WASTE SYSTEM REJUVENATION

Configuring the dialogue between waste collection stations and cities in the South Holland region

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AR2U086 R and D Studio: Spatial Strategies for the Global Metropolis
AR2U088 Research and Design Methodology

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Dr. Roberto Rocco | Dr. Marçin Dabrowski

PREFACE

The project Waste System Rejuvenation is a proposal for the province of South-Holland in order to achieve a circular economy with actively engaged citizens within the construction- and demolition sector by 2050. This regional design strategy is established by five master students during the 2020/2021 courses AR2U086 R&D Studio: Spatial Strategies for the Global Metropolis and AR2U088 Research and Design Methodology for Urbanism. These courses are part of the third quarter of the MSc Urbanism at the Faculty of Architecture and the Built Environment from Delft University of Technology and teach students to implement spatial strategies on a metropolitan- or regional level, rather than the neighbourhood or moderate city level.

A special thanks goes out to our studio tutors Dr. Remon Rooij, Dr. Nikos Katsikis and Dr. Daniele Cannatella, but also to our methodology tutors Dr. Roberto Rocco and Dr. Marçin Dabrowski, for guiding us through the entire process of this course. Despite the inhibiting circumstances due to Covid-19, they have provided us with a high-quality learning path through online guidance and -education.

ABOUT US

Our team consists of fi ve master students coming from various universities with different study backgrounds. Together, we form an interdisciplinary team that is striving to shape a built environment that is resilient for taking on today's and tomorrow's societal challenges. This page introduces ourselves and describes the personal motivations to develop this vision and strategy.

Jochem Vellinga - 4686098

Jochem Vellinga is a Dutch student, currently doing his masters degree in Urbanism at the TU Delft. He recently graduated his bachelor's degree in architecture, urbanism and building sciences. During his study he did an internship as city planner at the municipality of Utrecht, focussing on the development of a new innovative neighbourhood called the 'Beurskwartier'. After his internship he followed two minors specializing on the socio-economic complications of major Dutch cities and the integration of heritage in urban design.

Minyue Jiang - 5282055

Minyue is an Urbanism student of TU Delft. She had her undergraduate education in China and obtained the bachelor's degree in architecture. During her undergraduate studies, she found that things are more interesting when social, economic and other disciplines are combined with architectural and urban design, than merely architectural design. Therefore, she chose the subject of Urbanism, which covers a wider range of topics. She likes to use graphical language to communicate and think. Her ability to use a variety of different drawing software also helps the team in the project.

Panagiota Tziourrou (Patrisia)- 5391326

Panagiota Tzourrou, or unofficially, Patrisia is from a village in Cyprus. Her childhood in a small society developed the desire to visit new cities, escaping from the boundaries of this small Mediterranean island. However, she always has in her mind that the cities in her country need the knowledge that she aims to acquire, during her academic career. So, Patrisia is currently a student in Urbanism Master's degree at TU Delft. Also, she graduated as an architect engineer from the University of Cyprus, studying for a semester at University of A Coruña with the Erasmus+ program. After completing her bachelor studies, she worked in Barcelona as an internship student and then continued her professional career in Cyprus for two years. Her ability to express the group ideas with drawings in different graphic languages, but also her societal concerns were her characteristics that contributed more to the group dynamics.

Ydze Rijff - 5435749

Ever since Ydze was a child, he has been passionate about cities. From the age of six, he navigated his parents through cities such as Paris and Amsterdam whenever they went on a city trip. Through his bachelors in Spatial Planning & Design at the University of Groningen, this has translated into a passion for the built environment in general. At the time of writing he is following the masters Metropolitan Analysis, Design & Engineering at the AMS Institute in Amsterdam. This programme is a joint degree of Delft University of Technology and Wageningen University & Research, which educates him to become an interdisciplinary urban engineer that creates innovative solutions to complex metropolitan challenges deriving from urbanisation and climate change.

Zahra Agbaria - 4549538

Zahra Agbaria is a Dutch/Israeli student who studies Urban Planning and Architecture in Haifa Israel, before graduating with a Bachelor's degree in Architecture, Urbanism and Building Sciences in TU Delft. Zahra is currently doing her Master's degree in Urbanism at TU Delft. Having lived in two countries, three different cultures, and many different types of cities has given her the push to start studying and digging deeper into how cities work and connect, spatially and socially. Her strong ability to organize and communicate her knowledge are the primary qualities that helped her contribute in the group dynamic throughout the project.

ABSTRACT

At the moment, 23,5% of total waste production in the Netherlands comes from the construction sector. Therefore in view of international agreements and the developing climate crisis, by 2050 this construction- and demolition sector should be transformed into a circular system that limits CO2 severely. It is important to bear in mind that current waste collection and waste treatment in the Netherlands are often separated and that it is a system that does not integrate social and spatial aspects, such as education or embeddedness in the urban fabric. These processes lack in optimal use of existing spatial systems in order to stimulate a sustainable circular flow of materials.

In order to tackle this problem, we envision to integrate several systems of existing waste collection stations and treatment facilities and involve citizens in the waste system rejuvenation. In order to achieve this, we build upon the existing network of waste collection stations, by transforming it into a multi-functional system. Adding social values to the existing systems such as educational facilities and makerspaces improves their spatial quality and contributes to more public awareness about these systems. In order to achieve this, we propose to integrate systems into the urban fabric and improve the dialogue with the cities in the South Holland region. However, the unique identity of each location requires a multi-layered approach, consisting of central hubs and local- and flexible spokes. The central hubs emphasize logistical optimization of circular material processes, while the local and flexible spokes focus more on public awareness creation. The local spokes do so through integration with the city and the flexible spokes with a more adaptable character by being related to construction sites. To determine the functions and characteristics of each site, the regional strategy will take into account all individual spatial, environmental, social and technical characteristics in order to achieve the best interaction between them.
The multi-scale integration and rejuvenation of the system improves the efficiency and the sustainability of waste collection, with an impact on the spatial qualities of the waste collection stations. In turn, this leads to added social values and crucial society-wide awareness for the transition and active engagement of citizens in the circular economy.

Keywords: circular economy, South Holland, , waste system, socio-spatial integration, construction-demolition sector.

Content

CHAPTER ONE

INTRODUCTION

As stated in the Nationwide Program for a Circular Economy (Ministry of Infrastructure and the Environment, 2016), the Netherlands has to achieve a fully circular economy by 2050. Together with the plastic chain, food chain and organic waste streams, the construction- and demolition sector plays the decisive role in obtaining this objective for the province of South-Holland (Drift & Metabolic, 2018). Waste System Rejuvenation responds to these goals by scrutinizing the waste system and proposing a strategy to transform this system in order to achieve a circular flow of materials within the construction- and demolition sector of South-Holland.

1.1. THE PROVINCE OF SOUTH HOLLAND

With roughly 3,7 million inhabitants on 3400 km2, the province of South-Holland is the most densely populated area of the Netherlands (State of South-Holland, 2017). These numbers even rank the province among the most densely populated areas of the world. The Central Agency for Statistics (2021) estimated the GDP of South-Holland at 169.1 billion Euros in 2019 , which was 21% of the entire Dutch GDP at the time. Together with North-Holland clearly the largest share of all provinces. The province has established a strong position for itself by virtue of the port, the Rotterdam-The Hague metropolitan region, the many knowledge institutes and the favourable position in relation to its hinterlands (figure 1.1).

These characteristics offer the province a rich perspective on the future, but at the same time also present major challenges. For example, over the coming ten years, a total of one million new homes have to be built on a national level, of which around 210.000 are expected to be built in the province of South-Holland.

However, this high level of economic activity inevitably brings drawbacks. The construction- and demolition sector alone accounts for 5.6 Mton of material use on an annual basis, which makes it after the chemical sector in the port of Rotterdam, by far the largest consumer of materials in the region (Drift & Metabolic, 2018). The waste stream of around 4 Mton comes with a relatively high amount of negative externalities and puts notable pressure on the Dutch Waste System, consisting of the collection, treatment and recycling facilities (Royal HaskoningDHV, 2017). In order to make the transition to a fully circular economy by 2050, this system plays a decisive role and is therefore crucial to scrutinize.

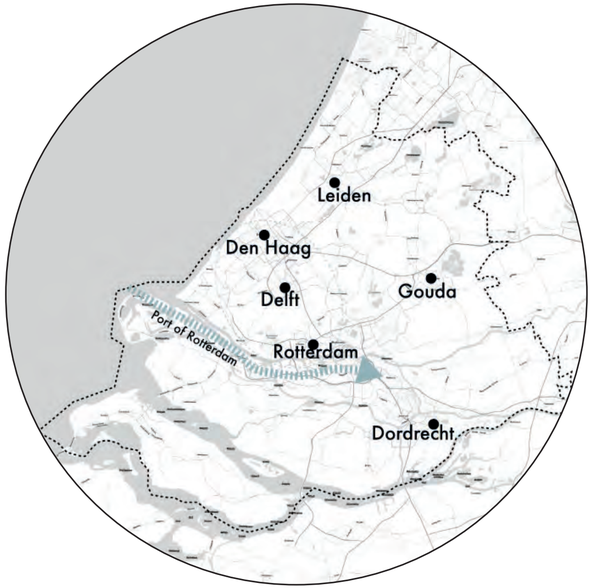


Figure 1.1. The province of South Holland. Illustrated by authors.

1.2. INTRODUCING CIRCULAR ECONOMY

The rising global societal challenges such as population growth, climate change, scarcity of resources and social inequality call for a new model that can replace the current linear economy, which is merely focused on maximizing economic growth by extracting materials and converting them into waste (Oxfam, 2018).
In order to meet the demands of both people, planet and profit, the world should work towards an economy that thrives, but does not exceed our planetary boundaries (Raworth, 2017). Policy documents worldwide refer to the circular economy as the right direction to take (European Commission, 2020; Ministry of Infrastructure and the Environment, 2016; UN Habitat, 2020).

Gladek (2017) defines the circular economy as "a new economic model for addressing human needs and fairly distributing resources without undermining the functioning of the biosphere or crossing any planetary boundaries". A mature and fully functional circular economy is transparent, equitable and resilient. This means that all materials are recycled in a high quality manner and all energy comes from renewable sources. In addition, the model ensures a social minimum, promotes the preservation of biodiversity and even offers opportunities for new economic development. A circular economy could even make a net contribution of 900 billion Euros to the European economy by 2030, according to the Ellen MacArthur Foundation (2015).

Yet again, the ubiquity of the circular economy in global policy plans indicates the urgency and awareness among global leaders. However, the realisation of the transition is heavily dependent on the behaviour of the individuals as well. Lieder & Rashid (2016) stress that "social awareness is crucial in order to achieve a circular economy as customers are an integral part of it". This factor will thus also be comprehensively included in this regional strategy for the province of South-Holland.

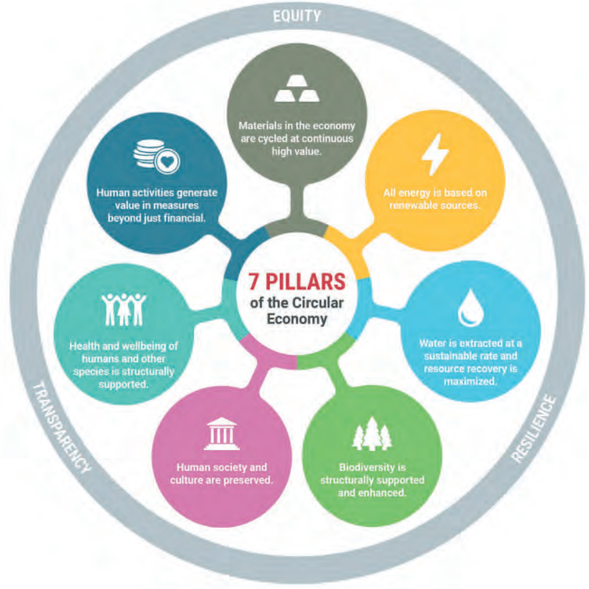


Figure 1.2. The seven pillars of the Circular Economy (Gladek, 2017).

1.3. PROBLEM STATEMENT

The current **waste collection and waste treatment** in the Netherlands is often **spatially separated**, especially within the processes of construction and demolition. The waste system thus relies on facilities that predominantly have a **single function**. This leads to difficulties such as **extra transport movements** of waste materials. In addition, it is a system that does **not integrate social and spatial aspects**, such as **education** and **embeddedness in the urban fabric**. These processes **lack in optimal use of existing spatial systems** in order to stimulate a **sustainable circular flow of materials** and **engage citizens actively** in the circular economy.

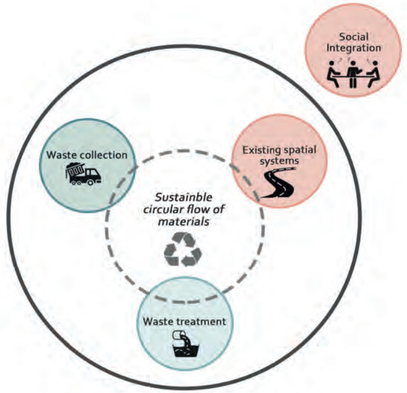


Figure 1.3. Schematic visualization of the problem statement, Illustrated by authors.

1.4. RESEARCH QUESTIONS

"How can a regional design strategy contribute to the transition towards a circular economy in the construction- and demolition sector by implementing a socio-spatial integration of (waste)material collection stations and treatment?

Supportive questions

How can the existing waste infrastructures be utilised and spatially integrated into multifunctional locations?

