes economic growth by safeguarding ship manufacturers, protecting their vulnerable economic position by implementing overruling legislative instruments. The newly emerging sectors such as 3D-printing and other circular economies can provide a more resilient labor market and boost the economy.

9. Industry, Innovation and Infrastructure
New technologies and more sustainable industries will join ship producing lifecycles, which will demand more blue and green infrastructures rather than grey ones.

11. Sustainable Cities and Communities
A more open and transparent manufacturing environment will welcome living communities. Industry should be embedded to be more mixed, diverse and resilient.

12. Responsible Consumption and Production
Through the implementation of a more circular economy, we promote responsible consumption and production. We aim for reuse of standardized components, efficient sharing and management of resources and facilities.

17. Partnerships for the Goals
Good collaboration and partnerships will be highly valued through the whole ship production lifecycle, in terms of shared equipment and expertise between companies.

1.4.2. Project-specific goals

From a global policy perspective, Dutch ship manufacturing follows the regulations of the Basel Convention, HK Convention, and EU Recycling and amending regulation. Our project goals will be aligned with the regional and global visions.

Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal was drafted in 1989 and became active in 1992. It is an international convention to control trans-boundary movements of hazardous wastes. The main purposes of the Convention include reducing the generation of hazardous waste and avoiding environmental pollution caused by cross-border shipments; promoting local disposal of hazardous waste to reduce cross-border shipments, and properly managing the cross-border transportation of hazardous waste to prevent illegal transportation. The convention improves hazardous waste treatment technology and promotes international consensus on environmentally nuisance management (International Maritime Organization, 2019). To respond to this, our strategy promotes the regional manufacturing loop and local production, maintenance, and recycling in South Holland. At the same time, the long-term use of the ship materials will be maximized to minimize waste.

The Hong Kong International Convention for the Safe and Environmentally Sound Recycling of Ships was established in 2009 by the International Maritime Organization. *EU Ship recycling and Amending Regulation* was amended in 2013 (European Parliament and of the council, 2018). Both of them refer to the Basel Convention, but it particularly aim to ensure that ships are recycled at the end of their useful life without unnecessary risks to human health, safety, and the environment. They ask the industry to standardize the process, professionalize the employees, and secure the material used within the manufacturing system (International Maritime Organization, 2019). This needs to also be carefully considered in our objective. Education of professional skills and technologies about ship manufacturing will be provided, and the quality of the working environment and employment will need to be improved.

On a nation wide scale, Dutch ship manufacturing responds actively to the circular shifts of South Holland. It is in need of finding a secure alternative for the supplyment of raw materials, and preserving maritime making-companies to achieve sustainability. It should promote the new economy, which aims towards “a full Circular South Holland in 2050, with the intermediate step of 50 percent less use of primary raw materials by 2030”, according to the report of Zuid Holland (2019). This is similar to our final objective, as aim at implementing circularity into every stage of the ship's lifecycle.

Decrease shortage of ship manufacturing professions

Improvement of the techniques of ship decommission

Reduce demands of ship decommission

Basel Convention (1989) , HongKong Convention (2009) and EU SRR (2013)

“...with respect to the **safe & environmentally sound recycling** of ships, in order to prevent reduce or minimize any adverse effects on **human health and the environment**”

(REGULATION (EU) No 1257/2013 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 20 November 2013 on ship recycling and amending Regulation (EC))

States proposal - Strategy to achieve a circular South Holland

“South Holland Province aims to meet with partners to a full **circular South Holland in 2050**, with the intermediate step 50 percent **less use of primary raw materials** (mineral, fossil and metal) in 2030. ”

(Provincie Zuid Holland, 2019)

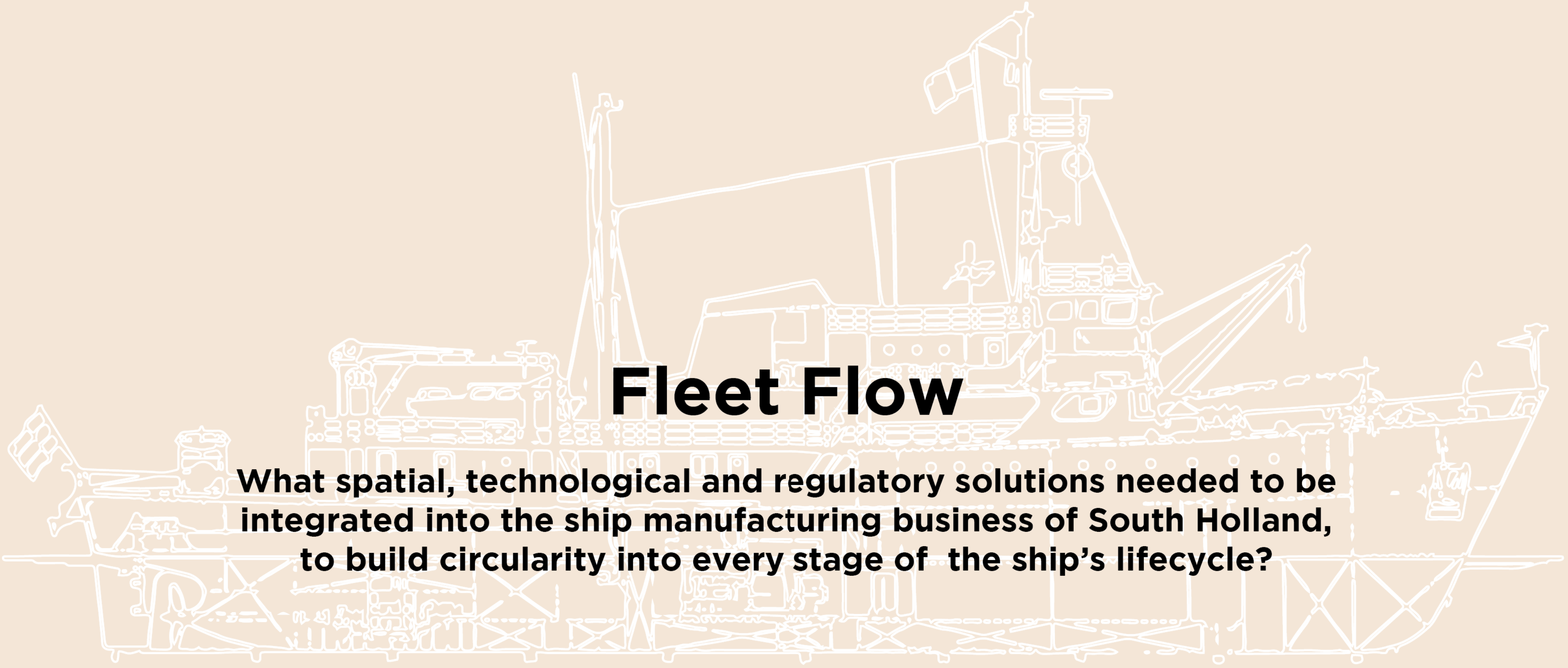
The security of supply of critical raw materials

Preserve maritime manufacturing companies

1.5. METHODOLOGY

The research process of FleetFlow

This is an evidence-based design project, in which there are four phases executed to achieve the final goal step by step. These phases include background research, problem specification, vision and strategy development, and spatial design.
It starts with the background research, in which members performed site research, using QGIS and other softwares to map data and review the related literature. After understanding the status quo of ship manufacturing and material flows on a regional and global scale, the problem statement is specified by analyzing a Damen case study and creating a SWOT-Analysis. After this, vision building and strategy development conceptualize the steps towards the future development of circular ship manufacturing in South Holland. In the last stage, to show the ideas of circular ship manufacturing in a more concrete and solid way, a long-term strategy and spatial design are proposed for four key locations. This full process will end with reflecting on environmental and social justice as well as an assessment in response to the 2030 Agenda of Sustainable Development Goals.



Fleet Flow

What spatial, technological and regulatory solutions needed to be integrated into the ship manufacturing business of South Holland, to build circularity into every stage of the ship's lifecycle?

Site analysis
- Analyzing economic and industrial activities of ship manufacturing in South Holland
- Analyzing regional flows and spatial structures
- Identification of key issues
- Mapping analysis

Review of related literature
- Material flow study of current ship manufacturing
- Network study of ship manufacturing within Province of South Holland
- Future prospects of ship manufacturing within Province of South Holland

Problem statement & Research question
- SWOT Analysis
- Topic sepcification
- **Research sub-questions**
1. What is the status quo of the ship manufacturing cluster?
2. How to transit ship manufacturing into a more circular and sustainable cycle in terms of environmental and social just in South Holland?
3. How to implement and spatialize circular ship manufacturing strategy in the case of Damen?
- Conceptual framework

Vision building
- Concluding the analysis and problem statement, and translating them into spatial actions

Strategy
- Development of pattern expansion pack
- Stakehoders analysis
- Recommendations of policies and incentives
- Phase developement planning

Implementation
- Adapting proposed vision to location-specific design

Result
- Social and environmental justice reflection
- SDGs assessment
- Implications

Figure 1.5, Methodology

1.6. CONCEPTUAL FRAMEWORK

The core objective of circular ship manufacturing is to implement circularity into every stage of the ship's lifecycle, which are the stages of; ship production, ship use, ship repairing and ship decommission. This goal will be achieved by involving actors, governance and related industries. The actors will be guided towards circularity by actions like spatial transitions, regulatory frameworks, stakeholder collaboration and transparent flows.

Produce
The first stage of the manufacturing lifecycle, ship production, is vital for all the mechanisms to work. To easily transport the ship's parts and avoid nuisance problems, the activities usually take place in shipyards at the edge of the industrial area of the city and near the river. To safeguard ship manufacturing, it needs to be better connected to possible employees and better integrated in the urban space where possible. The urban space should be better designed to welcome this sector, and to allow the industry to be better accessed, stimulating symbiosis with other services. Therefore, to improve the stage of the ship production, a spatial transition is needed in urban space. A mixed-use and multifunctional urban area can be a good incubator for ship-making, if proper transition zones are designed.

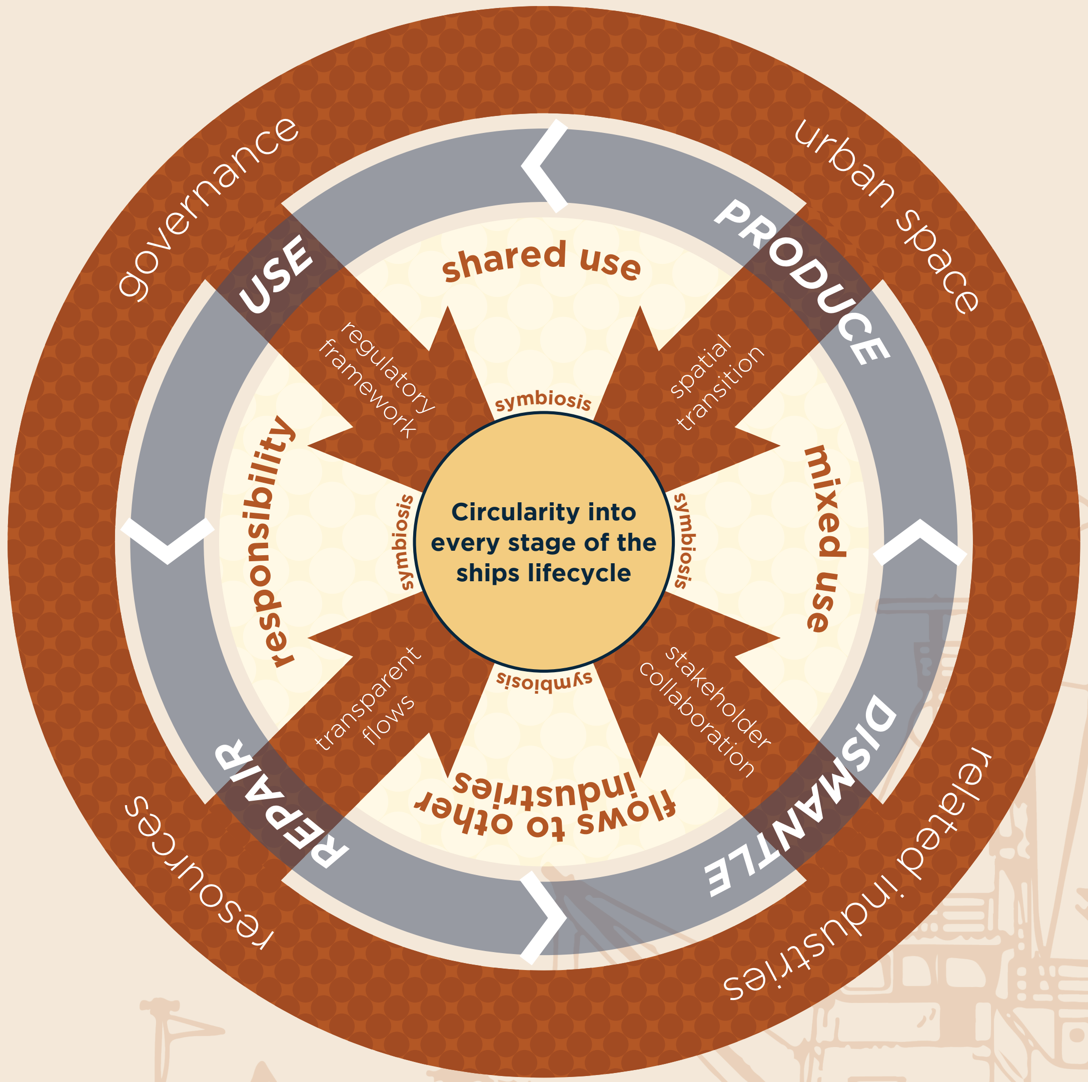
Use
During the lifespan of a ship, the utilization of ships should be supported and monitored regularly, to maximize the use of the ships and safeguard the whole system. Governments and related departments can play a powerful role in monitoring ship use. On the other hand, incentives and supporting policies can also help ship manufacturing to move towards a circular future with the use of universal regulations. According to Bevir (2012), facing increasingly complex challenges dependents on diverse stakeholders, good governance and a regulatory framework can guide and help with running the whole system and coordinate the relationships between participants. Therefore, in the process of ship use, the regulatory framework needs to be improved to standardize the governance of the ship use and help with coordination between the involved sectors and stakeholders.

Repair
In ship manufacturing, the stage of ship repair includes refitting, maintaining, and converting the detailing and fabric of ships, upgrading or changing the interior spaces of ships. Materials taken out of the ships during the repair process can be recycled or reused within the ship manufacturing cluster. If a shift towards a more circular economy is desired, maximizing the use of the material and sharing with related sectors will help to make a great step forward in the sustainability of manufacturing. Hence, to make the resources and material flow of ships more transparent and information open to the public is helpful to reutilize and make full use of the artifacts and resources. This benefits both social justice and environmental sustainability.

Dismantle
At the end of the lifespan of a ship, it will face the scenario of being dismantled. However, the broken down parts could still be functional in other services and industries, and be reused or recycled within the maritime cluster. Therefore, breaking the barriers between ship manufacturing and other services, and industries could be a milestone to introduce the used ship fabrics into other sectors. These actions ask for good collaboration, communication, and coordination between participants and stakeholders. Not only related industries can benefit from this but the ship manufacturing itself, because these material flows can also be reused and trace back to the initial stage of ship making.

When these four stages of the ship's lifecycle work together in symbiosis, true circularity can be achieved in ship manufacturing. Our conceptual framework summarizes the themes, phases and concepts that need to be analyzed and improved to have the highest chance at a successful circular lifecycle for ships.

Figure 1.6, Conceptual framework



Research Question

How can the ship manufacturing business of South Holland adapt to a more circular economy, through implementing spatial, technological and regulatory solutions into every stage of the ship's lifecycle?

2 ANALYSIS: UNDERSTANDING SHIP MANUFACTURING

2.1. INTRODUCTION

This chapter will address the first sub-question "What is the status quo of ship manufacturing cycles?" by explaining the current situation of ship manufacturing in the Netherlands. It emphasizes analyzing the key elements of ship making industry, the flow of material use, and the process of ship lifecycles.

As mentioned above, the primary objective of this project is to implement circularity into every stage of the ship's lifecycle, and a new economy is demanded for the future development in South Holland. It is important to understand the current situation of the manufacturing, every stage of ship making, material flows and involved stakeholders. The stated data and literature review can objectively reflect the challenges that need to be addressed and the opportunities that could be developed.

Therefore, this chapter will start by showing the current social and economical performances of ship-making sectors with mapping analysis. This demonstrates the significance of ship manufacture in maritime clusters in the Netherlands and the location of the port of Rotterdam to ship manufacturing in South Holland. The second part shows the related industries and departments running the material flows on a regional scale. This reveals the shortcomings of linear flow based on the current ship-making flow. On the other hand, it provides a glance at the potential of coordination between different services and industries with ship manufacturing and helps with developing a circular economy in the future. Followed by the drawing of systemic sections and material flow sketch, on the third part, involved stakeholders and spatial use of ship manufacture is clarified.

To sum up the current situation, we feel it is necessary to research ship manufacturing at the port of Rotterdam.

2.2. THE SCOPE OF THE CURRENT SECTOR

2.2.1. Economic activities

To kick off the analysis, we studied the current scope of the ship manufacturing sector and what it means for the economic activities of the Netherlands and the province of South Holland.

The ship manufacturing sector in the Netherlands produces both small ships, (super)yachts and seagoing ships. (Super)yachts are used by private entities which use them for recreational purposes. Small ships (mainly inland going ships, fishery boats or small seagoing ships) and large seagoing ships are often used by companies for industrial purposes. Later in this research, it becomes clear that the province of South Holland focuses on specific production types, but for the whole of the Netherlands, the manufacturing activities equally include all production types. Figure 2.1 shows how the different types of ships including similar shares, of around 30%, of the total turnover in 2020 of the Netherlands (Netherlands Maritime Technology, 2021). The same diagram already touches on the great amounts of money that circulates within the industry. To further explore the economic value of the maritime cluster to the province of South Holland, figure 2.2 shows the contribution to the local GDP. The maritime cluster of South Holland generates, with 8.2 bilion euros, a significart share of more than 5% of the GDP of South Holland (de Jong, et al., 2018).

To spatialize the quantity and size of the ship manufacturing sector within the province, the next page locates the businesses on a map, while refering to the amount of full time employees. The map shows that, especially along the waterfront of Rotterdam, there's a clear cluster of ship manufacturing companies. In chapter 3.1.3., the geographical reasoning behind this specific cluster is further explained. For now, it is important to acknowledge the underlying heatmap, which emphasizes the location of strong clusters.

From the analysis so far, it can be concluded that the maritime cluster of South Holland contributes to a significant part of the economic activities. These activities are especially important to the port of Rotterdam, as this is where the largerst companies are in close proximity to eachother.

Turnover of ship manufacturing of the Netherlands 2020 (mln)

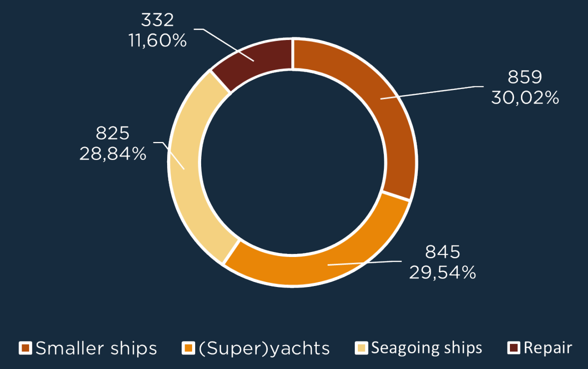


Figure 2.1, Turnover of ship manufacturing of the Netherlands 2020, (Netherlands Maritime Technology, 2021)

Maritime cluster contribution to GDP of South Holland 2016 (bln)

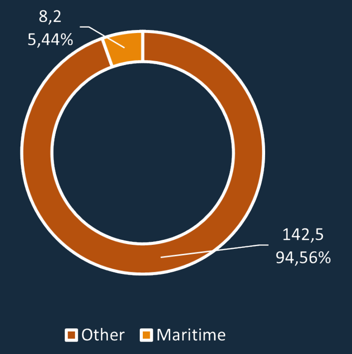


Figure 2.2, Maritime cluster contribution to GDP of South Holland 2016, (de Jong et al., 2018)

Subsectors in ship manufacturing South Holland

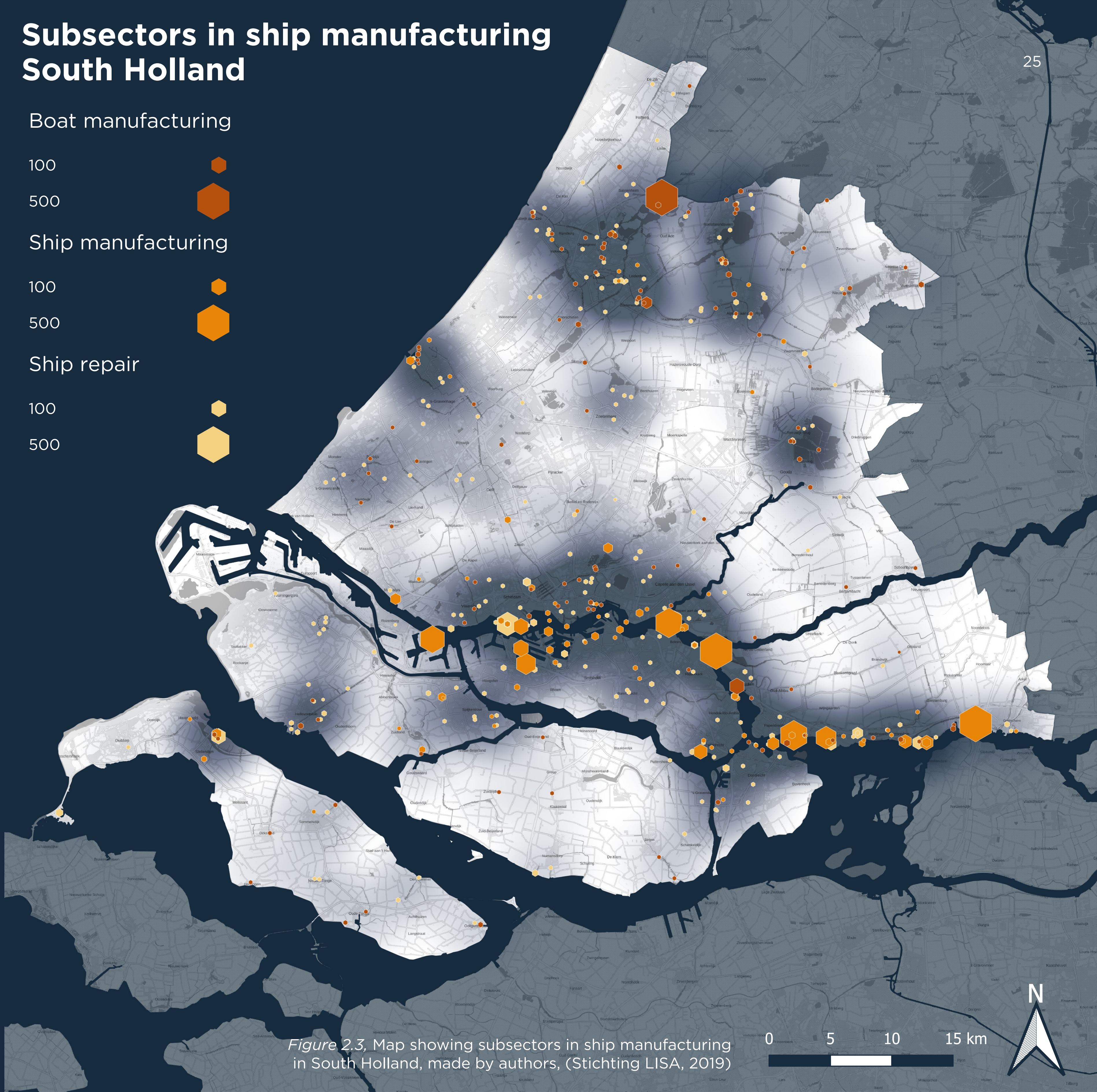


Figure 2.3, Map showing subsectors in ship manufacturing in South Holland, made by authors, (Stichting LISA, 2019)

2.2.2. Jobs

The ship manufacturing sector does not only contribute to a large share of the economic activities of the province, but it is also of great importance to the citizens in the sense of job provision. The ship manufacturing sector provides more than 4850 jobs for the province, which is by far the largest share within the Netherlands (Stichting LISA, 2019). The map shows the spatial distribution of these jobs, which are, aside from a smaller cluster around Leiden, again focused along the waterside of Rotterdam.

Full time employees in the ship manufacturing sector, South-Holland vs. the Netherlands

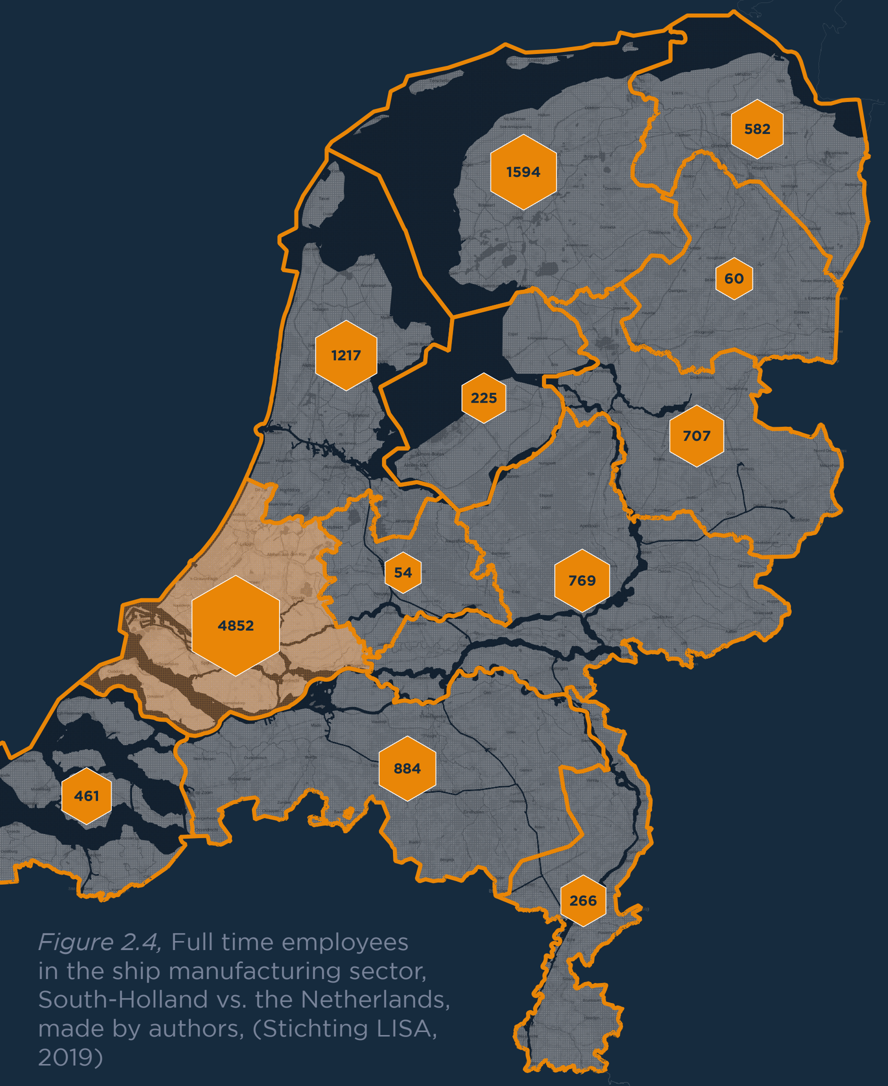


Figure 2.4, Full time employees in the ship manufacturing sector, South-Holland vs. the Netherlands, made by authors, (Stichting LISA, 2019)

2.2.3. Footprint

To further explore the spatial distribution of the companies, we generated a footprint map, which visualizes the plots on which the companies operate. Looking at those footprints, it becomes clear how centralized the businesses are. Especially in Rotterdam, the companies inhabit areas along the waterfront which are in very close proximity to the city centre.

This substantiates the potential value those areas can bring to the urban areas of the city. At the same time, it stresses the importance of safeguarding these manufacturing sites, as these locations are subject to a very high pressure on land. In locations like these, the biggest threats are the growing real-estate prices and the rezoning of industrial land. Even the rezoning of plots nearby can have a huge influence on the manufacturing activities, as they can come with a lot of restrictions and limitations (Croxford, et al., 2020). Later on, the report will come back to a suitable strategy to deal with this growing pressure on these centralized manufacturing sites.

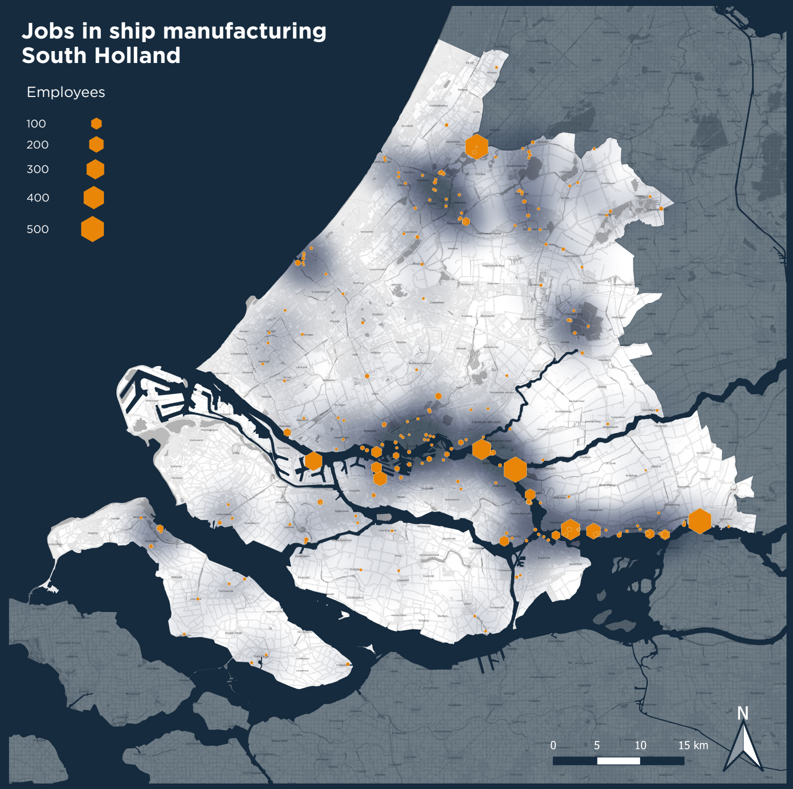


Figure 2.5, Map showing jobs in ship manufacturing in South Holland, made by authors, (Stichting LISA, 2019)

Footprint of ship manufacturing and water infrastructure South Holland

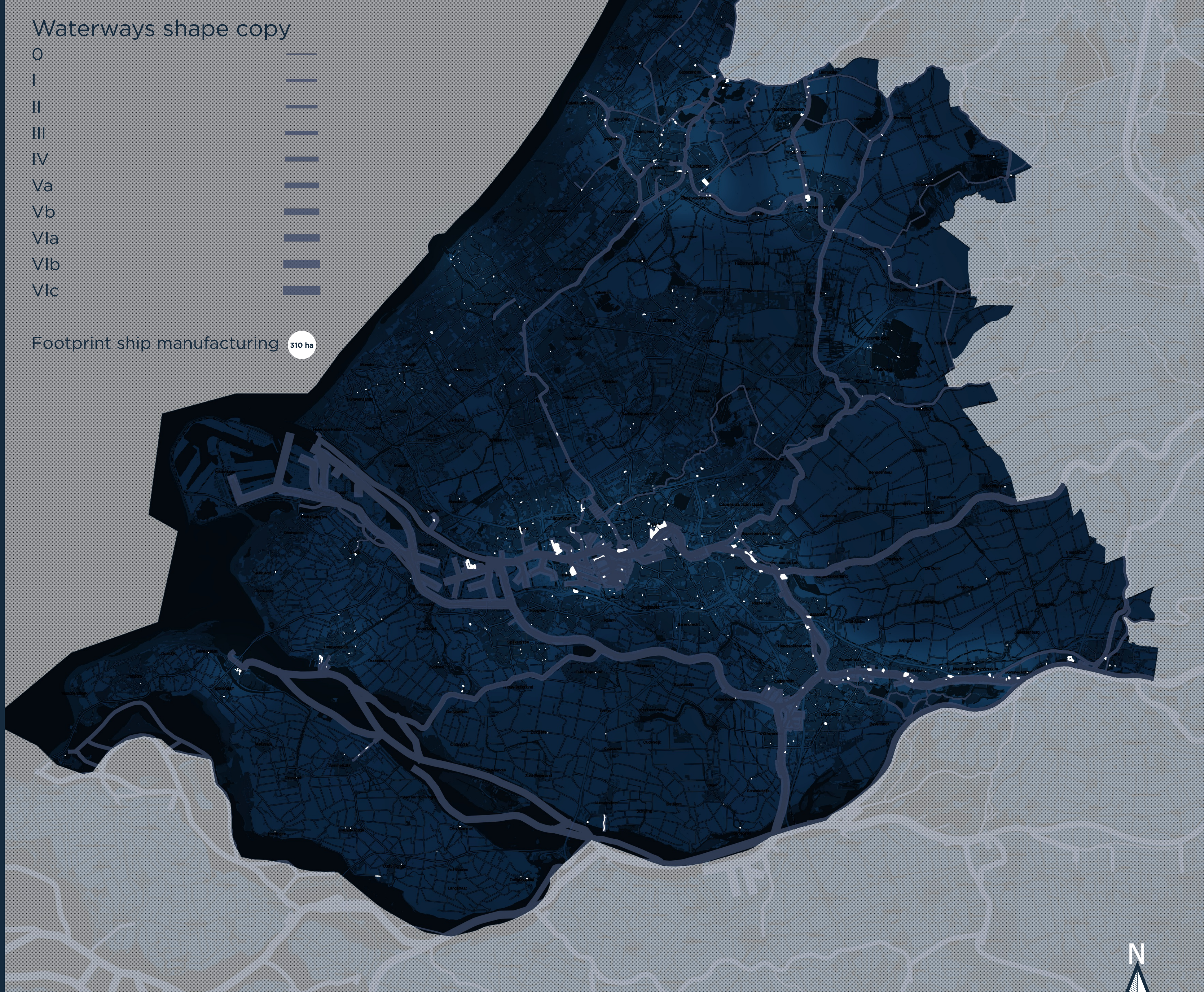


Figure 2.6, Map showing footprint of ship manufacturing and water infrastructure in South Holland, made by authors, (Stichting LISA, 2019; Kadaster, 2022; Rijkswaterstaat, 2017)

2.2.4. Geographical identities

Earlier it becames clear that within the Netherlands, there is an almost even division in the shares of the manufacturing of small ships, (super)yachts and seagoing ships. When the specializations of the manufacturing businesses in the province of South Holland are studied, more distinct and varying patterns come forward.

To better understand these patterns in situation and subsector specialization, we studied the geographical characteristics. The map illustrates how the province includes two clear maritime clusters. Both clusters have a different predominant subsector, and relate to different infrastructures.

Firstly, there is a cluster towards the north, which starts at the port of Katwijk. The companies within this cluster follow a network of lakes and canals, situated within a polder landscape. As the use of recreational boats fits this context best, this cluster focuses on boat manufacturing (LISA, 2019).

Secondly, there is a cluster which is situated more towards the south. This cluster lies in the highly industrialized landscape of the port of Rotterdam, which consists of railroads and canals. Self-evidently, the share of the ship repair and ship manufacturing businesses increases here (LISA, 2019).

These different specializations and geographical characteristics result in ship manufacturing sites with very different identities. Two pictures are chosen to illustrate these identities. One example is the manufacturing business of Royal van Lent in Kaag, where it is situated in a more rural environment of agricultural land. The second picture captures the atmosphere of the Damen company in Rotterdam, a highly industrial and more robust environment.

Polder landscape with lakes, more boat manufacturing

Figure 2.7, boat manufacturing in Kaag, (Brand, 2019)

- 45% boat manufacturing
- 45% ship repair
- 10% ship manufacturing

Industrial landscape, focus on ship manufacturing & repair

Figure 2.7, ship manufacturing in Amsterdam, (Damen, 2021)

- 20% boat manufacturing
- 50% ship repair
- 30% ship manufacturing

Subsectors in ship manufacturing and patterns related to infrastructure and location

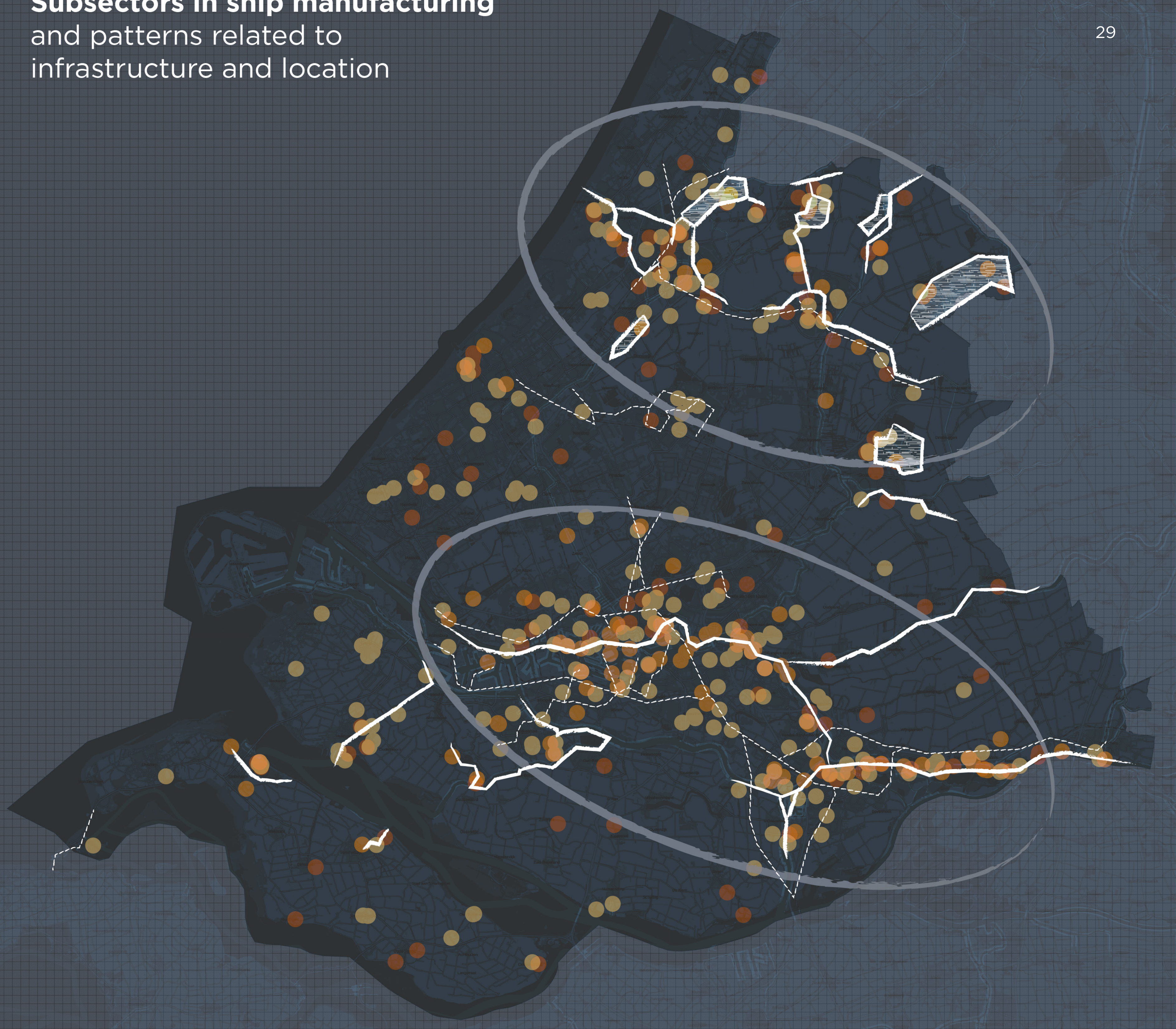


Figure 2.9, Map showing subsectors in ship manufacturing and patterns related to infrastructure and location, made by authors, (Stichting LISA, 2019)

2.3. RELATED SECTORS

2.3.1. Potentials for synergies

While the current possibilities for circular use and the reuse of ships is not sufficient, there are high potentials for improving the circularity of the system. This does not only include the maintenance, repair and decomissioning capacity of the sector, but also the potential synergies with other sectors that could support smart and innovative uses (and re-uses) of resources.

For this analysis, a heatmap is created, which illustrates the clustering of industries that can potentially relate to, or are related to, the manufacturing process of ships. The used data includes industries that focus on metal, rubber, plastics, paints and fibre, which are the main materials that are used in the manufacturing of ships. In addition, the location of general recycling industries are included, as they could have a role in the recycling process of ships.

The heatmap illustrates the great quantity and size these industries take up, especially near the port of Rotterdam. To further substantiate this finding, the mapping anlysis is shown to manifest the metal industry in South Holland (Figure 2.10). This data emphazies the great quantity and size of the metal industry, and shows the clusters of the businesses, which are in close proximity to the clusters of the ship manufacturing companies (LISA, 2019).

To conclude the findings so far, it has become clear that in the current context the ship manufacturing sector is of great importance to the province of South Holland. This is not only applicable within the scope of the sector, but could also influence (potentially) related industries in the future, of which a substantial amount is located in and around the port.

Implementing a more circular ship manufacturing system can bring great potentials, both to relate industries as well as maintenance, repair and decommissioning industries which could be intensified.

Metal industry in South Holland

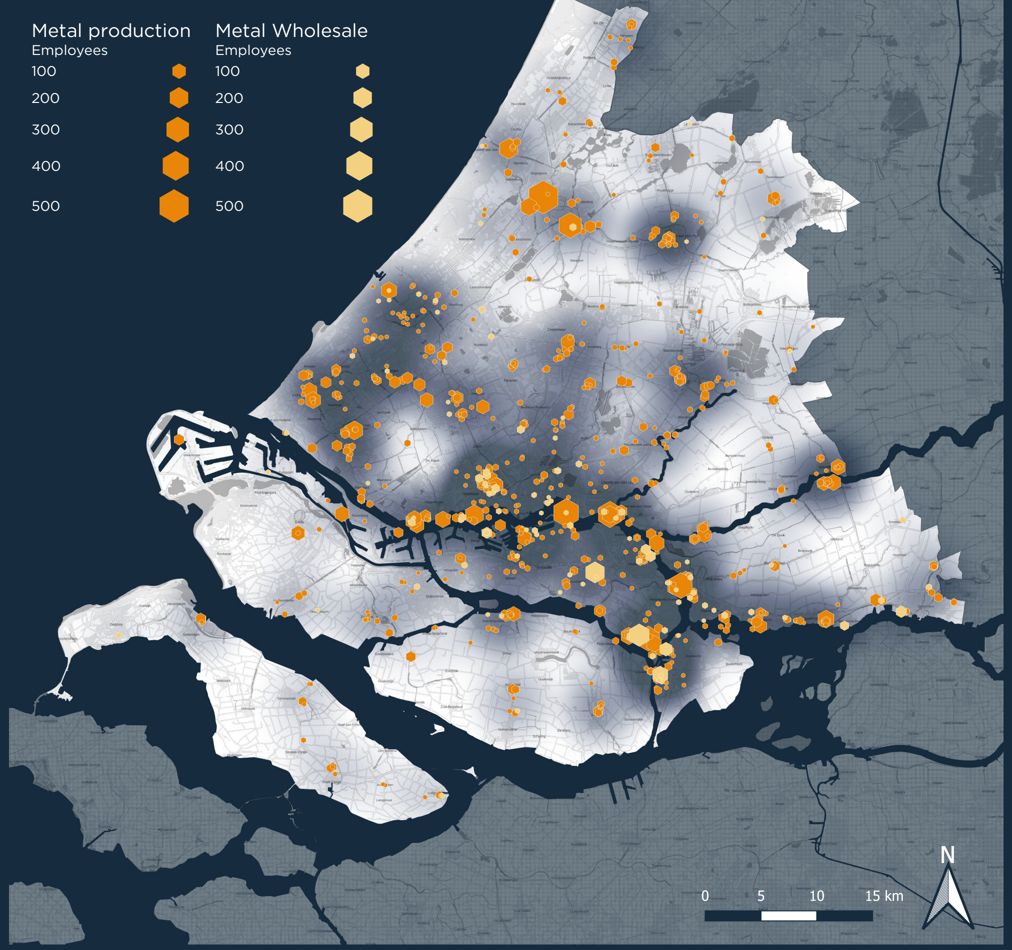


Figure 2.10, Map showing metal industry in South Holland, made by authors, (Stichting LISA, 2019)

Heatmap of Ship manufacturing and connected industries South Holland

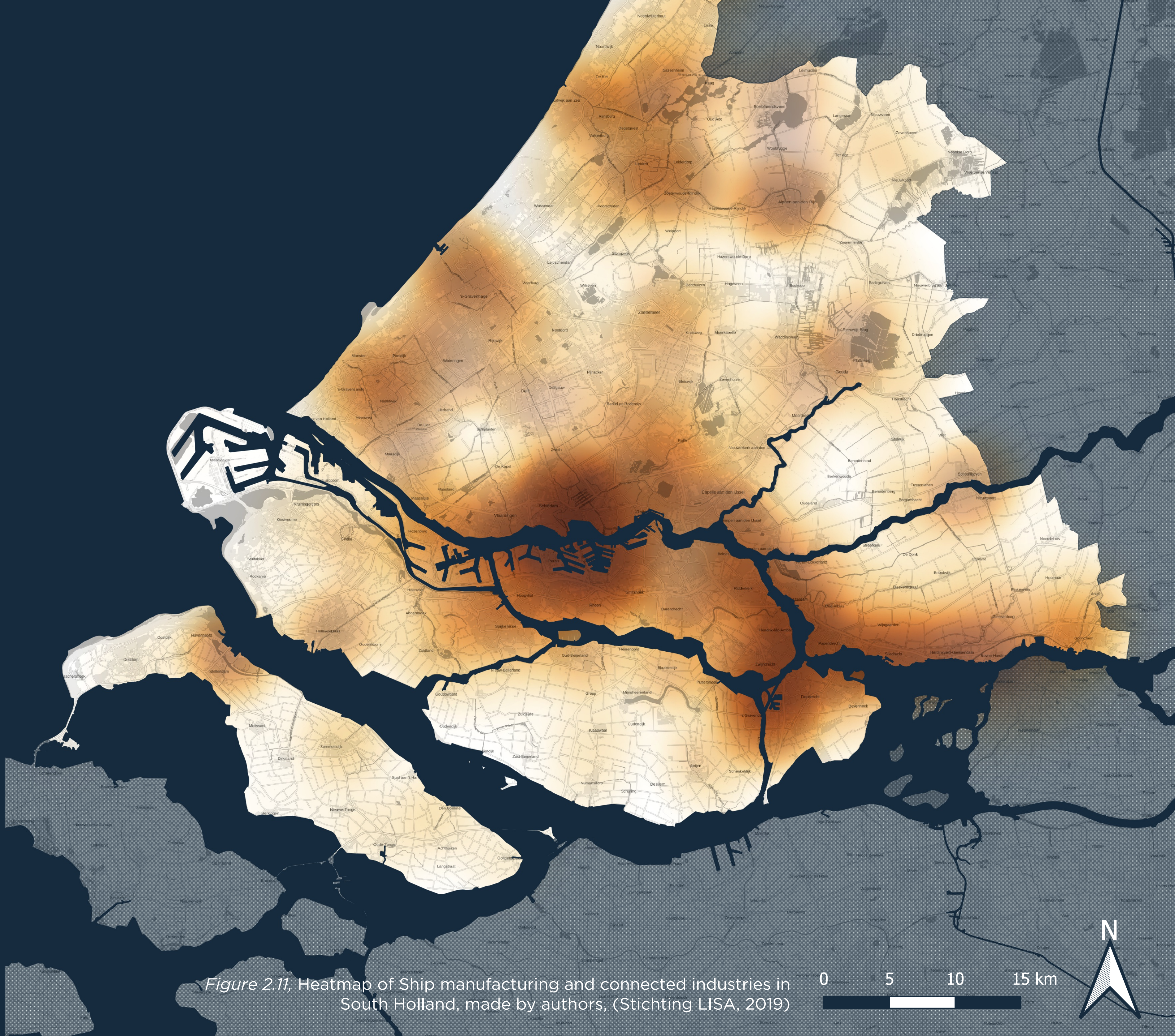


Figure 2.11, Heatmap of Ship manufacturing and connected industries in South Holland, made by authors, (Stichting LISA, 2019)

2.3.2. Maintenance and repair

So far, the analysis has mainly included the different manufacturing industries within the province. However, this reasearch focuses on integrating a more circular system into the ship manufacturing sector, so self-evidently the current circularity capacity has to be studied as well. This chapter briefly touches on the current maintenance, repair and decommissioning capacity of the sector. These are the current activities whihc are the most closely related to a more circular use and re-use of ships.

However, with the map of all the manufacturing businesses in mind, the shown map brings a clear imbalance forward. The current decomissioning, and maintenance and repair businesses are in severe minority to the manufacturing sites. This reflects a global problem, which is the fact that the current the capacity and capability of the current ship recycling sector is not sufficient to recycle all the ships that are reaching the end of their lifecycle (van 't Hoff & Hoezen, 2021). In order to be able to re-use resources more locally, these maintenance, repair and decomissioning businesses should most likely increase.

The diagram Figure 2.13 and Figure 2.15 support the hypothesis that the decommissioning capacity is not sufficient. In 2020, there were 28 seagoing ships produced (Netherlands Maritime Technology, 2021), which is already substantially lower than the average of 50 a year. The decommissioning capacity of seagoing ships depends in the Netherlands on one company: Damen Verolme in Botlek. This company has the capacity to decommission around 13 vessels a year (Greenlight, 2019). In regular years that is only a quarter of the production. If the decommissioning wants to keep up with the production, it needs more space and more employees, on the other hand, there is a huge potential to improve the revenue in this part of the ship's lifecycle.

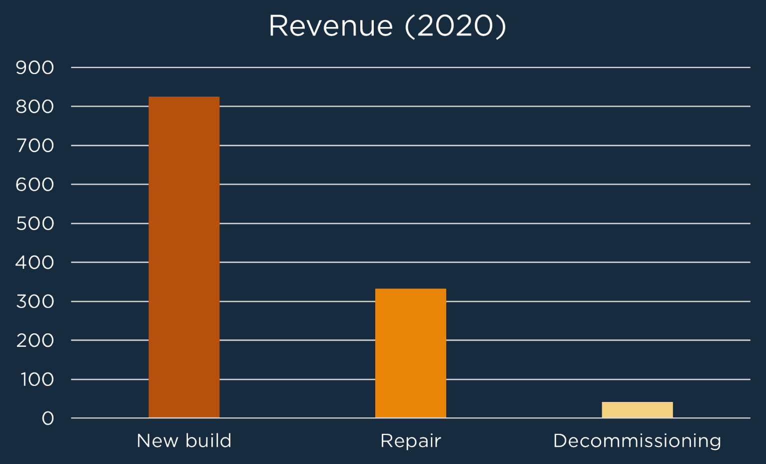


Figure 2.12, Revenue comparison of new build, repair and decommissiong, (Netherlands Maritime Technology, 2021; Dun&Bradstreet, 2020)

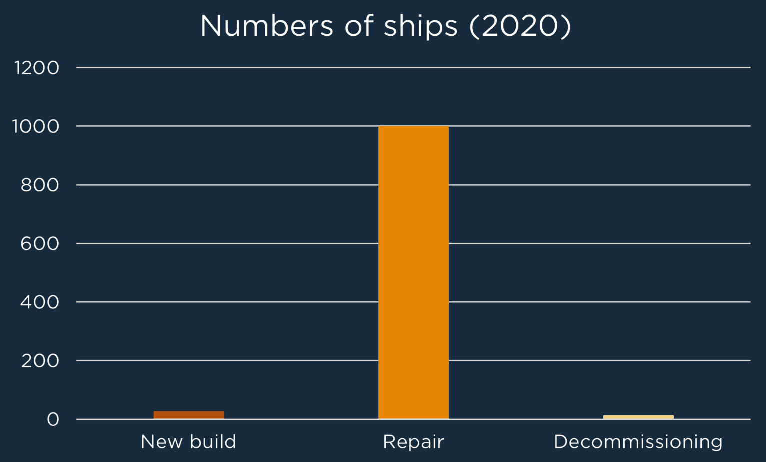


Figure 2.13, Ships' number comparison of new build, repair and decommissiong, (Netherlands Maritime Technology, 2021; Greenlight, 2019)

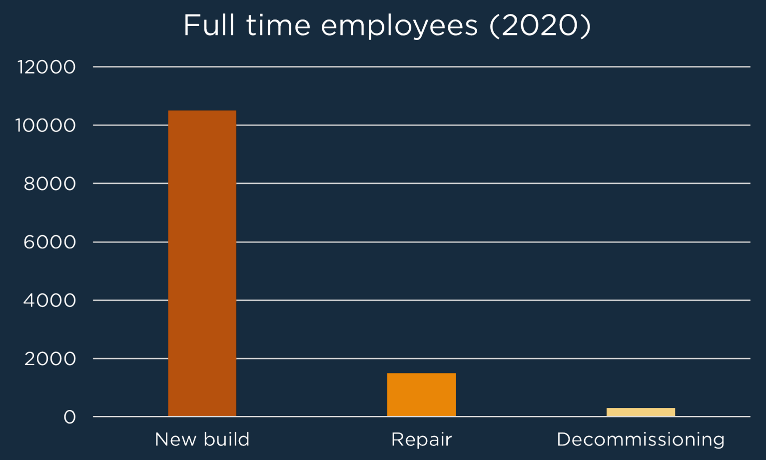


Figure 2.14, Fulltime employees comparison of new build, repair and decommissiong, (Netherlands Maritime Technology, 2021; Stichting LISA, 2019)

Maintenance and Repair and Decommissioning of ships and boats South Holland (National top 50)

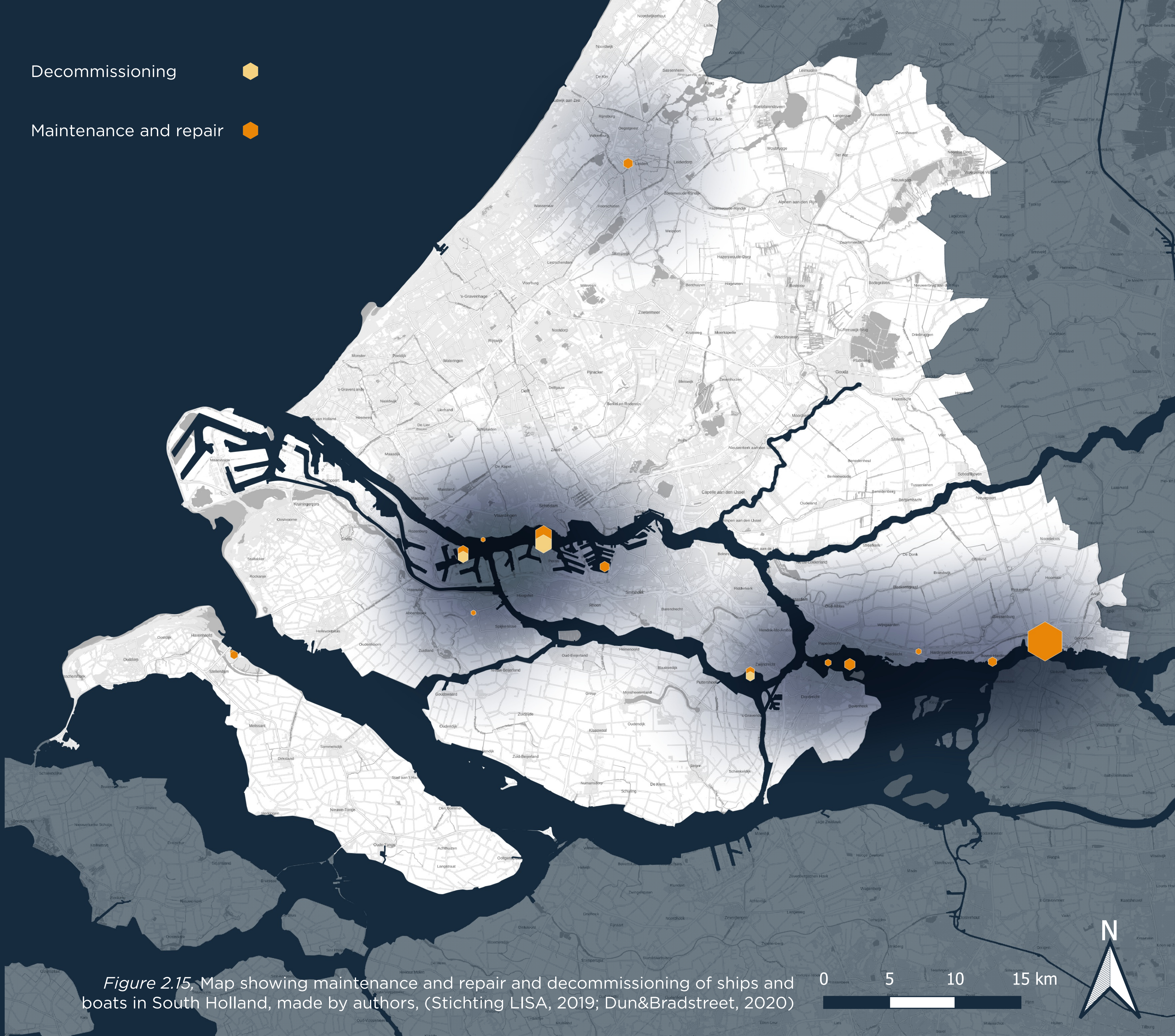


Figure 2.15, Map showing maintenance and repair and decommissioning of ships and boats in South Holland, made by authors, (Stichting LISA, 2019; Dun&Bradstreet, 2020)

2.4. PROCESSES

2.4.1. Current processes

Every ship will be carefully customised to satisfy the buyers from the start stage. The clients or agencies make orders first, and their demands will be transferred into ship design innovated in design sectors. The designed computer modelling of a ship will be translated to a plan drawing in favour of shaping the ship. The drawing sheets will be all-the-way used in the process of ship production in shipyards. In addition, before a ship getting retired, a long-time process of repairing, refitment and conversion is involved in the ship-use lifespan. This has the potential to involve the circularity flow which allows the wastes and old fabrics to be reused and recycled.

Among all the shipbuilding materials including paint, fibre-fortified plastic (FRP), Aluminum and polyethylene, the dominant raw material used in this system is steel, which is over 95% of the total use. Shipbuilding requires a high-qualified mild steel. Every year, Asia, especially China, will be the primary raw material supplier of mild steel sheets for Netherlands (71.1%). In EU, Germany and Italy will be the leading provider (25.1%). Before getting perfectly fitting into a ship body, these semi-manufactures will be processed into cutting, bending and welding into proper sizes and shaped under the supervision of the strict standards and regulations in the Netherlands. This procedure will largely add the values in the whole cycle of ship production.

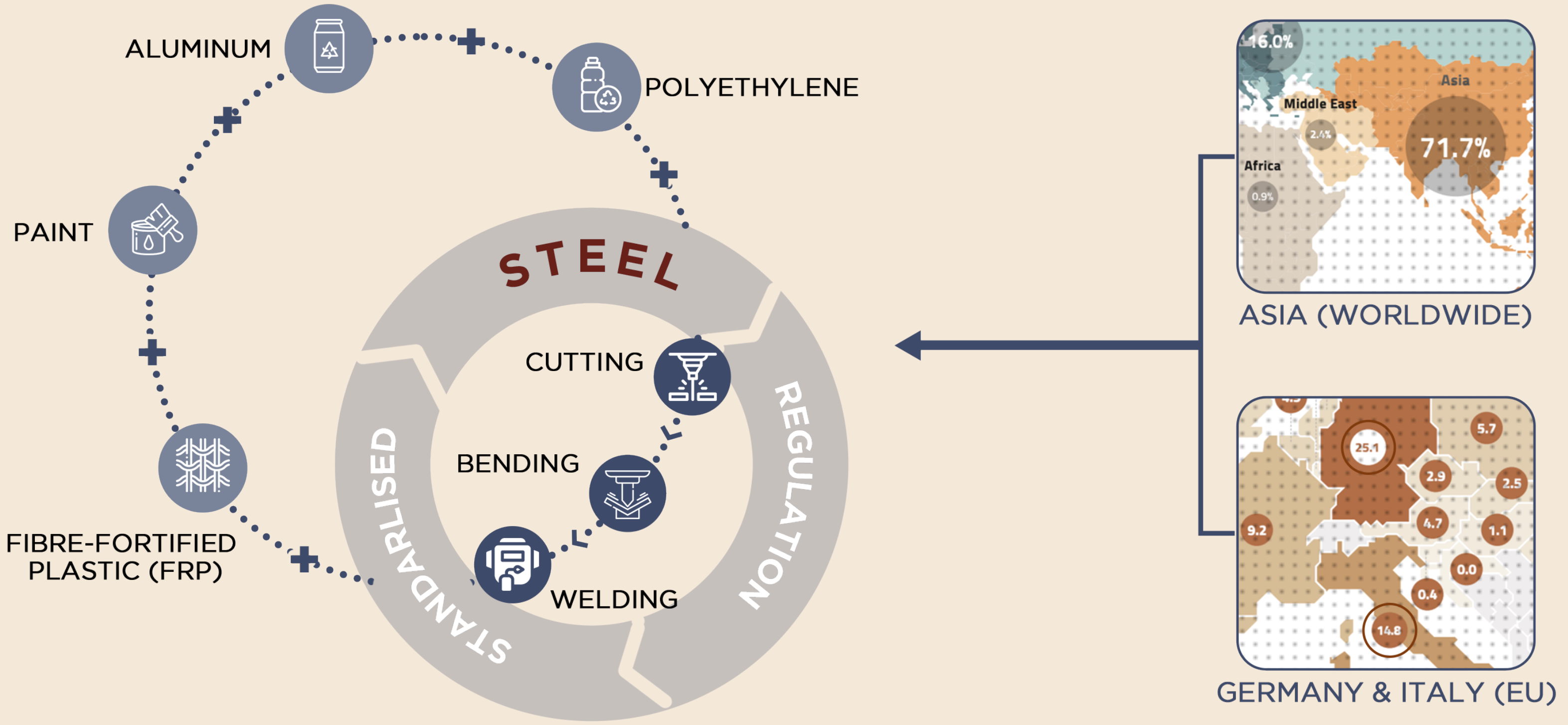


Figure 2.16, Raw materials & Steel import in shipbuilding, (European Commission, 2017; OECD, 2020)

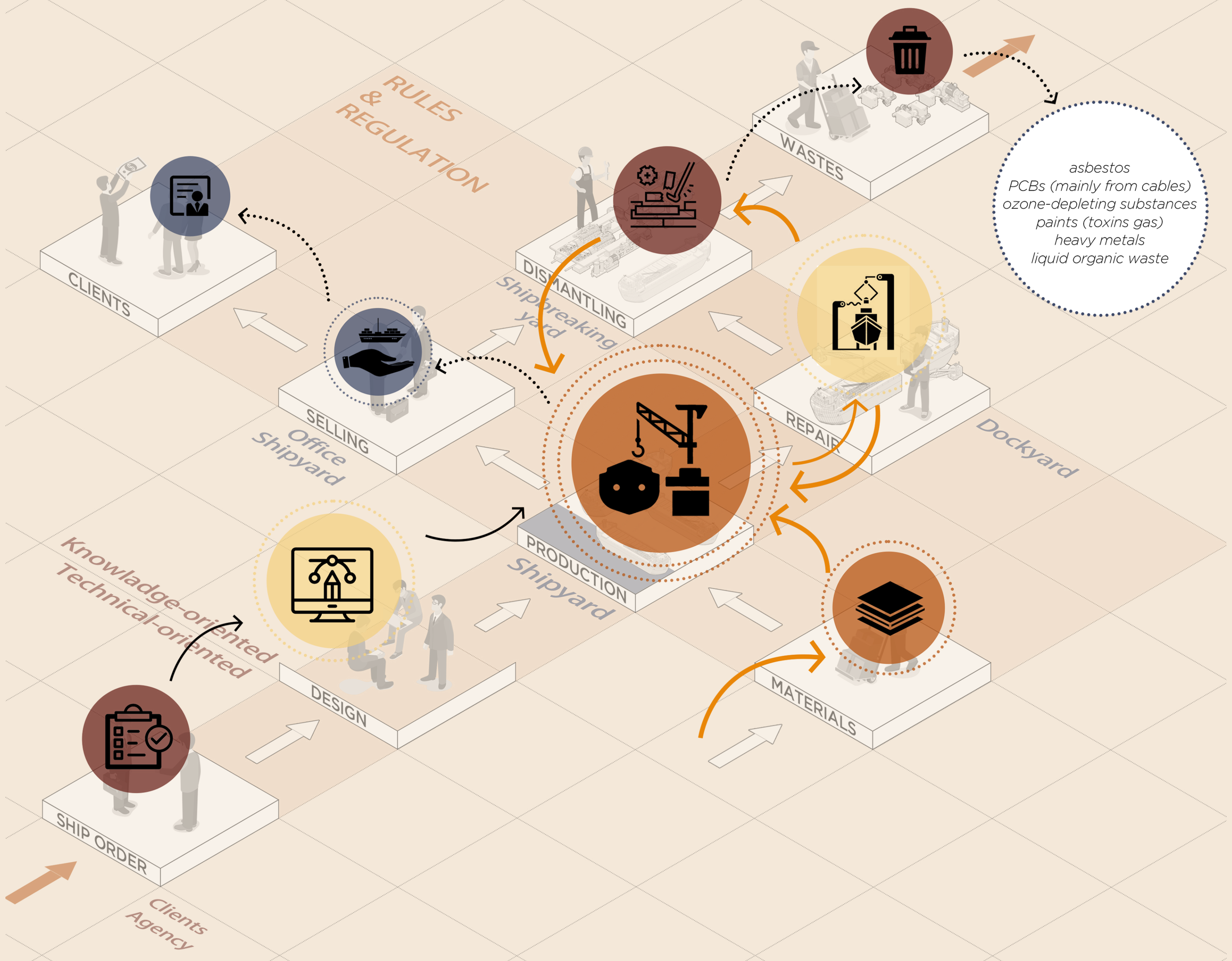


Figure 2.17, Process and location of ship's lifecycle

2.4.2. Systemic section

The lifecycle of steel in today's ship follows a linear path ending without being recycled or materials being refurbished for other sectors. The current system of flows outlines the main stages and related actors across the lifecycle of steel in a ship with ship designers, shipyards and ship recycling facilities as important actors.

Dominating considerations of design
Long before the ship building beginning, a ship is designed to meet market demands. Compared to other sectors, such as the automotive and aviation industries, the design of a ship is determined by the first ship owner rather than the shipyards. Shipbuilders will follow the design while meeting regulatory and industrial standards, overseen by classification bodies. Standardized models are available, but in practice ship-owners often require customizations (both major and minor), resulting in a large variety of types, sizes and configurations. Under current conditions, little attention is paid to principles of circular economy , as the dominant design considerations are the cost efficiencies in both building and operating phases, and compliance with minimum standards.

Dependence on materials import
Imported materials, especially crude steel, are the main raw materials for the Dutch shipbuilding industry. In the global market, Asia provides 71.1% of the steel, most of which comes from China, and a small part is recycled from the shipbreaking industry in West Asian and South Asian countries. Germany and Italy are the main suppliers of steel to the European market, with 25.1% and 14.8% of the supply respectively.

From production plan to selling
The production plan has a critical impact on manufacturing efficiency due to the enormous amount of components and the large number of workers involved in the job sites. At first, steel plates will be cut in to the parts that will form the hull and deck sections of the ship. The process of heating and bending a steel plate into curved shapes is of great importance in shipbuilding, and requires sophisticated skills and techniques. Then, the cut steel is assembled into smaller blocks that in turn are assembled into larger sections that mounted together to finally become a complete ship. When all the blocks are mounted and jointed, launching is the next stage. Finally, the captain, chief engineer and crew embark for the ship's maiden voyage.

Current situation of ship repairing
Ship recycling facilities are an important source of scrap steel used in other sectors, such as construction and electronics. When a ship is in need of repair, refurbishment, a ship-owner will send it to dock for repairing and refitting. Otherwise, if a ship reaches the end of its use lifespan, the ship owner is paid a price by a ship recycling facility or intermediary, who will recover and sell the steel and other components for recycling, refurbishing and reuse.

Shipbreaking in other markets
Shipbreaking does not primarily happen in the South Holland, and its current ship recycling capacity will not be able to process the increasing number of ships to be recycled. South Asia (primarily Bangladesh, India, and Pakistan) is the region with the largest global share of recycled tonnage, accounting for over 80% in 2020. The fourth main recycling country is Turkey. These four countries carry the vast majority of global ship recycling capacity (NGO Shipbreaking Platform, 2020).

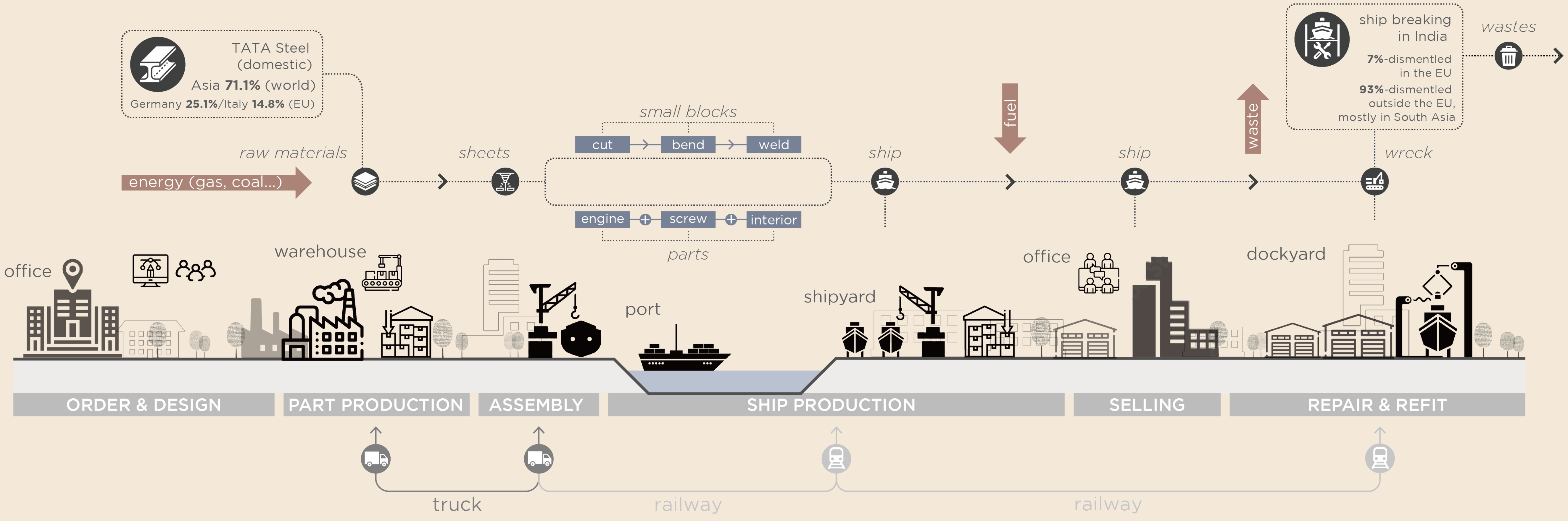


Figure 2.18, Current systemic section, (European Commission, 2017; OECD, 2020; Sustainable shipping initiative, 2021)

2.4.3. Current flows

To spatialize the current production process of a seagoing ship, we performed a case study on the Damen shipyard group in South Holland. Importantly to note is that, this process is our best estimation based on readings, data and logic. The suppliers in this project does not represent all the Damen's real suppliers, but it provides a good insight into the flows of materials.

The raw materials, mainly metals, arrive in the harbor by ship from Italy, China or India or by rail from Germany. It will be stored in a warehouse before transported by inland ships towards the shipyards where the ships are built from this metal. Other supplies like fibers, paint, plastics and rubber are transported from all over the province (or the country) by trucks to the manufacturing sites. Even important parts like the screws, engine and interior have to move large distances by trucks to the assembly site.

When the ship is produced, it sails out to seas all over the world. During its lifespan, it will visit the repair center of Damen a few times before getting decommissioned and recycled in Asia. The ship can only be recycled by melting the metals, which costs a lot of energy and the reuse of parts does not happen at the moment. So, most of the metal starts and ends in Asia, while the building of the ship takes place in South Holland. Long distances and open loops like this are not sustainable nor circular.

1. SHIP REPAIR (DAMEN)
2. SHIP MANUFACTURING (DAMEN GORICHEM)
3. EDUCATION
4. DESIGN OF SHIP
5. MANUFACTURING OF FIBRE
6. MANUFACTURING OF PAINT
7. SUPPLIER OF PLASTIC
8. SUPPLIER OF RUBBER
9. MANUFACTURING OF INTERIOR
10. MANUFACTURING OF SCREWS
11. MANUFACTURING OF ENGINE
12. WAREHOUSE WHOLESALE OF METALS

THE CURRENT SYSTEM OF FLOWS

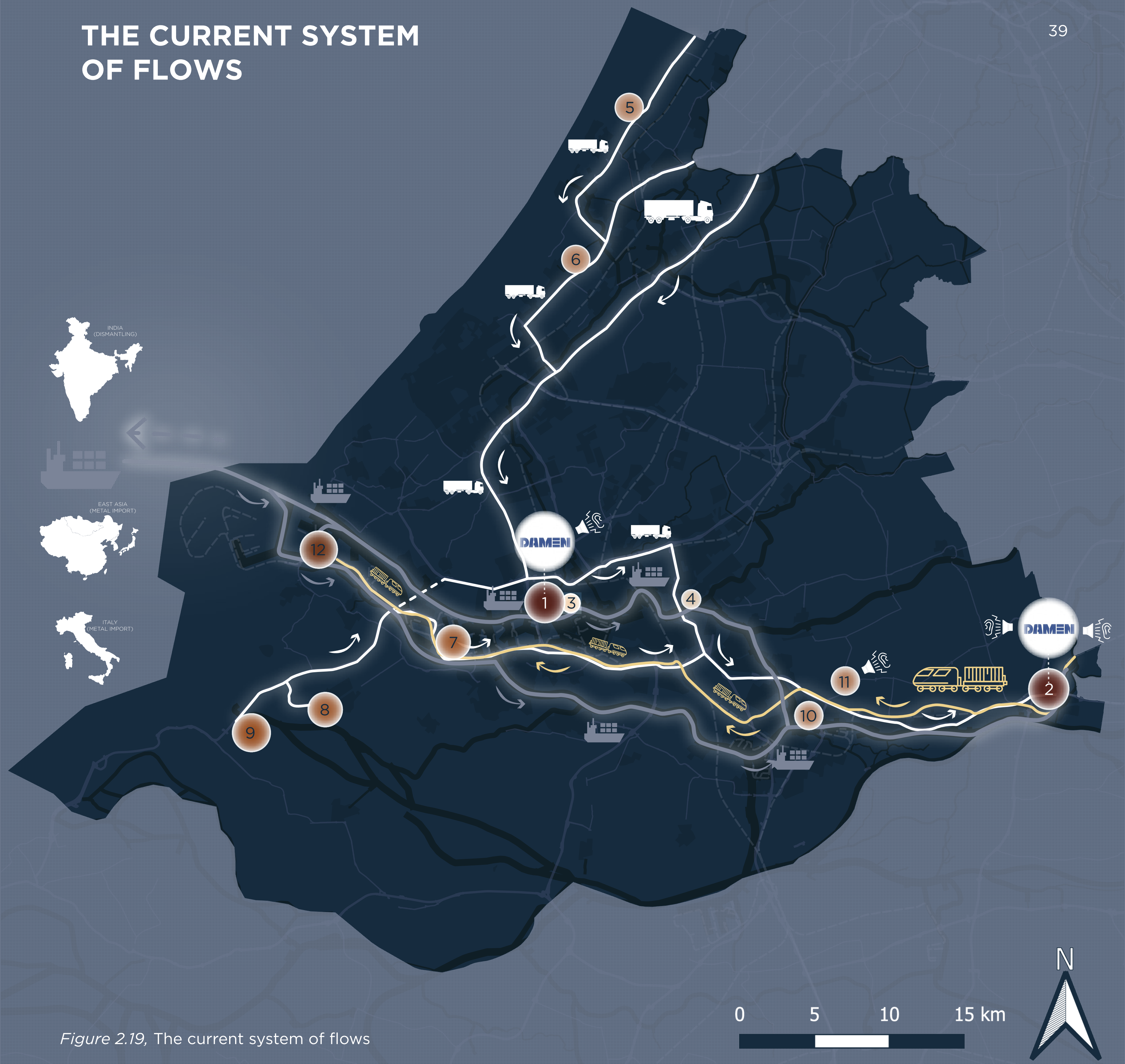


Figure 2.19, The current system of flows

2.5. SWOT-ANALYSIS

Strenghts
The Port of Rotterdam is the largest and busiest port in Europe, including 5 container terminals, more than 40 port basins, and the total length of the terminal shoreline is 37km. There are more than 650 berths, and more than 600 ships can operate at the same time. With more than 4,850 jobs in the shipbuilding industry, it plays an important role worldwide. In addition, the region is rich in educational resources, and both TU Delft and Erasmus university have close links with the Port of Rotterdam. The RDM Innovative Dock is offered as a core place to introduce companies to build knowledge relationship with educational institutions as well. What's more, the port has a competitive, favorable position as a logistics hub and a world-class industrial complex in terms of both sizes and qualities, making it an important share for the Western European market.

Opportunities
As the industry undergoes this transition period, there is an opportunity at the hand to begin raising awareness of considering, and applying circular economy principles across the ship lifecycle. And the port is in the early stages of a transition to a new economy that encourages clean energy, resilient high-tech solutions and radical innovation. In the future, it is possible for the shipbuilding industry to cooperate more widely with stakeholders, especially the large ship manufacturering is very close within the port area, and the circulation of material flow can be linked to different sectors within the area.

Weaknesses
Due to the huge number of ships and the scale, the current ship recycling capacity is obviously insufficient globally. The low transparency and openness of the flow of shipbuilding materials limits the possibilities for circulation, and in the process lacks legislative instruments to support a circular flow system. At the same time, the production process of current ships is not standardized enough, including specific and customized models, so that optimal reuse cannot be achieved.

Threats
The cyclic life cycle of ships is currently not economically attractive to ship owners, and it is common that ships are sold as scrap and dismantled at low cost in India, Pakistan, etc. The European shipbuilding industry is in a fragile competitive position. Meanwhile, there is also a lot of land pressure in the port area due to housing demands, the development of commercial premises, and the process of gentrification, which makes the area less accessible for small manufacturers.

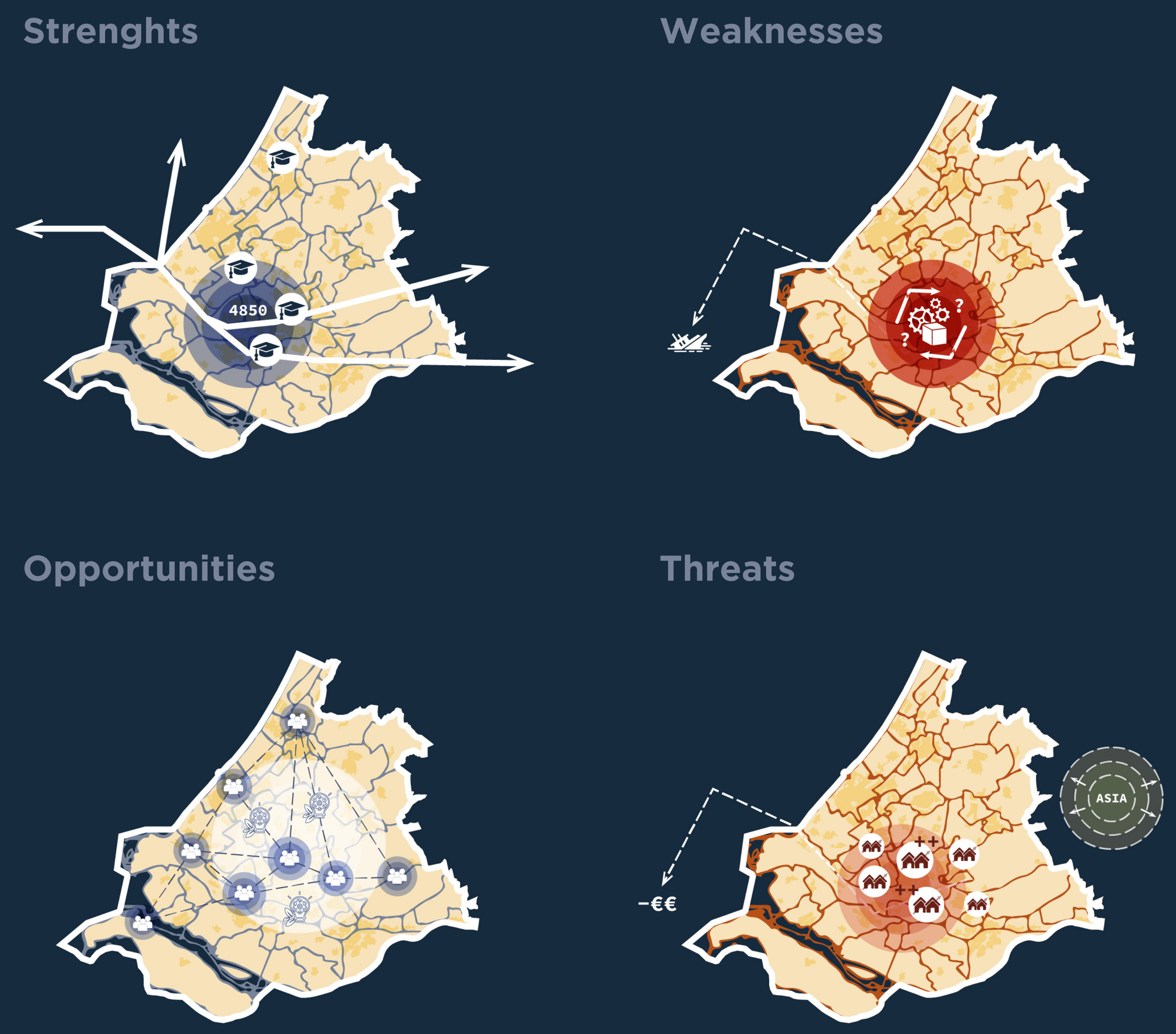


Figure 2.20, SWOT analysis

2.6. CONCLUSION

This chapter shows the significance of ship manufacture to South Holland, the importance of the port of Rotterdam and the material flows running though this business.