What could be the social added values of the rejuvenated material hubs?

To which extent can the socio-spatially integrated waste system contribute to societal awareness and encourage citizens to engage in the transition towards a circular economy?

1.5. CONCEPTUAL FRAMEWORK

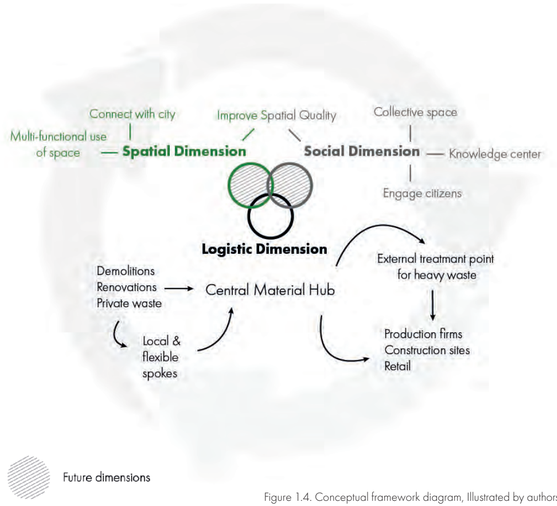


Figure 1.4. Conceptual framework diagram, Illustrated by authors.

Figure 1.4. represents the conceptual framework that has been established for this project. This framework is built upon theories referring to three dimensions that the waste system should incorporate according to our vision. The three circles in the middle represent the rejuvenated waste system, with the logistic circle as the only existing dimension that the nodes within the waste system currently have. The top two circles are the spatial and social dimensions which we aim to integrate by rejuvenating the waste system.

Logistic Dimension

Circularity

The circular economy that the province is aiming for, is in essence mostly determined by the logistic dimension of the waste system. The way that materials flow through the system depicts whether it's a linear system reaching from extraction to waste, or that it is a circular system where materials are continuously moving through the cycle.

The current waste system is predominantly built upon a linear model, where the waste station is often the final stage of a material. In our prospective scenario of a circular economy, the waste station is both the end and the beginning of the cycle of a material. The content of the logistic dimension can in fact be interpreted as a simplified material flow chart in the envisioned circular economy. The other dimensions of this framework are in fact meant to encourage the establishment of this logistic cycle.

Hub & spoke structure

The logistical dimension of the rejuvenated waste system is built upon a network of hubs and spokes. In contrast to the existing point-to-point structure of the waste system, such a network consists of several bigger locations that opt as logistical centers for the rest of the smaller locations. The main advantages of this structure are to reduce the number of routes and thus the number of transport movements. The economies of scale allow for increased efficiency both at the hubs and in the connections of the network (Rodrigue, 2020). The enlargement of the respective hubs therefore offers additional potential for making these places more attractive to the wider public.

Spatial Dimension

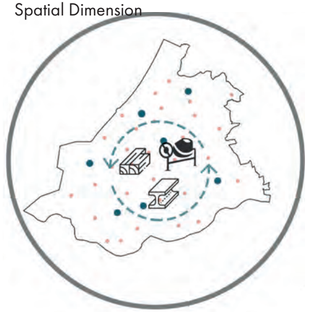


Figure 1.5. Logistic Dimension, illustrated by authors

Multi-functionality

One of the core-values of the rejuvenated waste system is to transform its nodes from places with a one-sided function of waste disposal to lively places with a multifunctional character. At first, multifunctional land use is favourable because of the scarcity of land in the province of Zuid-Holland. Combining different functions in the same place is an efficient way of land use and helps combatting the phenomenon of urban sprawl (Batty et al., 2004). Bearing in mind that waste stations will become both the end and beginning of the material cycle, the multifunctionality of these places is in fact a necessity.

Integration in urban fabric

The identity of today's waste stations leads to them being pushed out of the urban fabric as much as possible. In order to contribute to spatial justice and make the waste stations attractive and accessible to all, it is essential that they are integrated into the urban fabric and that they will develop a certain degree of indispensability in the urban image.

Spatial quality

The changed identity of the waste stations will benefit their spatial quality, as people will no longer associate them with the identity of a landfill. This facet is actually on the edge of the spatial and social dimension. The spatial consequences speak for themselves, but by achieving these higher quality standards, it also acts as a springboard for various social added values to follow.

Figure 1.6. Spatial Dimension, illustrated by authors

Social Dimension

Collective space

The idea of giving materials that arrive at the waste station a kick-start in their life cycle from that very spot offers many opportunities for both citizens and companies to work on this collectively. The collective space is thus a springboard for start-ups in circular businesses or for social workplaces to locate at the spot.

Knowledge

Knowledge is an important pillar within the framework. As emphasized by Lieder & Rashid (2016), it is crucial to create social awareness for a circular economy, as customers are an integral part of it. Customers will need to be aware of how the envisioned system works and what needs to be done to contribute to it. To achieve this, education is crucial (Ludwig, 2020b) and will have an important function at the waste stations. In this way, the younger generations can be brought up with circular thinking from childhood onwards. In addition, this innovative waste system could serve as an example to the rest of the world, allowing specific knowledge to be exported in the longer term.

Citizen Engagement

Involving citizens in the circular process is crucial, both to get economic models going, as well as to achieve social awareness. Involving citizens enhances their capacity building and learning, and it also promotes social cohesion, which is a key focus of many development agendas at the local level (Involve, 2005).

Figure 1.7. Social Dimension, illustrated by authors

1.6. METHODOLOGICAL FRAMEWORK

The aim is to propose a circular economy within the construction- and demolition sector in South Holland by 2050. Therefore, a methodological framework of the process was created (figure 1.8.). The approach is based on a set of mixed methods, consisting of both qualitative and quantitative research methods.
This approach starts with analysing the present situation of the province with a preliminary analysis that will identify critical problems within the construction- and demolition sector. In order to tackle these problems and to create a 2050 vision and strategy, a main research question is needed. This research question is supported by three main guiding principles: function integration, added social value, and socio-spatial integration for societal awareness. These principles are created during the preliminary analysis and will be guiding the main supportive questions that help to answer the main research question of the project. The answering methods of the supportive questions will be referring to and recurring to the preliminary analysis methods.
The SWOT analysis that is conducted in the preliminary analysis identifies social and spatial opportunities. These opportunities connect to the research questions and led to the establishment of the conceptual framework of the project, the vision goals, and the strategies toolkit for South Holland. The conceptual framework is the way to get a comprehensive understanding of the 2050 vision of South Holland. This vision also originates from the vision goals, the latter leads to forming the main strategies of this vision to create the main strategy of the circular economy within the construction- and demolition sector by 2050 in South Holland.
The strategy is followed by identifying stakeholder relations and the phasing of the strategies from 2021 to 2050. Continuing with testing these strategies in specific locations within the South Holland region, and concluding a result that will be assessed and reflected on.

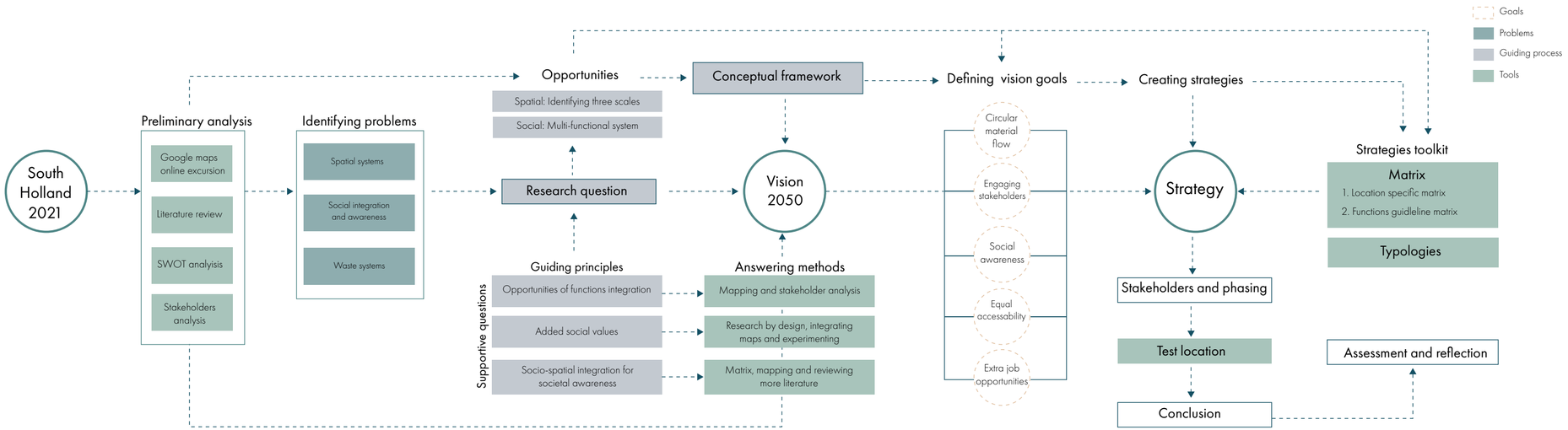


Figure 1.8. Methodological framework diagram, Illustrated by authors.

1.7. ETHICAL CONSIDERATIONS

The implementation of the research methods and the elaboration of the proposal itself hardly encounter any ethical difficulties. This is due to the fact that no sensitive information is collected through, for example, in-depth interviews, where it would be important not to hurt the participants and to keep the information provided anonymously. However, it remains crucial to ensure the transparency, integrity, and scrutiny of this research. Therefore, no biased results are shown and the authors have been careful with all the information collected.

With regard to the work developed, it is important to note that this proposal was developed by master's students with the intention of thinking 'out of the box' and inspiring for the societal challenges we currently face. The transition to a circular (construction) economy may have serious consequences for people and businesses that depend on the current industries in the construction and demolition sector.

On the ethics with regards to sustainable development, this project follows the Sustainable Development Goals (SDGs) of the United Nations (2015). These goals give the best chance of achieving the requisite cooperation and alignment to adopt global strategies to ensure an equitable, stable, and sustainable future for this generation and the coming generations (Morton et al., 2017).
Waste System Rejuvenation vision adapts to eight of the SDGs (highlighted in figure 1.9.):

- 4 Quality education: Education facilities within different hubs for different levels of education.
- 8 Decent work and economic growth: Offering jobs and help for start companies in our hubs.
- 9 Industry, innovation, and infrastructure: Improving connections and adding specialised hubs to the waste infrastructure.
- 11 Sustainable cities and communities: Connecting the waste stations to the city, offering collective spaces.
- 12 Responsible consumption and production: Transitioning to a circular flow of materials.
- 13 Climate action: Improving the efficiency of waste collection, treatment, and recycling.
- 16 Peace, justice, and strong institutions: Social functions added to include disadvantaged people.
- 17 Partnerships for the goals: Encouraging parties to collaborate within our multifunctional hubs in order to collectively achieve the goals.

Figure 1.9. Sustainable Development Goals (United Nations, 2015), edited by authors.

"For the SDGs to elicit public trust and confidence, ethics must be central to their realization"

Singh (2015)

CHAPTER TWO

ANALYSING SOUTH HOLLAND

In order to build a regional vision and development strategy, the existing situation that has to be coped with should be elaborated. This section thoroughly analyses the existing situation in the province of South Holland, both in terms of general characteristics, as well as with respect to the construction- and demolition sector and the waste system.

2.1. CURRENT SITUATION OF SOUTH HOLLAND

2.1.1. Characteristics of South Holland (SWOT)

In order to describe the characteristics of the province, a SWOT analysis has been conducted. This analysis determines the strongest and weakest aspects of the region and defines the factors that have to be dealt with when developing the strategy.
The characteristics are based on the general features of South Holland. The model is intended to evaluate which characteristics should be taken into account when formulating the design strategy for a rejuvenated waste system and how they should be approached.

Figure 2.1. SWOT analysis, Illustrated by authors.

Strengths

Benefiting from the geographical advantage of the Port of Rotterdam, the import and export transactions in South Holland are prosperous, and the region is closely connected with the international community. The wealthy economy in the region and the stable market environment provide a lot of potential (van den Bosch et al., 2011). There are lots of universities in the region, which acting as knowledge hubs, are enough to affect a broadly based transformation in a local economy. And are more likely to be able to address the problems and opportunities of their regions if they pursue active institutional engagement to generate and share human capital, knowledge, leadership and other resources (Youtie & Shapira, 2008). Education hubs in the region do not only improve the educational level of the local citizens, but also attract a large number of high-quality talents outside the region and abroad. These people have a stronger awareness of the importance of the circular economy and can make the project conduct more smoothly.
From the perspective of our strategy, there is a good infrastructure of South Holland (Casabella & Frenay, 2009), which provides the basic conditions for a smooth material flow. Furthemore, the strong connections between cities makes it easier to realize material recycling process networks at the physical level.

Opportunities

The strategy that we propose will bring a large variety of job opportunities. At the same time, the physical flow in this region will increase regional connections, and enhance cooperation opportunities between cities. With the big data trend currently occurring, this material flow system will also benefit, prompting the establishment of big data in the region. In the social background of a trend for sustainable development, society pursues environmental protection and circular economy. Therefore, the strategy will receive not only publicity and advocacy from the government, but also support and cooperation from the public opinion.
As the leading region for knowledge and innovation of the entire country, South Holland is a leader in the generation and promotion of new strategies and theories. There are a large number of high-level talents gathered here, who can make suggestions and provide theoretical support for this process. At the same time, South Holland currently has a large number of construction demands. Most substantial increase in South Holland: The largest expansion of built-up area was in the province of South Holland with large municipalities like Rotterdam (increase of about 300 hectares) and The Hague (increase of about 80 hectares)(Fazal et al., 2012). It means that a large number of construction materials will participate in this process. This demand kind of provides practical opportunities for the implementation of the new strategy.