Along the waterfront of Rotterdam, maritime clusters are highly concentrated, generating 5% GDP of South Holland. Among maritime industries, ship manufacturing takes a significant position in economic activities of the port of Rotterdam, South Holland Province, and the maritime clusters of the whole Netherlands. In addition, South Holland provides the largest number of occupations in ship manufacturing compared to the whole Netherlands. The employment is mainly located in Katwijk and Rotterdam, which reflects the similar pattern of the footprint of ship manufacturing. The business is especially highly inhabited along the waterfront of Rotterdam, while there are big opportunities to build closer connections with the downtown area. However, at the same time, the spatial distribution of the clusters is facing the threat of land-use pressures.

The two main subdivisions of manufacturing, which are small-boats-making and big-boats-making, result in totally different spatial preferences and geographical identities. The lake and canal network-based ship manufacturing near Katwijk pay more attention to recreational ship use, while railroad and river transport-based ship manufacturing along with Rotterdam waterfronts focus more on big ship making and repair.

The capability and capacity of resource reuse are considered the key standards to assess the sustainability of the circular system of ship manufacturing. However, in the current situation, it is obvious to see the limitations of the sites of ship maintenance, repair and decommission. And they are disconnected with other sectors and industries. Therefore a great exchange is expected from this stage.

A full process of ship-making life cycle includes designing, production, selling, using, and afterward repair and dismantling. This manufacture demands high collaboration and coordination with related industries and services, in which multiple materials flows run all over the regional and global scale. The current ship manufacturing in south Holland is linear and open. Even though ship-making is a complicated process, the systemic section of this business is simple and monopolized. Reflecting on the involved stakeholders, shipowners take the power of controlling the cost and production capacity of the chip manufacturing. The capital-driven mechanism mainly focuses on short-term interests, rather than considering the circular economy as a more far-sighted strategy. The prospect of seeing a circular ship manufacturing system going more locally and independently is the countermeasure to address the social and environmental pressures.

To incent the current ship-making industries, explained with the triangle framework, there is an urgent change calling from civil society, public sectors, and private sectors. Civil societies such as the Labour Union call for a change to a more open and inviting working environment to activate ship manufacturing and better connect with other industries. Private sectors should also transit the business into a more circular way and expand the business to activate the circular ship manufacturing within South Holland. The public sector such as the government should intervene in the material use and systemic system of ship manufacturing to safeguard social and environmental justice.

Context

- Location: highest concentration of ship manufacturing industries of the Netherlands
- Role: a significant factor in the maritime cluster of Rotterdam
- Intensifyng battles related to lands use, and environmental challenges such as climate change

Figure 2.21, Calls for change from analysis

3 VISION: TOWARDS CIRCULAR SHIP MANUFACTURING

3.1. INTRODUCTION

In this third chapter, we present our vision for the province of South Holland. We will give an impression of how circularity in every step of the ship's lifecycle will look spatially.

A vision "is a narrative about a possible and desirable future" (Rocco, 2022, p. 27). So, in this chapter, we elaborate on our proposal for a possible and desirable future for the ship manufacturing cluster in the province of South Holland. We also try to convince the reader that this is a vision they think is possible and desirable and one that they should adopt. This vision draws the lines for the future but is adaptable to changes in the future.

A vision is also "a shared exercise in which diverse voices are heard and given attention to" (Rocco, 2022, p. 22). In this course real interaction with stakeholders was not possible, however, we tried to emphasize with the stakeholders through reading literature and paying special attention to social justice. This vision is therefore not final and can be changed and adapted by others.

Through design testing and based on our conclusions from the analysis we will attempt to answer the sub-question for this chapter: how to spatially transition ship manufacturing into a more circular and sustainable cycle in terms of environmental and social justice in South Holland? To answer this question we need to know two things, what measures need to be taken to make the ship manufacturing industry more circular and how can these measures be spatialized in the province of South Holland. All while trying to make a positive impact on environmental and spatial justice. To demonstrate the changes necessary we adapted both the systemic section and the flow map to a desired and realistic future. Here we do not yet show the measures we need but rather the desired spatial relations and arrangements in the province. After that, the vision map and the breakdown of it will explain the measures taken and how they can be spatially implemented. This will lead to six actions and a strategy that will be elaborated on in the next chapter.

3.2. NEW PROCESS

3.2.1. Systemic section

Adopting circular economy principles requires a systemic shift in thinking. Instead of optimizing individual parts of a system, the system must be acknowledged in its entirety. In practice, this means considering the implications of a decision to other stakeholders and activities within the system and connecting them to the broader natural and social systems that maintain it. As a result, we implemented more sectors into the ship's lifecycle as our new focus.

Collaboration with education
It is not easy to give students a good grasp of all the issues that affect the success and the failure of companies in the shipbuilding business. The Dutch shipbuilding industry is internationally oriented and very cyclic, meanwhile, the demand for a skilled shipbuilding labor force has therefore increased rapidly. Collaborating with maritime education can provide a more stable source of labor for the shipbuilding industry and make jobs more attractive to the younger generation. What's more, higher education provides fertile ground for the development of new technologies in ship manufacturing.

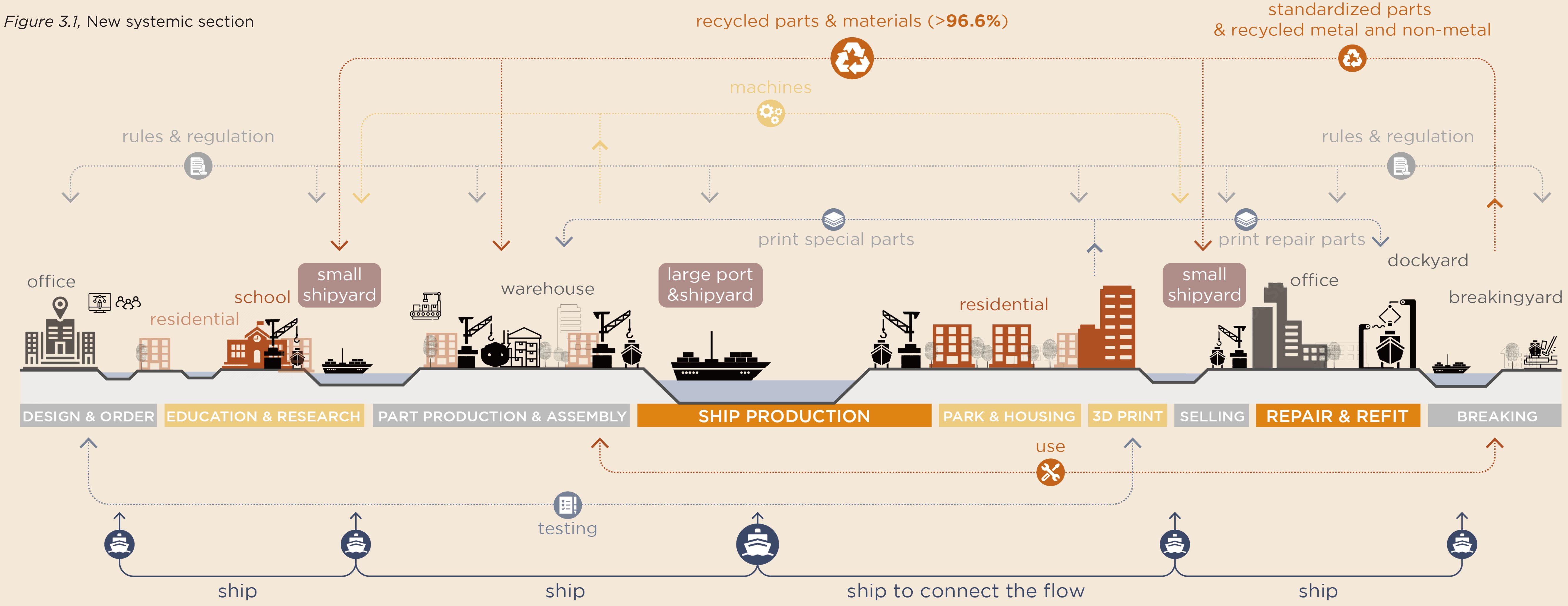
Innovation in technology-3D printing
The adoption of 3D printing technology in shipbuilding is one of the major trends being witnessed in the global market. 3D printing is a computer-controlled process in which materials are layered consecutively to form objects. Since the application of this technology especially in shipbuilding and repairing can bring new approaches for manufacturing an accurate replacement of parts and even a voluminous number of ship components, the shipbuilding industry is increasingly adopting this 3D printing technology to improve efficiencies and quality of the manufactured part. For example, one of the main applications of 3D printing in the shipbuilding industry is a technique called Direct Metal Laser Sintering (DMLS), which is an additive manufacturing process that uses a laser as a power source to sinter powdered metal in the space defined by a 3D model.

Mixed function pattern
Mixing ship manufacturing with complementary functions and activities on various scales creates conditions for efficient workflows and provides opportunities for resource and knowledge synergies through cross-sectoral innovation. The mix of land use for education, housing, urban parks, and shipbuilding improves land-use efficiency, maximizes collaboration between different sectors, and brings new technology, labor, and resources to every stage of the shipbuilding lifecycle.

Bring shipbreaking back
Working to increase awareness of circularity in the maritime sector as a way to reduce shipping's carbon footprint. With a mature ship recycling industry, the basic foundations for a circular economy for steel in ships already exist. Therefore, the shipbreaking industry must bring part of it back to the port of Rotterdam as the last link in the ship's lifecycle. It helps localize the economy especially material flows, making ship manufacturing less dependent on global business. However, greater transparency and traceability of all recycled materials from shipbreaking is a necessity, not only to enable circularity but to make recycling safer and more environmentally friendly.

Fundamental change is needed to transform the shipping industry and the material flows within it. Although such a change requires time, a bold vision can help distinguish between the current line of thinking and the radically different view of a circular economy. Incorporating circular economy principles needs to start in the design stage, challenging all the related sectors to include options to refurbish, rethink and reduce ship parts.

Figure 3.1, New systemic section



3.2.2. Future flows

To spatialize the predicted future production process of a seagoing ship we performed a case study on the Damen shipyard group in South Holland. Important to note is that this process is our best estimation based on readings, data and logic. The suppliers may not be Damen's real suppliers, but it provides a good insight into the flows of materials.

The decommissioning site has been expanded and provides most of the metal and standardized parts for the ship manufacturer. The metal and parts are transported along the Muse by autonomous ships. At the production site the new ship will be assembled with less nuisance and pollution. Special parts are 3D-printed in close proximity and the few other materials needed are all brought to the shipyard using autonomous ships as a sustainable transportation method.

During its lifecycle the ship will be repaired several times at Damen Schiedam. Here parts from the decommissioning site are used or replacement parts are 3D-printed. At the end of a ship's life it will be decommissioned in the province of South Holland. Most parts will be reused or recycled either in the ship building sector or in related downstream sectors. This way flows are more circular and local than before.

1. SHIP DECOMMISSION-ING (DAMEN)
2. SHIP REPAIR (DAMEN)
3. MANUFACTURING (DAMEN)
4. MANUFACTURING OF PAINT
5. 3D-PRINTING LOCATION
6. MANUFACTURING OF ENGINE
7. 3D-PRINTING LOCATION FOR SCREWS & INTERIOR
8. RELATED SECTORS TO SHARE EMPLOYEES OR MACHINERY
9. EUDCATION
10. DESIGN OF SHIP

THE FUTURE SYSTEM OF FLOWS

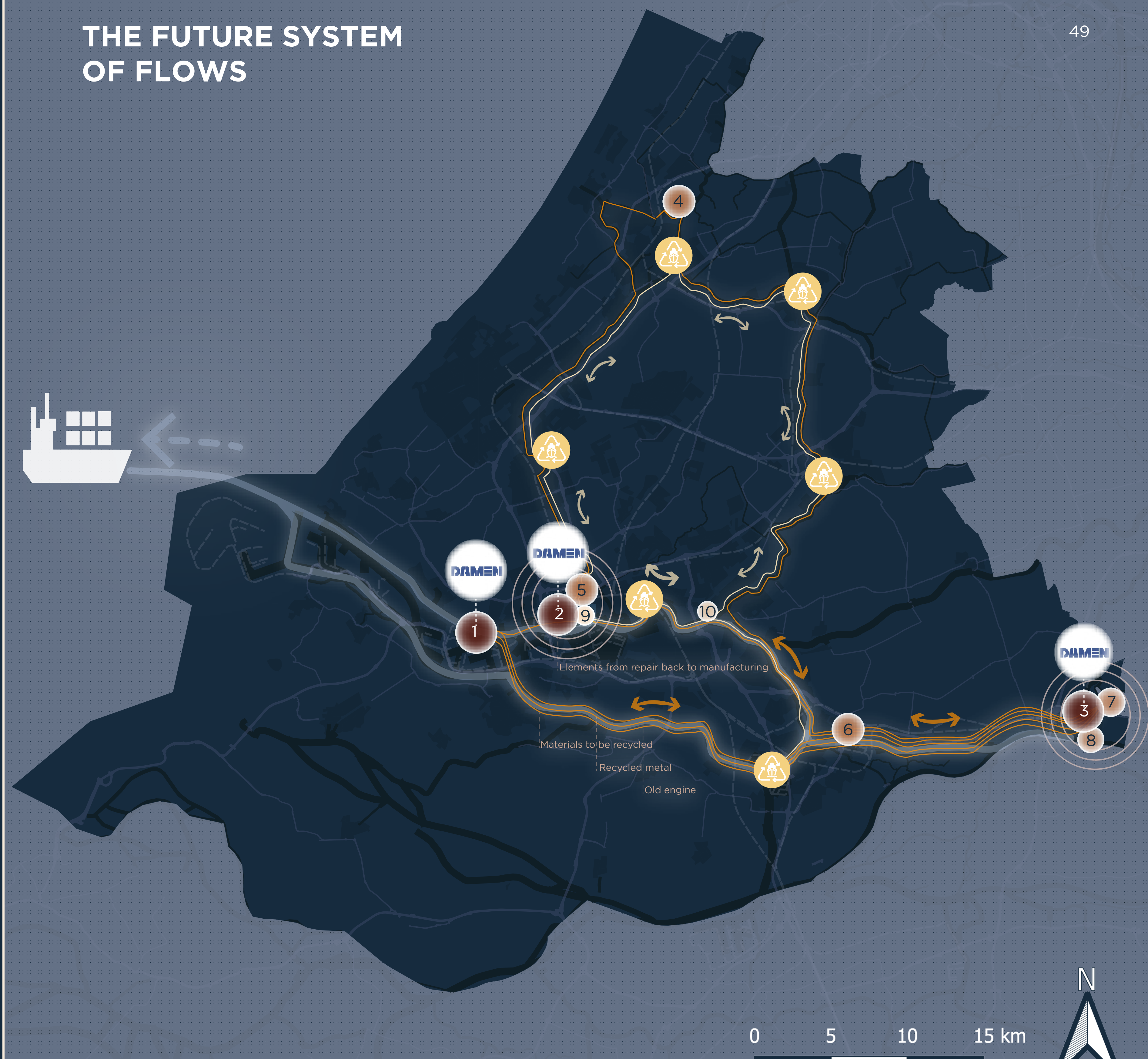


Figure 3.2, The future system of flows

3.3. VISION STATEMENT

For the province of South Holland, we have developed a spatial vision toward more circular ship manufacturing in the region. This is visualized on the right page. Below we will explain our general vision statement before we break it down in the coming pages.

Vision statement
In 2050, the province of South Holland will be a world-leading example demonstrating a more circular ship manufacturing sector in the port of Rotterdam, in order to mitigate the effects of climate change and resource scarcity. The vulnerable ship manufacturing in the region will be safeguarded in symbiosis with resilience, innovation, collaboration, and transparency. This will all happen in a way that is socially, spatially and ecologically just.

This will be achieved by creating an urban environment in which the ship manufacturing sector is embedded. Within this urban environment edges are smartly redefined and softened where possible, by synergizing the relation between living and making, especially in pressured areas. In these areas, waterfronts are smartly configured by providing private access where needed, and qualitative public space where possible.

A shift in skills and education and the way manufacturing is represented in the urban environment, will contribute to a more open and attractive work environment. A renewed spatial system will be implemented, which will make use of a long-term circulation of resources and 3D-printed parts, in which resource flows are well-connected by sustainable transport such as (autonomous) ships. This spatial transition will be guided by a regulatory (spatial) framework to establish a better port-city relationship.

Explaining the how
We will realize our vision by creating an urban environment in which the ship manufacturing sector is embedded. This is necessary to be able to safeguard the sector in highly pressured areas. To embed ship manufacturing better, edges in these areas ask to be smartly redefined and softened where possible, by synergizing the relation between living and making. This requires a precise zoning plan, where heavy industries that cannot be mixed will have to be organized in clusters of similar nuisances. Lighter industries can play an important role in transition zones, where a new typology is introduced to allow manufacturing, other industries, and living to coexist.

To optimize the production process within the ship manufacturing sector, complementary industries can be mixed to promote innovation and an efficient manner of sharing and managing staff, knowledge, resources, and machinery. An example would be 3D-printing facilities near manufacturing sites and/or educational institutions. These 3D-printing facilities can produce special or repair parts quickly and with less waste and noise. Close collaboration with industries that are essential in the provision of materials and energy, such as the metal industry will also help to be more efficient and close loops. All stakeholders will be part of a long-term circulation of resources, where resources stay in the loop as long as possible and loop back as often as possible. As an example, repaired standardized parts can flow back into the manufacturing process and used elements can benefit downstream industries.

This will all be part of a renewed spatial system, where resource flows are well connected by sustainable transport such as (autonomous) ships. This will mainly be used in an extended network of waterways, which reach into inner cities and utilizes dominant waterways that spread all over the province. The canals in the inner cities can transport waste from the cities to be recycled or reused, while the larger waterways will be able to transport industrial elements from one place to another wherever in the life cycle.

When all parts of this new system are implemented, it will establish a better port-city relationship, guided by a regulatory (spatial) framework.

Visionmap

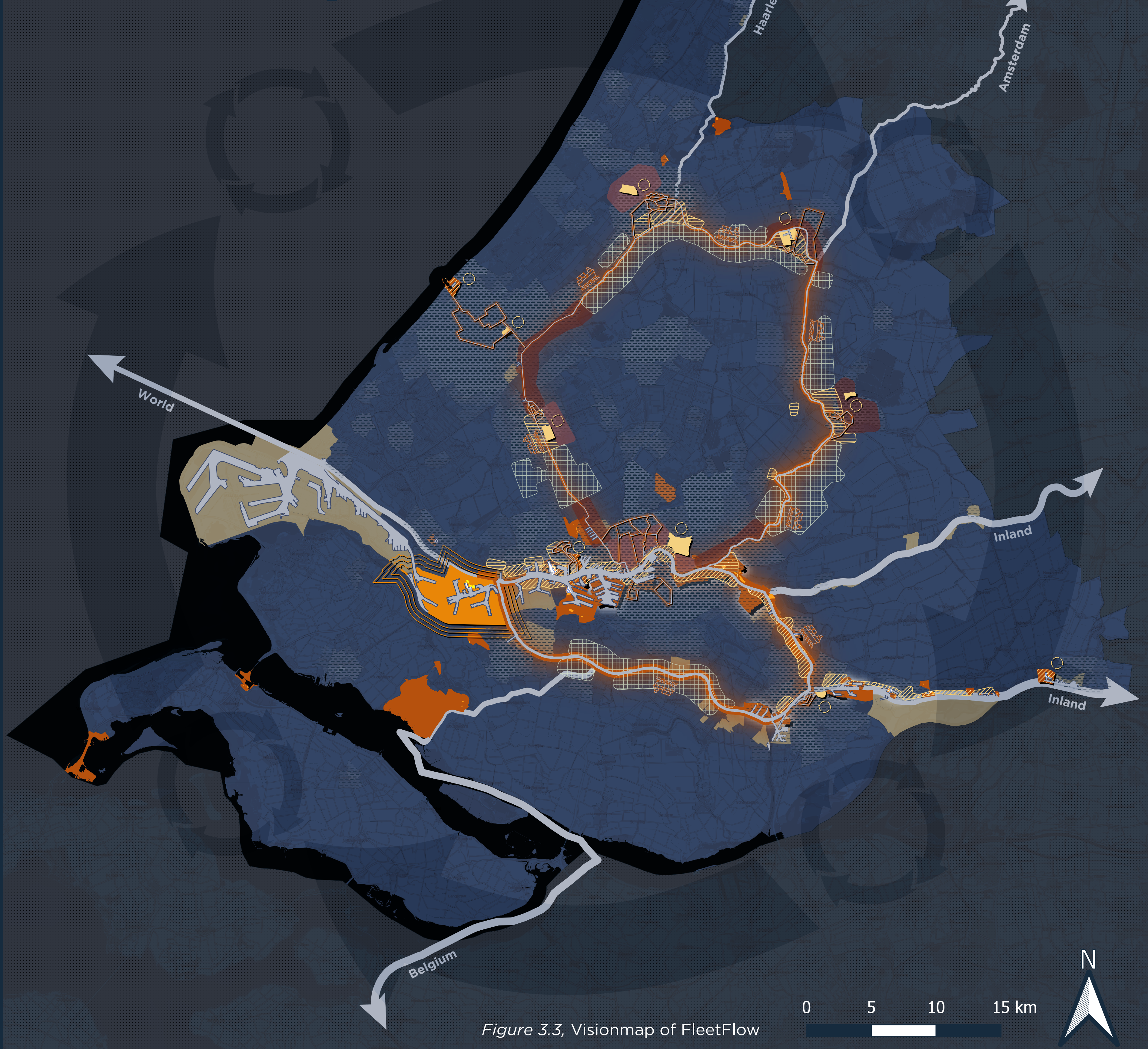


Figure 3.3, Visionmap of FleetFlow

3.4. VISION BREAKDOWN

3.4.1. Safeguarding ship manufacturing

In the next pages, we will break down our vision, starting with safeguarding the ship manufacturing sector. The vulnerable ship manufacturing in the region will be safeguarded in symbiosis with resilience, innovation, collaboration, and transparency.

The ship manufacturing sector is under a lot of pressure, especially by housing development at the edges of the cities. In Amsterdam, big ship manufacturers have to leave the harbor to make space for residential buildings (NH-nieuws, 2021). In South Holland, we do not want this to happen, because of the economic value, cultural importance, industrial resilience, and vital knowledge of the ship manufacturing industry.

The dark orange spots on the map on the right page are the neighborhoods in which one or more ship manufacturers with over ten employees are located, as discovered during our analysis. These locations need to be safeguarded, however not all locations are under the same amount of pressure. The locations which are under the most pressure will be highlighted on the next page. The light orange spot represents the only large ship decommissioning site in the region. We expect this sub-sector to grow as more and more ships are at the end of their lifecycle (Hoezen & van 't Hoff, 2021). Now decommissioning and recycling happen for a large part in Asia (Hoezen & van 't Hoff, 2021). In a circular economy, this should happen closer to where the ships are produced and where parts can be reused.

To safeguard the ship manufacturers they have to adapt to the circular economy. This will be done by innovating the production, repair, and decommissioning process, by better collaboration between education, the maritime cluster and related industries, and by more transparent flows of materials that improve the chances of reuse and recycling. This will all contribute to a shipbuilding sector that is more resilient and worth keeping.

Vision statement

In 2050, the province of South Holland will be a world-leading example demonstrating a more circular ship manufacturing sector in the port of Rotterdam, in order to mitigate the effects of climate change and resource scarcity. The ***vulnerable ship manufacturing in the region will be safeguarded*** *in symbiosis with resilience, innovation, collaboration, and transparency. This will all happen in a way that is socially, spatially and ecologically just.*

This will be achieved by creating an urban environment in which the ship manufacturing sector is embedded. Within this urban environment edges are smartly redefined and softened where possible, by synergizing the relation between living and making, especially in pressured areas. In these areas, waterfronts are smartly configured by providing private access where needed, and qualitative public space where possible.

A shift in skills and education and the way manufacturing is represented in the urban environment, will contribute to a more open and attractive work environment. A renewed spatial system will be implemented, which will make use of a long-term circulation of resources and 3D-printed parts, in which resource flows are well-connected by sustainable transport such as (autonomous) ships. This spatial transition will be guided by a regulatory (spatial) framework to establish a better port-city relationship.

Visionmap

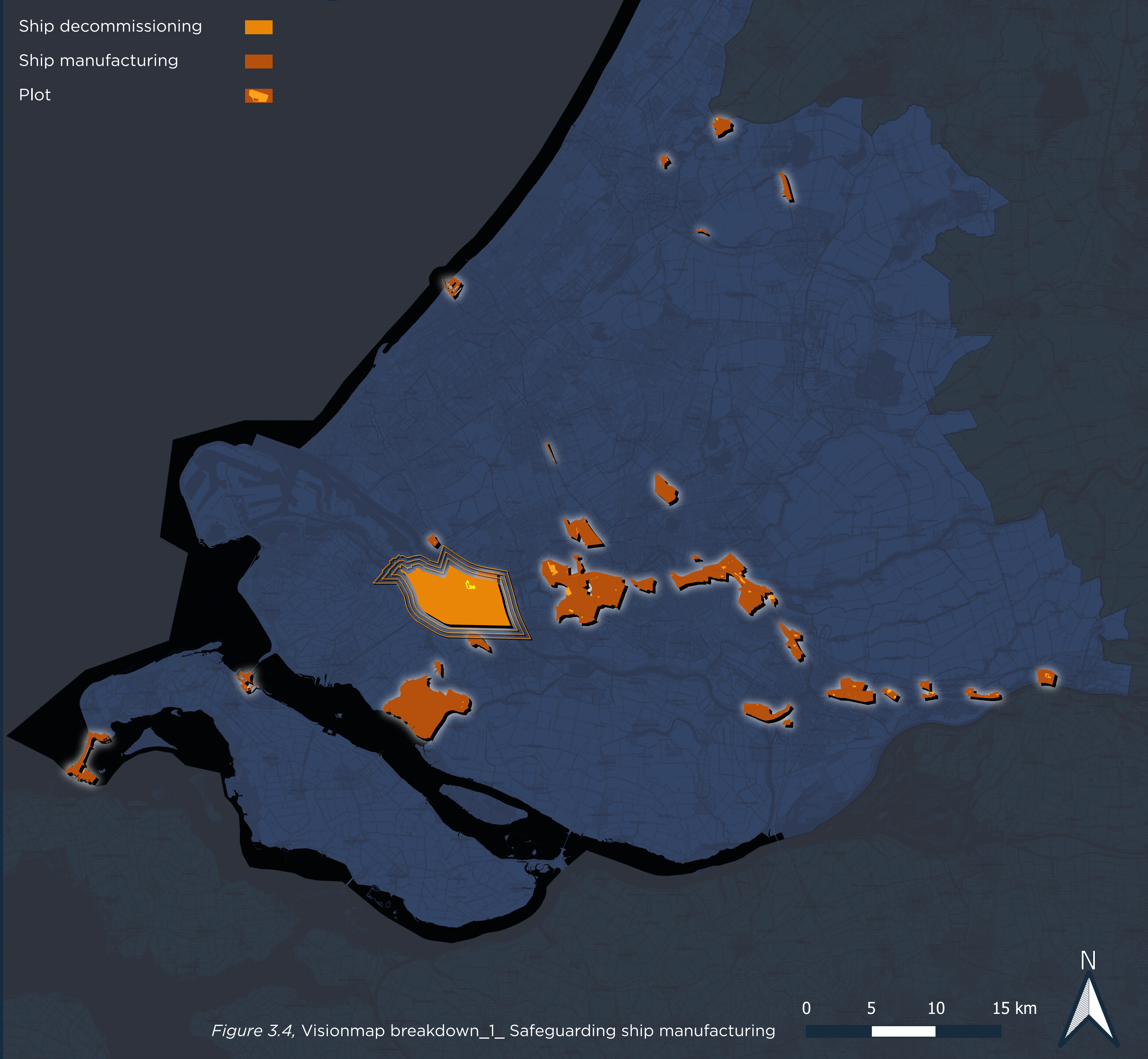


Figure 3.4, Visionmap breakdown_1_ Safeguarding ship manufacturing

3.4.2. Synergizing living and making

Urban areas in South Holland are expanding, as shown in the map on the right, and therefore threatening spaces at the edges of cities where a lot of manufacturing is situated, as discovered during our plot analysis. In our vision, we propose an urban environment in which the ship manufacturing sector is embedded. Within this urban environment edges are smartly redefined and softened where possible, by synergizing the relation between living and making.

The edges between living and making are currently quite rigid. To soften the transition and create space for both living and making without one being pushed away completely, a precise zoning plan is required. Lighter industries, with less pollution and lower nuisances, can play an important role in transition zones, where we propose new typologies to allow (ship) manufacturing, other industries, and living to coexist. What these typologies look like and how a transition could be regulated will be explained in the strategy by using strategic examples and patterns.

The synergy between living and making and between public and private waterfronts is relevant, especially in pressured areas. These areas are highlighted on the map on the right page. In these highlighted neighborhoods ship manufacturing fights for valuable land with housing developments.

Here it is most important to redefine the edges and implement the vision well. If a better synergy and a possibly better mix are not achieved in these locations, eighter (ship) manufacturing is pushed away or the housing pressure builds up further. In these locations, it is a fine balance between safeguarding and mixing.

All locations are different and therefore require a different new typology where living and making can coexist. In the strategy part of this report, we will look at four different key locations and how they deal with the balance and the pressure.

Vision statement

In 2050, the province of South Holland will be a world-leading example demonstrating a more circular ship manufacturing sector in the port of Rotterdam, in order to mitigate the effects of climate change and resource scarcity. The vulnerable ship manufacturing in the region will be safeguarded in symbiosis with resilience, innovation, collaboration, and transparency. This will all happen in a way that is socially, spatially and ecologically just.

This will be achieved by creating an urban environment in which the ship manufacturing sector is embedded. Within this urban environment edges are smartly redefined and softened where possible, by ***synergizing the relation between living and making****, especially in pressured areas. In these areas, waterfronts are smartly configured by providing private access where needed, and qualitative public space where possible.*

A shift in skills and education and the way manufacturing is represented in the urban environment, will contribute to a more open and attractive work environment. A renewed spatial system will be implemented, which will make use of a long-term circulation of resources and 3D-printed parts, in which resource flows are well-connected by sustainable transport such as (autonomous) ships. This spatial transition will be guided by a regulatory (spatial) framework to establish a better port-city relationship.

Visionmap

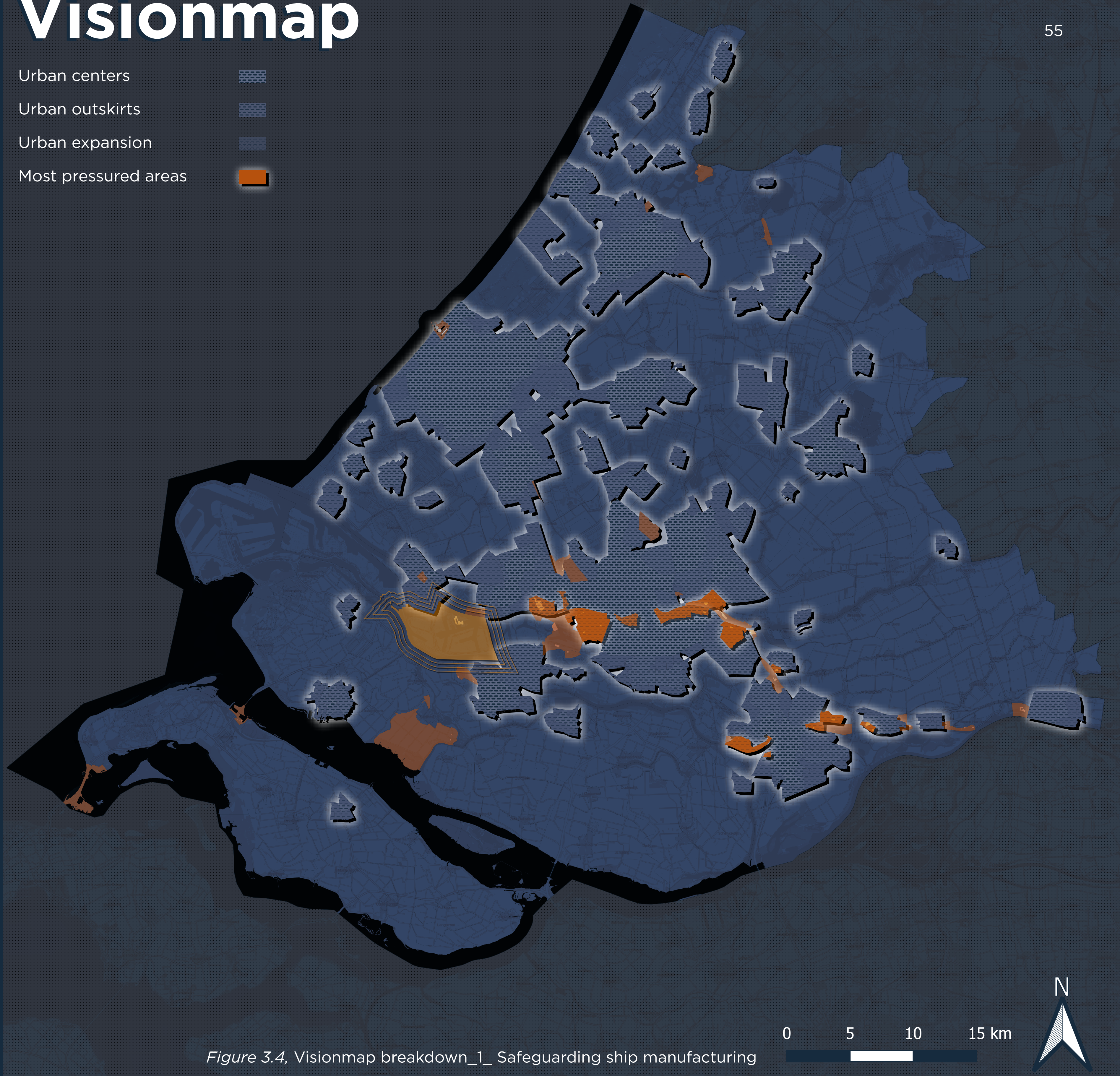


Figure 3.4, Visionmap breakdown_1_ Safeguarding ship manufacturing

3.4.3. Smartly configuring waterfronts

The edges of the waterfronts play a key role in the transition towards a more embedded ship manufacturing industry. In the current situation waterfronts are intensively used by ship manufactures. In the new urban environment, we strive to synergize the relationship between public and private waterfronts.

A waterfront that is open to the public and invitingly designed would improve the transparency of the manufacturing industry connected to this waterfront. A complete public waterfront sounds like a great solution to soften the line between living and making. This is however not feasible as many manufacturing companies use the waterfront edge to transport goods from the water to land and vice versa. According to our vision, shown later, transport of goods by water will only increase. Therefore smart decisions have to be made about where a public waterfront is desired and possible and where a private waterfront has the preference. In general, we propose the following rule of thumb: harbor edges will be more private in areas where the making industry needs efficient transport and more public where housing or mixed-use areas are located. This general principle is shown on the map on the right page.

Rotterdam has a lot of waterfronts with all different identities. In the smaller map on this page, a main framework of edges is suggested for this area. When we design our key locations we will design and differentiate the waterfronts more specifically.

Vision statement

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— Public waterfronts, • • • Private waterfronts
Figure 3.6, Map showing public and private waterfronts around Rotterdam.

Visionmap

Figure 3.7, Visionmap breakdown_3_ Smartly configuring waterfronts

3.4.4. Creating long-term circulation

3D-printing is an important part of our vision. Our proposed renewed spatial system will make use of a long-term circulation of resources and 3D-printed parts. 3D-printing can replace the isolated current production process, as demonstrated previously in the systemic section, as a spatially better-integrated solution.

Most parts will be standardized and are therefore suitable for long-term circulation as they can be recovered from old ships and used in new ones. However, not all parts can be standardized. Therefore we propose the use of large scale 3D-printing for special parts and repair parts. These 3D-printed parts can be produced locally and with less waste and less noise.

The 3D-printing technology is rapidly evolving, the printing of large metal parts is still a challenge right now but will be expected to be more accessible in the future. To stimulate progress in this technology we recommend locating a part of these 3D-printing facilities close to educational institutes. This will help with the transfer of knowledge. Other facilities are strategically located close to ship manufacturers, making sure that parts can be provided fast and efficiently. The best locations for large scale 3D-printing are where there are both educational institutes and ship manufacturers nearby. All locations we propose for these facilities are shown on the map on the right page.

The large-scale 3D printing facilities are there not only for the ship maritime cluster but can also provide parts for other sectors like construction, automotive, etc. A large-scale 3D-printing facility is therefore a welcome addition for each makers space or industrial park that wants to become more circular.

Vision statement

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A shift in skills and education and the way manufacturing is represented in the urban environment, will contribute to a more open and attractive work environment. A renewed spatial system will be implemented, which will make use of ***a long-term circulation of resources and 3D-printed parts****, in which resource flows are well-connected by sustainable transport such as (autonomous) ships. This spatial transition will be guided by a regulatory (spatial) framework to establish a better port-city relationship.*

Visionmap

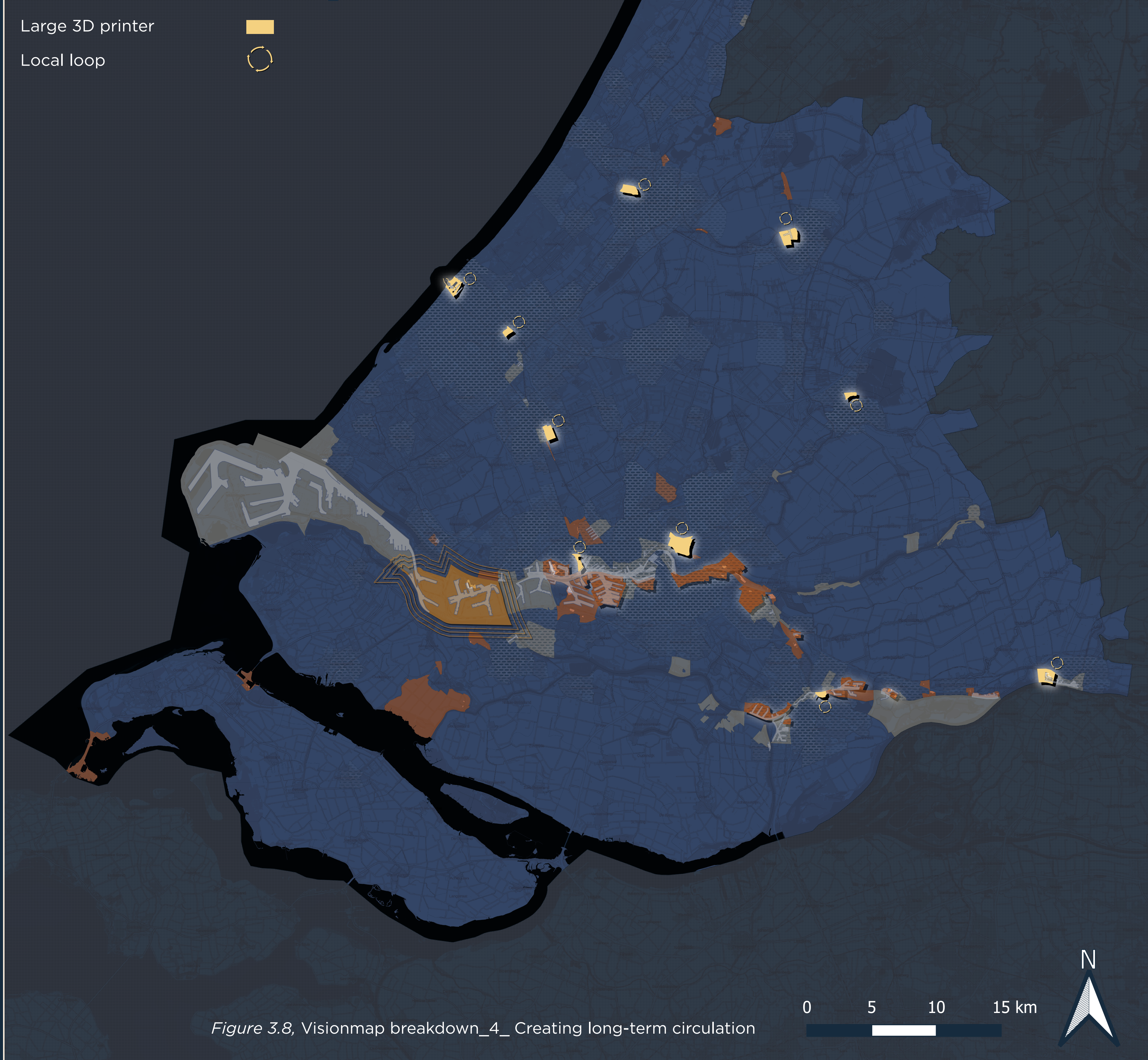

Figure 3.8, Visionmap breakdown_4_ Creating long-term circulation

3.4.5. Connecting by sustainable transport

All previously discussed parts of our vision will need to be connected in a circular way. In our renewed spatial system, resource flows are well-connected by sustainable transport such as (autonomous) ships. This new way of transport makes use of the already existing water infrastructure, which connects already to most ship manufacturers, as discovered during our analysis. This existing infrastructure will be extended to connect more places and allow higher capacities. The canals in the inner cities can transport waste from the cities to be recycled or reused, while the larger waterways will be able to transport industrial elements from one place to another wherever in the life cycle. This way of transport is more sustainable than the trucks that are currently used and does not cause congestion on roads.