Weakness

The region also suffers from a number of weaknesses. At first, the presence of social misidentification among the inhabitants of various cities in South Holland can be considered a weakness. The institutionalization of polycentric urban regions is particularly hampered by the lack of a common culture in a region (Albrechts & Lievois, 2004). Major sources of cultural difference include language, ethnicity, religion and political preferences, which, if present, may prevent people from identifying with the (polycentric urban) region (Goess et al., 2016). The cultural identity between, for example, Rotterdam and the Hague is notably diverse. This phenomenon is more frequent and more intense among the lower social classes, especially the working class. This phenomenon of socio-cultural fragmentation could lead to obstacles in the process of cooperation with the overall regional strategy.
Furthermore and with regards to the great housing demand, the national government plans to build 210.000 homes within the province of South Holland. Hence, this conflicts with the current land scarcity. To begin with, 't Groene Hart [the Green Heart] is a valuable rural area surrounded by the city in Randstad and should be protected. This poses severe difficulties for urban expansion and the realisation of building projects (Fazal et al., 2012). Moreover, if new homes are built according to the current tradition of demolition and renovation, these demolitions will inevitably lead to damage to the interests of the original users of the homes. The social and cultural phenomena behind demolition can be embedded within violence and take the form of massive eradication of culturally important buildings and ensembles as destruction of monuments (International Council on Monuments and Sites (ICOMOS, 2007). It can be considered worrying that these victims often come from vulnerable classes. If there is not enough social housing to solve the problem, the space of these vulnerable classes will be replaced by other classes, which will cause a series of social problems.
From the perspective of our strategy about creating an integral waste system; there currently is a lack of information about material flows. Secondly, due to strict building laws, there will be a lot of resistance in the implementation of the demolition process. These terms and laws limit the possibility of projects and reduce the enthusiasm of many companies to participate. Thirdly, construction and demolition waste may be contaminated, either through spillage from industrial processes or contact with contaminated land (Lawson et al., 2001). Thus, technical issues related to soil contamination during the construction and demolition process needs to be resolved.

Threats

Today's situation in the region faces a serious series of threats. Some of these are emerging from a global level, such as climate change and sea level rise, as well as possible future global financial crises. The population growth has led to increased demand for urban expansion (van Straalen et al., 2014), increased social pressure and resource shortages. The deterioration of air quality affects the ecology of the earth and human health.
Besides the threats to the project in the region include the lack of support from relevant stakeholders, which may cause the break of the capital chain and the failure of the investment. In addition, changes in the direction of different government policies will suddenly affect the implementation of the strategy, and even lead to the shelving and failure of the project.

What to invest in?

Obvious similarities between strengths and opportunities can bring advantages and increase the benefits.
South Holland, in which the cluster of many higher education institutions locate, must take advantage of its education hubs to attract talents and create knowledge and wealth.
The project should make use of the geographical advantages of the Rotterdam port and its good global connections. By improving and enhancing the port's functions, the port will become the leading center for circular industries, not only in the field of logistical transactions, but also in the field of knowledge.
Big data, a huge potential analysis tool, needs to be developed in theory and practice. By making good use of information networks and data sharing, it can make the material flow in the region more efficient. In addition, the existing recycling system can be combined with it in order to realize digital recycling.

2.1. CURRENT SITUATION OF SOUTH HOLLAND

2.1.1. Characteristics of South-Holland (SWOT)

What to decide on?

When defects and opportunities exist at the same time, decision makers have to make a decision whether to divest, invest, or cooperate. So when faced with the following situations, it is very important to make a sensible decision. This is the only strategy to reverse the situation and turn our weaknesses into advantages. The Netherlands and even the entire world are facing the problem of population growth. This phenomenon will bring great pressure to the society, but is also an opportunity. More population means more labor and intelligence. Furthermore, climate change is obviously a big problem which needs to be handled by wise decisions. For example, the rising sea level caused by climate change threatens seaside cities, such as the port city of Rotterdam. This reminds us that we need to adopt a more sustainable regional development strategy, while enhancing the resilience of the city to cope with the risks that may occur in the future. When faced with a scarcity of land and housing, decision-making departments need to make a wise decision whether to build a large number of new houses, rebuild old houses, increase land use, or improve the quality of housing.

What to defend?

Threats that overlap with strengths indicate a need for resource mobilization, either alone or with the help of third parties. Once strength goes out of control, it may cause a qualitative change from an initial advantage to a threat. For example, rapid economic development and city expansion must be environmentally friendly and sustainable. Urban expansion will bring more job opportunities, economic development and social prosperity, but excessive expansion will compress the original natural landscape and cause social problems. In the process of urban renewal and redevelopment, one should not simply pursue immediate interests, but pay attention to protecting the environment, social justice, and the interests of the people from vulnerable classes.

Where to control the damage?

When defects and threats exist at the same time, the loss needs to be controlled in time. Therefore, crisis awareness is very important. Due to doubts about the profitability of the project for certain stakeholders, there may be a lack of stable stakeholder support, resulting in the project being shelved and unable to proceed. In order to prevent the occurrence of such a crisis, it is necessary to clarify the profit model and source of financial support at the beginning, clarify the responsibilities and capabilities of the stakeholders, and create a good cooperative relationship.

The existing hidden dangers should be dealt with and prevented in time, such as soil contamination, and timely treatment and remediation should be carried out according to the existing situation, otherwise it will cause serious consequences. Therefore, in the whole process of construction and demolition, we must always pay attention to soil protection. In addition to the project itself, it is necessary to guard against possible future crises such as major disease outbreaks, global financial crises and regime changes at all times.

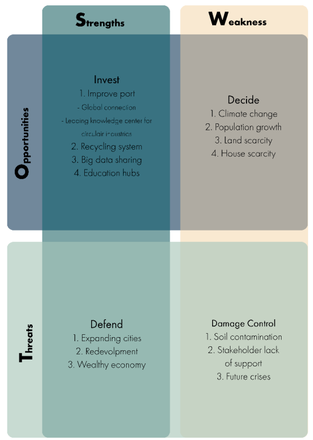


Figure 2.1.2. SWOT analysis overlapping, Illustrated by authors.

2.1. CURRENT SITUATION OF SOUTH HOLLAND

2.1.2. Current stakeholders analysis

In order to explore the status and influence of different stakeholders in the project, we conducted a stakeholder analysis. The chart distributes different types of stakeholder clusters according to whether the level of interest and power is higher or lower. Stakeholders cooperate with each other to see which problems can be solved together and which interests can be pursued together. According to different situations, decision makers need to decide whether to invest, consider, defend or control risk.

The Governmental association clusters are mainly distributed in higher interest and higher power zones, and serve as the leaders and promoters of the project. They need to be clear about threats and weaknesses, while controlling the overall risk.

The construction company clusters are mainly distributed within high interest and high power zones. However, their power is less than the governmental association. They are the most active participants and performers in the face of strengths and opportunities.

The waste station company cluster is mainly distributed in high interest and low power zones. They are the most relevant parties of the project, but their decision-making power is very weak and they are in a passive position in the overall situation.

Lastly, the social association cluster is mainly distributed in the zones of low interest and low power. They are not the most relevant group of the project and cannot profit from it, but they can play a role of guarantee and support and are an indispensable part of maintaining the operation of the entire system.

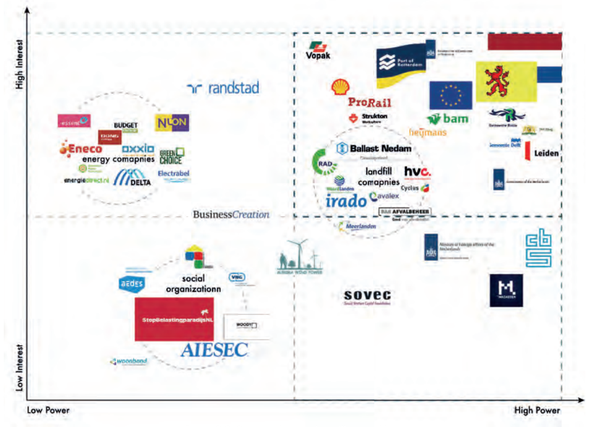


Figure 2.2. Stakeholders analysis, Illustrated by authors.

2.1. CURRENT SITUATION OF SOUTH HOLLAND

2.1.3. Construction and demolition

As mentioned before, the construction- and demolition sector in the province of South Holland is faced with a series of challenges and knows a substantial amount of material use with an amount of 5.6 Mton estimated by Drift & Metabolic (2018). The economic added value of the sector is also substantial, being estimated at 13 billion euros and 100.000 jobs. This section will further elaborate on existing activities and material flows within the sector and will make the connection to the Dutch waste system.

Material flows

Of the 5.6 Mton used by the construction and demolition sector, concrete and bricks make up the bulk with 2.1 and 0.8 Mton of input respectively (Drift & Metabolic, 2018). The rest of the material input consists of materials such as wood, metals, plaster and glass. The high demand for (new) materials stems from the large amount of construction plans compared to the amount of demolition plans. The total output of the construction sector is estimated at 2.6 Mton, consisting mainly of clean rubble and asphalt. Most of these materials are down- and recycled, yet a fair amount is still burned or landfilled (Drift & Metabolic, 2018). That being said, the amount of materials that become available for reuse is significantly lower than the input. More importantly, however, these amounts of reusable materials that become available are not even close to what would be required to meet all construction plans, making the importation of additional raw materials necessary to a large extent at this time. Other aspects that reinforce the current linear chain are certain material choices and the way of designing existing structures in the built environment that are scheduled for demolition.

The existing material flow diagram in figure x.. shows a simplification of the current flow from extraction to disposal.

Relevance to the waste system

The diagram shows that the end of the line for construction materials in the Netherlands is generally the waste station. In order to transform from a linear economy towards a circular one, we should figuratively connect the end of this line to the start of it.

The fact that 23,5% of the total Dutch waste production comes from the construction sector, underpins the influence of the sector. Considering that the majority of this waste consists of clean debris (as described in the previous chapter), it makes sense that 28 kilograms of clean debris per capita is annually brought to the Dutch waste stations. These substantial amounts also indicate that they have a decisive share in the material flow (Statline, 2016-2018).

Given the ambitious goals and tremendous material flows, the province has a huge job ahead of itself. Realizing this circular economy by 2050 requires a total shift in the construction sector including materials, usage, maintenance, re purposing and demolition of buildings and roads. The waste stations and their specific activities will be further elaborated in the subsequent section.

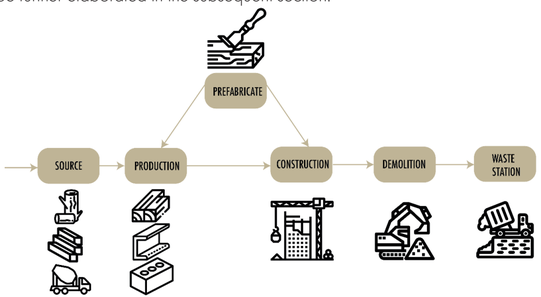


Figure 2.3. Current material flows, Illustrated by authors.

2.1. CURRENT SITUATION OF SOUTH HOLLAND

2.1.4. Waste collection and waste treatment

In the Netherlands, the vast majority of waste collection takes place at the Milieustraten (Waste Stations). Examples of such stations are shown in the pictures of figure 2.4.) These stations facilitate the collection and sorting of waste materials and are freely accessible for both individuals and businesses. When driving in, your net total mass is measured and subtracted with your net total weight when driving out. In this way, the amount of waste disposed is roughly calculated and provides a basic form of material tracing.

As can be seen on the pictures, these places are relatively clean and tidy. However, the 'end-of-life' atmosphere is strongly present at those places. After the waste is disposed of, the containers get transshipped to external treatment locations (AREA Cleaning, 2020). Yet, the destinations of these materials are not completely transparent to the public.

Avalex Wassenaar (Google, 2021)

GAD Crailo (Google, 2021)

Gemeentewerf Oostzaan (Google, 2021)

Afvalbrengstation Den Haag (Google, 2021)

Figure 2.4. Various sources, referred to below pictures.

2.1. CURRENT SITUATION OF SOUTH HOLLAND

2.1.4. Waste collection, treatment and recycling

The map in figure 2.5.1 shows the spatial distribution of waste collection stations in the province of South Holland. Figure 2.5.2. shows the spatial distribution of waste collection stations relative to the waste treatment facilities. It can be derived from these maps that these facilities are currently not situated in the same location.

Like the process of waste treatment, the process of recycling in the Netherlands is usually spatially separated from waste collection. The map in Figure 2.5.3. shows how these facilities are distributed across the province. Regarding these maps, it is obvious that there is not any collaboration between neither the related private companies nor the municipalities. It is also clear that the footprint from this situation is much wider than a connected system. However, the good distribution of waste stations in the whole province could contribute to the transition to a circular system, with less footprint, less CO2 from transportation, and more integration in the urban fabric. In the following chapters, we are going to elaborate more on how we propose to achieve this transition.

Figure 2.5.1 Distribution of waste facilities, Illustrated by authors.
Source: (LISA Data 2018)

Figure 2.5.2 Distribution of waste facilities, Illustrated by authors.
Source: (LISA Data 2018)

Figure 2.5.3 Distribution of waste facilities, Illustrated by authors.
Source: (LISA Data 2018)

2.1. CURRENT SITUATION OF SOUTH HOLLAND

2.1.5. Construction-related businesses

The maps in figures 2.6.1 and 2.6.2 show how the manufacturers of materials used in construction are distributed over the province. As can be clearly observed, this type of business activity is abundant and clusters of it are often located relatively close to the waste stations. This also offers room for potential cooperation between businesses and waste stations for the transit and high-quality recycling of materials.

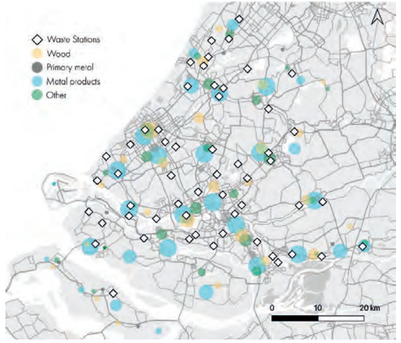


Figure 2.6.1. Manufacturer clusters (LISA, 2018)

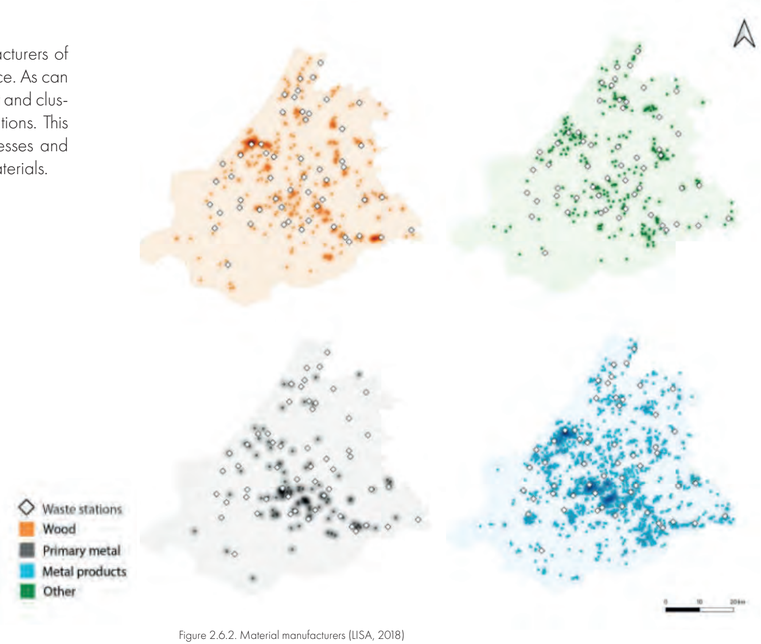


Figure 2.6.2. Material manufacturers (LISA, 2018)

2.2. CHALLENGES FOR A CIRCULAR CONSTRUCTION-DEMOLITION SECTOR

The transition to a circular economy is not a process without obstacles. Throughout the phases, caution has to be paid to several aspects. This section synthesizes the general challenges for achieving a circular economy.

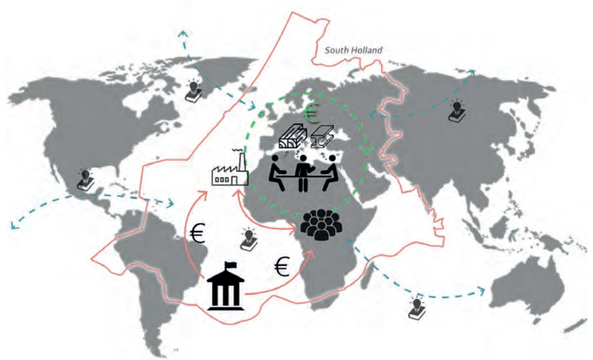


Figure 2.7. Economic feasability, Illustrated by authors.

Economic feasibility

One of the greatest challenges for a circular economy is, ironically, the economy itself. And especially whether it will be (financially) viable or not. For example, it will be difficult to get all (potential) stakeholders enthusiastic about the circular economy. The vast majority of the activities in the construction sector have their profit models and supply chains based on linear models (Youmatter, 2021). It is therefore necessary to think through how these companies can be persuaded. After all, they will not want to just abandon the familiar. The current models generally guarantee low purchase prices for goods, which brings us directly to the next challenge. How do we make recycled materials as affordable as raw materials from developing countries? Some materials will be very expensive to treat and prepare for re-use. The sustainable implementation of economies of scale could play a crucial role in overcoming this challenge. At the same time, care must be taken to prevent the import of cheap raw materials from abroad. If no comparable measures are taken in neighbouring countries, it is likely that companies will source their goods there. Therefore, it is important to approach the transition from multiple countries and invest in a cross-border circular economy (Ludwig, 2020a). This externality could also be mitigated by policy interventions such as subsidies and levies.

Ensuring high quality

Another major challenge for the circular economy is to safeguard the quality of the materials flowing within it's cycle. The recycling of materials may involve a loss of quality. For example, materials may be exhausted or not processed in a high quality manner. This should be anticipated and could perhaps mean that certain materials are no longer used, or at least to a lesser extent. The transition phase is therefore intended to provide a great deal of research and development for this issue.

Lack of social awareness

Social awareness has already been mentioned several times as a crucial prerequisite for the establishment of a properly functioning circular economy. However, it is at the same time one of the biggest challenges. Why would people cooperate in something they do not see any point or need for, when the current system seems to work fine in their eyes? According to Ludwig (2020b), it is noticeable that an increasing amount of people and businesses are recognizing the urge for a circular economy. Nevertheless, there is still a lot of ground to be gained. Education could play a big role in getting the circular line of thinking moving.

"Social awareness is crucial in order to achieve a circular economy as customers are integral part of a circular economy "
(Lieder & Rashid, 2016)

CHAPTER THREE

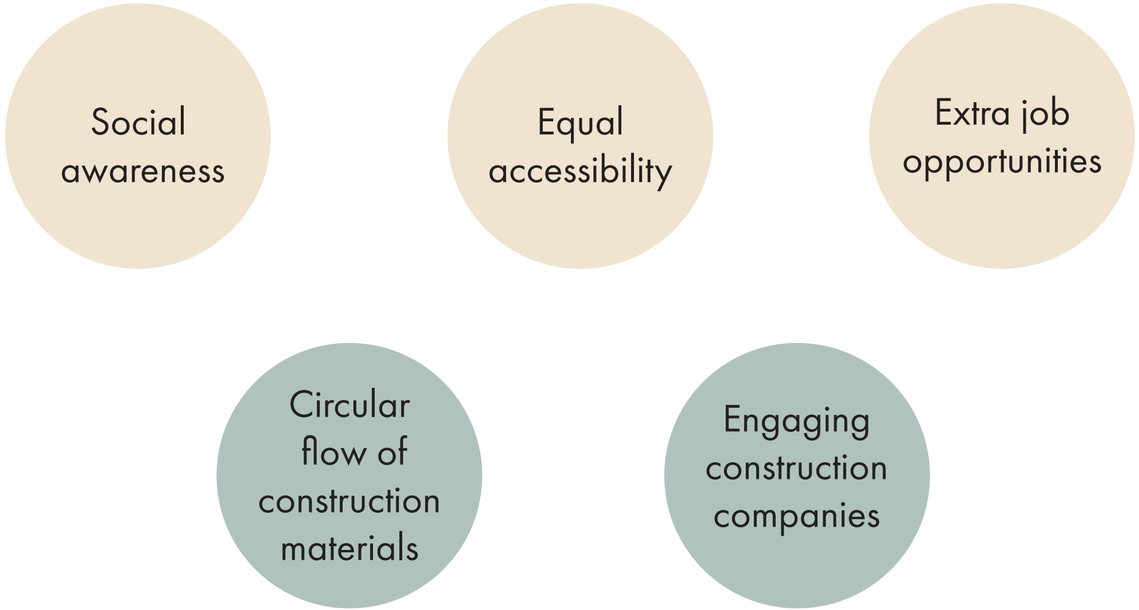
WASTE SYSTEM REJUVENATION

The analysis conducted in the previous chapter has laid the foundation for our spatial vision. This chapter shapes the bigger picture of how we envision the circular transition to come about by rejuvenating the waste system.

3.1. Vision goals

This section elaborates on the vision of Waste System Rejuvenation and how this transforms the existing waste system of the Netherlands into a network of multi-scale and multifunctional material stations. Several examples of initiatives around the Netherlands show that Dutch waste stations could well have multiple functions (Antea Group, 2020; Boels, 2018). It is indisputable that the reuse of materials should be encouraged as much as possible, so why couldn't waste stations become places for both disposal and pick-up of materials? The Upcycle Centrum Almere (figure 3.1) is an example of an integrated waste station- and material hub in the same place and has in particular served as an inspiration to our vision. The combination of such functions leads to various additional benefits, such as less material transportation and reduced vehicle movements (Merriënboer & Rondaij, 2020). The rejuvenation of waste stations also improves their spatial quality, which in turn opens up possibilities for adding social values to them.
This idea is also in line with the ambition of the Province to create so-called bouwhubs (Program team Circulair Zuid-Holland, 2019; Royal HaskoningDHV, 2017), where construction companies can collect their raw materials. We believe that these hubs could be well integrated, or at least in close proximity to the existing waste stations. Keeping the waste-to-value process as spatially concentrated as possible.

Figure 3.1. Upcycle Centrum Almere (Antea, Group 2020)



Definition of goals

The main goals to be achieved can be categorised in two main sections, consisting of respectively two and three sub goals. The two main goals are to achieve a circular economy and socio-spatial justice. The circular economy consists of achieving a circular flow of materials and the full engagement of construction companies in the circular economy. Socio-spatial justice consists of achieving social awareness, equal accessibility to materials and the creation of extra job opportunities. The strategies applied to achieve these goals will be elaborated on in chapter 4.

- Social awareness: We aim to raise social awareness in order to transform the scientific knowledge of the circular economy into common knowledge. This will happen if we convert the conventional operations of circular economy spaces into multi-functional spaces for all.
- Equal accessibility: One of the key objectives is equal access to circular economy processes by all stakeholders, seeking the use of recyclable materials by both the construction manufacturers and citizens.
- Extra job opportunities: Taking into account the problem of unemployment and low income, especially in poor areas, we aim to create new types of jobs by shifting the labor sector towards a circular economy.
- Circular flow of materials: The broader goal of a circular economy requires the development of a circular flow of materials in the construction- and demolition sector. A fundamental change, that will eliminate the use of raw materials and reduce the CO2 emissions from transport.
- Engaging construction companies: We aim to involve construction companies in recycling processes, which will bring both economic and social benefits, for example by reducing demolition costs.

3.1. Vision goals

By 2050, The construction- and demolition sector in South Holland is transformed into a circular system by having integrated several systems of existing waste collection stations and treatment facilities. A multi-scale integration and rejuvenation of these systems has improved the efficiency and the sustainability of waste collection, with an impact on the spatial qualities of the waste collection stations. Which in turn led to added social values and society-wide awareness for the transition and active engagement of citizens in the circular economy.

Figure 3.2. Vision statement collage, Illustrated by authors.

3.2. Multi-scale system

In this vision the current waste stations will be transformed into a three-scale system, giving each location a designated function in the logistical system. We will dive into the three different scales more after we give a short introduction. First we have the locations that will be transformed into central hubs. These hubs will function as the main logistic centers for recycling materials. Waste will be sorted and treated on location if possible. After that the new recycled material will get a material passport making it easier to get insight on the quality, usability and net CO2 reduction of this material. Secondly we have the local spokes. The local spokes will be more focused on the surrounding areas and improve the connection with the city. Here individuals can bring their waste, which after sorting can be transported to one of the central hubs or to an external recycling company. Finally we have the flexible spoke. The flexible spoke will be a modular one that can be located temporarily on large construction sites to sort and transport materials, increasing efficiency and reducing transport movements. We also include several social functions on all scales, which will be explained later in this chapter.

3.2.1. Central hubs

As mentioned in the previous sub-chapter, we have the central hubs. These hubs will be the main logistical centers where a large proportion of all waste will be collected. To create an efficient system we locate these hubs near existing main infrastructure, near clusters of recycling-, manufacturing- and construction- industries and give these hubs lots of land to fill with facilities that can help each other improve the circular system. As we described in the introduction of this chapter, the central hubs will be the place where all waste comes together from all the different spokes, and from where it will be recycled. After recycling the materials will get a passport, which we will explain more about later on. There will also be added functions based on the characteristics of the location.