The (autonomous) ships will connect upstream and downstream flows within the province of South Holland, but they can also use the waterways to connect to the North Sea and other important industry areas such as Antwerp and the Ruhr Area. For this new sustainable mode of transport new kinds of ships need to be built or refitted. The company Roboat has developed a small boat that can collect waste in cities and also transport small parcels or people. For larger transports, a different kind of ship is required. Existing shipyards might be able to produce a part of this new fleet, especially the larger ships. The Roboats however are very different and need their own production facility. In the strategy chapter, we suggest a location where this could happen and where the new production can benefit from the existing cluster and its knowledge.

Related to this improved infrastructure are new identities that can benefit from it. This is not only the maritime cluster but also other industries that can benefit from water transport. The improved waterways also create new urban and natural identities where there is no industry. The water and the waterfronts will be used more for recreational purposes in these areas. So, the water infrastructure is not just a transport line but also has it effect on what happens on the quays and beyond.

Vision statement

In 2050, the province of South Holland will be a world-leading example demonstrating a more circular ship manufacturing sector in the port of Rotterdam, in order to mitigate the effects of climate change and resource scarcity. The vulnerable ship manufacturing in the region will be safeguarded in symbiosis with resilience, innovation, collaboration, and transparency. This will all happen in a way that is socially, spatially and ecologically just.

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Visionmap

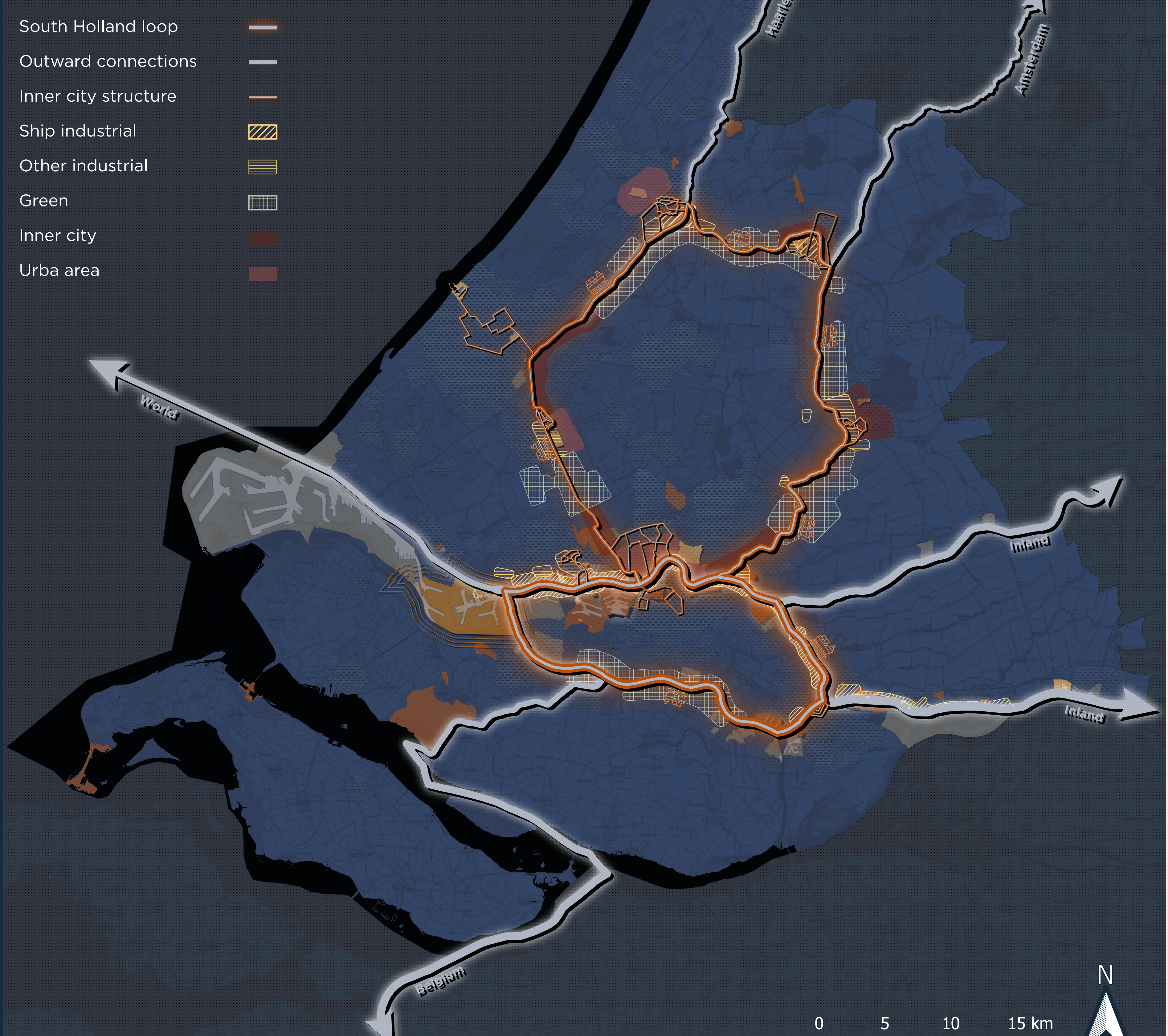

Figure 3.9, Visionmap breakdown_5_ Connecting by sustainable transport

3.4.6. Providing attractive jobs

In our vision the ship manufacturing cluster expands and localizes, especially the decommissioning of ships will grow substantially. This will lead to an increase in jobs in a sector where it is already hard to find skilled employees. Moreover, the technological innovations we envision require new skills. Together this creates a challenge to find and educate suitable employees. Solving this gap in job supply and demand is vital for the succes of this project, without people no transition.

A transition towards circular jobs is the most important action to make jobs and education more attractive. According to research by Circle Economy and Ehero (2020, p.4) "has the circular economy the potential to provide fulfilling jobs for an exponentially growing population in a shifting economy". By making the transition toward a circular economy with circular jobs, cities attract innovative businesses and stimulate existing ones to transition. At the same time this empowers the citizens by providing well paying jobs for high and low educated employees in a livable and healthy environment.

"A circular job is any full or part-time occupation that directly involves one of the elements of the circular economy or indirectly supports such activities" (Circle Economy and Ehero, 2020, p.4). What these jobs look like in the ship manufacturing cluster is show in the diagram on the right.

Other strategies to make jobs and education more attractive will be explained in the strategy chapter.

Figure 3.10, Map showing higher educations related to visionmap

Vision statement

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This will be achieved by creating an urban environment in which the ship manufacturing sector is embedded. Within this urban environment edges are smartly redefined and softened where possible, by synergizing the relation between living and making, especially in pressured areas. In these areas, waterfronts are smartly configured by providing private access where needed, and qualitative public space where possible.

A shift in skills and education and the way manufacturing is represented in the urban environment, will contribute to ***a more open and attractive work environment****. A renewed spatial system will be implemented, which will make use of a long-term circulation of resources and 3D-printed parts, in which resource flows are well-connected by sustainable transport such as (autonomous) ships. This spatial transition will be guided by a regulatory (spatial) framework to establish a better port-city relationship.*

DIRECTLY CIRCULAR JOBS IN SHIP MANUFACTURING

ENABLING JOBS

Director of a Trade Association

The director of a trade association manages a membership organisation composed of multiple companies within the maritime industry. The director can support the circular economy by encouraging greater collaboration, knowledge sharing, and networking between companies. As such, the director can employ the 'collaborate to create joint value' strategy in order to contribute to the circular economy.

Nautical architect

The nautical architect is responsible for designing ships and by extension for the materials used during a ships manufactiring, its energy efficiency during the use phase and the potential for material recovery when it is decommissioned. An nautical architect can thus contribute to the circular economy by 'designing for the future'.

Data Analyst

The data analyst makes sense of large amounts of information by means varying from simple data aggregation to complex data mining. The data analyst's occupation involves the 'incorporate digital technology' strategy and thus allows for smart systems and technology integration in the circular economy. This job often requires tertiary education in relatively new fields of data science and computer engineering.

CORE JOBS

Solar Panel Installer

The solar panel installer works within the energy sector to promote the use of solar as a renewable energy source, also on the roofs of shipyards. The job contributes to the circular economy by 'prioritising regenerative resources', the first strategy of the circular economy.

Repair Technician

The repair technician contributes to the circular economy by extending the lifetime of ships. By embodying one of the strategies of the circular economy, 'to preserve and extend what's already made', all repair and maintenance jobs are considered circular.

Recycling Operative

The recycling operative's job consists of sorting the recyclable parts of decommissioned ships and separating standerdized parts to be reused. This sorting and separating constitutes an essential element in the recycling process, which involves the 'use waste as a resource' strategy, and thus presents itself a circular job. Day to day activities of the recycling operative include physical labour and machine handling such as forklift driving.

Leasing Process Manager

The leasing process manager is responsible for the coordination of the external service partners distributed across market segments. By contributing to the workings of a ship as a service model, the leasing process manager contributes to the circular economy through the 'rethinking the business model' strategy.

3.5. CONCLUSIONS

This third chapter presented our vision for the province of South Holland. It gave an impression of how circularity in every step of the ship's lifecycle will look spatially.

In this chapter, our vision has been broken down into six main actions. With this knowledge, we can now answer the sub-question: how to spatially transition ship manufacturing into a more circular and sustainable cycle in terms of environmental and social justice in South Holland?

This vision helps the transition towards a more circular ship manufacturing cluster by safeguarding the vital and vulnerable ship manufacturing while also expanding the decommissioning site, implementing large-scale 3D-printing technologies, and improving the water network for sustainable transport. Safeguarding manufacturing is essential for industrial resilience but also makes the Netherlands and Europe less reliant on Asia. Expanding the decommissioning site supports this by keeping materials as long as possible in the loop and therefore being less reliant on new raw materials from global market. 3D-printing parts contribute to circularity as it uses less material and can be produced close to where it is needed. When we connect these elements by a sustainable transport network like the waterways we have successfully transited towards a more circular ship manufacturing cluster.

Our vision aims to improve environmental justice by reducing the need for raw materials. The expansion of the decommissioning site will recover more materials locally and the 3D-printing of parts produces less material waste than conventional methods. Together with the introduction of standardized parts and a sustainable transport network, we limit the impact of ship manufacturing on the environment.

Social justice is improved by our vision because safeguarding vulnerable making prevents jobs from being lost for employees with lower education but a lot of hands-on skills, these people could have trouble finding a job in an economy without local industry. Focusing on circular jobs guarantees that these jobs will not disappear soon and make them more attractive for young and female students.

Spatial justice is about sharing burdens and benefits evenly. Our vision contributes to that by mixing where possible in pressured areas near the cities. To make sure that not only the companies benefit from the proximity to employees and to make sure that not only residents have the burden of pollution and nuisance, special attention needs to be paid to transition zones. What solutions we propose will be discussed in the next chapter. 3D-printing also benefits spatial justice as it produces lees burdens like noise and pollution compared to conventional ways of part production. Moreover, it creates more benefits because 3D-printing is flexible and can therefore be used by more companies and people by putting into large volume production.

On the right page, there are two collages both spatially representing a different part of our vision. The top collage shows a mixed-use area where a new typology is introduced to blend living, education, and making. All organized around the water where people can walk and sit and where smaller ships can transport for example plastic waste and 3D-printed parts. The bottom collage shows an area further away from the city that is specialized in the decommissioning and dismantling of ships. The experience is more industrial and separated. The connection with the water allows for transportation of the dismounted standardized parts towards the ship manufacturers where they can be reused. These collages are just a way to conclude our vision, in the next chapter we will explain what key locations could look like.

Figure 3.11 collage of vision_Manufacturing & Mixuse & 3D-printing

Figure 3.12, collage of vision_Manufacturing & Decommissioning & Waterflow

4 STRATEGY: IMPLEMENTING CIRCULAR SHIP MANUFACTURING

4.1. INTRODUCTION

In this chapter, the strategies have been developed to concretize this vision in more specific and spatial ways. The chapter begins with six main actions that are extracted from the main vision: *1) Safeguarding vulnerable ship manufacturing; 2) Synergizing living and making in pressured areas; 3) Smartly configuring public and private waterfronts; 4) Creating a long-term circulation of resources and 3D-printed parts; 5) Connecting resource flows by sustainable transport; 6) Providing an open and attractive work environment.* After adressing the main actions, it's illustrated that all actions are applied differently to specific locations, depending on their specific characteristics.

To fulfill these actions in different locations, we firstly set up a regional system of flows clarifying their division and cooperation. For the complete transformation process, a general timeline and stakeholder engagement matrix are defined. After the general implementation strategy is made clear, we zoom into smaller scales by implementing the vision on the key locations. By doing this, we build the bridge from general strategy to specific redesign for better understanding.

Then, the Patterns developed by the Cities of Making are explained as they were for great use in the development of our project. To add to the already excisting Patterns, we have created our own expansion pack. In four strategic key locations the use of these Patterns will be visualized.

As mentioned above, four key locations have been selected for further elaboration: 1) shipbuilding in Gorinchem; 2) ship repair in Schiedam; 3) decommissioning in Botlek; 4) 3D-printing in Delft. Each location will be explained in regional scale, current situation, usage of Patterns, a redesign map, timeline, local stakeholders and collages.

4.2. MAIN ACTIONS

The previous chapter has broken down the general vision into six main actions. These six main actions articulate the general actions that we advise to be undertaken in the province. However, translating these actions into a design asks for a more location-specific approach. This is because each location that is in some way related to the shipbuilding industry of South Holland, is characterized by a different urban setting and/or a different industrial context. In the following text, the application of the main actions will be briefly described.

Gorinchem, ship building
The main action for the shipbuilding industry of Gorinchem will be providing an open and attractive work environment, which is based on various local characteristics. For example, the work environment can be related to the already present Damen Academy. Secondly, the positioning of the shipbuilding site in between the historic city center and green areas, comes with a high potential for making the spatial appearance more attractive. In this location, the current shipbuilding industry is safeguarded and expanded. However, the intensity of this action is less strong for this location compared to for example Schiedam, where a more intense pressure on land is experienced.

Schiedam, ship repair
The location of Schiedam integrates all six main actions, which is mainly because this highly urban area comes with a high pressure on land. This asks for strongly safeguarding the industry, and defining a new relation between living and making, and public and private land. Connecting resource flows by sustainable transport serves a less dominant role here, as this location carries out a strong synergy of functions on the mainland.

Botlek, ship decommissioning
In contradiction to Schiedam, Botlek integrates the least main actions. This is because the industrial identity of the area is mostly preserved due to the required expansion of recycling. As Botlek is a highly segregated, island-like area, sustainable transport is strongly utilized here.

Delft, 3D-printing
Delft focuses on synergizing living and making, as the Schieoevers lie close to the city center and the local activities fit in a mixed-use setting. As Delft will be one of the main actors in the 3D-printing industry, the action of creating a long-term circulation of resources and 3D-printed parts is strongly represented here.

The above text introduces the four locations that are chosen for a more elaborate location-specific design. The core message is that while the vision articulates six main actions, these main actions will not be equivalently relevant for each location in the province of South Holland. Several local characteristics are named which illustrate which elements determine the exact implementation of actions. The exact design of the four locations will be shown in this chapter.

Six main actions

- Safeguarding vulnerable ship manufacturing
- Synergizing living and making in pressured areas
- Smartly configuring public and private waterfronts
- Creating a long-term circulation of resources and 3D-printed parts
- Connecting resource flows by sustainable transport
- Providing an open and attractive work environment

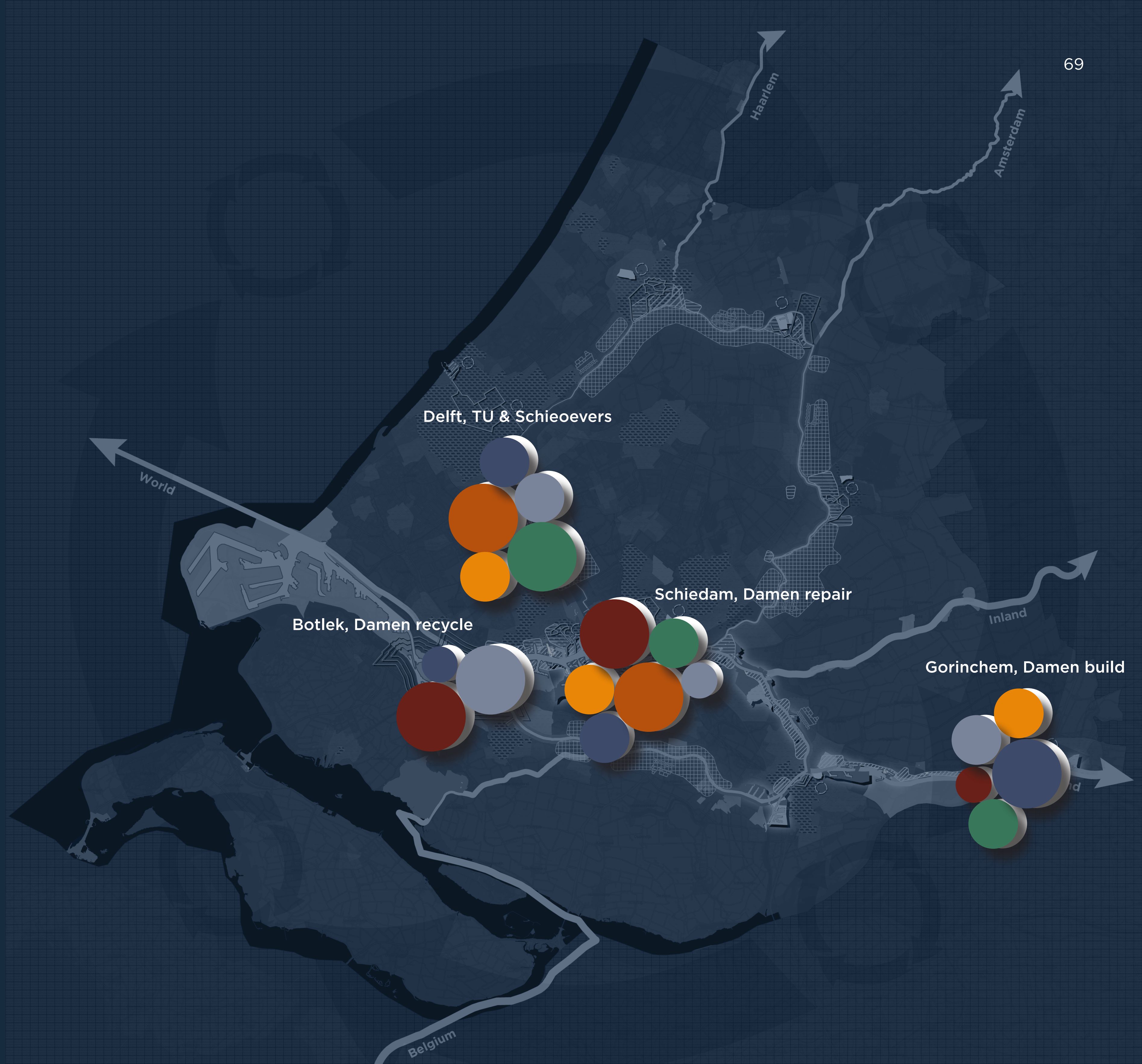


Figure 4.1, Map showing ratio of six actions in each key location

4.3. REGIONAL SYSTEM OF FLOWS

After undertaking main actions in key locations, the regional network has been established, demonstrating a new division of resources and collaboration among different sectors. The water structure is the main skeleton, connecting almost all the locations and industries associated with them. The flow of resources bring a close interrelation in every step of the ship's lifecycle. The technology and knowledge flows, shown with green arrows, link 3D printing and education, which means they can share innovative high-tech and talents.

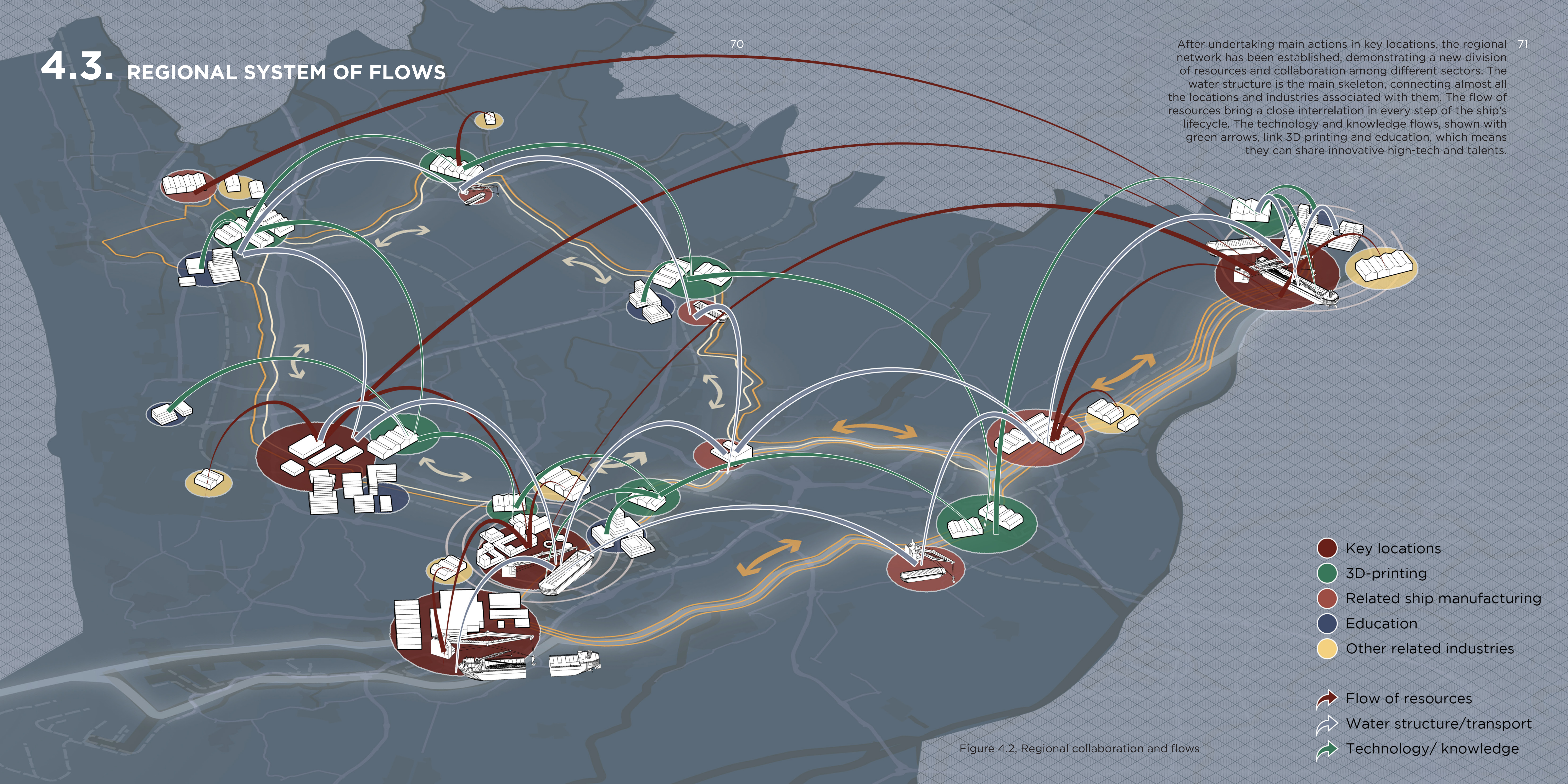


Figure 4.2, Regional collaboration and flows

4.4. GENERAL TIMELINE

The regional system of flows and the proposed vision is not realized overnight. The timeline on this page offers a roadmap toward a circular ship manufacturing sector in 2050. The bars in the timeline correlate with the six main actions proposed earlier and elaborate on how to complete the respective actions. The timeline consists of four phases where the actions in the first phases are more determined and the actions in the later phases are more adaptable to changes in the future.

Besides the six main actions, policies and incentives are also incorporated into the timeline. The policies and incentives all follow an event cycle, which can work towards a different goal but still follow the same four phases (as shown in figure 4.3). Each cycle starts with engaging and collaborating with stakeholders, generally through a placemaking event/festival. This is followed by formal meetings with stakeholders and evaluations of the progress, and closed by an opening or celebration of what is achieved in this phase. The cycle starts over again in the next phase.

In the coming page, we will show how important a good stakeholder collaboration is to execute this proposed timeline. Later in this chapter timelines and stakeholder analysis will elaborate on how we plan to develop the strategic locations.

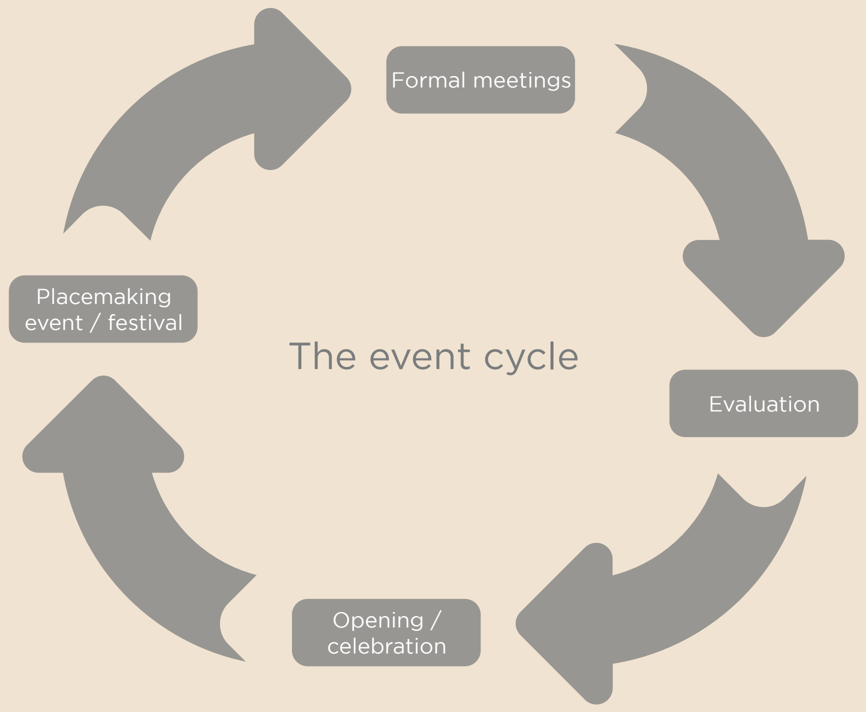


Figure 4.3, Diagram of the event cycle

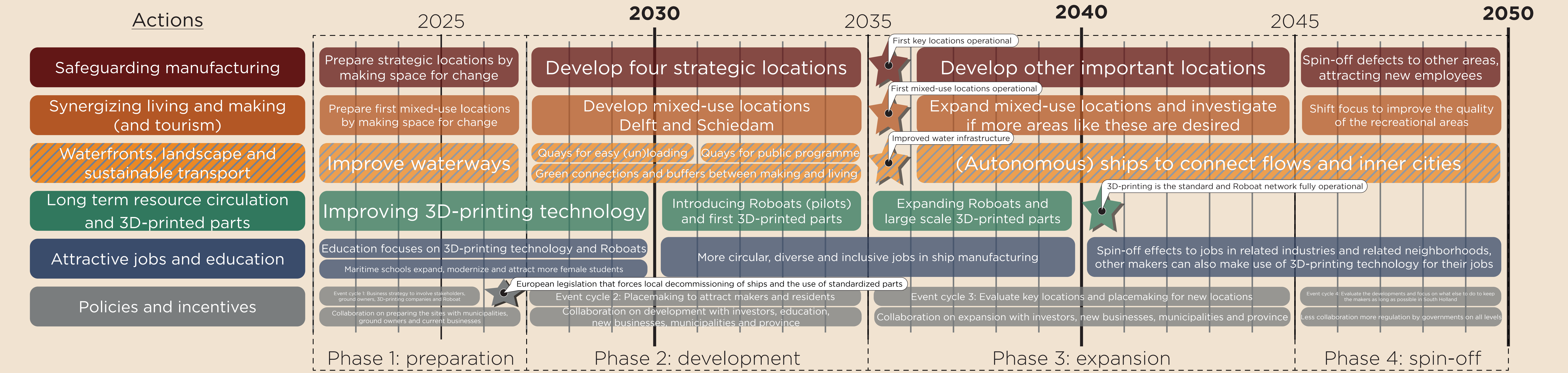


Figure 4.4, General timeline of FleetFlow

4.5. GENERAL STAKEHOLDERS

No project can become a success without stakeholder collaboration. Top-down regional planning without consulting and involving stakeholders is something from the past. To realize our regional vision we identified the most important stakeholders and their attitudes. Afterward, we placed them in a power-interest matrix, as seen in figure 4.5. This ordering of stakeholders allows to come up with strategies to engage the different stakeholders and make the most of their attitudes. For the success of the project, it is important to start engaging as soon as possible, in the first phases of the previously shown timeline.

Stakeholders engagement strategies:

Phase 1:
[awareness building] Collaboration with with real estate investors and developers is needed to realize a mixed-use area. However, they would prefer to turn the entire harbors into dwellings. Therefore, mutual understanding that we need each other is needed, which can be achieved by approaching them early. In addition, the municipality will regulate the zoning of mixed-use areas through zoning laws.

[attracting] Collaboration between 3D-printing locations, which can still have their own specialism, but should share knowledge and arrange joint procurement. A private party has to be found, which can carry out the 3D-printing.

[attracting] Incentive to involve Roboat to produce autonomous boats and ships, provide them with great location and access to knowledge and skilled staff.

[convincing] Improvements in the water infrastructure is a vital incentive to be able to develop the key locations. Rijkswaterstaat and the Waterboards should be convinced of this importance and should execute it as soon as possible.

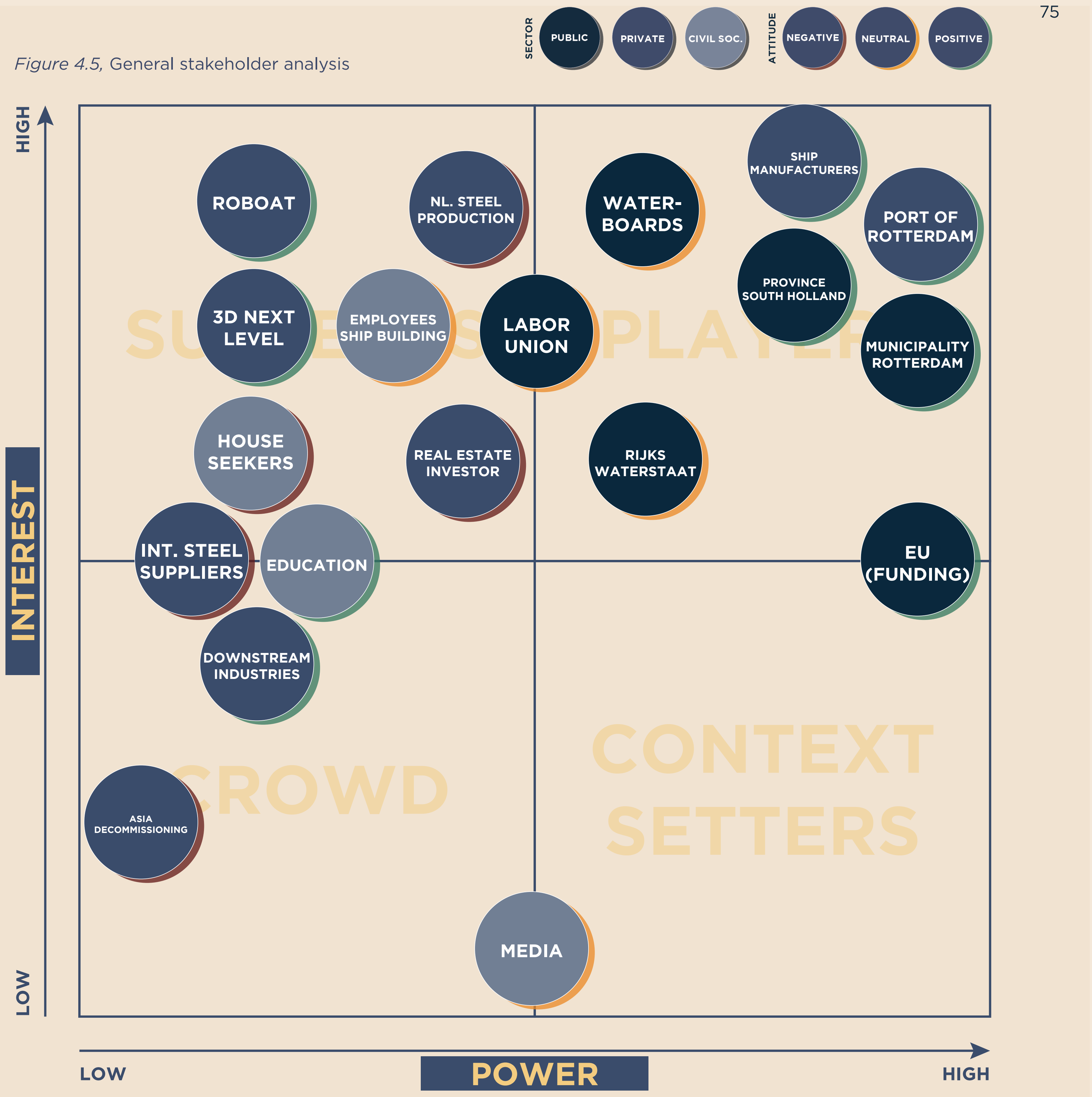
[regulating] While European legislation already stimulates the use of standardized parts, it is still voluntarily. To make the European green deal (European Commission, 2019) and the circular economy action plan (European Commission, 2020) a success, there should be laws that regulate more strictly by 2026.

Phase 2:
[attracting] Local placemaking to attract makers.

[attracting] To make sure that the ship manufacturers stay in South Holland, and want to cooperate with the proposed developments, the business environment should be optimal. This would include the optimized water infrastructure and its sustainable way of transport, better-educated staff, proximity to and collaboration with educational institutes, and being less dependent on raw materials.

[regulating] Regulation regarding the circular economy should be organized on an European scale, instead of national, as national regulation might push the ship manufacturers away to other ports in Europe.

Figure 4.5, General stakeholder analysis



4.6. THROUGH THE SCALES

To achieve this circularity in the province of South Holland, changes have to be made on various scales. On the regional scale, an identity belt will be the backbone of the network aimed for. On the scale of the port of Rotterdam and inner cities, most sectors and stakeholders will be brought forwards. Then, key locations further showcase our specific strategies benefiting industries and humans locally.

The identity belt clearly shows how the different functional zones are connected, spatializing our vision on the regional scale. The primary network mainly consists of waterways, which guide the physical flows of resources and materials, well-connected by sustainable transport. Along this network of waterways, waterfronts are smartly configured, by providing private access where needed and qualitative public space where possible. In the future, a similar strategic approach to the different scales, could also be applied in other parts of Europe, using the connections of the port of Rotterdam.

Smaller circularities are embedded on the scale of inner cities and identified neighborhoods mainly in Delft, Leiden, Alphen aan den Rijn, Gouda and Rotterdam. On this scale, small closed 'loops' will be established, so that the shipbuilding process can operate more locally. This will be done by improving accessibility locally, while cooperating with 3D-printing, maritime education and downstream industries nearby.

Applying the vision to specific key locations, allows to adapt to more local characteristics, while the key businesses still performs a role in the broader network they are part of. In the process of creating location-specific designs, the main actions from the vision are linked to more specific design interventions, called Patterns (which will be explained in the following page). This steps relates directly to the smallest scale, which are the human activities.

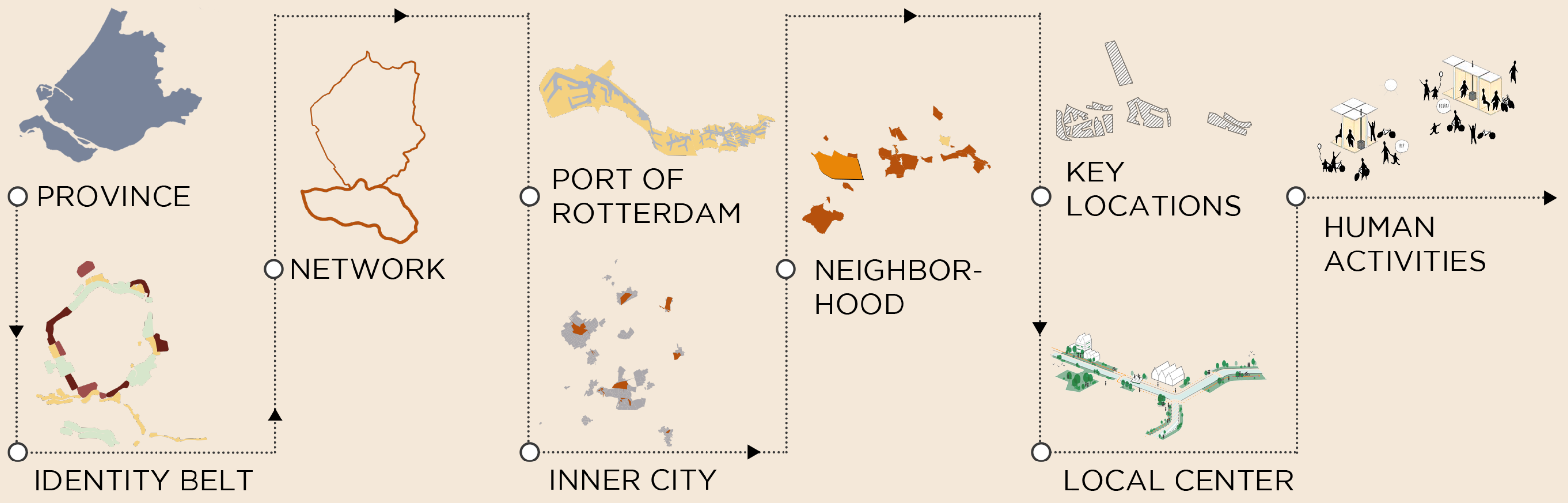


Figure 4.6, The scales of FleetFlow

4.7. ALL PATTERNS

The Cities Of Making (CoM) patterns (Hausleitner, et al., 2020) are a set of solutions that can help cities to adapt to a new era of urban making. In our project, we will implement these patterns to transform our key locations into areas in which making is embedded. Which patterns are used where will be explained later in this chapter.

In total there are fifty patterns available. These patterns are divided into five scales, as shown with the decks below, from transcalar (R) through city/neighborhood (C), neighborhood/block (N), and block/building (B) to programme (P). Not all patterns are completely visible on this page, to read all patterns please scan the QR code. The most relevant patterns for our project are on top of each deck.

The patterns are divided into three colors with all a specific aim. White is aimed at improving urban integration. Green focuses on people, networks, and policies. Black cards include topics related to circularity and technology. Each pattern explains how its goal can be achieved and which other patterns are connected to that solution.

SCAN ME TO DISCOVER ALL PATTERNS

Figure 4.7, Patterns, (Cities of Making, 2018)

4.8. EXPANSION PACK

Added solutions by FleetFlow

To the existing fifty patterns, we decided to add thirteen more patterns that were essential in order to transition (our key locations) towards more circular ship manufacturing. Our new patterns can be seen as an expansion pack, which includes missing solutions that are more specific to FleetFlow. How we have come to these patterns is written on the cards themselves, they are either based on: CoM, literature, design testing, analysis, or circularity trends.

The thirteen new patterns all apply to different scales and themes. We introduce three new patterns within the theme of people, networks and policy. These patterns propose solutions to elements that are important in our story; attractive jobs in making, safeguarding vulnerable making, and accessible making without a car. On the theme of circularity and technology we also introduce three new patterns; smart disassembly, autonomous ship technology, and improved 3D-printing technologies.

For the theme of urban integration, we propose seven new patterns that will provide solutions for our key locations and locations alike. Four patterns touch on integrating water and land; sustainable ship transport, utilizing the waterscape, quays for public programme, and quays for easy (un)loading. The last two are opposites of each other and can be used alternating. The other three patterns of this theme are; shared 3D-printing facilities, green as buffer and connector, and make physical connections.

How our new patterns are applied at our key locations will be explained later in this chapter.