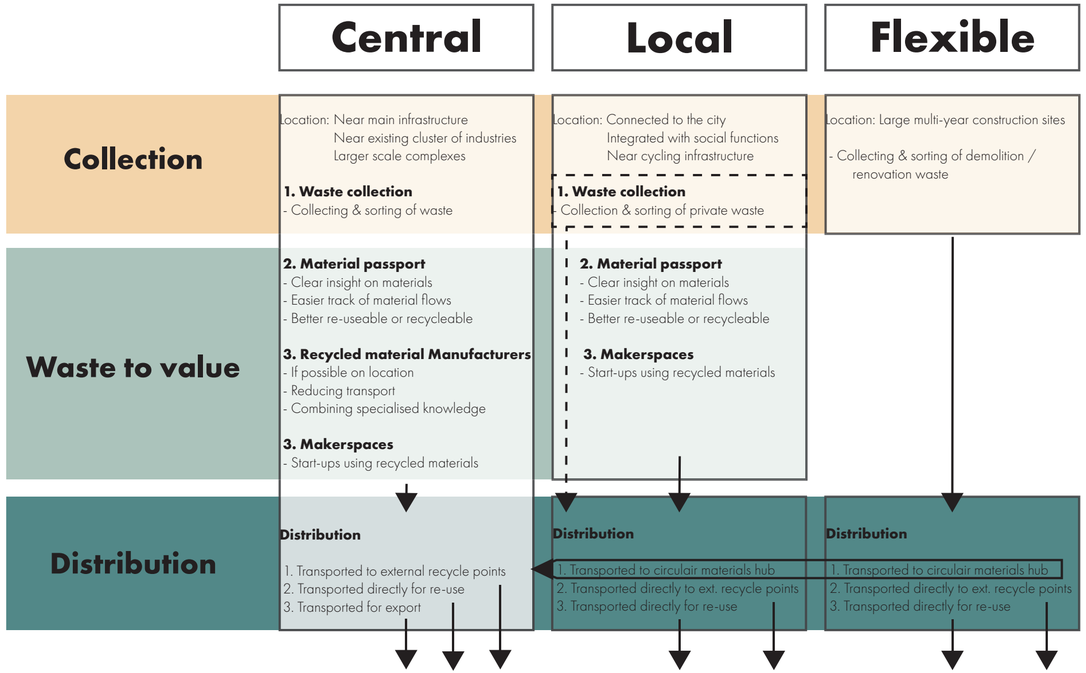


Figure 3.3. Multi-scale system, Illustrated by authors.

3.2.2. Local spoke

The local spokes are facilities that are closer to cities and their residential areas. By sending large amounts of especially construction and demolition waste to central hubs, the local spokes will be much more friendly places to be in, which creates opportunities to transform these places into more socially oriented places. We envision these local spokes to be nice places to go to, that also represent the circular system. By adjusting functions and spatial design to surroundings we want to integrate the spokes in the urban system and make them attractive for people to visit. Beside collection waste, there will also be room for social-, educational-, and makerspaces for local start-ups. Later on we will explain more about these added functions.

3.2.3. Flexible spoke

There are a large number of construction and demolition sites in the area of South Holland. In the multi-scale system we create flexible spokes that consist of modular units that can be moved to these locations. By collecting and sorting the waste on location, the different materials can be transported to either a central hub to be recycled or to an external recycling facility. By moving this process to the location of construction and demolition, we increase efficiency and reduce transport movements in the area.

3.3. Multi-functional system

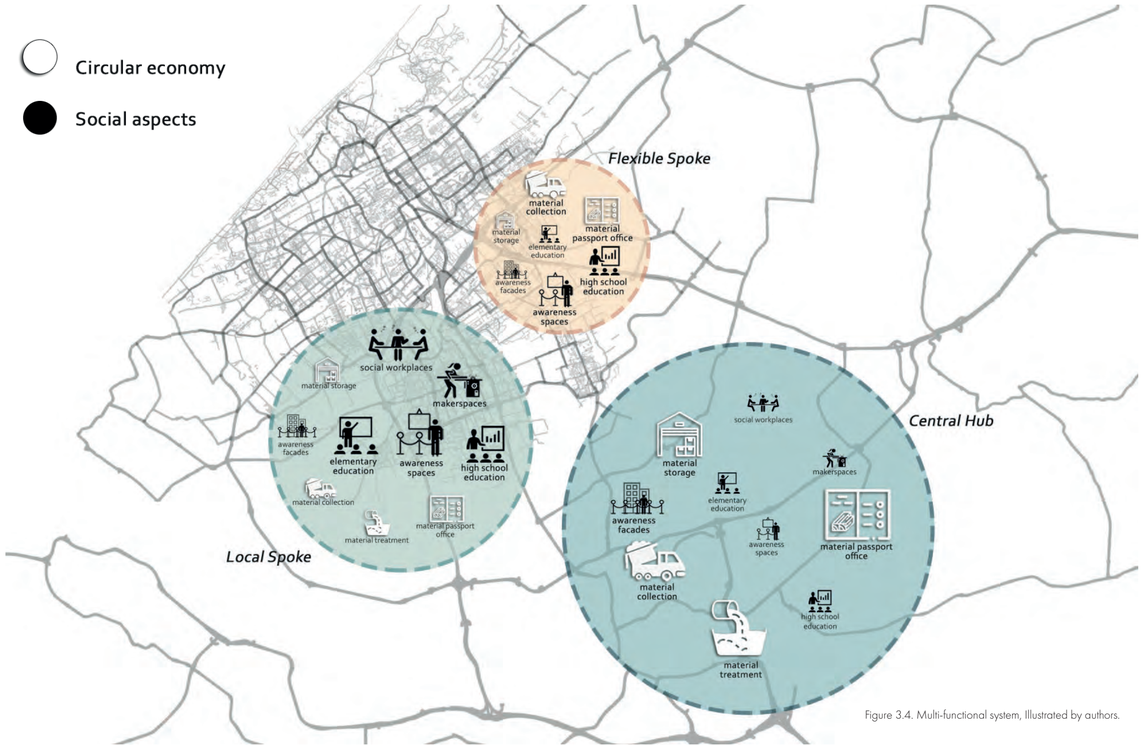


Figure 3.4. Multi-functional system, Illustrated by authors.

In the rejuvenated waste system, each node will have a set of different functions. Which function will come where will be decided in the next chapter.

- Material collection

The material collection and sorting facility is one that already exists in each waste station. Using these existing waste stations means that not much has to be changed to this function, however for a good and complete recycling process additional sorting boxes have to be added to effectively filter out different materials for treatment.

- Material registration

Materials that get delivered to the nodes will get a material passport after treatment. This passport will give information about the quality, reusability and net CO_2 emission of the specific material. A material office has to be built on the nodes to accommodate this function.

- Material treatment

Material treatment facilities are companies that recycle raw waste. To increase efficiency, share knowledge and facilitate room for these businesses, material treatment facilities can be located on the central hubs. If existing treatment facilities already exist in close proximity, they can be relocated to the central hub.

- Material storage

Material storage facilities can be built to store processed materials or products before transporting them to construction- or demolition sites.

- Educational facilities

Educational facilities can help by raising awareness among young people. Which can lead to more involvement into the circular system when they grow up. They can also influence parents and family by starting the conversation about the topic. We divided educational facilities in two types.
(1) Elementary school facilities are spaces in which kids can learn interactively about the circular economy. The kids attending elementary school are between 4 and 12 years old and will learn most about it when they learn by experiencing. These places for example could contain toys made of recycled materials or demonstrate the material flow by using scale models that move and make sounds.
(2) High school facility
High school facilities are spaces where kids learn interactively by engaging in quizes or by viewing processes in a virtual reality simulator. There could also be a window from which the room has a view on the actual hub or spoke.

- Social workplaces

Social workplaces already exist in multiple variations in the Netherlands (NLW Groep, n.d.). These are places where people with disabilities, who are illiterate or who lack the necessary skills to find a job can work. The wages are lower, but the people working here will gain skills on many different levels. For example they can learn the language better, gain labor skills or get better in communicating with employers who also work on the location. These social workplaces can also be added to the different hubs and spokes in our system, preferably near neighborhoods with relatively many low income-, illiterate- or unemployed residents.

- Makerspaces

Makerspaces are areas within the hubs and spokes that facilitate workplaces to start-ups that are doing work related to the recycling industry. These places help start-ups with low funds to start building their businesses and thus contribute to the total recycling share. The products they produce will be made of materials from the hub and by having access to material passports, these businesses have clear insight on availability and quality of available materials.

- Awareness spaces

Awareness spaces are areas within the hubs and spokes that function as exhibition space for recycled and reused materials. By showing these products the visitor can see what's possible with the materials and thus it will raise awareness.

- Inviting facades

In the current system, most waste stations are surrounded by either buildings, walls or fences, making it hard for bypassers to know what's inside. By creating interesting facades that are made of recycled products or that are see-through, we want to draw attention and invite people to come into these hubs or spokes to get involved and learn more about the process.

3.4. Adjusted material flow diagram

In the diagram (figure 3.4) we visualized the material flows after implementing the multi-scale system. On the left we see the import and export of raw materials, which will be limited in the new system, but because of a higher demand than supply of materials we can not eliminate the use of raw materials completely (Bouwend Nederland, 2018). After production and prefabrication the materials can be used in construction and after time get disassembled on demolition sites. From these demolition sites the materials get either collected in a local spoke that is located on the demolition site or will be transported to a central hub. Individuals can bring their private waste also to local spokes, which will then collect, sort and transport it to central hubs. In the central hubs, multiple recycling facilities will be located that can process the collected materials and for materials that can't be recycled on location there will be existing external recycling facilities. After recycling in the central hub the materials will get a material passport and will be ready for re-use in production, construction or prefabrication.

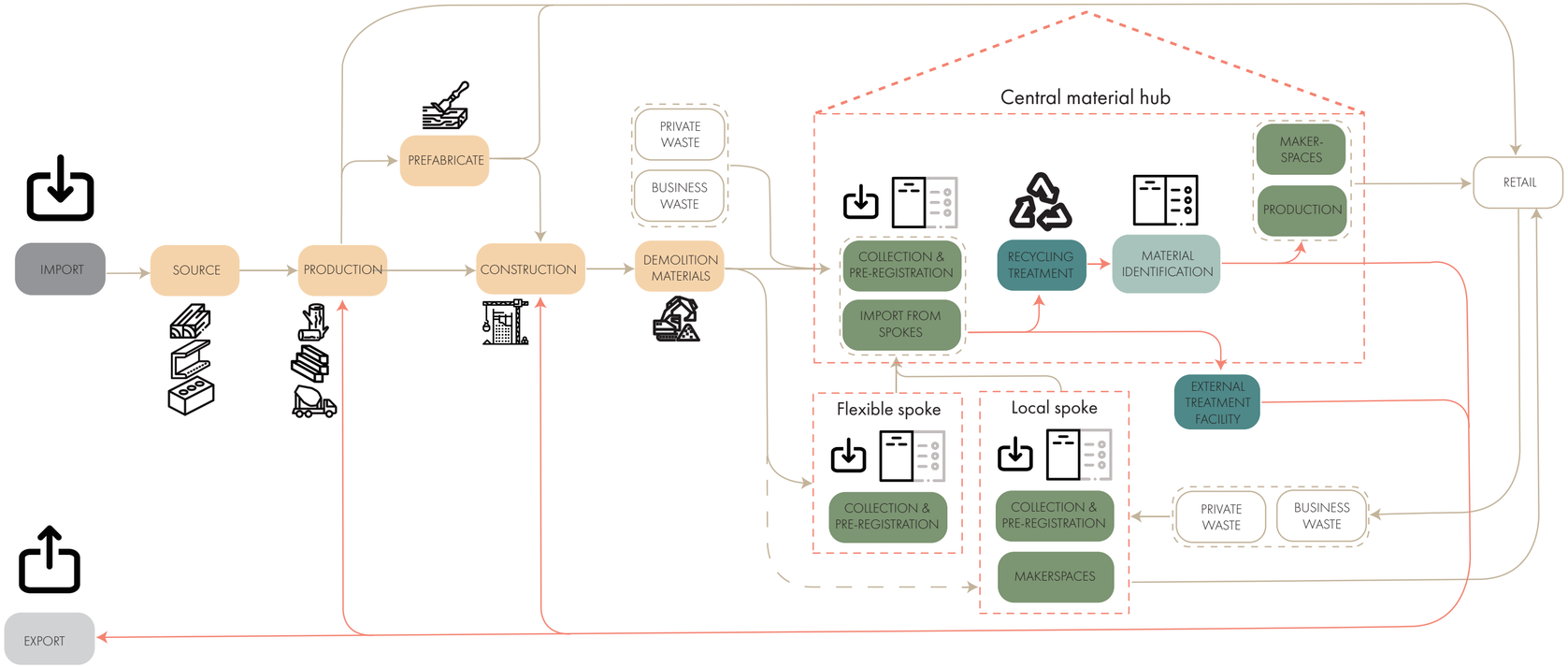


Figure 3.5. Adjusted material flow diagram, Illustrated by authors.

3.4. Vision 2050

In figure 3.5. we visualize our vision, showing all the different hubs and spokes. It's visible that a wide and evenly distributed network of central hubs is connected to a larger number of local spokes. These local spokes also connect locally to multiple facilities such as recycling companies, thrift shops and schools. This complex and multi-scale network strengthens the existing waste system and by integrating and improving socio-spatial and logistical connections, efficiency and involvement of citizens and stakeholders can be increased. By involving citizens and stakeholders from all parts of society, awareness can be raised and thus the willingness to participate individually in the circular waste system.

Focusing on the construction- and demolition sector, extra nodes in the system will be added. Modular units will be located on construction- and demolition sites, creating an addition to the system of flexible nodes that adjust to the situation over time.

Figure 3.6. Vision of South Holland 2050, Illustrated by authors.
Source: (LISA Data 2018)

CHAPTER FOUR

STRATEGY

In this chapter, an agenda of different goals and strategies are proposed. The goals are divided into two catagories, which is circular economy and socio-spatial aspects. In addtion, two matrices are developed in order to chose the locations and the functions of the nodes. Using the matrices, we mapped certain socio-spatial characteristics of South Holland, which helped us to identify the functions that are going to be added to the nodes. A series of typologies are created with different combinations of functions, based on their locations. Testing the typologies in different specific locations, we came out with four case studies, which elaborate the urban conditions more clearly.

4.1. Strategies

To carry out our vision we created a set of strategy goals which can be divided in 2 main categories. The specific strategies can apply to multiple goals and thus are not necessarily connected to one category only.

The first category focuses on the logistics to create the multi-scale circulair system. The goals are to create a circular flow of construction materials and to engage construction companies. To achieve this we will integrate different parts of the system in the central hubs, such as recycling companies, waste collection facilities and construction material manufacturers. By putting these businesses close to each other, they can share knowledge and help each other innovate faster. We will create and apply material passports to all materials, which will make it easier for companies to see the quality and reusability of certain materials. We will also implement taxes and subsidies making recycled materials more affordable than materials produced from raw materials.

The second category focuses more on the social qualities and social justice. The goals are to achieve societal wide awareness, to create equal accessibility and to create extra job opportunities. As mentioned before we will integrate educational functions to raise awareness. We will create awareness spaces or exhibitions to show the possibilities of recycling and reusing materials and we will retrain low skilled people to qualify them for the new type of jobs. Depending on the characteristics of the surroundings we will integrate makerspaces for start-ups or create social workplaces for low-skilled and illiterate residents. Finally all the interventions need to be designed to integrate with the urban fabric.

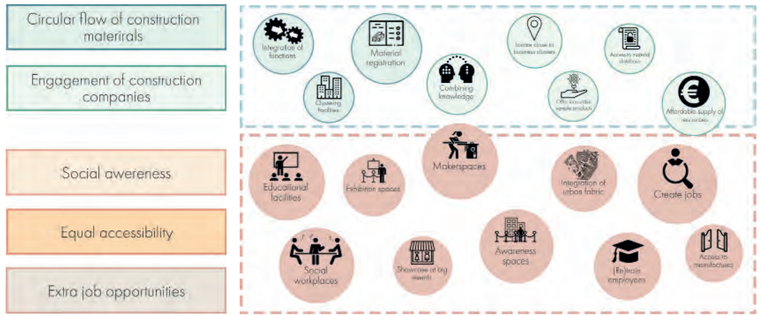


figure 4.1. Goals and strategies

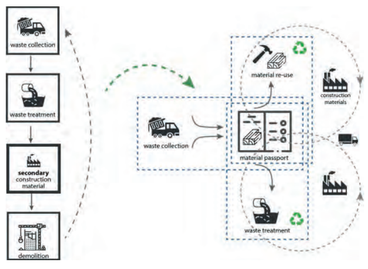


figure 4.2. Strategy

Material registration: Integrating material passport registration right after waste collection by assigning them a passport.

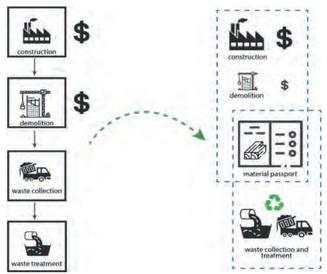


figure 4.3. Strategy

Access to material passport data: Giving companies access to material passport data to minimize the construction- and demolition costs

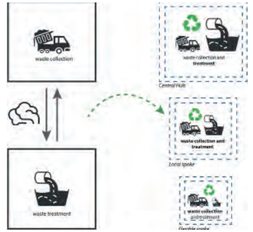


figure 4.4. Strategy

Intergration of functions: Transform the existing system of separated waste collection- and treatment facilities by integrating these functions (where possible).

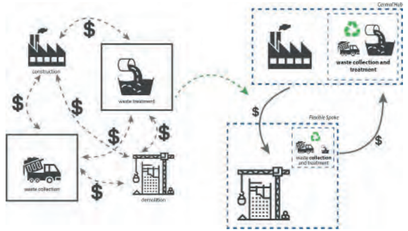


figure 4.5. Strategy

Locate close to business clusters: Use locations close to clusters of manufacturers in order to offer them recycled materials in proximity to their businesses, which offers reduced transport costs..

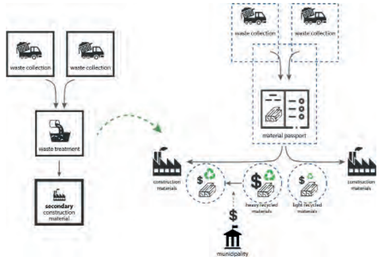


figure 4.6. Strategy

Affordable supply of resourses: Cheap supply of light recycled materials and subsidies for heavier recycled materials to manufacturers and recycling companies.

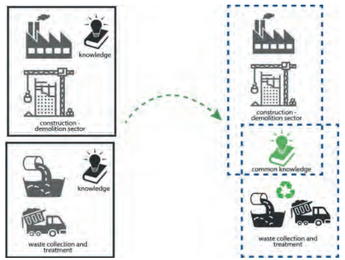


figure 4.7. Strategy

Combing knowledge: Combining specialized knowledge about recycling processes by integrating several functions in the same location

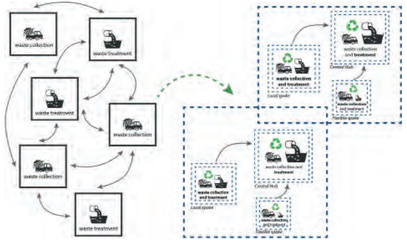


figure 4.8. Strategy

Clustering facitilies: Realise a clustered system of three different types (scales) of nodes, which are connected spatially, using the existing transportation infrastructure.

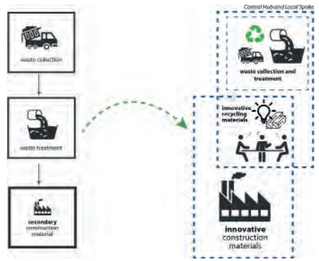


figure 4.9. Strategy

Offer innovative sample products: Offering innovative recycling materials or products to companies to try them out.

4.1. Strategies

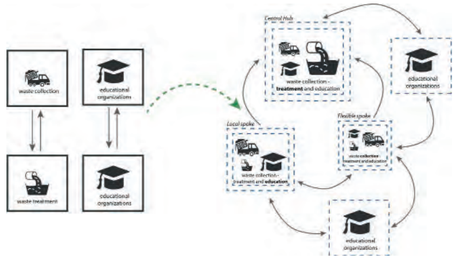


figure 4.10. Strategy

Educational facilities: Educational facilities in nodes close to the educational organizations to involve children and young people in the circular system processes.

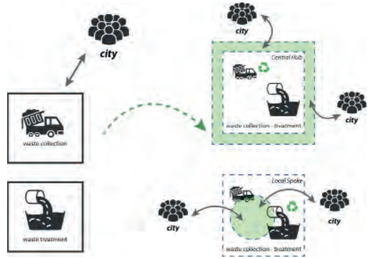


figure 4.11. Strategy

Awareness space: Create awareness space (green strip, cycling path, walking path) on the boundaries of the nodes to get people attention about circular material process

Exhibiton space: Create exhibition space in the nodes to get people attention about circular material processes.

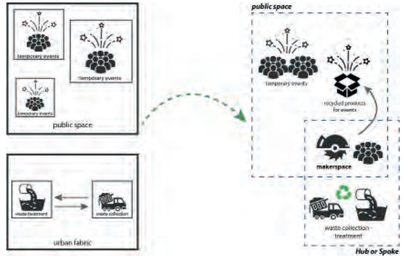


figure 4.14. Strategy

Showcase of big events: Take advantage of temporary big events (local or national) to showcase or sell recycled products in public spaces.

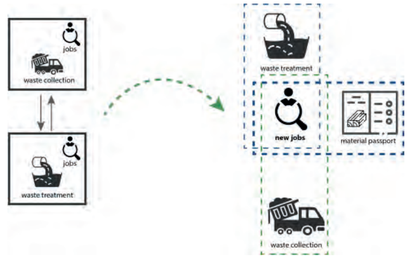


figure 4.15. Strategy

Creating jobs: Creating new jobs in the nodes, including new types of jobs related to recycling.

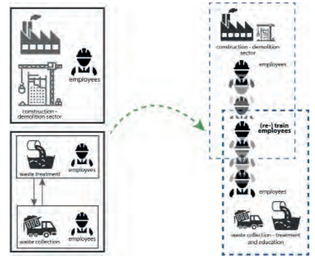


figure 4.16. Strategy

(Re-)train employees: (Re-)train construction sector employees to obtain skills relevant with the circular material process.

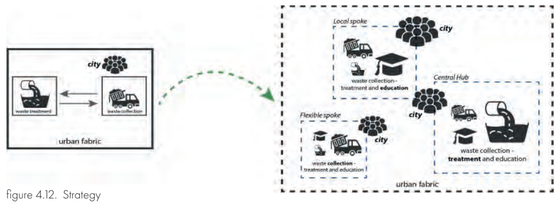


figure 4.12. Strategy

Intergration of urban fabric: Local spoke are well integrated in the urban fabric, accessible for all.

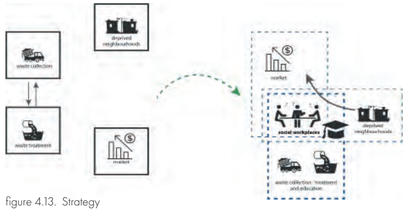


figure 4.13. Strategy

Social workplaces: Social workplaces offering opportunities for citizens who are behind on the labour market to improve language and labor skills.

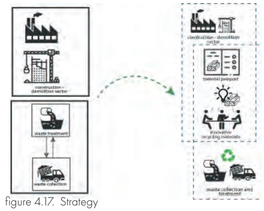


figure 4.17. Strategy

Access to manufacturers: Access to manufacturers in order to use material passports or innovating recycled materials that are created in the nodes.

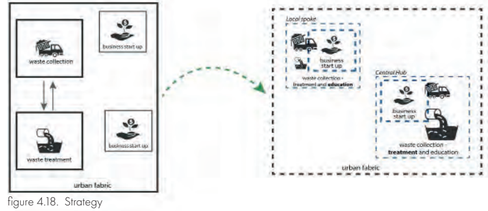


figure 4.18. Strategy

Makerspaces: Makerspaces offering opportunities for entrepreneurs to kickstart their business, related to re-use of materials.

4.2. The matrix

4.2.1. Location specific matrix

The transformation from a waste station to one of the three scales, an assessment criteria was created; this assessment is referred to as the location specific matrix (figure 4.19). Starting with questioning which one of the existing stations will become a central hub and which will become a local spoke, the identification will start by analysing the radius of the stations. If there are residential areas within a radius of 1km, that indicates that the station is transforming into a local spoke because it is more accessible to people. If there are no residential areas within the radius of 1km of the station, that means it is a safe distance from housing, the next step is checking if this station contributes to a fair distribution between other waste stations. If yes, the process leads to checking if this station has more than 4000 m2 available to create more functions in the area, and it is connected to four 4 directions of infrastructure to be easily connected to the rest of the central hubs then it will be transformed into a central hub. If the is a fair distribution between other waste stations but the station does not have more than 4000 m2 available and/or is not connected to 4 directions of infrastructure, then assessing the potential of relocating is needed. If the station can be relocated then it will be transformed into a central hub. However, if there is more than one waste station that is transforming into a central hub, the preference of becoming a central hub would be to the one that is closer to construction companies and treatment facilities as there will be a collaboration between them and the central hub.

If there is no contribution to a fair distribution between other waste stations, the station becomes a local spoke. Nonetheless, if there is distribution and it is not possible to relocate, then this station will become a local spoke.

Creating a flexible spoke depends on the existence of a construction or a demolition site, and the construction/demolition period is more than one year and has space of more than 300 m2 in order to have the time to create and integrate these spokes (socially and spatially).

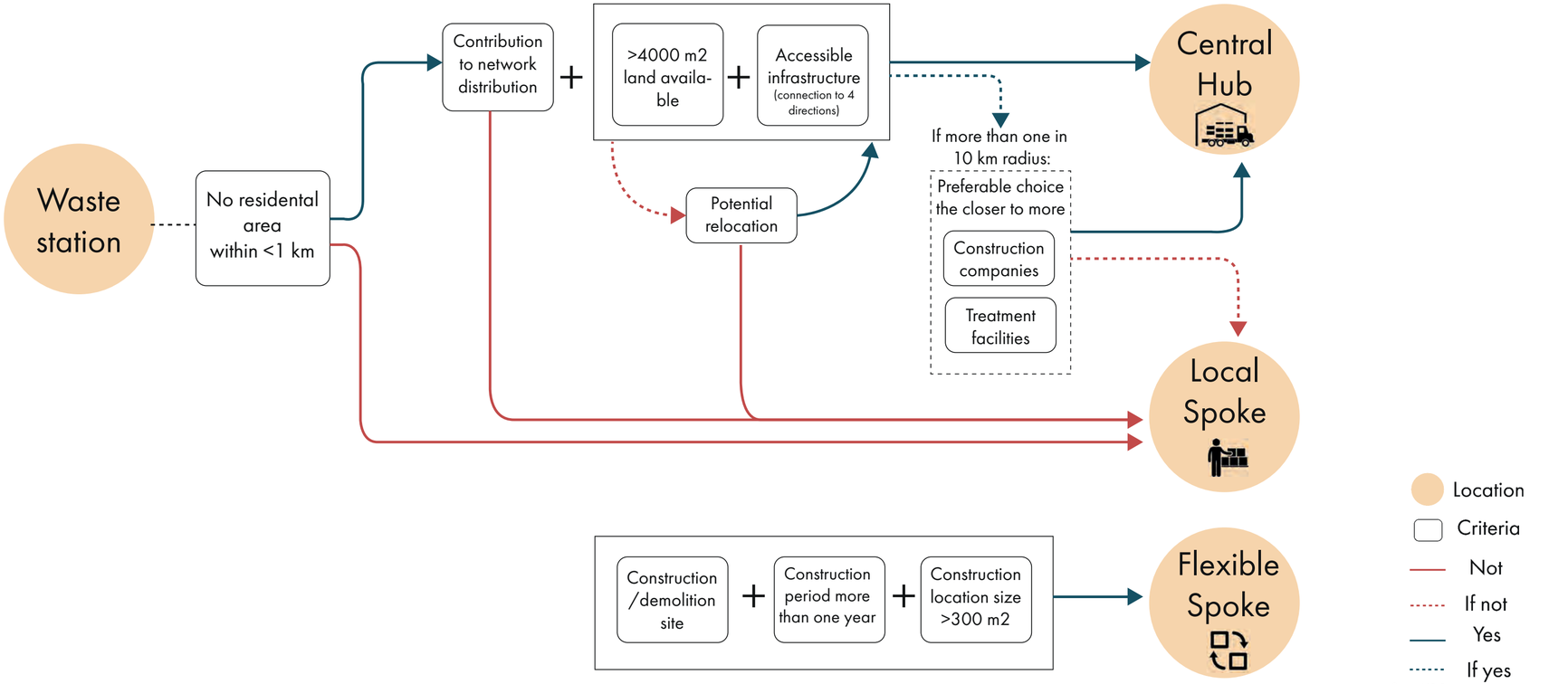


Figure 4.19. Function decision matrix, illustrated by authors

4.2. The matrix
4.2.2. Functions guideline matrix

In order to implement the functions that were described in chapter 3.3. and to determine in what scale should it be implemented the functions guideline matrix is created (figure x).The functions guideline matrix is based on spatial conditions that are necessary for a specific function, and social preferences which are preferable for creating functions and determine in what node (central hub, local spoke, flexible spoke) each function will be placed.