Figure 4.8, Expansion patterns of FleetFlow, * patterns will also be used in 4.10.3; 4.11.3; 4.12.3; 4.13.3

4.9. KEY LOCATIONS

Building, repairing, decommissioning, 3D-printing

The vision, and its related main actions and patterns, will be applied first to four strategic key locations before they will be implemented in all of the province. These four key locations all represent a different part of the ship's lifecycle. Moreover, these locations are essential for the success of FleetFlow: they fulfill an essential role in the transition to circular ship manufacturing and can function as catalysts for the circular transition in South Holland.

Build
The first key location is in Gorinchem. Here Damen produces part of its seagoing ships. The analysis has taught us that this is one of the few locations where shipbuilding and education, the Damen academy, are so close together. For this reason, this location is the best example of how we want to enable attractive and circular jobs. As this location already focuses on production, the production of Roboats (which are in our vision proposed to connect flows), is also implemented here. This location might be perfect for it as the existing cluster can be utilized to share knowledge and machines.

Repair
The next step in the ship's lifecycle is repair. A ship will visit Damen repair in Schiedam several times during its lifecycle. At this location broken parts of ships are replaced, ships are repainted, and sometimes even refitted. This location, which is close to the city center of Schiedam and Rotterdam, is a great example of an area where the housing pressure threatens vulnerable making. Mixing living and making, and designing good transition zones, is necessary to safeguard Damen repair in this area.

Decommissioning
At the end of the ship's service on the sea, it will have to be decommissioned. Damen Verolme in Botlek is the only location where this happens for seagoing ships in the Netherlands. As concluded from the analysis, the decommissioning site needs to expand to deal with the growing amount of retiring ships locally. The location is separated from any residential neighborhoods, and therefore does not need improved transition zones or mixed-use areas. The focus here will be on finding a place for the expansion of decommissioning, and on transporting the recyclable or reusable standardized parts from the decommissioning site to the shipyards.

3D-printing
Besides the three locations which are mentioned above, that are already part of the current ship's production cycle, a new location is introduced. Schieoevers Delft will be a location for large-scale 3D-printing. This location can replace part of the dirty production locations currently used, by providing 3D-printed parts for the ship manufacturing industry and other sectors.

Along the Schieoevers, a new makers district is already planned. In addition, the location shows great potential for developing improved 3D-printing and maritime technologies, due to the situation near the TU-Delft.

In the remainder of this chapter, we will elaborate more on each location. For each location, we will propose a design and explain the strategies necessary to realize them. Important to note is that these locations are examples that can be an inspiration for similar transitions in comparable locations. They can either be within our vision area, but also outside of it.

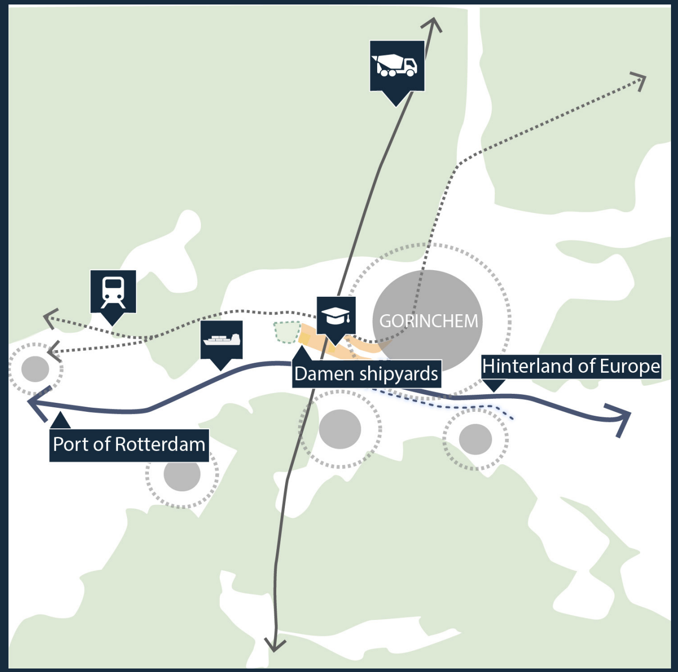
Figure 4.9, Key locations for strategic design

4.10. SHIP BUILDING

4.10.1. Regional background

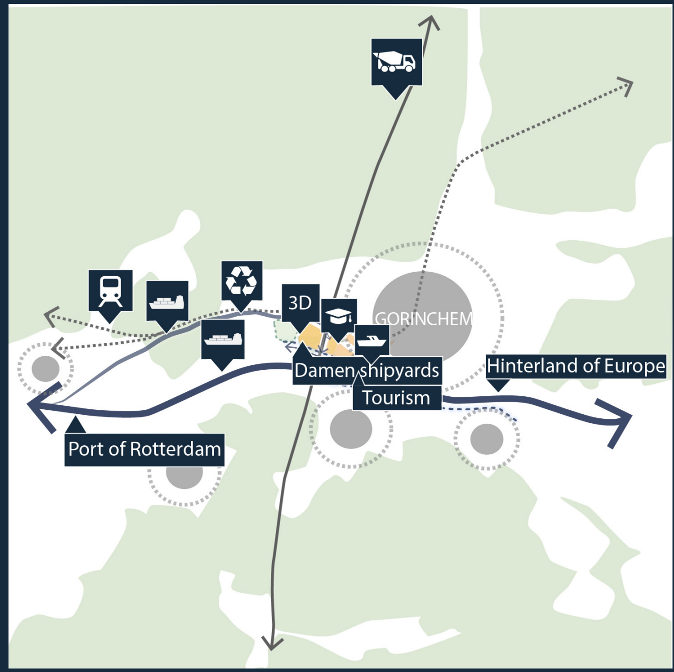
Damen's shipbuilding yard and the Damen Academy are located in the western rural area of Gorinchem. Gorinchem is well known for its beautiful fortified inner city, and for being part of the new Dutch waterline (Gemeente Gorinchem, 2021). The shipyard is located in the highly concentrated industrial area Avenling Industrie Estate, below a new residential area developed in the 20th century. In this industrial area companies are located which for example focus on plastics and heavy industrial installations. They are located on an industrial 'island', which is surrounded by the main river Boven Merwede and the Steenenhoek Canal. Currently the highway, the railroads along the canal and the main river, serve the main logistics of the site. The highway and the green belt play an important role in dividing the industrial area into two sides. As a result, the Damen shipyard is separated from the Damen Academy, which limits potential synergies.

Figure 4.10, Current situation, regional scale



After implementing the circular ship manufacturing strategy, a more diverse industrial estate will be realized, with newly established connections with related industries and services. The most important change on regional scale, will be the enlarged focus on the waterscape. The Boven Merwede river will be utilized more intensely, and will connect to the Steenenhoek Canal to increase possibilities for water transport. As the highway is currently a strong barrier, part of the A27 will transform into a bridge, to allow connections across the water. In order to align with the landscape tourism of Gorinchem, a new sight visiting route will be developed along the renovated industrial estate. This will be done to attract visitors, and to enlarge awareness around ship manufacturing.

Figure 4.11, Future situation, regional scale



4.10.2. The current site

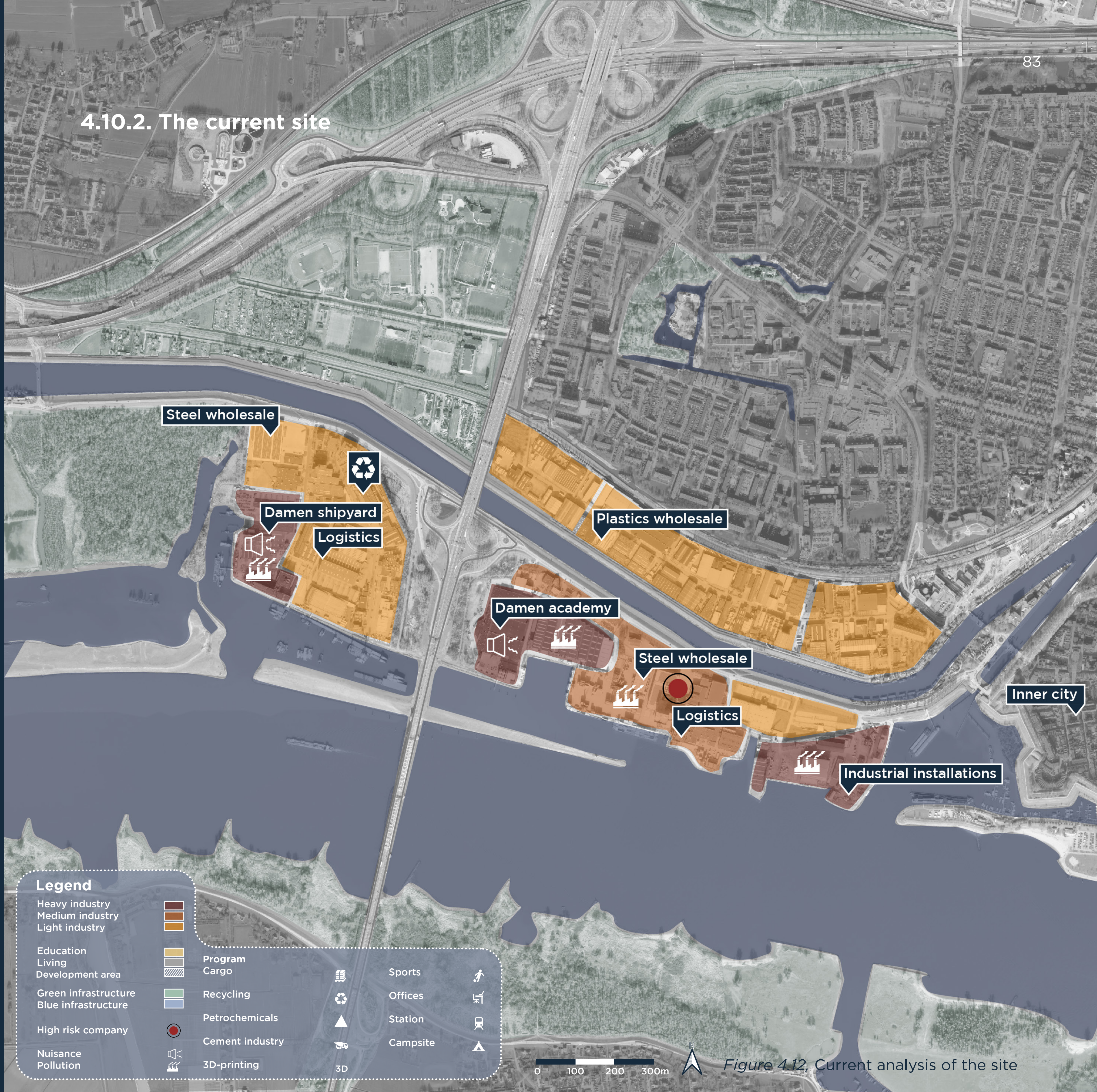


Figure 4.12, Current analysis of the site

4.10.3. Future design

In Gorinchem, one of the main actions is providing an open and attractive work environment. To enable that action, the Damen Academy will play a more dominant role in this location by *Implementing (more) Spaces for Development and Education (P.7)*. In addition, the domain of the academy will be part of a high-quality urban realm as a *Quality Urban Environment in Making Areas (N.8)*. This is mainly done by expanding the Academy's facilities, redesigning the public square, and connecting it through boat transport. To further enable the main action, locations with new *Quays for Public Programme (FF.8)*, such as the inner city waterfront, the Damen academy, and the green campsite, are connected though a recreational boat route. Along this route, spatial qualities will be boosted by creating a *Public Face (B.3.)*

To accommodate the Roboat production and to connect the shipyard to the academy, the Damen shipyard will be expanded towards the east. To enable this investment, and safeguard the industry, this asks for *Assured Security of Space (R.9)*. The expanded industry will be better embedded in its surroundings by *Making Making Visible (R.1)*, by creating a green window toward the residential area.

There will be a 3D-printing facility, using *Improved 3D-Printing Technologies (FF.6)*. Together with the 3D-printing industry, already existing local industries such as steel wholesales and recycling facilities will be utilized to contribute to a *Sustainable Product Cycle (R.6)*. Water surfaces and related harbors around industrial areas will be expanded so that *Sustainable Ship Transport (FF.7)* can operate as efficiently as possible.

For every key-location, related cards are connected through lines, which refer to the colors of the main actions (chapter 4.2.). The shown relations are extracted from above text.

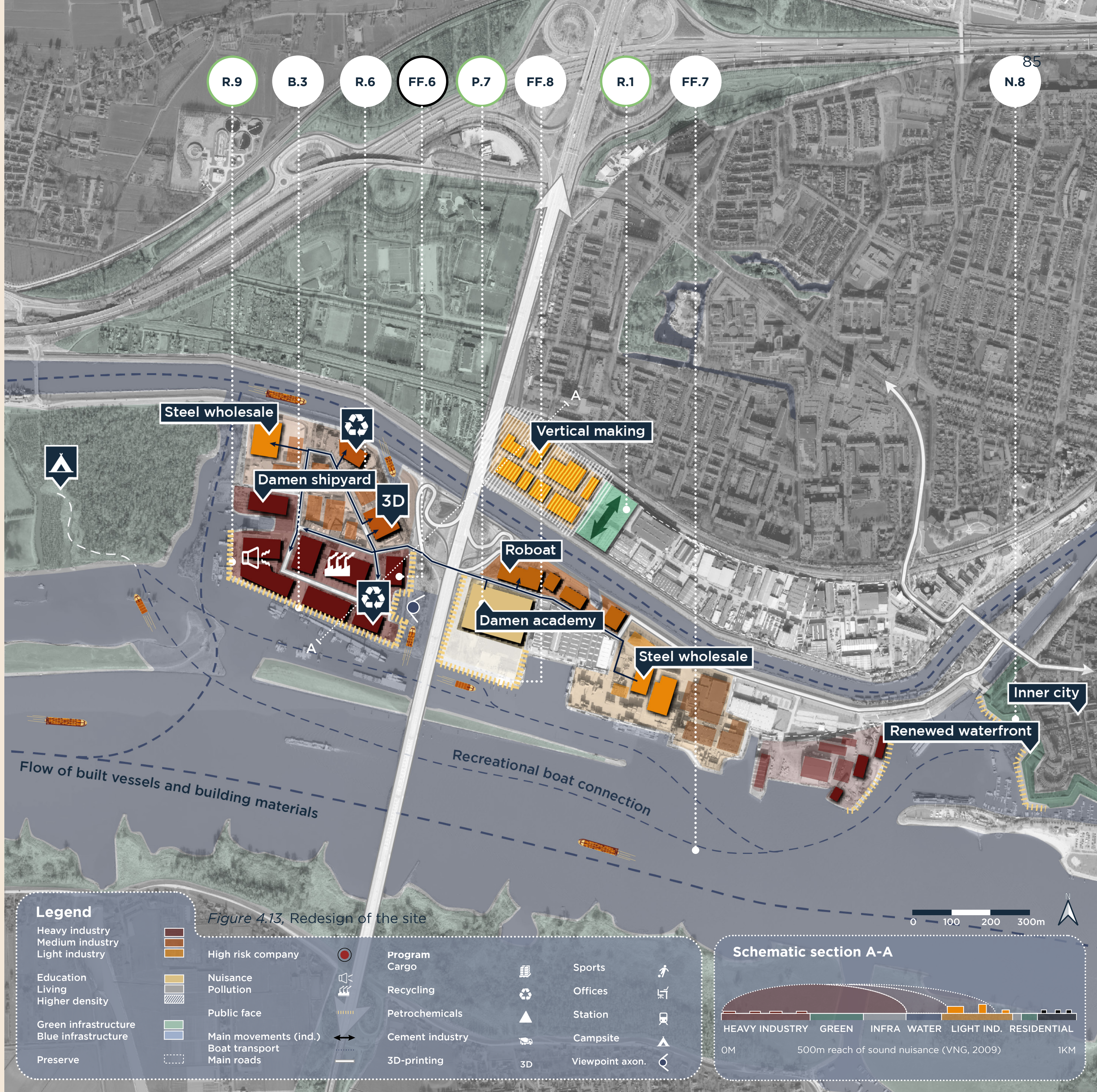
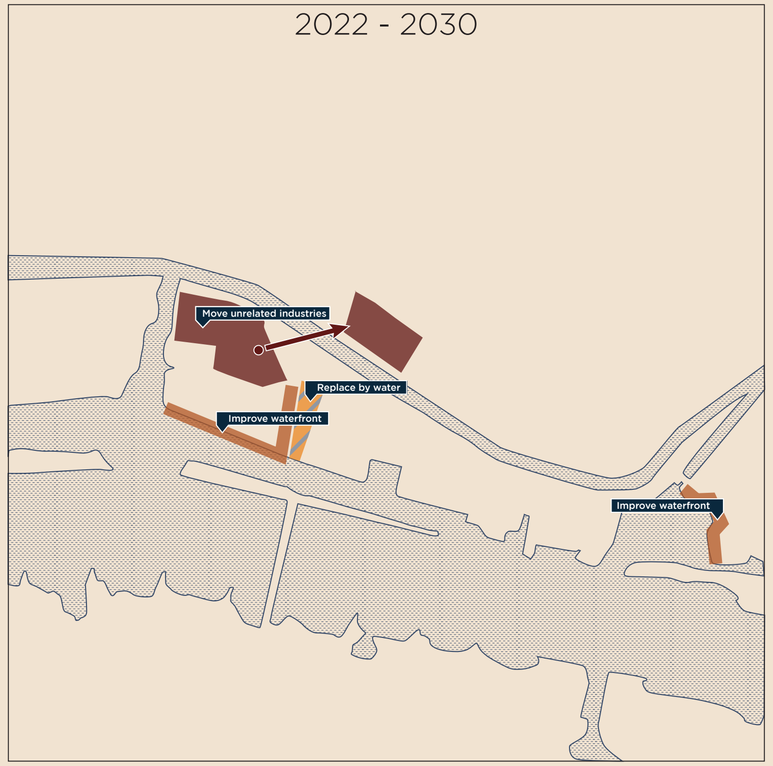
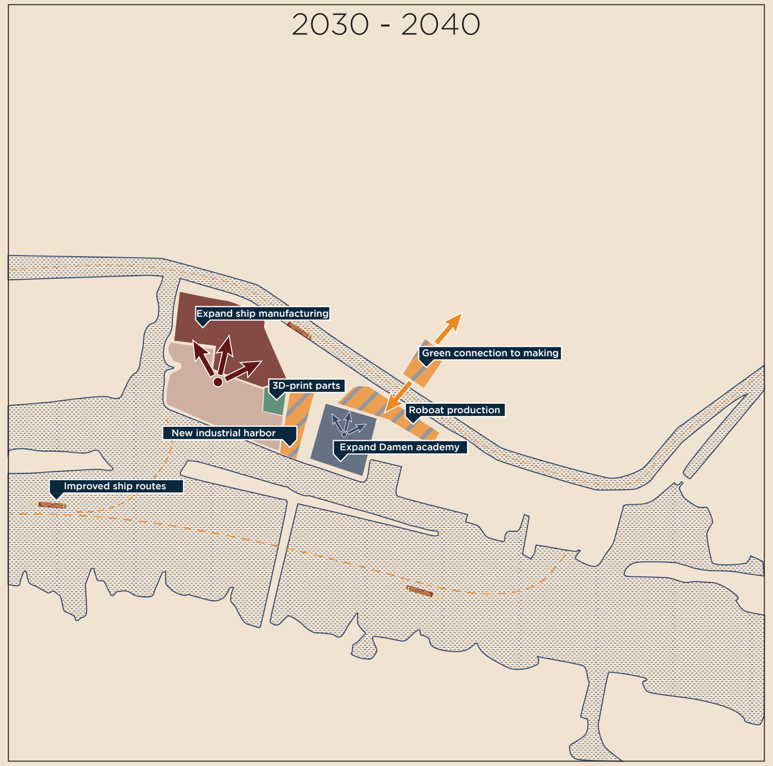


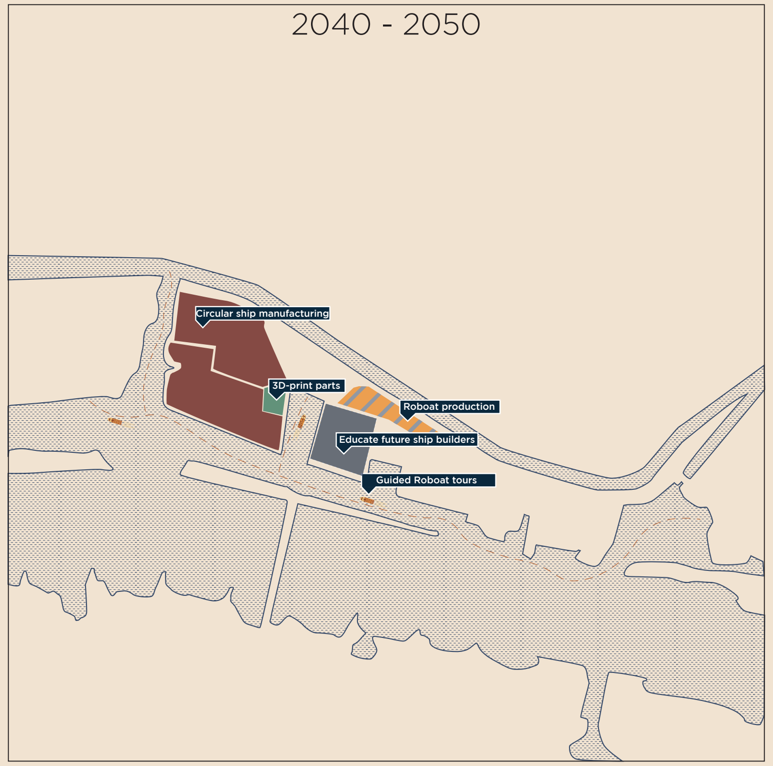
Figure 4.13, Redesign of the site

4.10.4. Timeline

To guide the transformation of Gorinchem towards a more transparent and attractive manufacturing site, multiple main actions need to be implemented step by step. This is shown in this site-specific timeline. In the first phase, the site will be prepared for expansion and increasing tourism. In the second phase, new elements such as the 3D-printing and Roboat facilities will be developed. Finally, in phase three, the renewed ship manufacturing is operational and can be shown to the public.







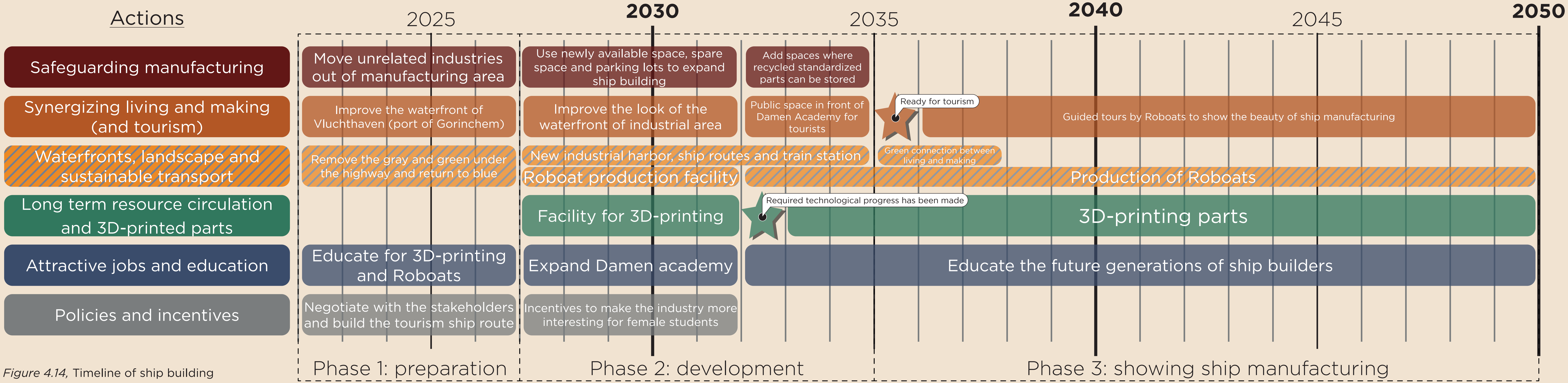


Figure 4.14, Timeline of ship building

4.10.5. Local stakeholders

The strategic key projects need stakeholder collaboration to become successful. For this key location, we identified the most important stakeholders and their attitudes. Afterward, we placed them in a power-interest matrix, as seen in figure 4.15. This ordering of stakeholders allows to come up with strategies to engage the different stakeholders and make the most of their attitudes. For the success of the project, it is important to start engaging as soon as possible, in the first phases of the previously shown timeline.

Stakeholders engagement strategies:

Phase 1:
[attracting] Waterschap Rivierenland and Staatbosbeheer are important stakeholders to reshape the landscape, involve them early. They can make or break this project.

[attracting] Negotiate with stakeholders like VVV, Staatsbosbeheer, Municipality Gorinchem, and Damen academy to build the tourism sector. An incentive of the waterboard and Rijkswaterstaat for improved waterways is needed to make this a success.

[convincing] Unrelated industries are not happy that they have to move. Relocate them in the north part of the industrial area. Use policies to stimulate moving and make vertical making possible in the northern part. Economic incentives by the Municipality and Damen could make this easier.

Phase 2:
[attracting] Initiate incentives to make the sector and education more interesting and more accessible for female students. This can be done by campaigns, requiting on high schools and adding new and more inviting tracks.

Phase 3:
[attracting] Join the forces of the Damen academy and tourism to show and tell the public about the ship manufacturing business by inviting public space.

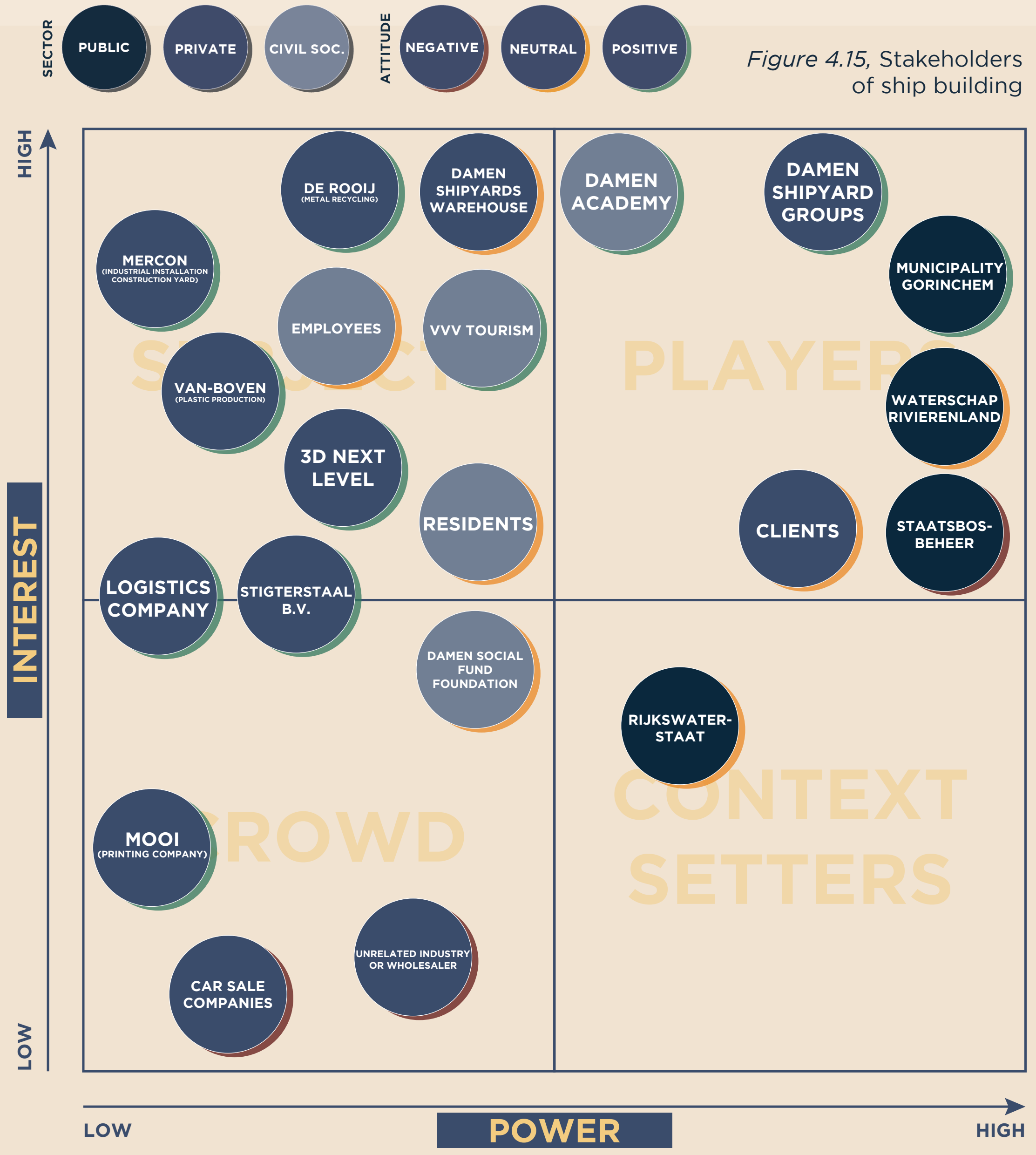


Figure 4.15, Stakeholders of ship building

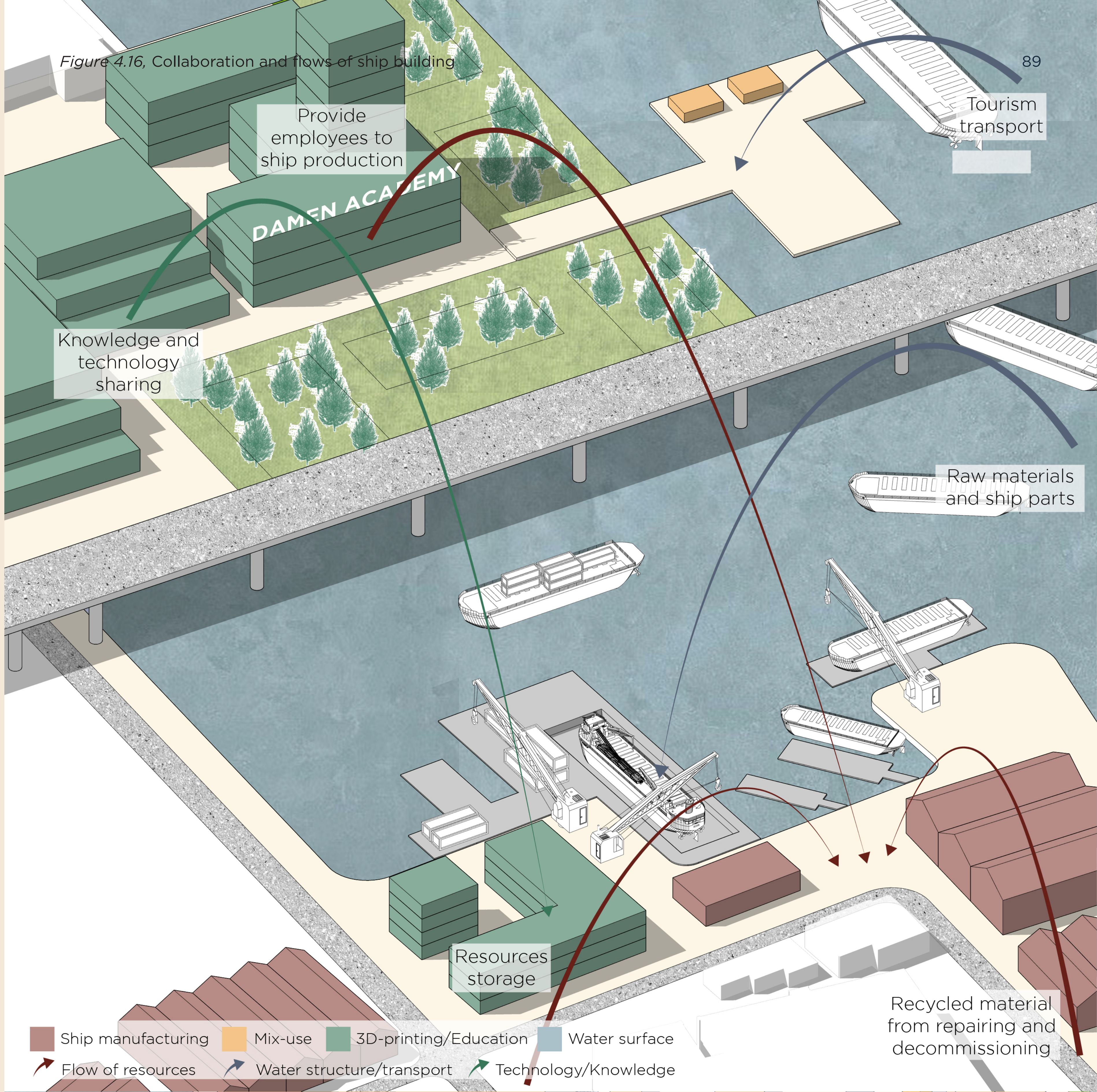
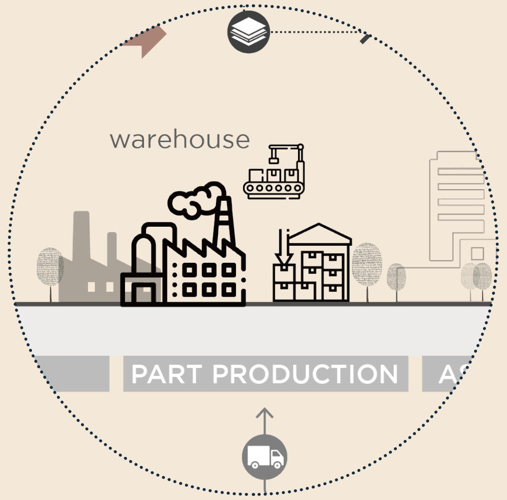


Figure 4.16, Collaboration and flows of ship building

4.10.6. Impression before

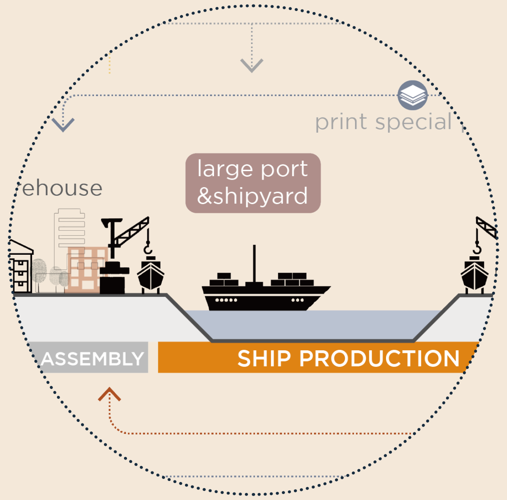


The collage shows the view of the current shipbuilding site of Damen in Gorinchem. The shipyard is located in a big industrial area on the southwest side of Gorinchem along the river Boven Merwede. However, as a result of the nuisance problems, pollution, large demands for raw material storage, and the stereotype of the bad impression about heavy industry, the Damen shipyard is isolated as an 'island'. The island is isolated from its surroundings by green belts, a highway and the river.

In addition, due to a lack of spatial regulation and management, there are some offices of unrelated services and stores (such as car retail stores) scattered around the edge of this 'island'. The buildings are usually simple white cube houses with unattractive parking lots. Therefore the quality and atmosphere of the current ship-making site are not public- welcoming nor visually appealing.

Figure 4.17, Gorinchem, Damen build, (Google map, 2022, https://www.google.com/maps)

4.10.7. Impression after



After the improvements, the area of the ship-making site will be more open, and better oriented towards the waterscape. The space of segregating green infrastructures will be transformed into a new harbour, which allows for new connections. As shown in the collage, there is now also a visual connection towards the Academy. All of this will result in a more accessible and inviting atmosphere, optimizing potential synergies with the Academy and other industries.

At the site, the environment will be regulated better to ensure good quality of open space. In addition, architectural qualities are improved to create a more appealing public face. By doing this, the tourism sector can be further developed, and visitors can be made more aware of the vitality and charm of ship manufacturing. Alongside the original workers of the shipyard, new external users are introduced, mainly on the waterscape.

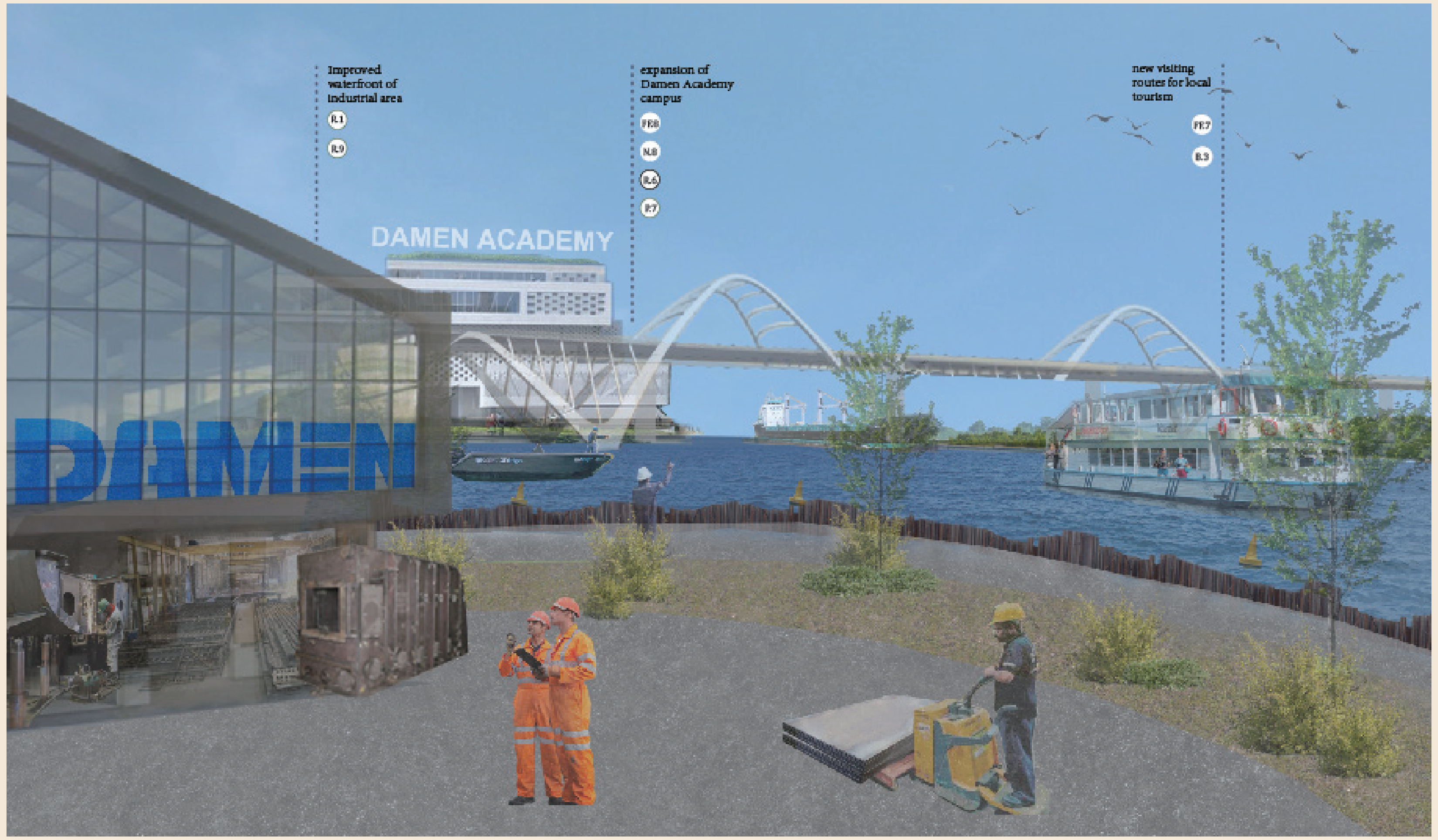


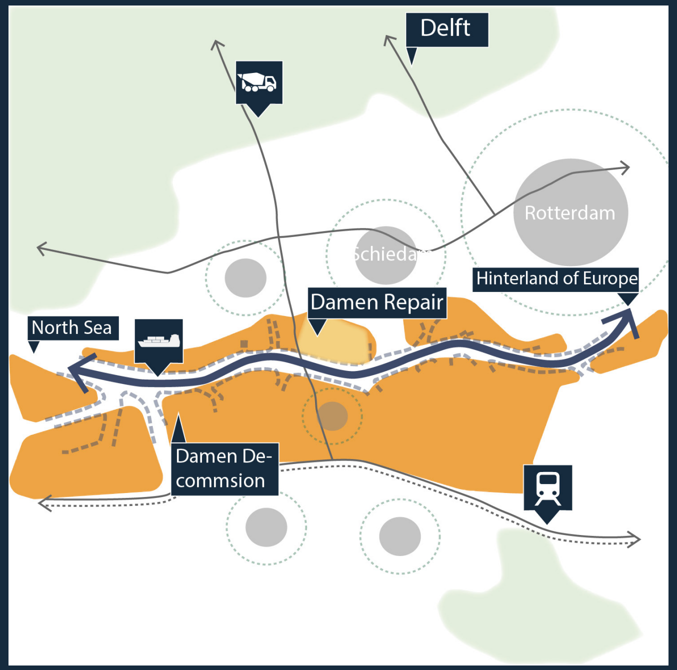
Figure 4.18, Production harbor of Damen

4.11. SHIP REPAIR

4.11.1. Regional background

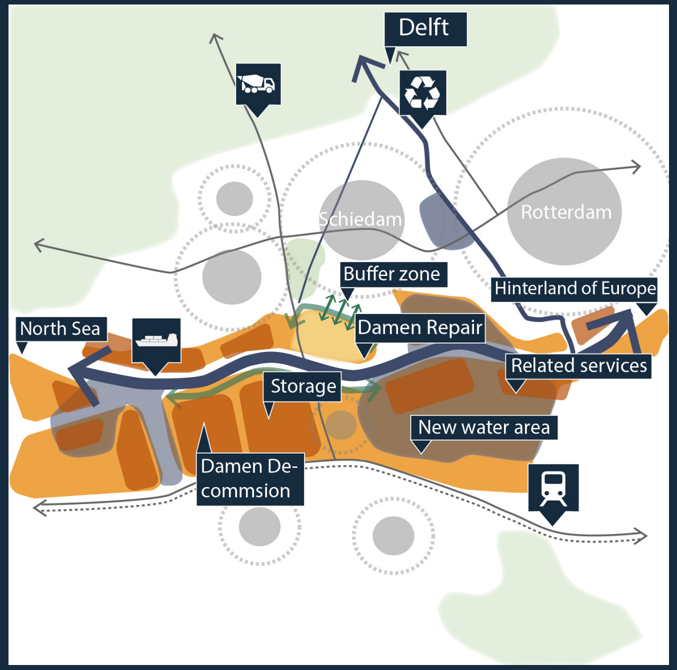
Damen repair is located in the center of the Port of Rotterdam, right next to Schiedam. It is at the cross-over of the A4 highway and the Nieuwe Maas river, which is convenient for water and land transportation by trucks and boats. Due to Damen's highly accessible positioning along the Nieuwe Maas, Damen Repair could accomodate used ships from the hinterland of Europe, as well as the ships traveling worldwide and arriving passing through the North Sea. However, there are also severe challenges. The industrial area is cut into segregated and monotonous areas, which barely relate to other industries and services. Secondly, due to the proximity to the residential area, the nuisance and air pollution caused by the industry has to be carefully managed.