Treatment facility: function requires the absence of nearby treatment facilities so that it will be concentrated within the treatment facility, this function will be placed in the central hub. Due to the fact that one of the goals that this function serves is creating jobs, the social preference of the function is the high unemployment of inhabitants in the surrounding.

Elementary facility: has to be accessible within 15 mins walk for the children, the walking option makes this function most suitable for a local spoke.
The high school facility: is accessible within 15 mins of cycling for highschoolers, making it possible for this function to be implemented on all three nodes.
For both facilities: in order to achieve social justice in relation with the spatial condition, the function's social preference is to have the surrounding society have a low average of education level and have limited accessibility to quality education.

Social work places: As social work places are for all people to be part of the system it has to be accessible for people of low income, the surrounding society of this function is preferable to be with high unemployment and illiteracy rate so that these function, which are placed in central hubs and local spokes, be part of achieving the social integration and social justice.

Makerspace: makerspace function is for entrepreneurs who need the space to start their businesses, the accessibility to nearby recycling shops leads to possible implementation of this function in the central hubs and local spokes.
Awareness spaces: awareness spaces should be in safe spaces around the hubs and spokes and preferably surrounded by public places with a variety of visitors, meaning that this function has the possibility to be implemented in all three types of the nodes.

Inviting facades: needs to be next to a pedestrian or cycling route making it possible to be implemented in all three nodes of the system and is preferable to be located where it could have a variety of by passers.

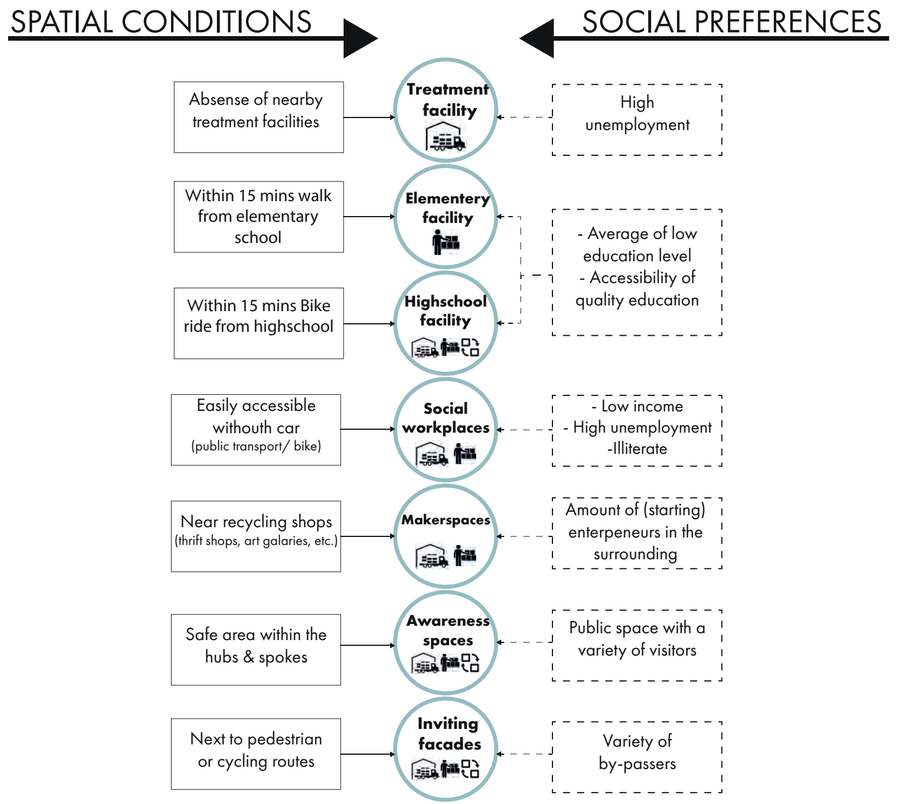


Figure 4.20. Function decision matrix, illustrated by authors

figure 4.21. Spatial conditions for central hubs and local spokes Source: (CBS, LISA Data 2018) Basemap:(snazzymaps.com)

Spatial Conditions for Central hubs and Local spokes

Our new system is based on the existing waste station. In the figure, we can see that most of the waste stations are not within the radius of 2km of waste treatment facilities. Besides, the recycling and treatment facilities are also separated from each other. Therefore, we need our new hubs and spokes to combine the two functions and for a better and more efficient material recycling flow.
Our decision of whether to use the existing waste station as a local spoke or as a central hub is based on the location decision-making matrix. Most of these sites chosen for central hubs are located on the edge of urban areas and are in the industry areas, with the possibility and potential for future expansion. But there are still some central hub positions that need to be moved, which have been marked on the map.

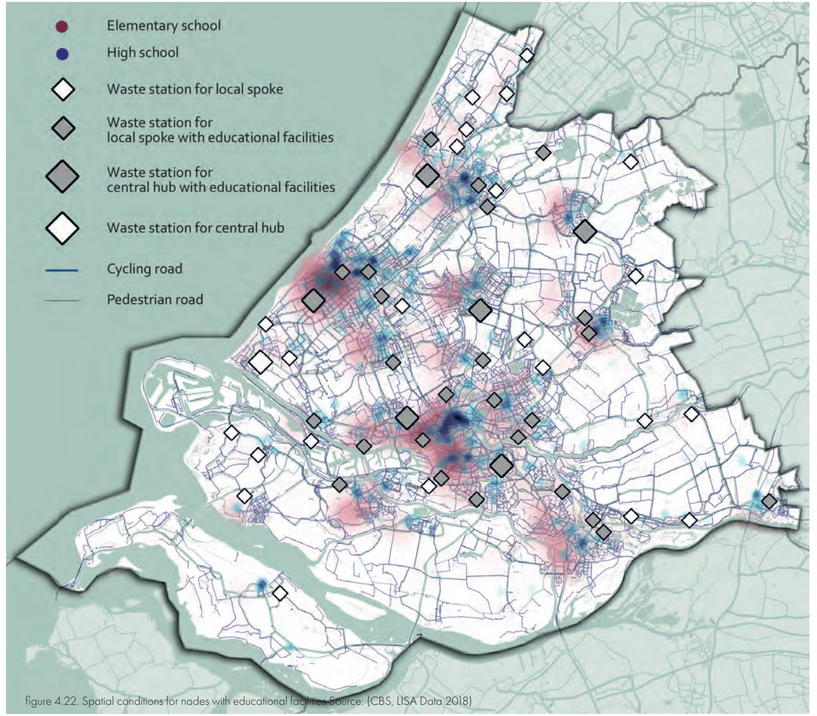


figure 4.22. Spatial conditions for nodes with educational facilities Source: (CBS, LISA Data 2018)

Spatial Conditions for Nodes with educational facilities

Educational facilities both for elementary school students and high school students will be added to our nodes. By visiting the waste hubs and spokes, the children will be able to form the idea of recycling and obtain the knowledge about the circular economy and material recycling in the construction and demolition sector, so as to cultivate the next generation of citizens with recycling awareness. At the same time, for high school students, we can also provide courses or practical opportunities that correspond to their courses. In particular, students in vocational technical schools can get in touch with the real environment and knowledge related to the material recycling sector earlier, which will help them in their future career development.
Therefore, when selecting the site, we considered the area where the elementary schools and the high schools gather and cluster. The most obvious ones in the picture are in the central areas of The Hague and Rotterdam. There are also sporadic distributions in the vicinity of other cities where the waste hubs or spokes will also have educational facilities.

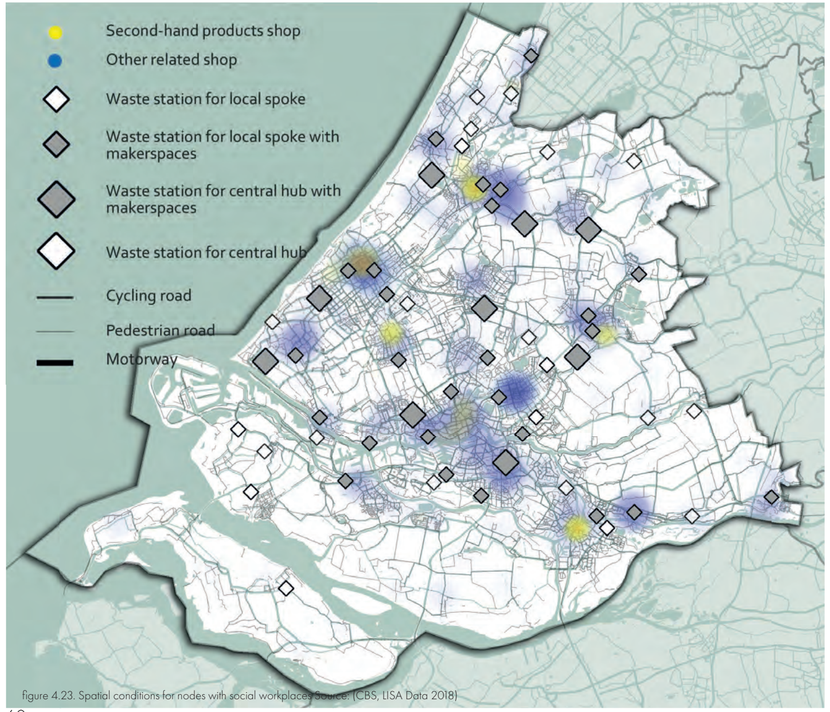


figure 4.23. Spatial conditions for nodes with social workplaces Source: (CBS, LISA Data 2018)

Spatial Conditions for Nodes with social workplaces

In the figure, there are some poorer areas in the south of Rotterdam and the central part of The Hague. Due to the concentration of labor or immigrants in these areas, the average income of many people is below the standard.

The new waste system will also add some social workplaces. In order to achieve the goal of social justice, according to the matrix, we choose the location of hubs and spokes with social workplaces in the poorer neighborhood. Therefore, some people who have job and income difficulties can get some help in the social workplace there. These people will be engaged in processing and other work related to the recycling of building materials. Besides, they can also learn certain skills and knowledge while working and raise awareness of circular economy.

figure 4.24. Spatial conditions for nodes with makerspaces Source: (CBS, Explanation for District and Neighborhood Map 2017, 2018 and 2019)

Spatial Conditions for Nodes with makerspaces

Maker-space will be added to the waste hubs and spokes. Many materials that can be reused directly or have been simply reprocessed can be immediately used in the makerspace.

The figure shows the cluster of thrift stores and other related shops such as furniture shops in the region, which have the potential to sell the recycling products from our hubs and spokes. According to the matrix, any hubs and spokes in or near these store clusters will be given the function of makerspace.

4.3. System of typologies

After applying the matrices we know which waste station will be turned into a central hub and which will become a local spoke. We also used the matrices in combination with the decision maps to assess where different functions will be added. After doing this assessment we know the combinations of functions that will be realised. Due to the different criteria, many combinations are possible and in theory every waste station can be transformed into a different variation. However there are some combinations that are more common in the area of South Holland. In figure x we can see different possible typologies for nodes, which are related to the added functions. The separation of the functions into two categories, the circular economy, and the social aspect highlight that local nodes are in direct dialogue with the social aspects of the city, however central nodes are necessary places to achieve the circular economy with more heavy industry and less accessible to people. Furthermore, in flexible spokes the functions from two categories are equally added, as they are temporary places that allow certain programs to be added. In addition, it is clear that local spokes can have much more combinations of functions, due to their bigger multifunctionality, compared to other kinds of nodes. This also means that these nodes involve different types of stakeholders in a common field.
At this point, we zoom in on specific case studies in South Holland to illustrate what these places will look like. We choose to examine locations with different socio-spatial characteristics in order to design different kinds of nodes, spatially and functionally. It's also possible that locations change over time and that more functions be added, due to changes in the characteristics of the surroundings.