Figure 4.19, Current situation, regional scale



In the view of 2050, a multi-functional mixed-use cluster will be established. Instead of being a single functioned area, Damen ship repair will share materials and technologies with relative services. Thus the area will be turned into an industrial area, but with mixed functions. The new network connection on the regional scale, will help connect the Damen site to other services and industries, for example in Delft. The Nieuwe Maas connection gains importance as water mobility is strongly activated. To better embed the industrial area into it's residential surroundings, the existing green buffer is extended and redesigned. As a result, the ship repair site can have a closer relationship with the urban system, while not intervening too much with the residential life.

Figure 4.20, Future situation, regional scale



4.11.2. The current site

Figure 4.21, Current analysis of the site

4.11.3. Future design

The main action in Schiedam is safeguarding vulnerable ship manufacturing, which is done by better embedding it in its urban surroundings, through using *Green as a Buffer and Connector (FF.11)*, *Concentrating Messy Making Along Infrastructure (C.9)*, and creating *Transition Zones (C.10)*. This is done by expanding the existing green infrastructure, clustering heavy industries near the A4, and having offices and other light industries more towards residential areas.

The same patterns support the main action of synergizing living and making, together with *Making Physical Connections (FF.12)* and *Making Along High Streets (N.10)*, which is mainly done along the green corridor to increase visibility and enhance pedestrian flows. Together with the green corridor, a *Utilized Waterscape (FF.13)* will contribute to *Quality Urban Environment in Making Areas (N.8)*, so that the area is both attractive to new residents as current and new companies. Part of the newly attracted companies will be start-ups in the north part, between whom exchange will be promoted through creating *Shared Making Spaces and Technology (P.2)*.

Improved 3D-Printing Technologies play an essential role in creating standardized parts for repairs, which can be transported to the local Damen site by *Autonomous Ship Technology (FF.5)* and *Sustainable Ship Transport (FF.7)*.

FF.5

AUTONOMOUS SHIP TECHNOLOGY

Improving the autonomous ship technology can contribute to more sustainable connections of flows on the local and regional scale. To achieve this close collaboration between the private sector and educational institutes is required.

Connected to:
R.6 / R.7 / R.8 / R.11 / B.7 / FF.1 / FF.6 / FF.7

Based on: Circularity trends

CIRCULARITY & TECHNOLOGY – TRANSCALAR

FF.6

IMPROVED 3D-PRINTING TECHNOLOGIES

Improving 3D-printing technologies will lead to a way of manufacturing parts that produces less waste, noise and pollution. Improvements is scale and materials are required and can be achieved by close collaboration with education.

Connected to:
N.7 / R.6 / R.11 / B.7 / FF.1 / FF.5 / FF.10

Based on: Circularity trends

CIRCULARITY & TECHNOLOGY – CITY/NEIGHBOURHOOD

FF.7

SUSTAINABLE SHIP TRANSPORT

Sustainable ship transport will help connection flows on the local and regional scale. It requires and upgrade of the waterways and adjustments to quays so the loading and unloading is efficient as well.

Connected to:
N.5 / N.6 / R.6 / R.7 / R.8 / FF.5 / FF.9 / FF.13

Based on: Design testing

URBAN INTEGRATION – TRANSCALAR

FF.11

GREEN AS BUFFER AND AS CONNECTOR

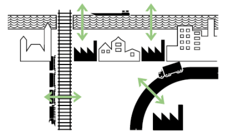
Green infrastructure can functions as a buffer for noise and pollution between making and living. It can also be a connection creating an inviting route that encourages residents to visit the makers district and make use of the facilities.

Connected to:
N.8 / C.2 / R.1 / FF.8 / FF.12

Based on: Design testing

URBAN INTEGRATION – CITY/NEIGHBOURHOOD

FF.12



MAKE PHYSICAL CONNECTIONS

Industrial areas and makers districts are often separated from other neighbourhoods by heavy infrastructure. Physical connections are necessary if a mixed used area is the goal, if not connections can encourage visitors and new employees.

Connected to:
N.8 / R.1 / R.2 / FF.3 / FF.8 / FF.11

Based on: Analysis

URBAN INTEGRATION – CITY/NEIGHBOURHOOD

FF.13

UTILIZING THE WATERSCAPE

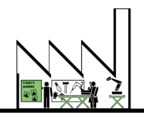
Utilizing the waterscape of for example old harbours means that the space is used more efficiently. The waterscape can be used for public space, infrastructure or even housing. Flexible floating structures are the desired solution.

Connected to:
N.1 / N.8 / FF.5 / FF.7 / FF.8 / FF.9

Based on: Design testing

URBAN INTEGRATION – CITY/NEIGHBOURHOOD

P.2



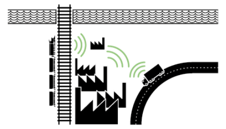
SHARED MAKING SPACES &TECHNOLOGY

Smart use of space and technology through sharing can increase accessibility to expensive equipment, make more effective use of technology, while encouraging knowledge transfer between manufacturers.

Connected to:
R.4 / R.6 / R.9 / R.11 / R.12 / C.4 / C.8 / N.2 / N.7 / B.2 / B.7 P.3 / P.6

URBAN INTEGRATION – NEIGHBOURHOOD/BLOCK

C.9



CONCENTRATING MESSY MAKING ALONG INFRASTRUCTURE

Concentrating manufacturing activities that produce noise, dust, and problematic odours along infrastructure, minimises nuisances.

Connected to:
R.9 / C.1 / C.2 / C.7 / C.10 / N.1

URBAN INTEGRATION – CITY/NEIGHBOURHOOD

C.10

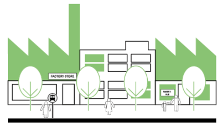
TRANSITION ZONES

Zones adjoining industrial areas can provide ideal space for small to medium size manufacturing businesses and supporting services that help transition into mixed-use and residential areas.

Connected to:
R.3 / R.4 / C.1 / C.5 / N.3 / N.9

URBAN INTEGRATION – CITY/NEIGHBOURHOOD

N.8



QUALITY URBAN ENVIRONMENT IN MAKING AREAS

A high quality public realm is attractive for both employees and clients, increasing a sense of safety, encouraging mixed use, improving staff retention and encouraging visitors.

Connected to:
R.1 / R.2 / R.3 / R.5 / R.8 / R.10 / C.1 / C.2 / C.3 / C.4 / C.5 C.6 / N.1 / N.5 / N.6 / N.9 / N.10 N.11 / B.1 / B.2 / B.3 B.6 / P.8

URBAN INTEGRATION – NEIGHBOURHOOD / BLOCK

N.10

MAKING ALONG HIGH STREETS

Concentrations of mixed-use activities along high streets can take advantage of the best regional accessibility and the highest amount of pedestrian flows, enhancing visibility.

Connected to:
R.3 / R.4 / C.2 / C.3 / C.4 / C.7 / N.1 / N.3 / N.5 / N.8 / N.11 P.5 / P.6 / P.7 / P.8

URBAN INTEGRATION – NEIGHBOURHOOD / BLOCK

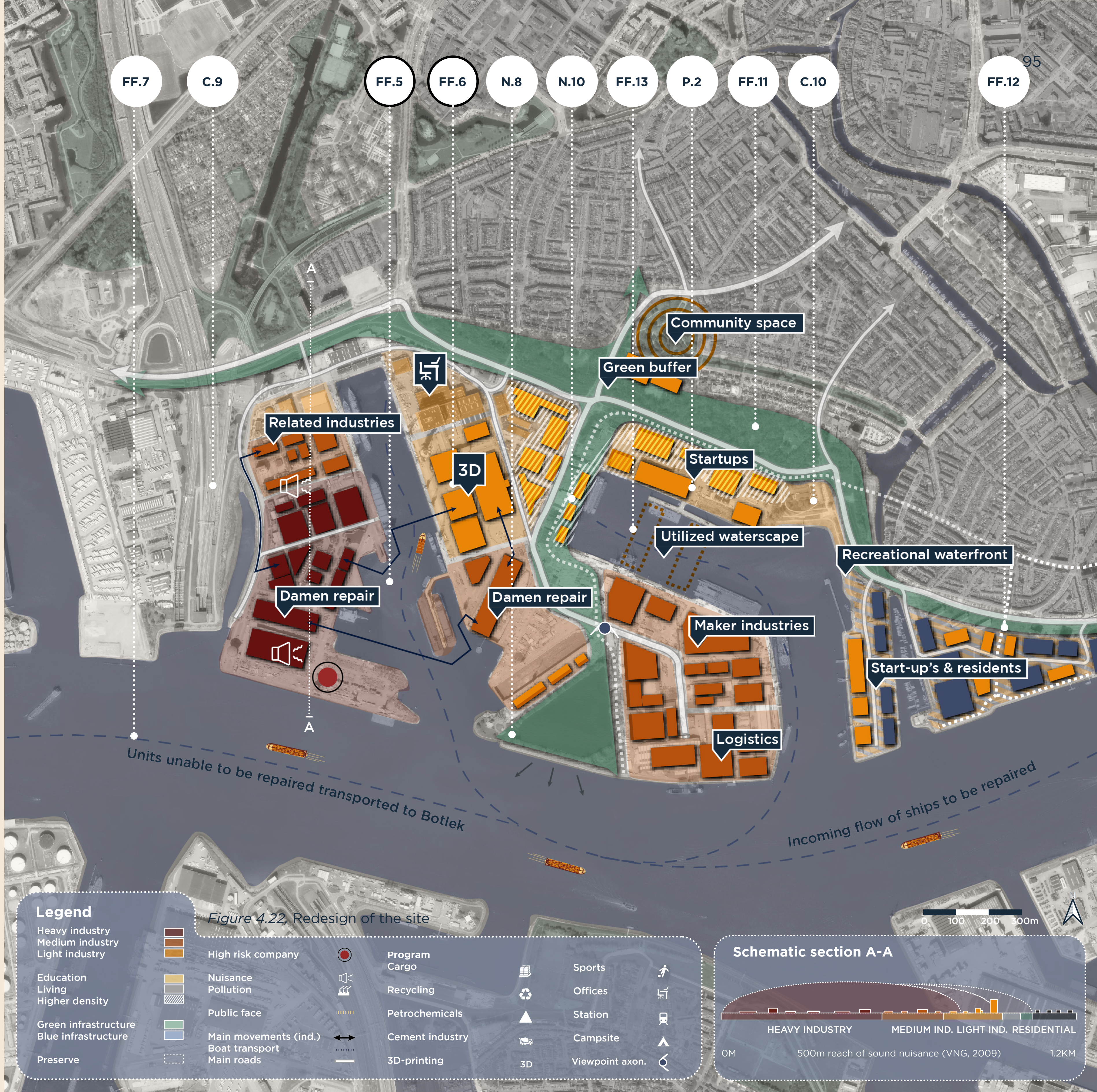
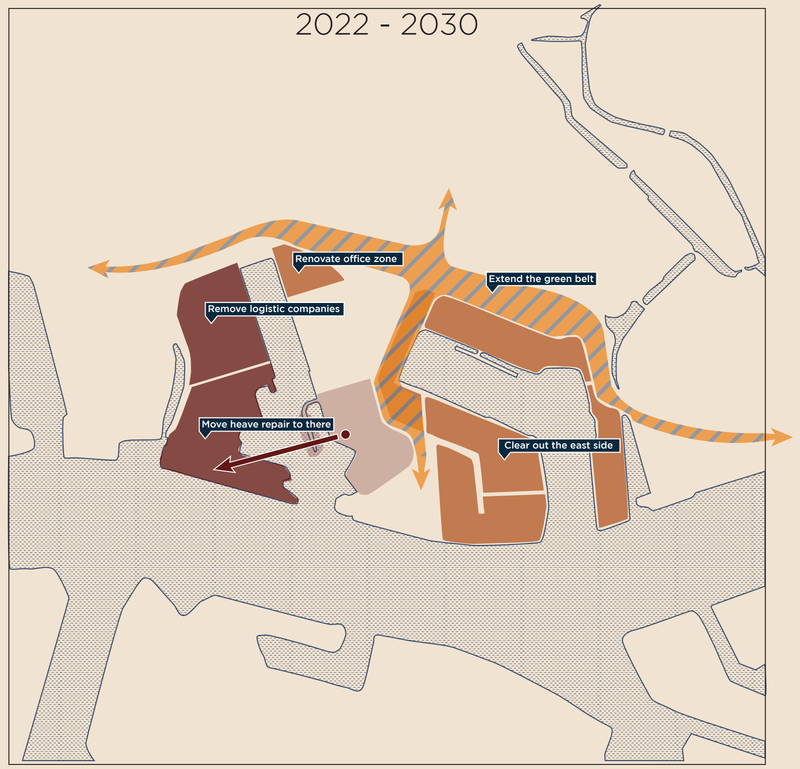
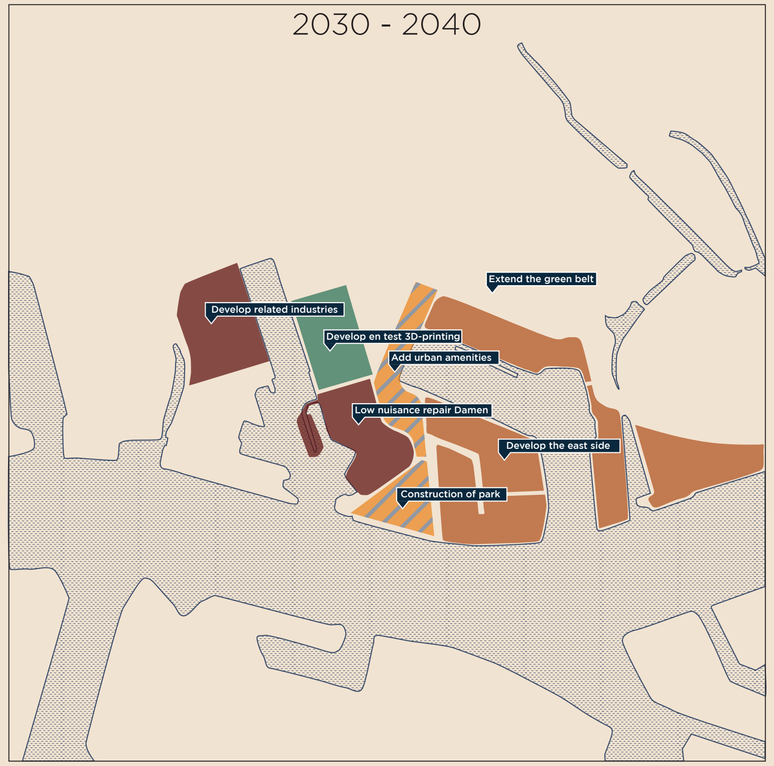


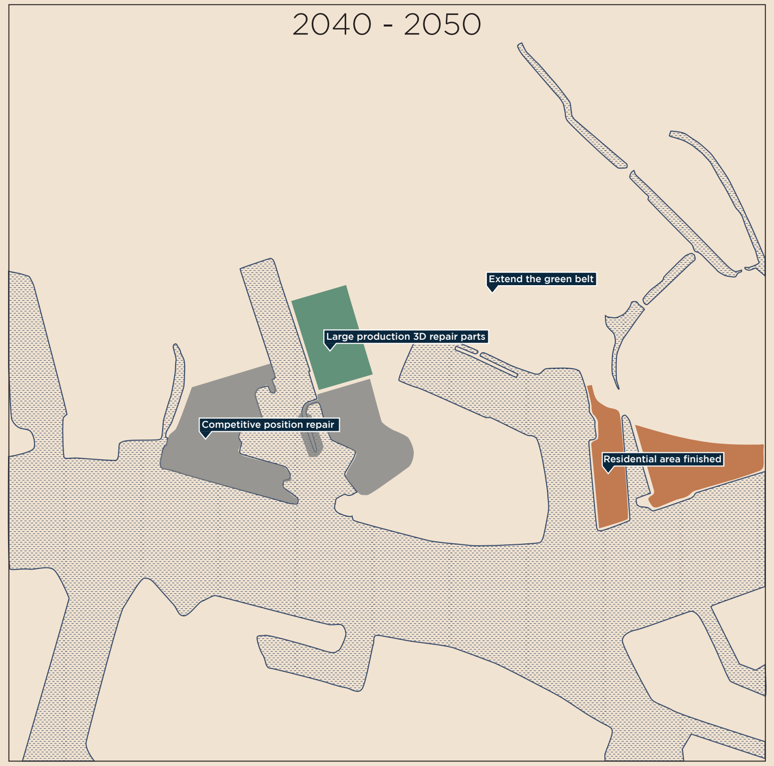
Figure 4.22 Redesign of the site

4.11.4. Timeline

To guide the transition towards a more mixed-use area in Schiedam, in which heavy repairing activities will shift to the westmost side to allow the introduction of new functions, multiple main actions need to be implemented step by step. This is shown in this site-specific timeline. In the first phase, the east side will be prepared to locate the heaviest industries. In the second phase, the new repair yard will be developed, along with the first mixed-use area. In phase three the mixed-use area will expand, and finally, in phase four the entire area is operational. During this phase, the area hosts a nice mix of living and making, connected and buffered by green infrastructure.







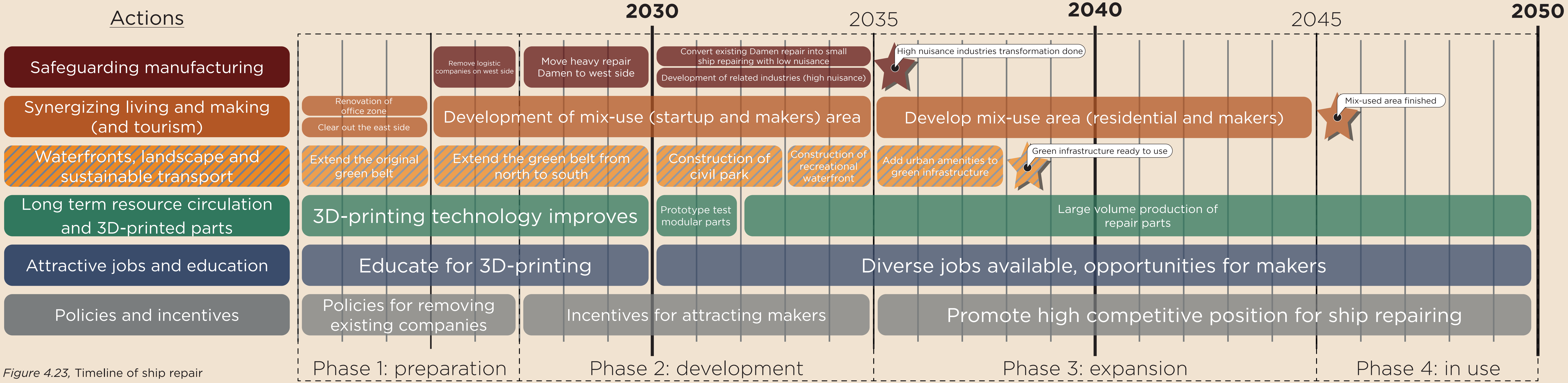


Figure 4.23, Timeline of ship repair

4.11.5. Local stakeholders

The strategic key projects need stakeholder collaboration to become successful. For this key location, we identified the most important stakeholders and their attitudes. Afterward, we placed them in a power-interest matrix, see the image on this page. This ordering of stakeholders allows to come up with strategies to engage the different stakeholders, and make the most of their attitudes. For the success of the project, it is important to start engaging as soon as possible, in the first phases of the previously shown timeline.

Stakeholders engagement strategies:

Phase 1:

[attracting] Incentives to attract a 3D-printing company, by establishing an inviting settlement area with sufficient customers. Also, educate students about this new technology at nearby institutes.

[regulating] Policies by the municipality of Schiedam to move current companies, plans for this already exist (Gemeente Schiedam, 2013).

Phase 2:

[awareness building] Residents might want all industry replaced by dwellings. However, this is not feasible as the province needs industry and making to be resilient. Measures like an extended green buffer zone and bundling infrastructure and heavy making, makes the area as pleasant as possible.

[awareness building] The port of Rotterdam wants to grow. Transforming part of the harbor into housing does not fit that image.

There is a need to convince the port that heavy making close to the city is not desired and that 3D-printing can replace part of the production line

[attracting] Placemaking and incentives to attract makers to the mixed-use area in the east, for example by creating temporary and cheap makerspaces in one of the industrial buildings

[regulating] Damen needs to make investments to move heavy repair to the west side of the harbor, therefore they need assured security of space.

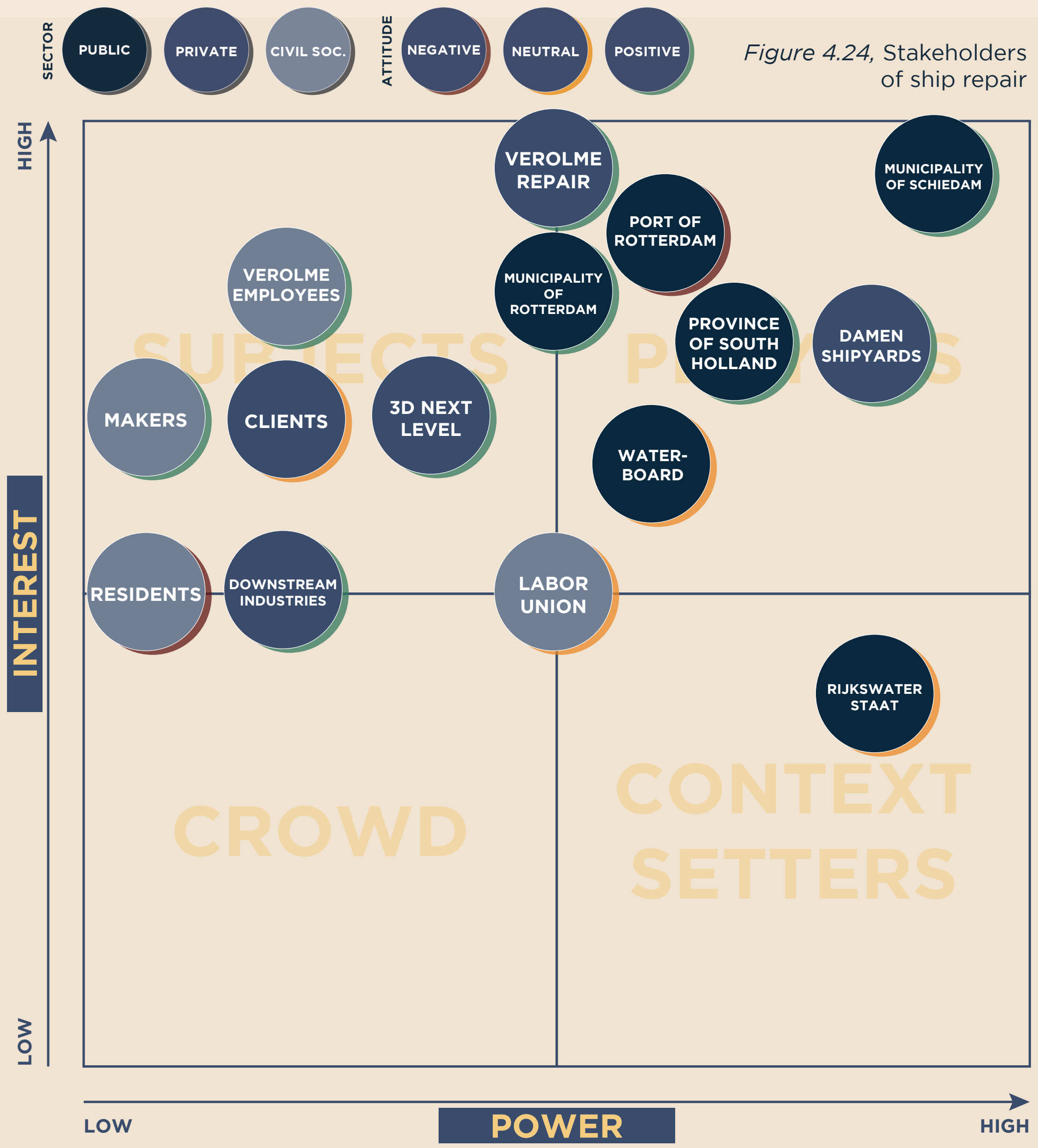
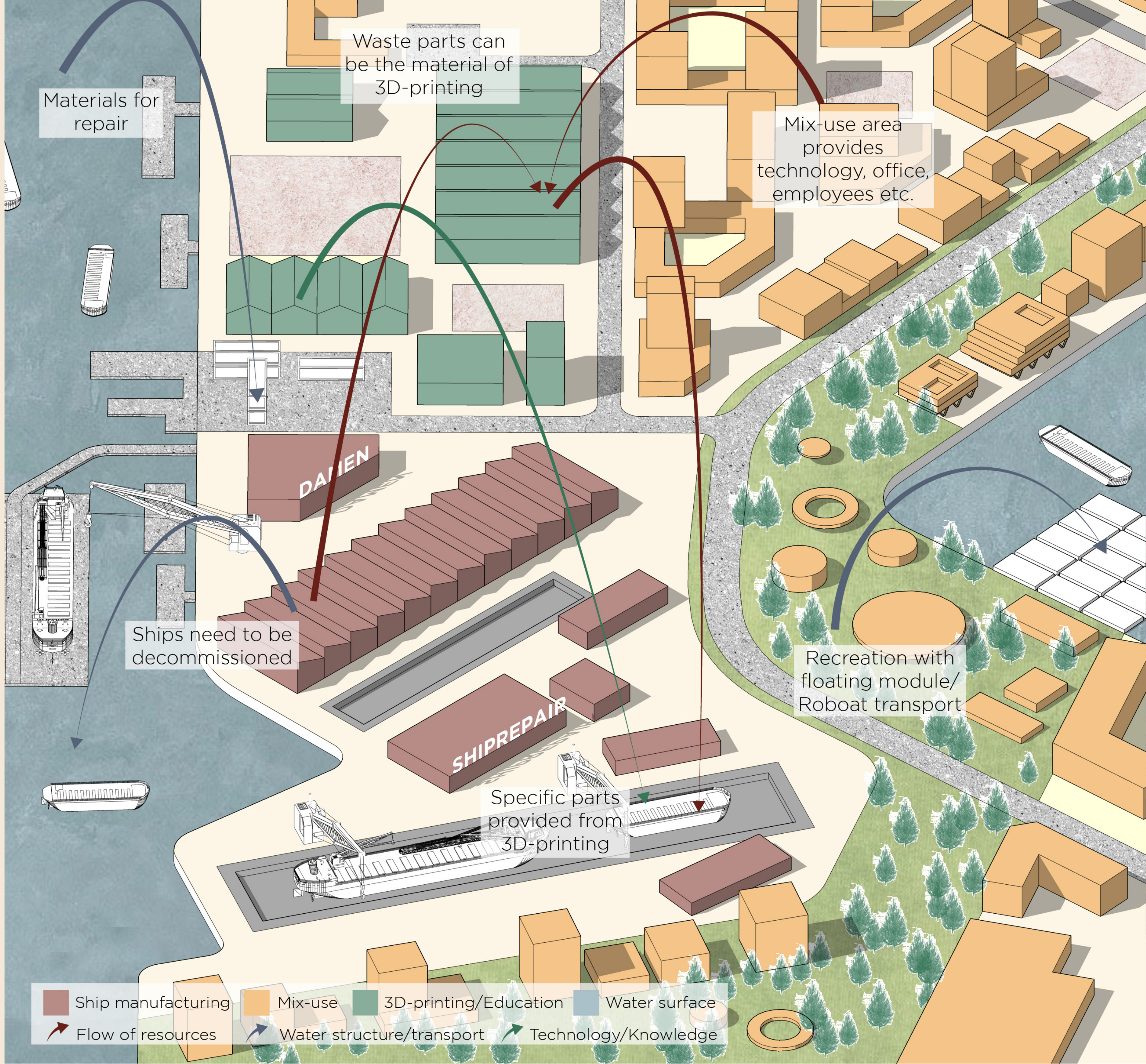
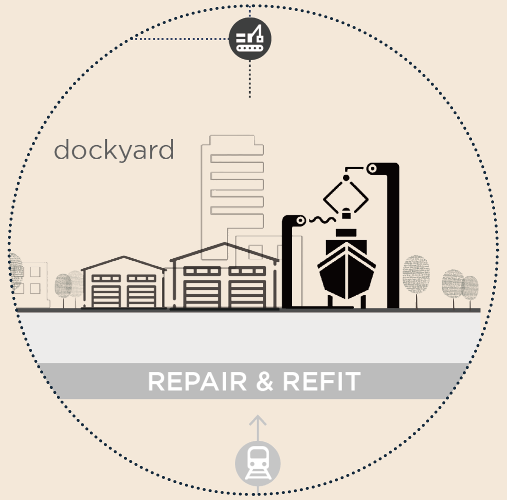


Figure 4.24, Stakeholders of ship repair

Figure 4.25, Collaboration and flows of ship repair



4.11.6. Impression before



The meeting between the Admiraal de Ruyterstraat and the back of the Damen Shiprepair & Conversion, is chosen as the view to show the contrasting change in atmosphere and program. In the current systemic section, this industry shoulders the burden of bridging the phase between shipbuilding and decommissioning, while at the same time dealing with the need to bring a synergy of mixed-use functions to the mainland.

Currently, the industrial areas are separated from each other by fences and walls, resulting in monotonous closed atmospheres, and inefficient use of land. There are primarily large industrial buildings with large open spaces, which lack human scale. The ship repair dockyard generates a high level of nuisance, which have a negative impact on surrounding offices and residents in Schiedam-West. The main users of the space are the employees of the local industrial companies.

Figure 4.26, Schiedam, (Google map, 2022, https://www.google.nl/maps)

4.11.7. Impression after

With our strategies established, the ship repair sector will become a multi-industrial zone integrating with living, 3D-printing and green infrastructure. Based on the level of nuisance in different industries, we adjusted the distribution of them, switching the high nuisance of large vessel repairing to the side closer to the highway. Therefore, from west to east, a transition is formed from industrial zone to mixed-use functions. The location shown below forms an essential shackle in this transition.

The core of the site is supported by green infrastructure, which is part of the buffer between the repairing site and mixed-use area. Meanwhile, this space meets the needs of residents, workers and makers nearby, providing them with amenities and a high quality public space. The back-face of the Damen repair building is decorated with graffiti, so that it adds value to the public space. This adds to the efficiency of land use, while making shipyard work more attractive.

Figure 4.27, Green belt & Plaza

4.12. DECOMMISSIONING

4.12.1. Regional background

Damen decommissioning is located at the heart the Port of Rotterdam, and lies in a purely industrial area. A lot of medium and heavy industries are situated around the shipyards. This location deals with huge infrastructural barriers, surrounding and cutting through the area, creating an island-like situation. For the current situation, traffic on land like highways and railways still play a dominant role in transporting goods. The goods are transported from the west side of the Port of Rotterdam towards the north side, and towards the hinterland of Europe. The underwater tunnel situated right beside Damen decommissioning is the only way to allow car-running traffic to connect to the north side, towards the inner city of Schiedam and Rotterdam.

Figure 4.28, Current situation, regional scale

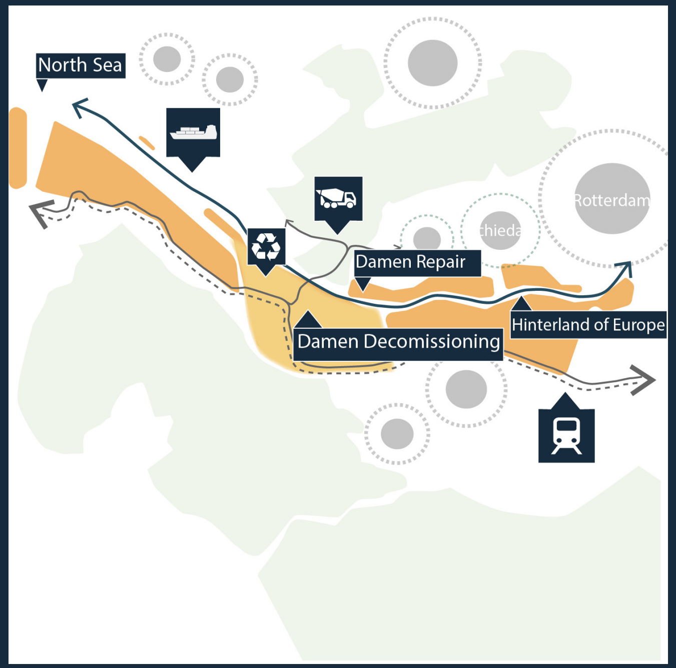
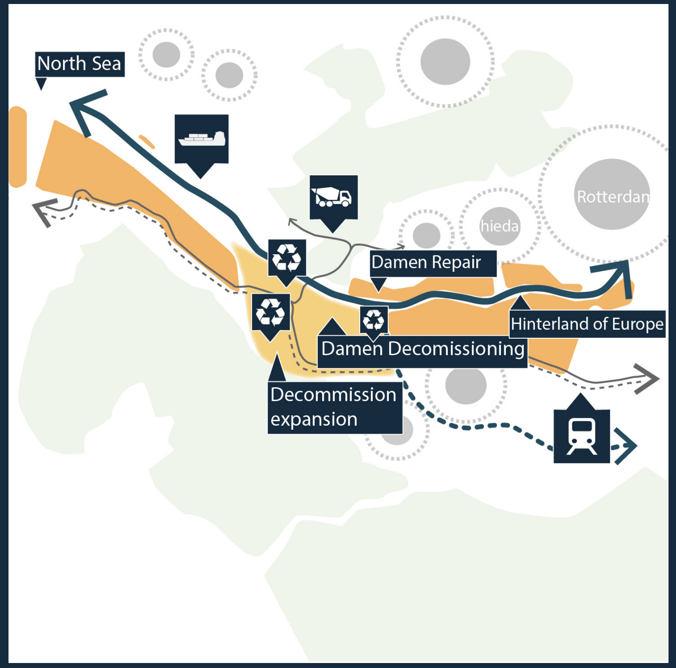


Figure 4.29, Future situation, regional scale



After implementing the circularity strategy, the orientation of the area will shift. Making use of the separated, island-like characteristics, the area is now focused towards the waterscape of the Nieuwe Maas. The waterscape will be used to transport materials, which connects to the regional loop of waterways. As a result of the expansion of Damen Decommissioning, and a more efficient use of quays, the industrial productivity will be raised. In addition, a zoning plan will help introduce more related industries and preserve recycling facilities. With this approach, Botlek contributes to a more sufficient recyling and decommissioning capacity.

4.12.2. The current site

Figure 4.30, Current analysis of the site

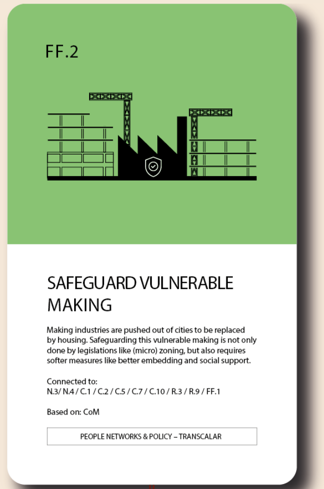
4.12.3. Future design

The main action for the Botlek area is safeguarding the industry *(Safeguard Vulnerable Making, FF.2)* which will mainly be done by increasing their local value, trough adapting the manufacturing process to more circular (recycling) standards, and *Mixing Complementary Making and Related Services (N.3)*. In addition, a residual energy exchange will be established with the local refineries, which will shift towards a bio-based sector *(Re-use of Material and Energy Flows, N.2)*.

The recycling industry will be clustered around the main inner harbor *(Accessible Material Recovery Facilities, C.8)*, where the space will be redesigned to optimize the recycling activities, for example by creating *Quays for Easy (Un)loading (FF.9)*.

Autonomous Ship Technology (FF.5) can form connections between the two Damen sites, while *Sustainable Ship Transport (FF.7)* imports to be recycled vessels and exports recycled resources *(Re-Use of Material and Energy Flows, N.2)*.
To further maximize material recovery, *Smart Disassembly of ships (FF.4)* is implemented and a *Material Database (R.12)* is centrally located in the Damen cluster. All of these interventions are part of a new *Centralized Logistics Zone (N.6)*.

To contribute to an open and attractive work environment, the green quay will be extended into the area through a *Quality Urban Environment in Making Areas (N.8)*, leading to a meeting space for employees.



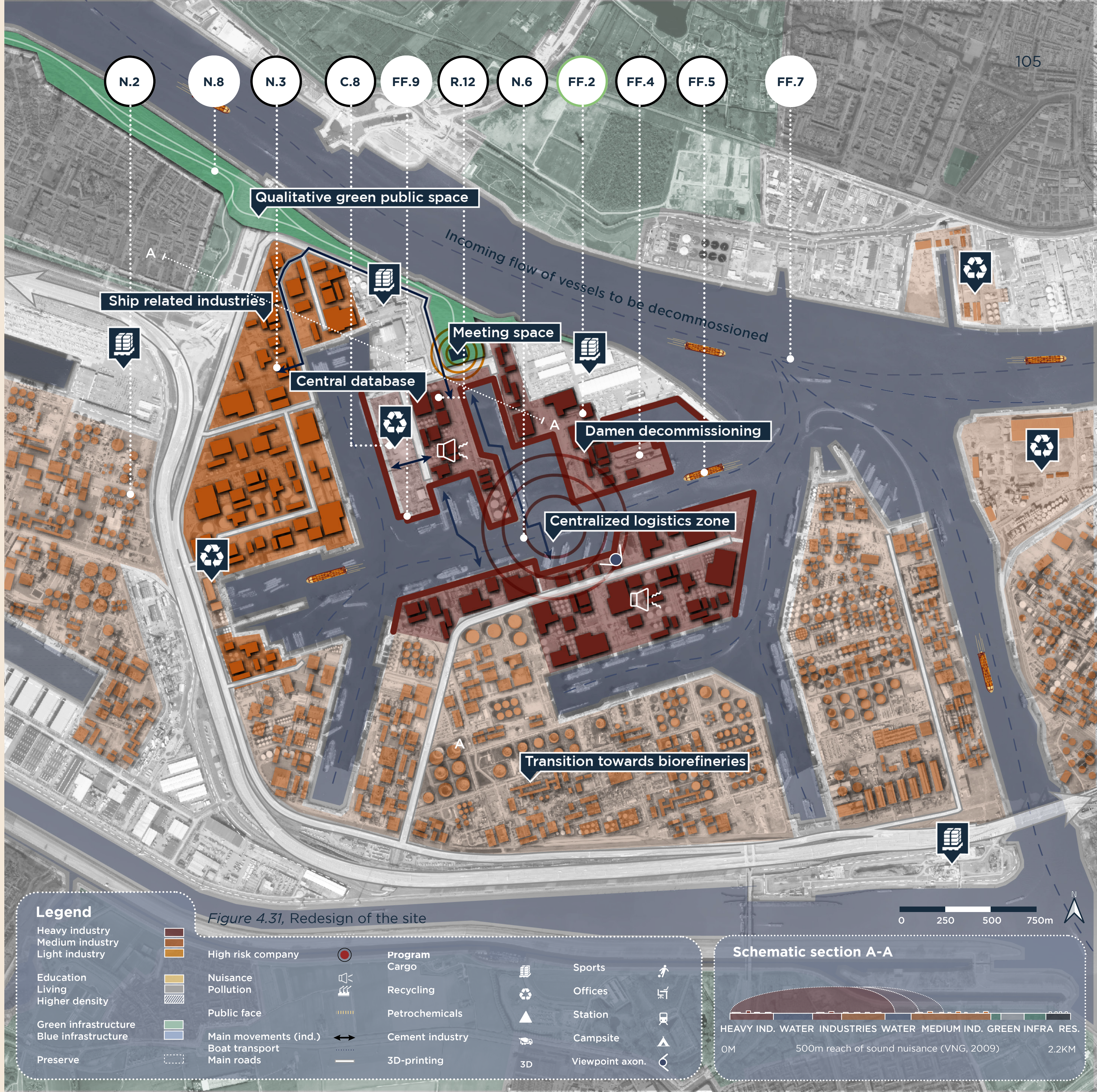
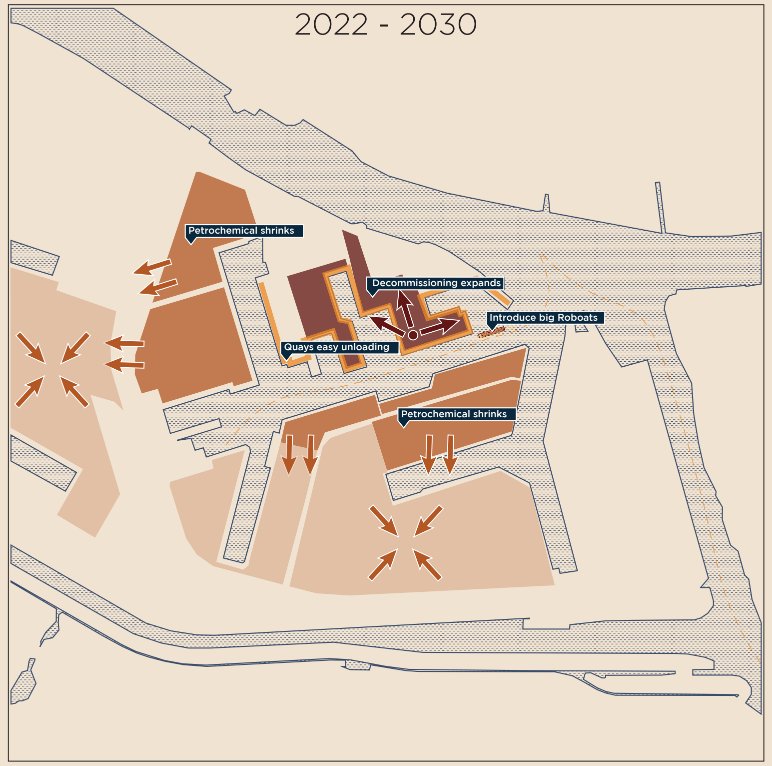
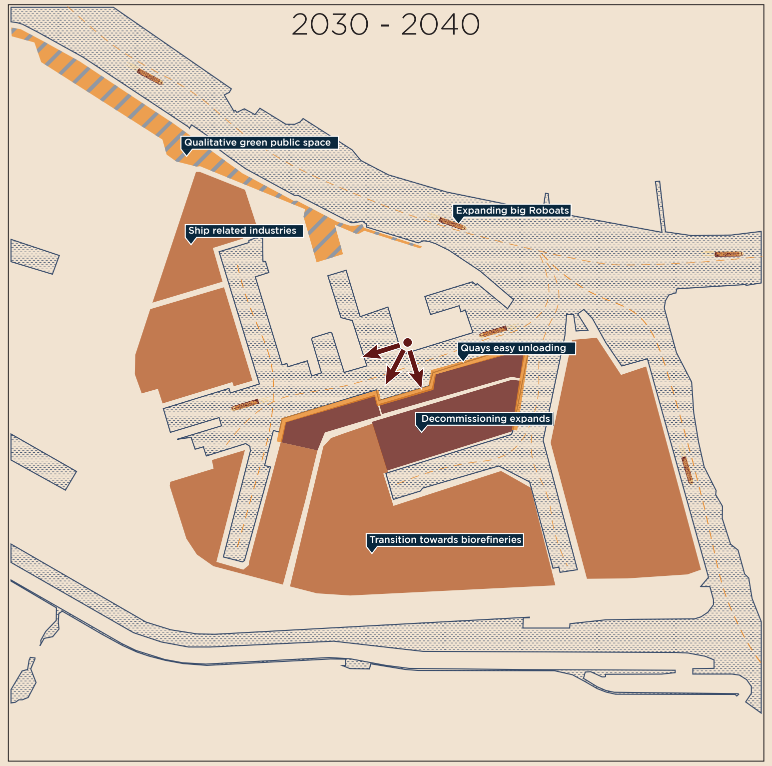


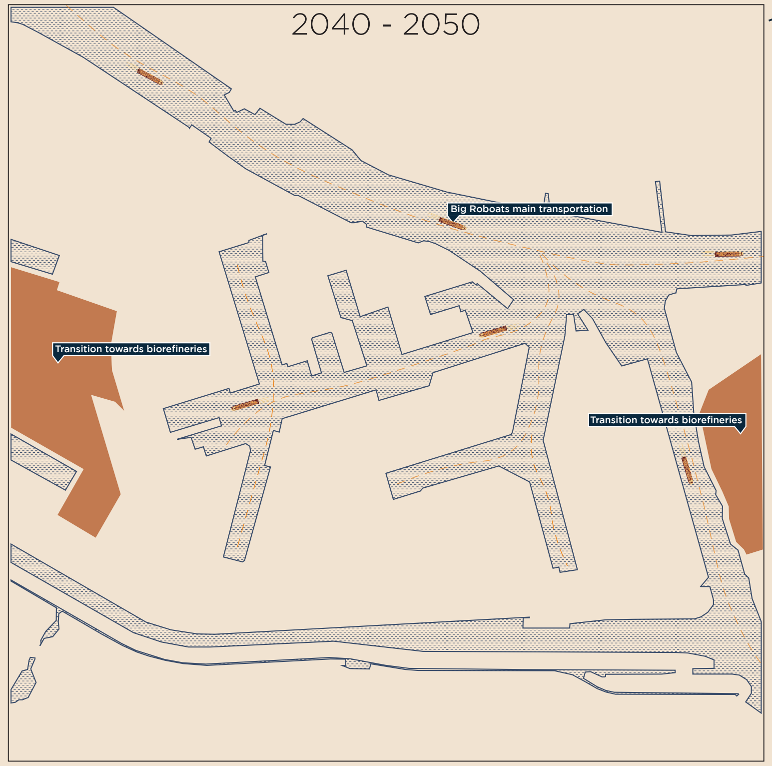
Figure 4.31, Redesign of the site

4.12.4. Timeline

To guide the expansion of Damen Verolme in Botlek, where the petrochemical industries will shrink and transform, multiple main actions need to be implemented step by step. This is shown in this site-specific timeline. In the first phase changes in education, jobs and policies are important to prepare for the shift. In the second phase, petrochemical industries will move and shrink, while the ship decommissioning site will take their place and expand. Finally, in phase three, the entire area is operational. During this phase, more ships can be decommissioned locally. total shift can be finished as early as 2040, as in this specific location time-intensive mixing is not part of the plan.







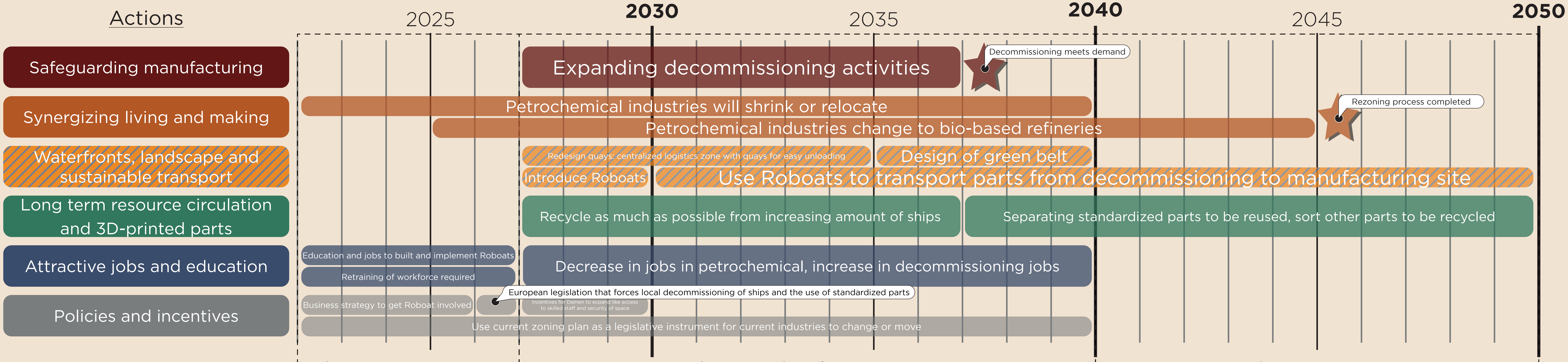


Figure 4.32, Timeline of decommissioning

4.12.5. Local stakeholders

The strategic key projects need stakeholder collaboration to become successful. For this key location, we identified the most important stakeholders and their attitudes. Afterward, we placed them in a power-interest matrix, see the image on this page. This ordering of stakeholders allows to come up with strategies to engage the different stakeholders, and make the most of their attitudes. For the success of the project, it is important to start engaging as soon as possible, in the first phases of the previously shown timeline.

Stakeholders engagement strategies:

Phase 1:

[attracting] Need for a business strategy to get Roboat involved.

[convincing] Stimulate shift in education and retraining of workforce, to prepare for circular and attractive jobs.

[regulating] Use the current zoning plan as a legislative instrument for petrochemical industries to move and/or change. (Gemeente Rotterdam, 2011)

[regulating] European legislation for more local decommissioning and the use of standardized parts by 2026.

Phase 2:

[awareness building] Residents would prefer to see all heavy industry go. This is impossible as the province needs the industry and industrial resilience. A conversation will improve mutual understanding.

[attracting] Incentives for Damen decommissioning to expand. Besides the European legislations, incentives like access to skilled staff and assured security of space, together with the improved water infrastructure, will stimulate expansion.

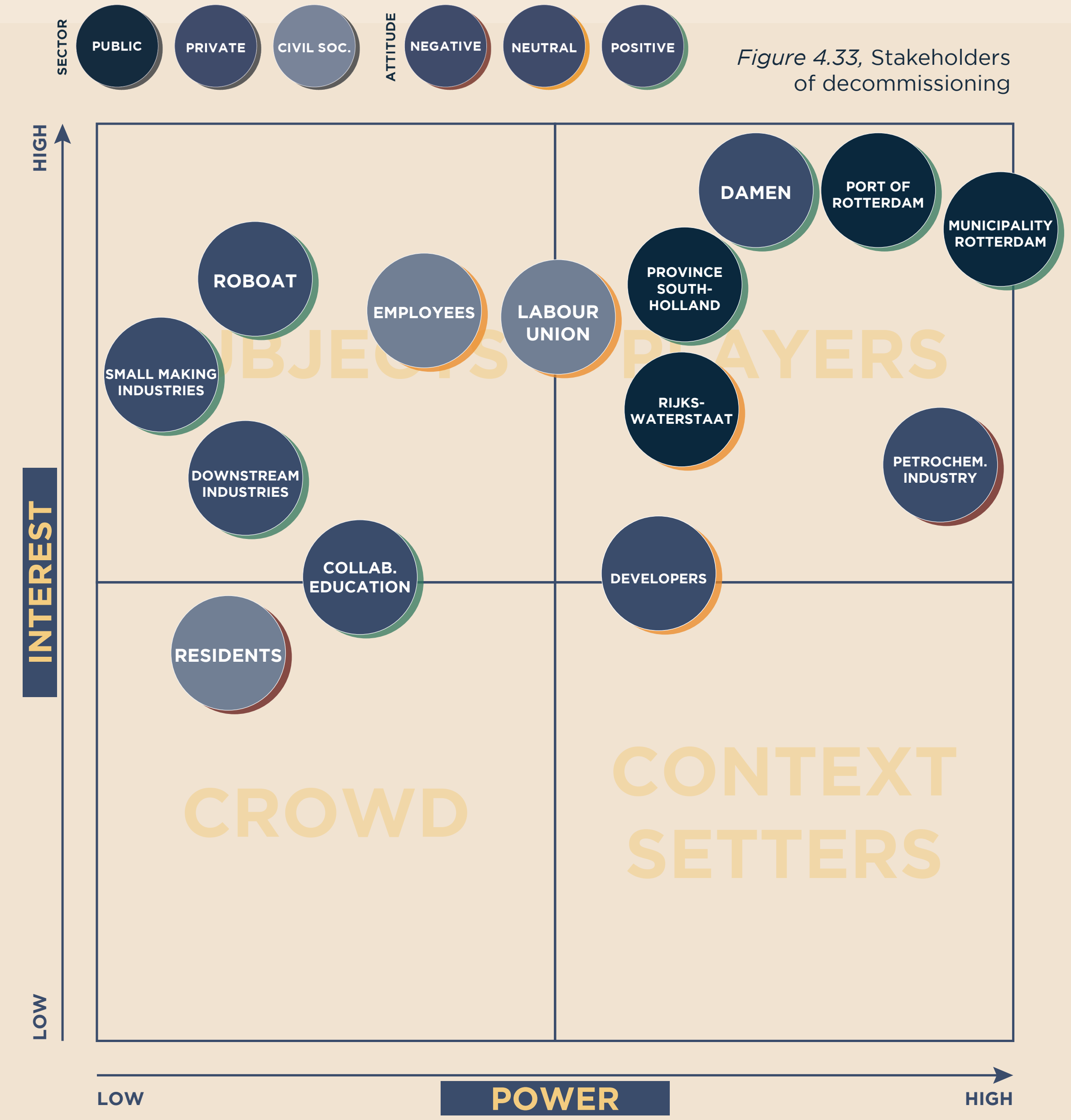


Figure 4.33, Stakeholders of decommissioning

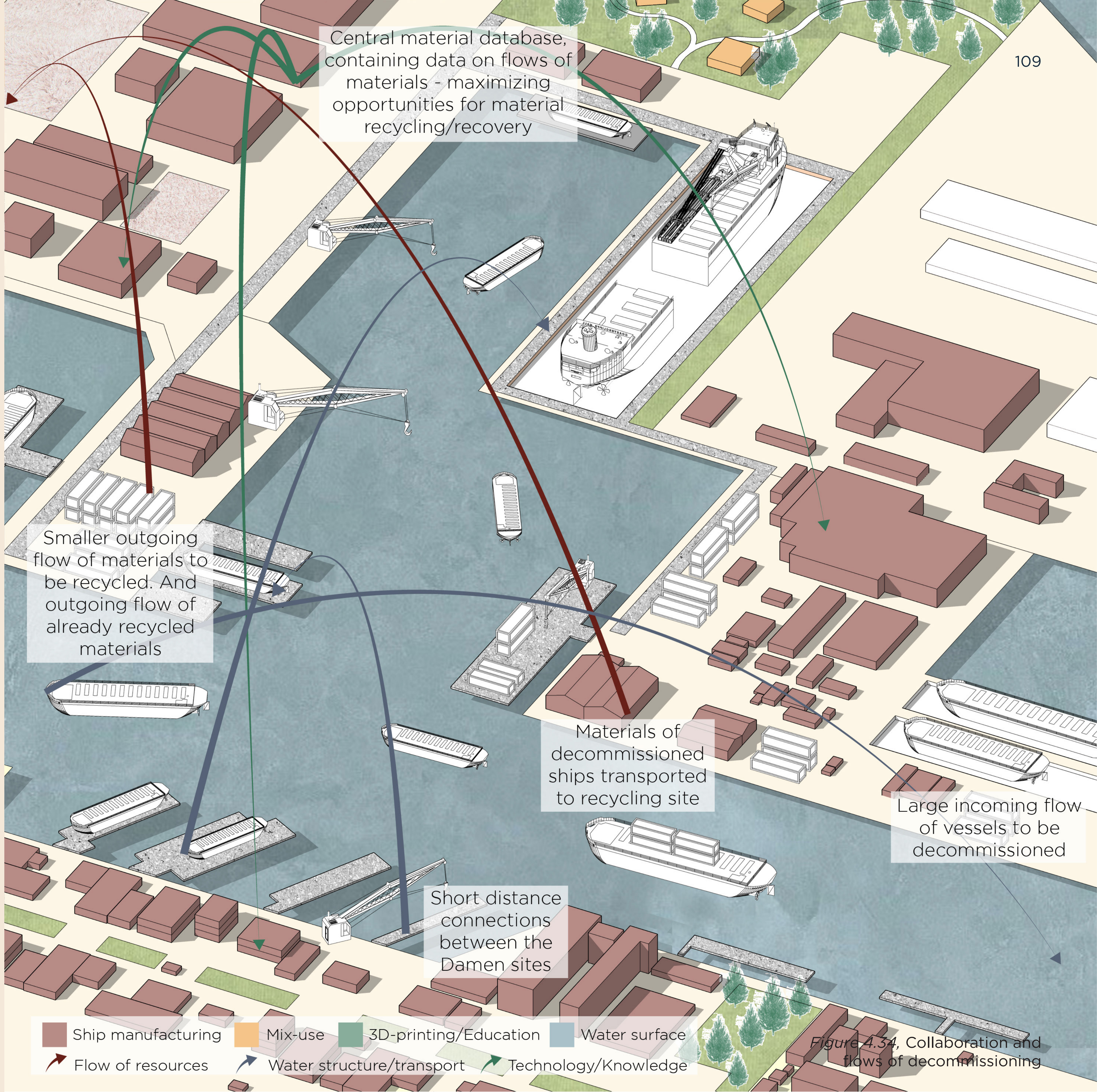
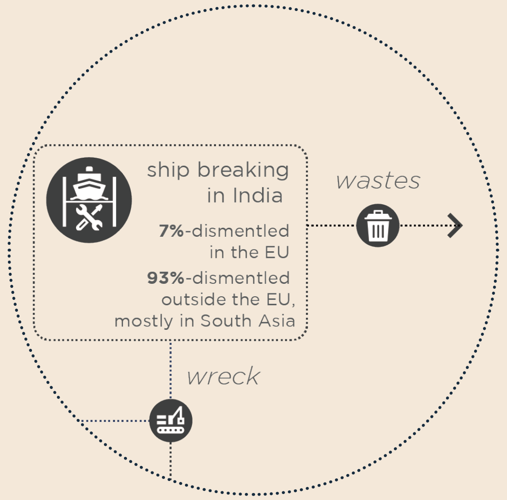


Figure 4.34, Collaboration and flows of decommissioning

4.12.6. Impression before

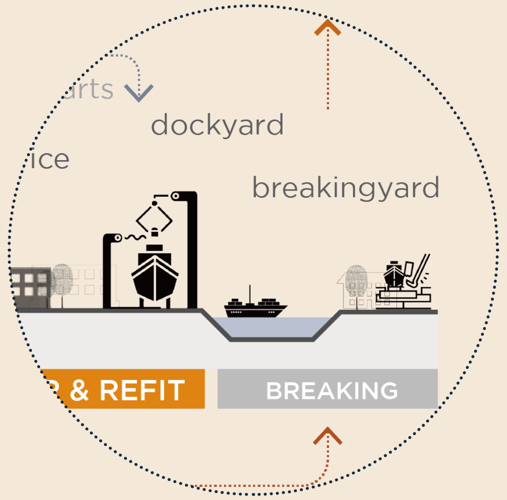


While Damen has ship decommissioning facilities in the Botlek area, these facilities don't dominate the main spatial characteristics of the area. Instead, the view is characterized by a skyline of petrochemical industries. The lack of decommissioning activities in the current view, symbolizes the current lack of local ship decommissioning and recycling processes. The fragment of the systemic section refers back to this problem: ship breaking currently mostly takes place outside of the EU (Hoezen & van 't Hoff, 2021).

The current view shows how the area displays a strong industrial atmosphere. This includes industrial infrastructures such as pipes, lighting and cranes, and a highly paved surface. As of right now, the space is strongly segregated by private plots of land that are divided by fences. What is remarkable, is that the parking lot obstructs the access to the quay, which could be used for the exchange of goods. The space is solely used by the employees of the company related to that specific plot.

Figure 4.35, Botlek, Damen recycle(Google map, 2022, https://www.google.com/maps)

4.12.7. Impression after



After implementation of the vision, ship breaking and recycling is now locally introduced into the systemic section. In the Botlek area, this means that a large share of the current petrochemical industries will make space for the expanding decommissioning and recycling activities of Damen.

Instead of being closed-off plots of land, the area has opened up towards the waterscape. The waterscape can now be perceived as an essential part of the industrial activities. The view is dominated by decommissioning activities and the processing of parts that are to be recycled. A redesign of the quays assures that they now serve the intensified water transport as efficiently as possible. The space is still mostly used by employees of local companies, but as the industrial activities are now more opened up and interconnected, employees move more freely through the area.

Figure 4.36, Decommissioning and recycle harbor

4.13. 3D-PRINTING

4.13.1. Regional background

The Schieoevers area in Delft is not yet an actor in ship manufacturing in the current situation. Compared to the other key locations, Schieoever has the closest relation to central urban areas, with a railroad connecting to the Hague and Rotterdam. However, the current water transport is underused and the canal Delftse Schie is barely used for industrial transport. However, the water of the Delft canal flows directly into Delfshavense Schie, Rotterdamse Schie, and Schiedamse Schie, which all play important roles in the water network of the port of Rotterdam.

Currently, the Schieoevers area is mainly occupied by medium and heavy industries along the waterway. Schieoevers is in close proximity to the TU-Delft, which is a cluster of innovation and high technology.

In 2050, water transport in Delft will be fully activated, and the Schieovers area will be involved as a key chain in the maritime cluster. Water transport will take responsibility for waste collection, roboat transport, and ship metal delivery. A 3D-printing technology hub, which will be strongly related to other areas along the provincial loop, will be placed here to support the innovation of ship-making. The transformation of the Schieovers area will be centralized along the waterway, incorporating program for living, recreation, education, and industry.

Figure 4.37, Current situation, regional scale

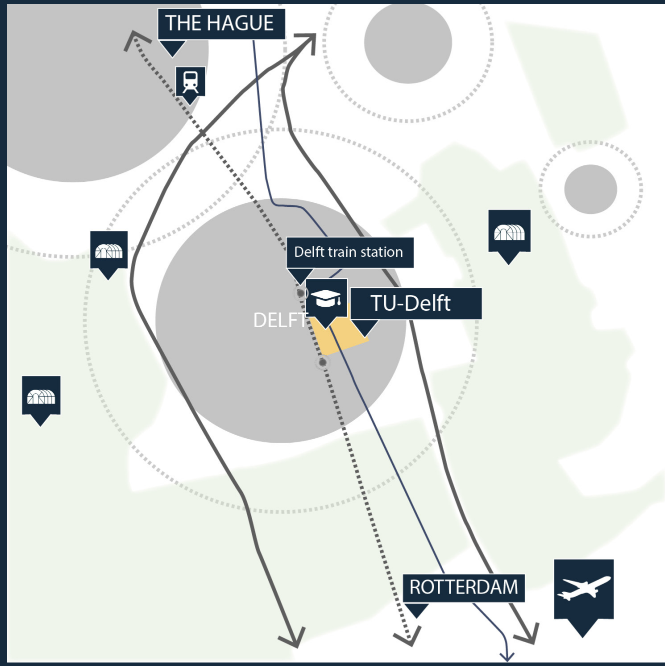
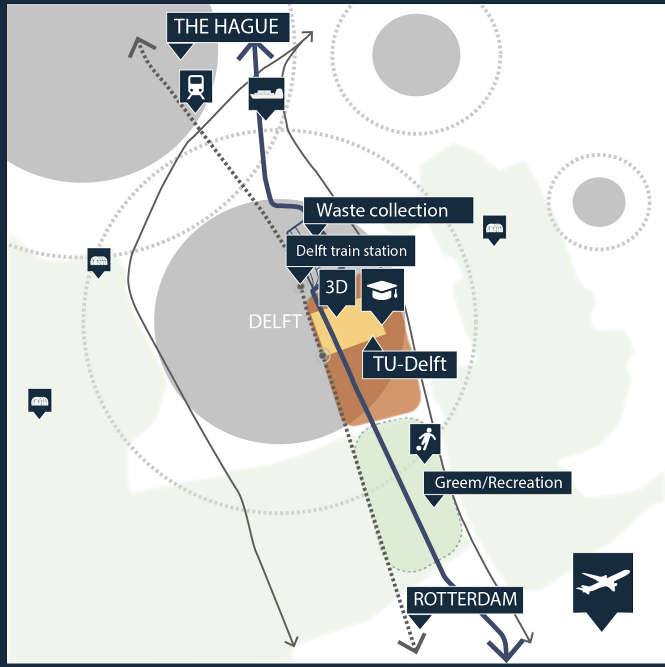


Figure 4.38, Future situation, regional scale



4.13.2. The current site

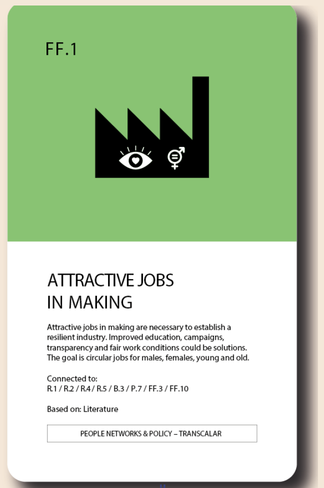
Figure 4.39, Current analysis of the site

4.13.3. Future design

Delft will mainly focus on small scale light industries and *Improved 3D-Printing Technologies (FF.6)*, related to the main action of creating a long term circulation of resources and 3D-printed parts. The 3D-printing industry is connected to the provincial water structure with *Sustainable Ship Transport (FF.7)*, along which quays are smartly configured by creating *Quays for Easy (Un)loading (FF.9)* where needed, and green *Quality Urban Environment in Making Areas (N.8)* where possible. This is done to balance both the need for efficient exchange of goods as well as the desires of local residents.

To further embed the industry into its urban context, a small scale synergy between making and living is supported in a mixed-use makers district, through facilities such as *The Work Home (P.5)*, *Re-Use and Repair Centres (P.6)*, and *Making Around Courtyards (B.1)* combined with student housing.

Ship manufacturing and education are related both through practices, such as *Local Design & Prototyping (N.7)*, as physical elements, such as a new bridge across the Schie *(Make Physical Connections, FF.12)*. This helps achieving the main action of creating an open and attractive work environment, as it helps improving the exposure of the ship manufacturing sector as an innovative work field (towards students).



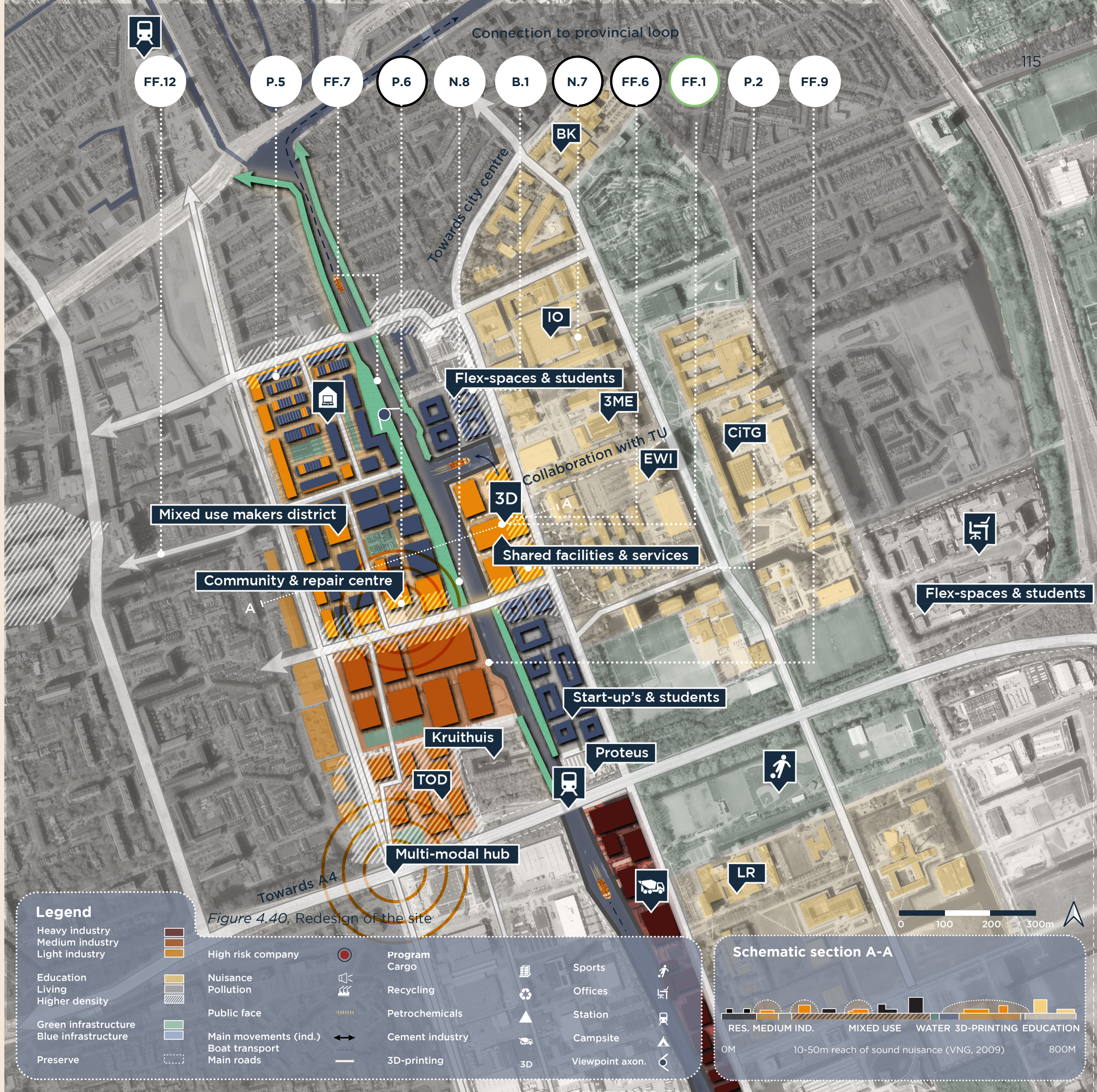
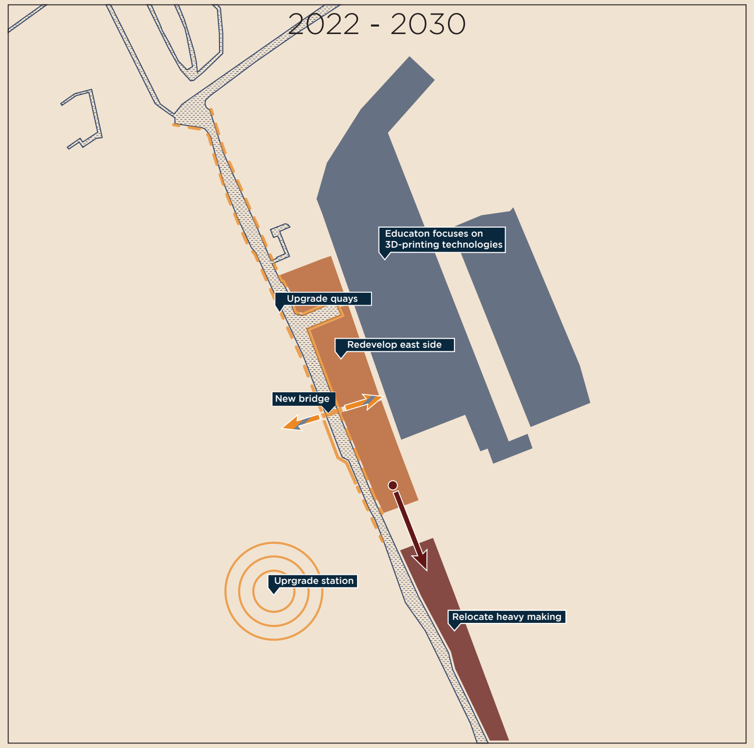
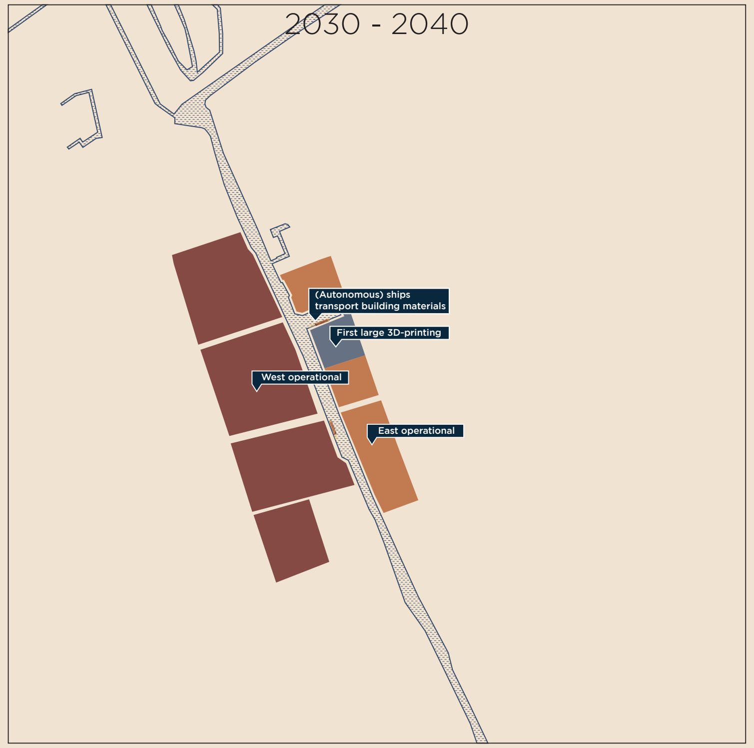


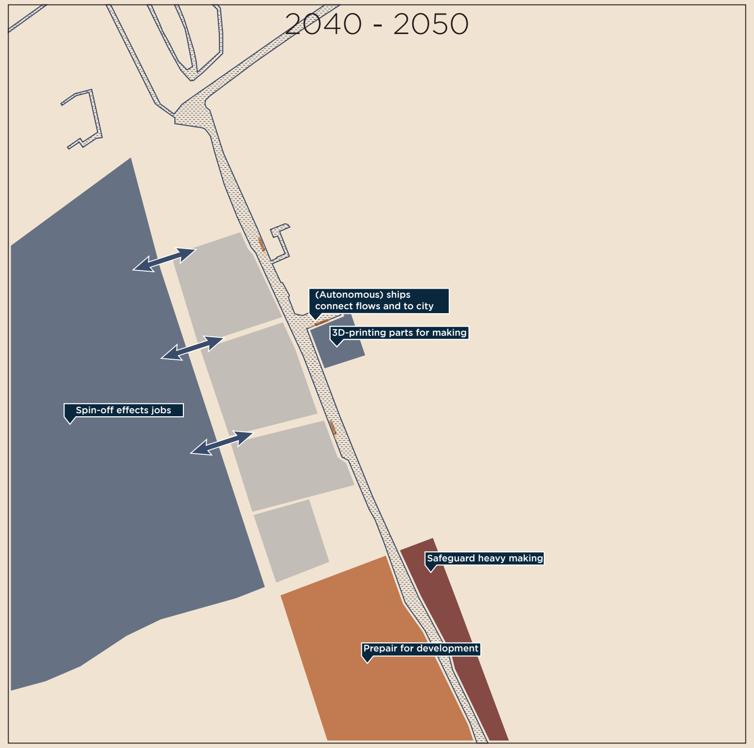
Figure 4.40, Redesign of the site

4.13.4. Timeline

To guide the development of a makers district at Schieoevers Delft, where the heavy industry will make place for a mixed-use environment with a new large scale 3D-printing facility, multiple main actions need to be implemented step by step. This is shown in this site-specific timeline. In the first phase, heavy industries will move south, so that the east side can prepare for new functions. The education focuses on improving 3D-printing technologies. In the second phase, both sides of the water are redeveloped as mixed-use areas. Finally, in phase three, the makersdistrict is operational, parts are 3D-printed and flows are connected by autonomous boats and ships. The spin-off effects also become visible in neighboring areas.







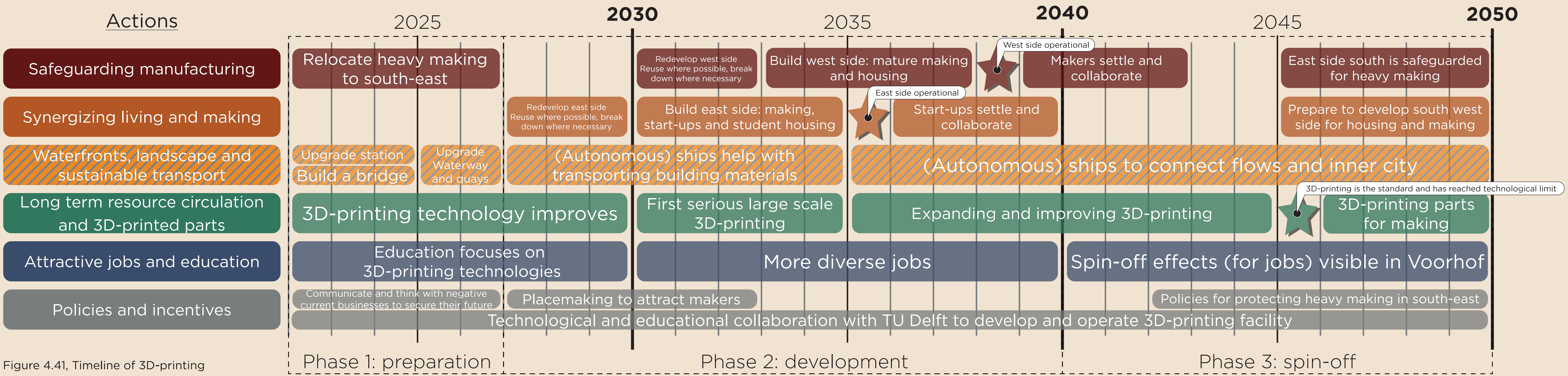


Figure 4.41, Timeline of 3D-printing

4.13.5. Local stakeholders

The strategic key projects need stakeholder collaboration to become successful. For this key location, we identified the most important stakeholders and their attitudes. Afterward, we placed them in a power-interest matrix, see the image on this page. This ordering of stakeholders allows to come up with strategies to engage the different stakeholders, and make the most of their attitudes. For the success of the project, it is important to start engaging as soon as possible, in the first phases of the previously shown timeline.

Stakeholders engagement strategies:

Phase 1:

[awareness building] Communicate and think with stakeholders such as SUEZ, Kabelfabriek, Dyckerhoff Basal, Lijm & Cultuur, and other current companies to get them on board or at least make them more aware of the needed transition.

[attracting] Work close with TU-Delft to make fast technological advancements, mainly in 3D-printing.

[convincing] Convince neutral stakeholders like the waterbody and ground owners with good communication. Use a great vision, which focusses on the possibilities related to the improved water infrastructure and sustainable transport.

[regulating] Relocate heavy making in the southeast part and assure the security of that space for at least 50 years.

Phase 2:

[attracting] Placemaking to engage positive but less powerful stakeholders, like 3D Next Level and other makers. This placemaking can also show neighborhood association Delftzicht that the new developments can be something positive for them.

[convincing] Make use of the power of positive stakeholders like the municipality of Delft and the client (GDPT), who owns parts of the land, to make progress.

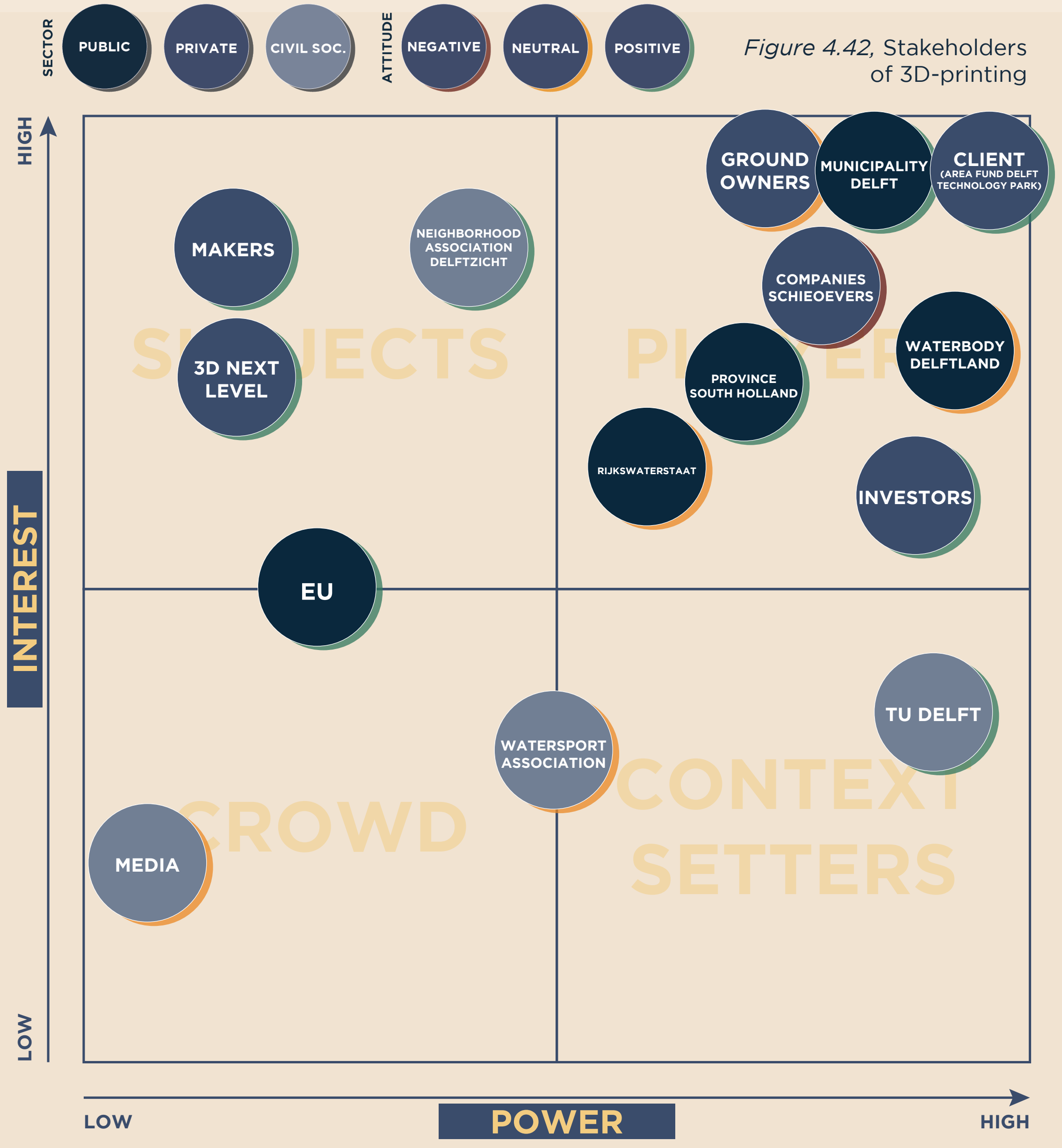


Figure 4.42, Stakeholders of 3D-printing

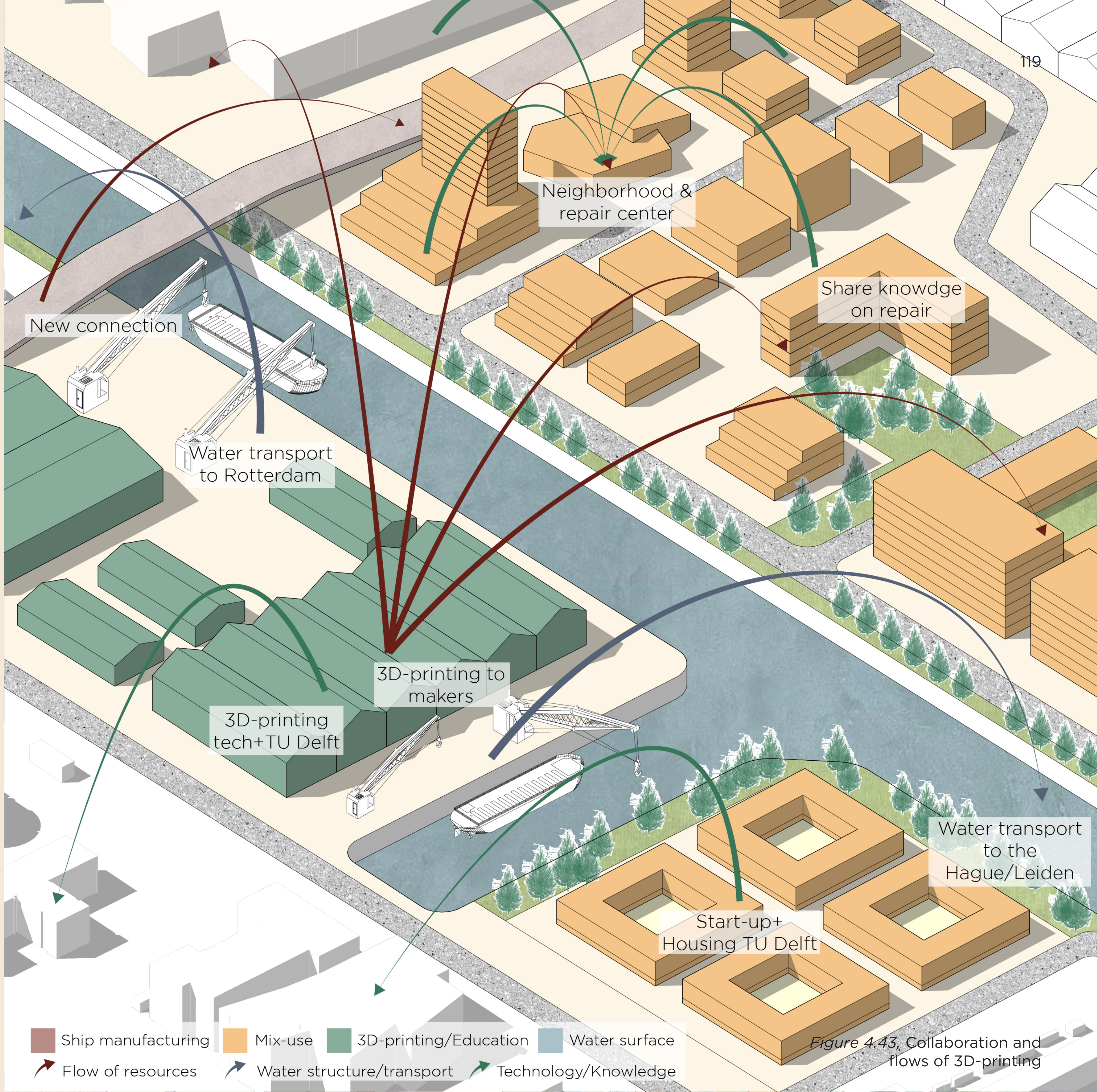
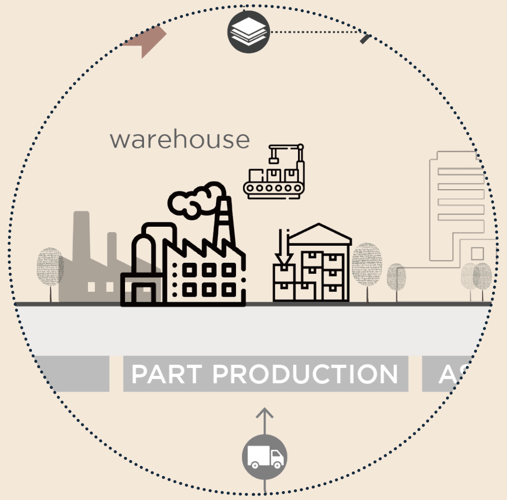


Figure 4.43, Collaboration and flows of 3D-printing

4.13.6. Impression before

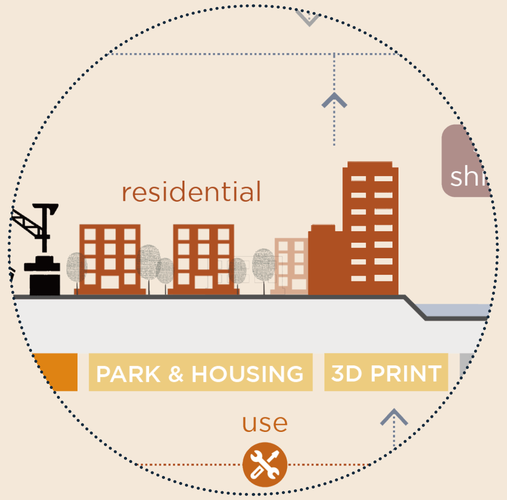


Schieoevers Delft is currently not part of the maritime cluster, as the manufacturing of parts currently takes place in other areas where more heavy industry is allowed. Currently, there is a lot of medium and high nuisance industry situated here along the Schie waterway, but there is also a significant number of unused or underused plots. In the current view, important actors such as TU-Delft and Dyckerhoff Basal (concrete factory) are visible in the background.

These functions result in a spatial atmosphere that is separated from other functions like living, and is therefore quite monotous. The streets are often dominated by trucks transporting goods. These trucks, together with the nuisance and smells produced by the concrete factory, conflicts with the neighboring TU-Delft and the students moving through this space. Most characteristics merely benefit the companies, which makes the area not spatially just.

Figure 4.44, Delft, TU & Schieoevers, (Google map, 2022, https://www.google.com/maps)

4.13.7. Impression after



After applying the vision and strategy, the Schieoevers in Delft will be completely transformed by 2050. The Schieoevers are now part of the maritime cluster, as education and large-scale 3D-printing are now integrated. The improved waterways connect this area to the rest of the newly established loop. The Schieoevers changed into a mixed-use makers district with student housing on the east side.

This big change in function results also in a new atmosphere: this area is now the most urban of our four key locations. The waterfront now provides new public qualities where possible, while being alternated with quays for easy unloading to benefit the makers. The space is now more inviting for all people. On land, slow traffic has priority and a new bridge connects east and west for them. In the water, the space is shared between small Roboats, larger autonomous ships, and rowing students. So, in 2050 this area will be inviting for both making and living.

Figure 4.45, Mixusing with 3D-printing

4.14. CONCLUSIONS

The previous four location-specific designs illustrate how the general vision can spatially be applied, according to which timeline, and with which involved stakeholders. The designs clearly show how the necessary design solutions vary a lot, depending on the characteristics of the site. This substantiates that when applying the vision to other locations, the vision should always be adapted to fit a specific urban setting and/or a different industrial context. The most dominant differences and similarities between the designs of the four key locations will be briefly summarized in this conclusion.

Gorinchem, ship building
The first location is Gorinchem, the shipbuilding location. The design primarily influences the industrial site, leaving the residential areas mostly untouched. The proposed solutions mainly evolve around creating new relations, either to the waterscape or between different local industries. In addition, the focus lies on expanding the Damen Academy and creating qualitative industrial space, which contributes to enabling the main action of 'providing an open and attractive work environment'.

As Gorinchem is the only location integrating the tourism sector, there are location-specific stakeholders involved such as the VVV and Staatsbosbeheer. Most interventions can be implemented before 2035, in the following years the timeline is dominated by newly implemented processes such as producing Roboats, the printing of 3D-printing parts, and educating the future generations of shipbuilders. The collage clearly symbolizes that the industrial atmosphere is mostly preserved, while new qualities are added such as qualitative architecture.

Schiedam, ship repair
The location of ship repair, Schiedam, would be the location that changes most. This is mainly because the huge pressure on land asks for a complete rezoning of land, which allows redefining the relation between working and living. This is also why in this location, the dominant main action is 'synergizing living and making'. In contradiction to for example the Botlek area, this location asks for an impactful redesign of (green) public space, to generate a high-quality environment in such a mixed urban area.

The fact that this location includes an elaborate design, is something you can see back in the related timeline. Developing the mixed-use area is something that will continue developing through the years up until 2045. Contrary to Gorinchem, where the residential area remains untouched, important stakeholders are the residents. Their initial standpoint might be negative, but the design proves how working and living can sufficiently be mixed without experiencing heavy nuisances. The collage shows a completely different atmosphere than Gorinchem. In this location, the current strong industrial atmosphere fades away and blends with a new high-quality public space.

Botlek, ship recycling
In comparison to the other sites, the identity of the Botlek ship recycling area remains the most preserved. This is because in this location, the already present recycling facilities will be expanded, without shifting to a more mixed-use or residential area. For that reason, the most dominant main action is 'safeguarding vulnerable ship manufacturing'. Most implemented patterns focus on optimizing processes and introducing new technologies. This substantiates why most used patterns are black (which are patterns about Circularity and Technology). It's something that comes back in the related timeline: implementing new technology is most of the time less time-intensive than elaborate spatial interventions. The intervention that takes the most time is the rezoning process, just as in the Schiedam location. In this case, the rezoning includes the petrochemical industries that will change over time to bio-based refineries. In the collage, the industrial atmosphere is most strongly articulated of all locations. It becomes very clear that this is the location where the priority goes to the industrial activities, with the employees working at the shipyard as the main users of the space.

Delft, 3D-printing
Schieoevers Delft shows, as well as the Schiedam location, that embedding manufacturing in a highly mixed urban area, asks for a quite impactful design. In this location, 3D-printing industries are introduced, which allow for heavy mixing. For this reason, 'creating a long-term circulation of resources and 3D-printed parts' and 'synergizing living and making in pressured areas' are the dominant main actions. Nearly the full industrial area is shifting towards a mixed area with new housing introduced, which comes with an important redesign of (qualitative) public space.

The extensive redesign of the location is also apparent in the timeline: various interventions can only finish by 2050. Just like the other locations, in Delft stakeholders such as the municipality, ground owners, and local companies are involved. A stakeholder that's newly introduced in this location is the TU-Delft. The Gorinchem site includes the Damen Academy, but Delft is the only location with a newly involved educational institution in such close proximity. The collage of Schieoevers Delft reveals the most mixed-use atmosphere, characterized by the most qualitative and accessible public space. Compared to the collage of the Botlek area, this manufacturing space allows new users: families can safely use the space, without experiencing any strong nuisances.

5 CONCLUSION AND REFLECTION

5.1. CONCLUSION & REFLECTION

This report provides the results of the implementation of spatial, technological and regulatory solutions that are needed to integrate circularity into every step of the ship's lifecycle, in this case specifically in South-Holland.
Research has shown that fundamental change is required, as the ship building industry has to deal with environmental challenges, social pressures and (inter) national regulations on implementing a more circular production cycle.
To make the change happen and transition the ship manufacturing cluster towards a circular future, we analyzed the current situation, proposed a vision and made a strategy based on three sub-questions.

What is the status quo of the ship manufacturing cluster?
While a lot of the shipbuilding activities are centralized around the port, not all of the related industrial activities take place in the province of South Holland. The ship manufacturing system is characterized by a linear life cycle in which various activities depend on other countries, such as the supplying of steel (mainly China) and the decommissioning of ships (primarily Bangladesh, India, and Pakistan). This system is thus based on large distances and open loops, which are not sustainable nor circular.

The shipbuilding sector and its industrial and economic activities are of high significance to the province of South Holland. The economic significance is, among other things, based on the fact that the industry in the province generates billions of euros yearly, and includes the largest share of shipbuilding employees in the Netherlands. The spatial importance is mostly proven by the finding that the province houses two important shipbuilding clusters, a seagoing cluster and a recreational cluster, of which the shipbuilding sites often lie near or in crucial urban areas. The clusters do not only consist of shipyards but also include other parts of the maritime cluster and suppliers of parts and materials, like metal, rubber, paint engine, and interior suppliers.

How to spatially transition ship manufacturing into a more circular and sustainable cycle in terms of environmental and social justice in South Holland?
On the basis of the analysis, a vision is proposed to spatially transition the ship manufacturing sector into a more sustainable and circular cycle in terms of environmental and social justice. The main actions include safeguarding vulnerable ship manufacturing, synergizing living and making in pressured areas and smartly configuring public and private waterfronts. In addition, to improve the system of flows it is proposed to create long-term circulation of resources and 3D-printed parts and to connect them by sustainable transport. The final main action is providing an open and attractive work environment.

Environmental justice is improved by reducing the need for raw materials. The expansion of the decommissioning site will recover more materials locally and the 3D-printing of parts produces less material waste than conventional methods. Together with the introduction of standardized parts and a sustainable transport network, we limit the impact of ship manufacturing on the environment. Spatial justice is about sharing burdens and benefits evenly. Our vision contributes to that by mixing where possible in pressured areas near the cities. To make sure that not only the companies benefit from the proximity to employees and to make sure that not only residents have the burden of pollution and nuisance, special attention is paid to transition zones.

How to implement a circular ship manufacturing strategy into a location-specific design with the case of Damen as an example?
Location
In this report, the vision is implemented in key-locations, resulting in four location-specific designs. From this it can be concluded that while general main actions are proposed in our vision, the manner and intensity in which these actions are applied should always be adapted to fit a specific urban setting and/or a different industrial context. Sometimes an impactful transformation with a high level of mixing is desired, for example in Delft Schieoevers, while in other cases smaller or mainly strategic solutions are sufficient, for

example in the Botlek area where no mixing is required to safeguard the manufacturing. How different the locations may be, lessons that are relevant for all locations are to connect flows locally and regionally to make the areas work and transitions between making and living where mixing is necessary to safeguard manufacturing.

Patterns
The designs illustrate that different patterns are often implemented in collaboration in order to fulfill a specific main action. Sometimes, even patterns that enable different main actions strongly relate to each other. An obvious example would be Quays for Public Programme (FF.8) and Quality Urban Environment in Making Areas (N.8), which respectively contribute to a smart configuration of public and private waterfronts and a more open and attractive work environment.
Stakeholders and phasing

The regional system of flows and the proposed vision is not realized overnight. Therefore we propose a roadmap toward a circular ship manufacturing sector in 2050. No project can become a success without stakeholder collaboration. To realize our regional vision we identified the most important stakeholders and their attitudes. To benefit from different levels of power and interests of the stakeholders and to deal with their not alway positive attitudes, different strategies to engage the different stakeholders have been established. The different strategies can be grouped into; awareness building, attracting, convincing, and regulating. All dealing with a specific kind of stakeholder. For the success of the project, it is important to start engaging as soon as possible.

Combined, the answers on the sub-questions give an answer to our research question: What spatial, technological and regulatory solutions needed to be integrated into the ship manufacturing cluster of South Holland, to build circularity into every stage of the ship's lifecycle? So, in short, to build circularity into every stage of the ship's lifecycle we propose a spatial framework based around sustainable water infrastructure and transitions to allow making and living to be mixed more, technological developments like large-scale 3D-printing and standardized parts to create long-term circulation of resources, and regulations that safeguard vulnerable making, mandate standardized parts, and mandate local decommissioning.

Relevancy
The conclusions provided by this report are proven to be relevant for the province of South Holland and the Port of Rotterdam as it provides a spatial strategy on how to transform the ship manufacturing sector into a more circular sector. By transitioning to a more circular ship manufacturing sector, the port of Rotterdam can contribute to the mitigation of the negative effects of climate change and resource scarcity. In addition, it provides a solution on how to deal with the growing pressure on land, which is for example also highly relevant for the municipalities of Rotterdam and other cities.

As the port of Rotterdam and its shipbuilding sector is of great international importance, the implementation of the solutions proposed in this report can result in an (inter)national shift which stimulates change both on a local and a global scale.

By emphasizing the safeguarding of ship manufacturing, this report acknowledges the importance of the preservation of making industries in the city. This can support shipbuilding companies in their fight against the rezoning of industrial land. This report is highly relevant in today's context of high environmental pressure. In addition, the results of this report can help to create awareness on circularity, and inspire other industries by showing how a traditionally very linear product lifecycle can transition into a more circular system.

Recommendations for implementation
To implement the results of this report we recommend to use this document as an inspiration, as it shows that mixing making and living is not impossible. In the key project we demonstrated the importance of transition zones in four very different locations with specific degrees of mixing. Use these projects as an inspiration and analyze always take site specific characteristics into account. On the larger scale the vision and strategy provide enough flexibility to be adapted and improved. However, we believe that they could be the basis of a circular transition in South Holland. For all spatial planners and designers we recommend to make use of the patterns from the Cities of Making project supplemented with our patterns and even new patterns. This report can also be an inspiration for ship manufacturers, especially Damen, to not wait until

they are pushed out of the city and then fight that, but rather to take the initiative and start the transition to circularity themselves and safeguard their business in that way.

Limitations
Our research has its limitations. Besides the obvious time limit of four people and only nine weeks, our research is mostly based on literature, data, logic and design testing. We would have loved to be able to really interact with stakeholders, unfortunately that is not possible in this course. This research builds on current trends in circularity and existing literature. However, before implementing any of this we recommend more research is done.

Further research
This report focuses on the manufacturing of large industrial ships and seagoing vessels. In future research, it would be relevant to focus on the manufacturing of small ships and recreational boats. Research as such would cover the subsector that is dominant in the north of the province, which plays an important role in the shipbuilding industry of South Holland as well. Secondly, additional research would be needed to further explore the global impact of implementing this vision on a large scale.

Reflection on ethics, values and public goods
This conclusion will end with a reflection on the ethics, values and public goods of FleetFlow. To do this four questions raised by Roberto Rocco (2022) will be answered in the perspective of our project.

1. Can urban space produce/guide specific kinds of behavior on people?
In our project FleetFlow urban space produces specific kinds of behavior. For example, we introduce two types ofs quays. One stimulates people to recreate and enjoy the water, while the other restricts people from using the quay and reserves it for industrial activities. This means that the quay is not everywhere a public good. The question can be raised if exclusive access to a waterway that is maintained with public funds is morally right. In our case we think it is justifiable as industries are vital for our national economy however, when the exclusive right to a quay or waterfront is owned by one homeowner instead of it being part of the public space we think that it is not morally right.

2. Is it true that urban space is "neutral" or can it be planned and designed with values and expected results in mind?
An urban space can be "neutral" when it allows all kinds of uses and is not privately owned. However, most urban spaces are planned and designed with values and expected results in mind. In our project as well. The improved water infrastructure allows all people to use it, however, it is designed with more intense use by sustainable transport as a result in mind. This can make it less pleasant for recreational users. So, in this case the economic and sustainable values are prioritized over recreational and natural values.

3. Shall urban space be regulated or should we regulate people and how they use urban space?
In FleetFlow we regulate the urban space by safeguarding locations for vulnerable making and designing transition zones. So, we decided to regulate the urban space and let the people be more free in how they use urban spaces. However, we think that by regulating urban space, people are indirectly regulated in how they can use these spaces. Moreover, trying to regulate how individual people use the public space is harder than regulating the urban space itself and trying to guide people with its design.

4. Do we have responsibility, as planners & designers, for the outcomes of our plans and designs?
Yes, as designers we should always try everything we can to get a desired outcome of the plan that is spatially just. A weakly researched and designed plan that is based on assumptions rather than evidence is more likely to have an undired outcome. However, not everything is in control of the planner or designer. Sometimes plans are carried out differently or corners are cut because of budget. In these cases the outcome can be undesirable despite the planner or designer's efforts. In FleetFlow we hope to inspire the province and other stakeholders to take action in the field of ship manufacturing and circular economy, but we have very little influence on the final results. Therefore we have a responsibility but in the end it is not up to us.

5.2. ASSESSMENT

1. NO POVERTY

Circular ship manufacturing will provide more jobs, and address the problem for ship companies who are facing employee loss. The proposed circular economy of the maritime cluster in 2050 will create a big opportunity in the phase of ship recycling and decommission. This will demand a great increase in jobs. The approach of sharing and mixing using technologies and services is of great importance to activate spare spaces and buildings, as well as fill in the shortage of job vacancies. This will make the working environment of ship manufacturing more attractive and flexible, allowing people who work in this area to have more job options.

4. QUALITY EDUCATION

The quality education provided in ship manufacturing will be guaranteed by teaching acadmic knowledge, chances of intnership and vision buildings. The mainly involved actors of education in strategy 2050 are TU Delft and Damen academy. The main task of the education revolution in this industry is to provide a professional tutorial about 3D printing and roboats, encourage the trainee to be more innovative and creative, as well as shaping their awareness and attention to ship recycling and the sustainable approach of the manufacturing. The scale of the related education and the institutes' campus will be expanded. As a result, after the training, the counterpart educational mode will be created to safeguard the employment as well the qualities of market-need professions.

3. GOOD HEALTH AND WELL-BEING

To mitigate the environmental problems happening in the current stage, such as nuisance and air pollution, transitional zones and green buffers play an unneglectable function in the new vision. Transitioning from industrial-dominant estates to mix-using areas, green infrastructures, green transport network, and smart spatial re-location are carefully designed on the locations. This countermeasure will balance not only the working and living environment but also public and private land use. This will assure the mental and physical health of both employees working for ship manufacturing and residents living nearby.

8. DECENT WORK AND ECONOMIC GROWTH

A eoconomic stimulate is expected in the prospects of the future development of ship manufacturing, and our strategy can help to combat the crisis emerging in the current stage. A circular ship-making way implementing into the every stage of the manufacturing will be in proximity to use the materials and convert the waste to valuable resources. High-echonology innovation and circular produce chain expanding the scale of ship decomissiong and recycling will support the industry transition to a more sustainbel economy mode. At the same time, decent working enviroment will be safeguarded by transparantizing the flow and developing supporting communities and civil organizations.

9. INDUSTRY, INNOVATION AND INFRASTRUCTURE

To unleash dynamic and competitive economic forces with inclusive and sustainable industrialization, the project embedded the concept of technology innovation such as 3D printing on different scales in support of the transition of material flows and new circular economy approaches. It will also safeguard ship manufacturing in symbiosis with resilience, innovation, collaboration, and transparency. What's more, green infrastructures, blue infrastructures, and landscape changes are considered key tactics in the vision. They can function as a buffer for noise and pollution between making and living, and mitigate environmental problems as well.

11. SUSTAINABLE CITIES AND COMMUNITIES

FleetFlow created an urban environment in which the ship manufacturing sector is located by synergizing the relation between living and making to alleviate the pressure of shortage of land resources and solve problems of inadequate and overburdened infrastructure and services. Meanwhile, a mix-using and sharing using spatial design strategy is proposed, converting the industrial areas into high-quality and resilient zones. Cities and communities are well-connected by sustainable ship transport that helps connect flows on the local and regional scale.

12. RESPONSIBLE CONSUMPTION AND PRODUCTION

Fleetflow leads to a way of manufacturing parts that produce less waste by improving 3D- printing technologies instead of using the natural environment resources in a way that continues to have destructive impacts on the environment. It also increases material-using efficiency and promotes a sustainable production process. Furthermore, after bringing back ship decommissioning locally, the smart disassembly allows parts to be reused. Introducing standardized parts is also established in shipbuilding and repair which help reduce the cost of production.

17. PARTNERSHIP FOR THE GOALS

To encourage growth and trade, FleetFlow promotes a close and continuous collaboration with various stakeholders not only within the ship manufacturing sectors (like 3D-printing institutions and maritime education) but also with other related industries (like glass and furniture industries) in order to achieve the circular flow of materials and energy with inclusive partnerships. The cooperating model can also be achieved in other parts of Europe using the connections of the port of Rotterdam.

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7 APPENDIX

7.1. POLICY RECOMMENDATIONS

This list of recommendations provides a diverse range of points that can be starting points for policymakers, designers, and planners who deal with circular (ship) manufacturing. The patterns by Cities of Making (Hausleitner, et al., 2020) and our expansion pack can help execute the recommendations. All policy recommendations will consist of a sentence explaining what, why, and how.

Jobs
Make jobs in making more attractive, especially for females, to secure industrial resilience by improving education, campaigning, transparency, and fair work conditions.

Transitions
Design transition zones between living and making, to make mixing possible in pressured areas by carefully identifying the nuisances for each activity and dealing with them appropriately and by mixing complementary functions.

Safeguard
Safeguard vulnerable making, to prevent all making being pushed out of the city by not only legislations like (micro) zoning but also softer measures like better embedding and social support.

Standardized parts
Mandate the use of standardized parts in (ship) manufacturing, this stimulates long-term circulations of materials and easy disassembling by implementing European legislation.

3D-printing
Invest in and create an attractive business climate for large-scale 3D-printing companies, to be able to produce parts with less noise and less waste by offering locations close to makers and education.

Transport
Invest in sustainable transport by water, to connect flows sustainably by improving the water infrastructure and collaborating with innovative ship manufacturers.

Access
Plan accessible making, to improve visibility and transparency by making connections between living and making not only for cars and trucks but also for cyclists and pedestrians.

Education
Involve educational institutes, to improve making technologies and educate future employees through active communication and promising visions. .

Sharing
Stimulate sharing of facilities and knowledge, to innovate faster and help smaller businesses by designing shared spaces for professionals and students within clusters of making.

Water
Make use of the water and waterfronts, to make use of valuable and desirable space by alternating between public and private quays for making and floating structures like markets or houses.

Technology
Push technology and attract private parties, to accelerate circularity by creating a financially desirable business climate and awareness that the current technologies are too linear.

Awareness
Build awareness among opposing parties, because the city needs making and making needs the city this can be realized by organizing placemaking events and inviting all parties.

Vertical making
Introduce vertical making, as a solution for the building pressure on land by allowing it in zoning plans and stimulating it by presenting safe designs for vertical making.

Material lifespan
Extend the lifespan of materials as long as possible, to maximize the use of the materials and minimize waste by using innovative solutions like 3D-printing and standardized parts.

Site-specific
Design site-specific, to tailor circularity to local opportunities by applying our main actions but adapting them to local characteristics.

7.2. INDIVIDUAL REFLECTIONS

7.2.1. Kim van Balken

First steps within FleetFlow
For project FleetFlow, we have developed a regional design that aims towards establishing a more circular ship manufacturing sector in the province of South Holland. Eager to map the current status quo of the ship manufacturing sector, we started this project by mapping the current manufacturing sites, presenting them as singular dots within the stark administrative boundaries of the province of South Holland. Along with these maps, demographical data was collected, and large figures helped explain the great amounts of profit that were generated within this context.
It was about a few classes later, when we realized that it was essential to think beyond these isolated 'dots' and generalized datasets. To spatialize the current production process of ships, we started mapping the key actors, the activities they carry out, and which flows of resources and knowledge are exchanged between them. This was the first step, in which we touched on the fundamentals of regional design.

Fundamentals of regional design
As Karel van den Berghe stresses in his lecture Circular Ports, for a regional design you have to acknowledge the greater complexity of the region. The challenge is to understand the larger metropolitan entities, which include complex relations between a multitude of places (van den Berghe, 2022). Regional design is not merely about the context of the network, nor just about the context of the location. It's about the domain where the two merge, where critical interdependencies come forward and both global and local processes are at work.

The process of metropolisation explains how these complex interdependencies between scales emerge. Rodrigo Cardoso & Evert Meijers (2021) explain this process as the series of events in which urbanized regions become integrated along various dimensions, and emerge as connected systems at a higher spatial scale. In this way, the connectivity of functions, people, and activities can structure a 'city' that goes beyond the traditional city, which was previously not recognized as one urban entity. Successful regional design should always consider entities like this, as they cut through various scales and depend on complex relations.

Towards multi-scale regional relations
This approach of regional design slowly started to integrate into FleetFlow as the weeks went on. For the Vision, a new metropolitan entity was visualized: the provincial loop. The loop includes ship manufacturing sites, 3D-printing facilities, and inner-city structures, which are connected through a system of waterways and large outgoing flows. This is the first step, where we managed to approach regional design in a way in which we talk about a multi-scale system.

When we started to include the designs of the key locations, a more coherent regional design started to emerge. We started touching on the challenge of integration, which talks about integrating individual locations into a metropolitan system of synergies and collaboration (Cardoso, 2022). As part of this metropolitan integration, we designed a coordinated transport system, a more connected labor market, and a more balanced distribution of manufacturing. Designing these regional interdependencies, and then specifying them on the smallest scale, was the last crucial step in creating a regional design.

Certainly, completing this process towards a regional design does not automatically lead to a perfect outcome. The success of a solution on one scale will depend on the success of another solution on a different scale. The design of the key locations has shown that the exact implementation (and therefore also the potential success) of the strategy will strongly depend on the local characteristics of each urban entity. Additionally, FleetFlow has brought forward how much the implementation of the strategy depends on the extent to which stakeholders are willing to collaborate. However, I do believe that FleetFlow has made a sufficient step towards a regional design. We have sufficiently touched on the relevant disciplines, scales, and relations between essential activities and resources.

Collaboration and teamwork
During the process of coming to our final project, the team members of FleetFlow have all equally shown major efforts. As a team, we agreed that we had a very efficient way of communicating, which made our group collaboration way easier. We set up clear tasks for everyone, which were systematically carried out throughout the whole project. Timo has taken responsibility for organizing tasks and results, and encouraging the team to keep moving forward. Chii has shown great effort in thoroughly collecting data, and translating that into coherent and clear products. Jinlai has accumulated a lot of knowledge about several topics, which she could implement in high-qualaaity visualizations. Personally, I have been able to focus a lot on drawing maps, organizing results in the booklet, and critically revising them. When I wanted to broaden my focus and shift to a different task, there was room for that within the group. I would like to thank my teammates, tutors, and lecturers that have been of great value to FleetFlow.

7.2.2. Jinlai Song

Converting from street and neighborhood scale in Quarter 2, I was struggling starting regional research. In my previous view, the regional design consists of only maps and illustrations that represent a desirable future for a region. But it is more than that, R&D studio and other sessions enabled me to a better understanding of the region, the viewpoints of various stakeholders, the possible vision and options, the strategies and actions that can be taken. Regional designing aims to improve the regional situation and address multiple scales through space and time.

The other main topic in this quarter is circular economy. This concept can be formulated by high efficient product reuse, remanufacturing and refurbishment in an economic system, which demand fewer materials and energy than conventional recycling way in a linear system. So that the product value chain and life cycle retain the highest possible value and quality as long as possible. Furthermore, Bob's lecture in Capita Selecta brought me spatially strategic approaches in which could reframe South Holland by closing all cycles in 2050. Development of a spatial main structure for the most essential system in order to make raw material, energy, and infrastructure circular is needed with knowledge, IT, logistics and packaging as supportive conditions (Bob, 2022).

The lecture, Spatial Conditions for Manufacturing (Birgit, 2022) triggered my interest in manufacturing that I have never touched before. The diagram was impressive that showed the relationship between urban manufacturing and cities. Making them need each other is a challenging process that synergizes people, network, policy, circularity, and technology in between the urban integration. Although the task is complex, I feel like we as a group did a great job in achieving such a vision and strategies. In our project, FleetFlow, we proposed the vision to safeguard vulnerable ship manufacturing in symbiosis with resilience, innovation, collaboration, and transparency. These visions on a regional scale are accompanied by proposals for small-scale toward the desired future tangible. It is therefore the circular economy has been embedded into every stage of the ship's lifecycle synergizing the relation between living and making in the regional vision loops while smaller circularities have also been brought locally.
That reminded me of the project in my bachelor's called 'Urban Master Planning' which was also on regional scale but focused more on spatial structure, regulating land use, transport planning, and strategic cooperation among regions in China with distinct urban hierarchy and administrative edges, helping me a lot with geoinformatics technology and regulation-making. With FleetFlow in South Holland, we tend to aim for specific manufacturing with democratic legitimacy, justice, and the realization of public goals. Both of them have brought me a better understanding of regional design under different socio-economic and political backgrounds.

During the whole process, I have acquired much knowledge collaborating with multiple members. The team that I have been a part of exchanges mutually and progress together, optimizing the project step by step. Special thanks should go to my productive teammates and all the tutors who provided multiple inspirations and opinions, which also helped me jump out of my comfort zone of design to explore uncharted territory with border prospects. I will bring them all in every step on my way to being an urbanist.

7.2.3. Timo van Oorschot

It all depends on the perspective
The subtitle of Dr. Karel Van den Berghe's lecture on circular ports as part of the SDS and Capita Selecta lecture series was “It all depends on the perspective” (van den Berghe, 2022, p. 1). So, in this individual reflection, I will look through my perspective at our regional design project FleetFlow, making use of the lectures by Dr. Karel Van den Berghe (2022) and Birgit Hausleitner (2022).

Cities and ports are growing apart. The cities specialize in services and harbors in making and logistics. Too much separation and dependence on one global sector could lead to economic problems and a new ‘Dutch disease’. Is mixing port and city then the solution? Well, the answer is not so straightforward. Our cities are becoming greener and healthier, reintroducing industry into the city would reverse this process. So, do we keep it separate and hope that the global port economies stay stable? I do not think that that is a good idea, definitely not in the perspective of the current developments concerning Russia.

With our project FleetFLow, we cannot gamble that Bangladesh will keep decommissioning our ships and we cannot gamble that China will provide us with raw metals for building our new ships. Therefore we localize the ship manufacturing cycle and reuse as much as possible from decommissioned ships.

Many of the current shipyards are located near the water at the edge of urban areas. There is huge pressure on these parts of land (NH-nieuws, 2021), and (heavy) making does not mix well with residential buildings. In FleetFlow we tried to mix where possible, by creating transition zones, but also realized that mixing is not possible everywhere. We require these places of making, as they provide industrial resilience and make what the city needs.

As made clear in the lecture (Hausleitner, 2022), and studio sessions, by Birgit Hausleitner, transition zones are key to the success of a mixed-use zone. In Fleetflow we showed different degrees of mixing. From very little mixing and very industrial in Botlek to lots of mixing and more urbanity in Schieoevers. Positioning low nuisance and low pollution industries, like 3D-printing, closer to residential is possible. Industries like these can form a great transition between the medium/heavy industry and the more residential areas. We can use making to connect industry and living, instead of building housing on one side of the highway and industry on the other side.

Finally, I want to react to Dr. Karel Van den Berghe’s remark that, “we first ‘mix’, then we evolve to ‘creative industry’, finally we end up with a monofunctional living/shopping/office area”. This will lead, according to him, to a new ‘Dutch disease’ as this means that all industry would disappear over time. I do not agree with this statement. I think with FleetFlow we show that these mixed-use industrial areas can become highly attractive and will therefore have the support of the public. Moreover, these areas bring people closer to making, this transparency will contribute to raising awareness about the importance of making. So, mixing now is a resilient solution for the future and we will not end up with monofunctional residential areas. If we leave the industry as it is, it will be pushed out in a few years and we will have no industry left, and a real new ‘Dutch disease’.

I want to finish this individual reflection with a quick reflection on our group work and on the scale of regional design. The scale of regional design was new to me as I have an architecture background. Designing on this scale I found particularly difficult. Understanding the region through data analysis and coming up with strategies for the key locations I enjoyed most. The patterns and books of COM were super helpful to guide users through this very new and complex scale.

I enjoyed working with this group, the process was smooth and we came to decisions and consensus relatively quick, sometimes too quick. As persons, we are in the sweet spot where we have enough in common to work together efficiently and also are complementary to each other. From all three girls, I learned something valuable during this quarter. Kim taught me not to move on too soon and be critical of what we propose, also that the way you formulate something can make a huge difference. Jinlai showed me what real beautiful drawings look like and that details matter. Chii demonstrated to me that you should get out of your comfort box and do things that are less familiar to you instead of always doing the parts where you already have the skills. As a group, we worked hard but also had fun.

7.2.4. Ziqi Xu

In the course AR2U086 R and D Studio: Spatial Strategies for the Global Metropolis (2021/22 Q3) and AR2U088 Research and Design Methodology for Urbanism (2021/22 Q3), I gained a lot of knowledge about regional development, methodology of strategy design as well as improved my teamwork ability. This reflection mainly refers to the Capital Selecta and Sustainable Development Strategy (SDS) lectures given by Dr. Karel Van den (2022) and Remon Rooij (2022).

At the first stage of our project, based on our interests, we specified the topic of maritime manufacturing in the Port of Rotterdam, and Birgit gave us implications about the ship manufacturing sectors that we finally decided to focus on. After a field trip and site analysis, we realized that ship manufacturing plays an important role in the Maritime of South Holland, and there is a big manufacturing cluster including related industries and services supporting the turnover of ship manufacturing. Tracing back the material used for ship making, we found out the supplier market is from South Holland scale to global scale. With this regional zoom-in and zoom-out practice, we weaved a network that could make the ship as a full-cycle closed loop. Consider aligning with the Strategy 2050 of South Holland at the same time, we finally decide to set our regional scale within the province of South Holland, and our proposed vision of “ making circularity into every stage of ship manufacturing” is based on that.

After assuring our goal, we started to shape our ways of narratives and visions. During this process, SWOT analysis and SWOT-TOWs analysis are really helpful for us to prioritize our attentions. Stakeholders analysis also helped us with opening our minds to think about the opportunities from a more economic and social perspective. After drawing our conceptual work, a clear mind has been stated to guide us to our final spatial implementation.

In the spatial design, I suggested using the case of the Damen company to translate our concepts into a storyline and provide a scenario for every stage of ship making situated in key locations. For each location, every team member could also develop their creative thoughts and visions for the site individually. When coming up with the final combination as a group work, it is really happy to see the four locations with innovative design ideas to match each other perfectly as a beautiful collage.

Finally, I would like to thank for the help from my group mates. I learned a lot besides just professional skills. I studied Policy studies in my bachelor's study and had not related to design at all. But I have a big interest to learn how to translate my arguments into spatial languages. All my team members would like to trust me and gave me chances to practice my painting and respect my thinking. In addition, each of them had great highlights in the teamwork. Kim is great at logic organizing and concluding performances with brilliant writing skills. Jinlai showed professional drawing skills and have a strong sense of responsibility for teamwork. Timo is a good organizer for the whole teamwork and very productive which can stimulate group members a lot. All in all, I would appreciate the organization of this quarter and all the professors, lecturers, and mates I met.

7.3. IMAGE LIST