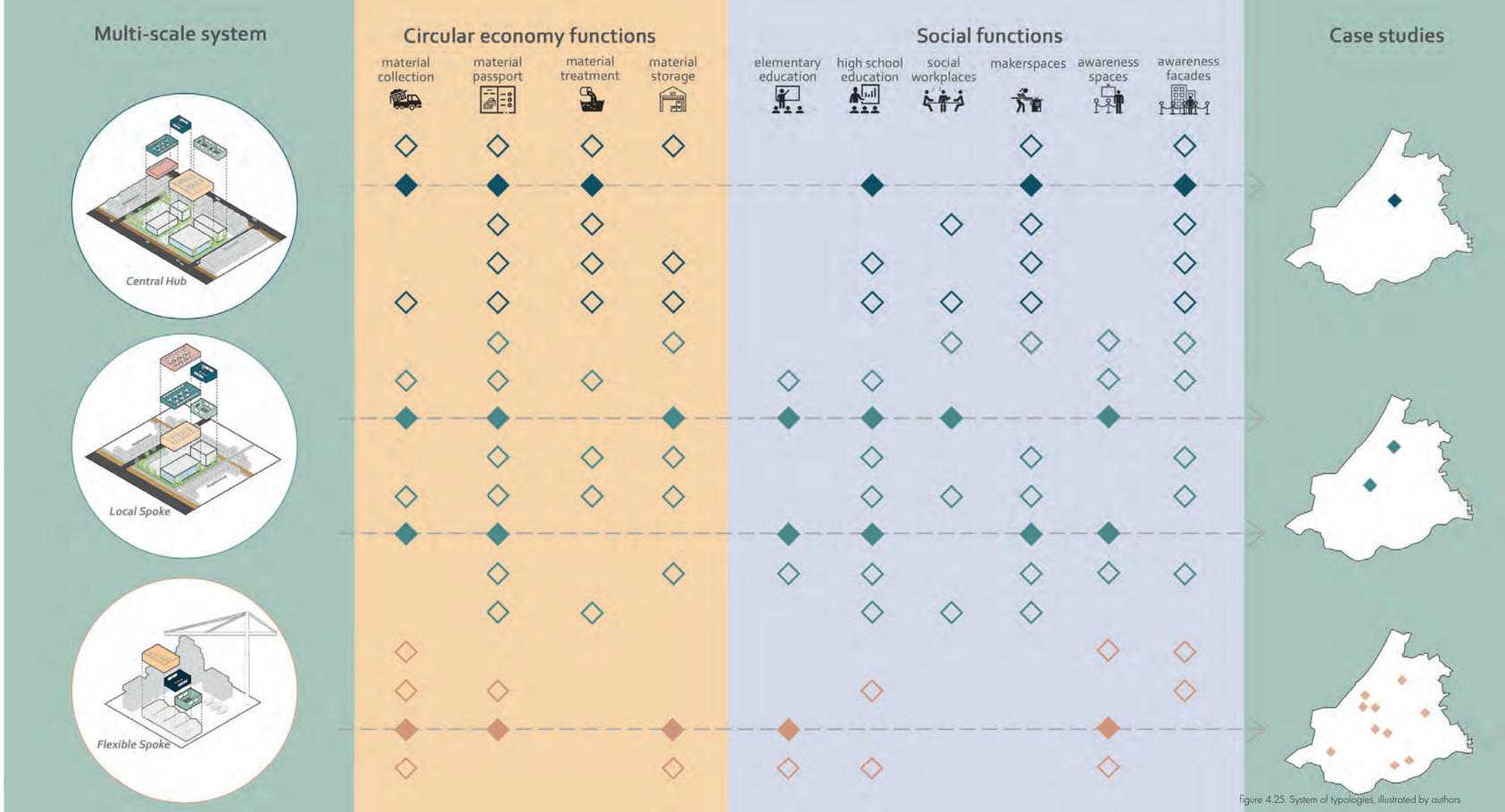


Figure 4.25. System of typologies, illustrated by authors

4.3. System of typologies

This exploded axonometric view shows an abstract case example of one kind of the typologies of the central hubs. The example is located in the industries area which has a lot of warehouses and manufactures in the surroundings. Different colors in the picture represent different functions. Moreover, to create attraction to the citizens to visit, new green spaces and transparent awareness facades are also added on site.

The four small axonometric views on the right show different kinds of possibilities of the function combinations which are also mentioned in the typology table.

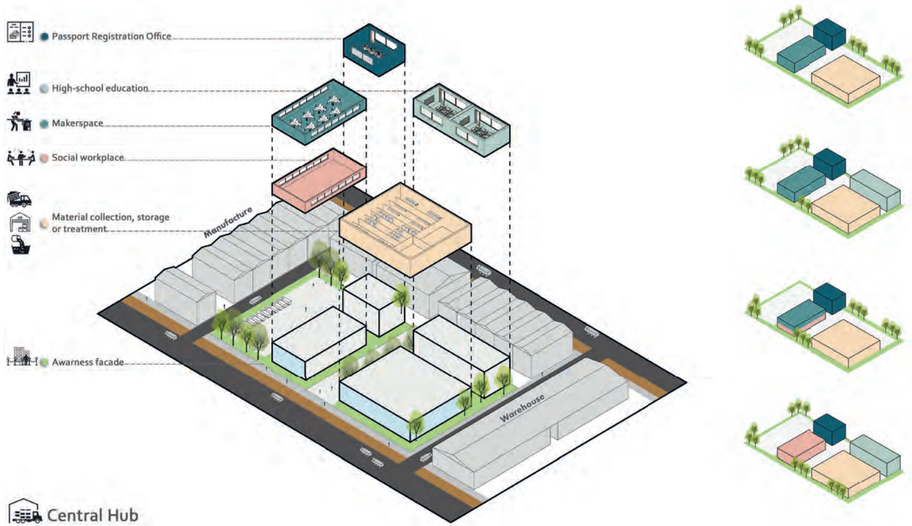


figure 4.26 Central hub typologies, illustrated by authors

This exploded axonometric view shows an abstract case example of one kind of the typologies of the local spokes. The example is located inside the tight urban fabric of a residential neighborhood and of which the scale is much smaller than the central hubs. Different colors in the picture represent different functions. Moreover, to create attraction to the citizens to visit, new green spaces and transparent awareness facades are also added on site.

The six small axonometric views on the right show different kinds of possibilities of the function combinations which are also mentioned in the typology table.

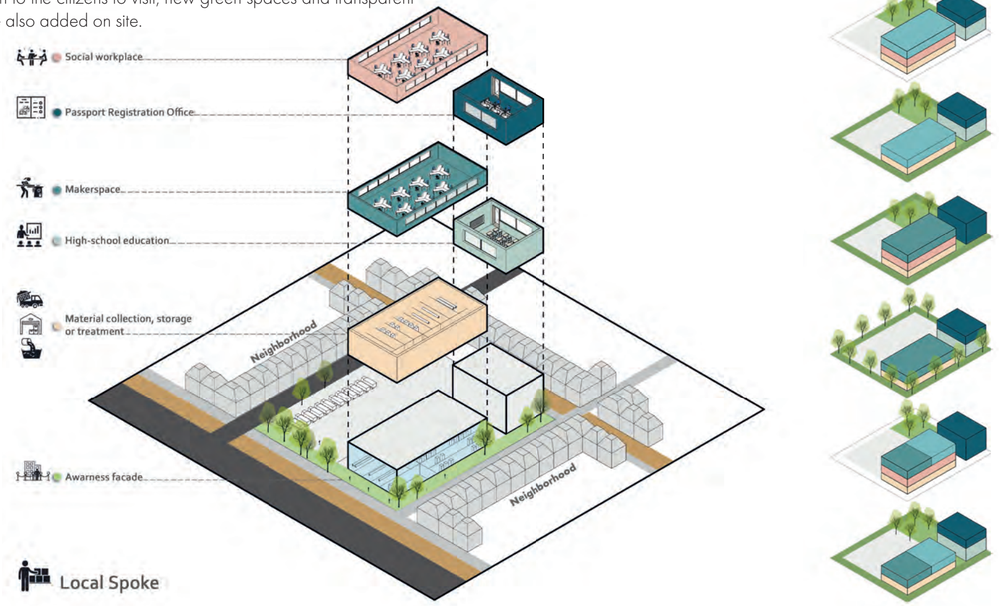


figure 4.27. Local spoke typologies, illustrated by authors

4.3. System of typologies

This exploded axonometric view shows an abstract case example of one kind of the typologies of the flexible spokes. The example is located on a demolition site. Different colors in the picture represent different functions.

The three small axonometric views on the right show different kinds of possibilities of the function combinations which are also mentioned in the typology table.

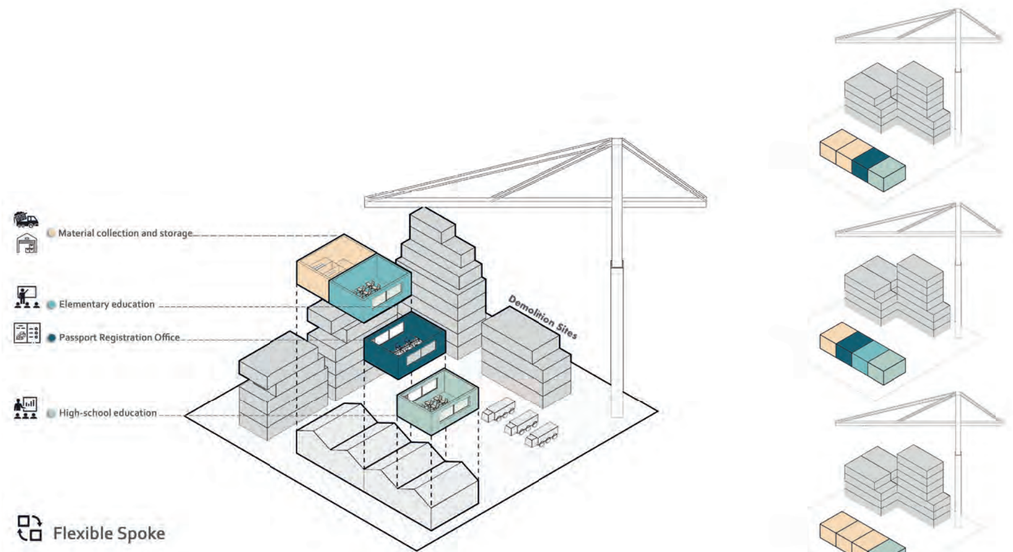


figure 4.28. Flexible spoke typologies, illustrated by authors

4.4. Flow of rejuvenated system

This figure shows the new material flow spatially in the construction and demolition sector of our proposal in the section, and how our new implemented waste hubs and spokes are connected to the surrounding urban fabric as well as how they operate as a whole efficient system.
The flexible spokes are built temporarily on the demolition and construction sites to have the easiest access to get materials. And the local spokes are located inside the tight urban fabric which is next to residential neighborhoods and schools to have better interaction with local citizens. The central hubs are usually located at the edge of the cities because of bigger land use and potential expansion demand.

Compared with the one-way linear material flow, the new material flow has many double arrows and loops. Reusable materials will be collected from demolished sites and neighborhoods and be collected by the waste spokes and hubs, and finally sent to manufacture for production or directly be re-used. Temporary flexible spokes have better flexibility, while fixed central hubs and local spokes with a clear hierarchical system ensure the stability and high efficiency of material collection and flow. In addition to logistical functions, multiple added social activities and functions are added to the hubs and spokes to achieve our vision goals that also contribute to the public circular economy awareness.

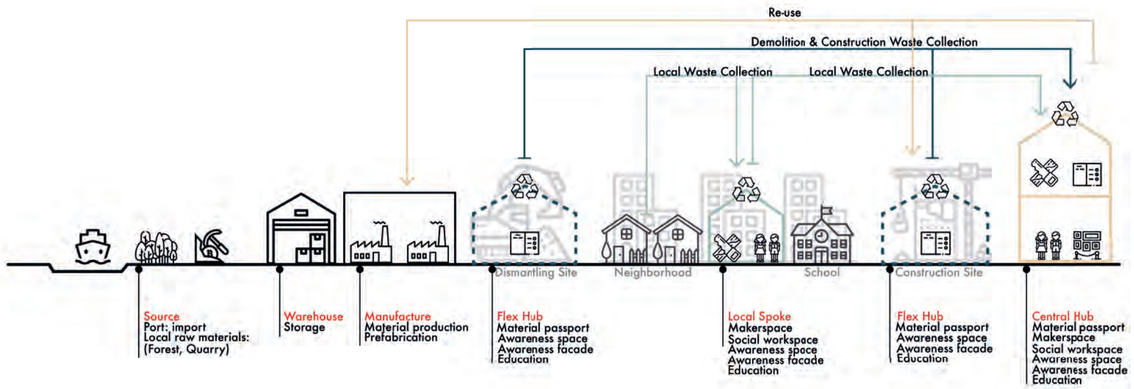
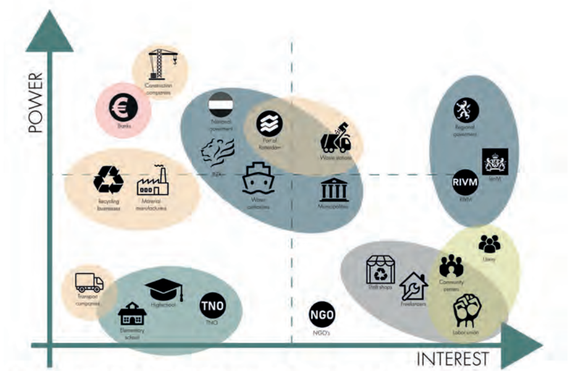


figure 4.29. Systematic section, illustrated by authors

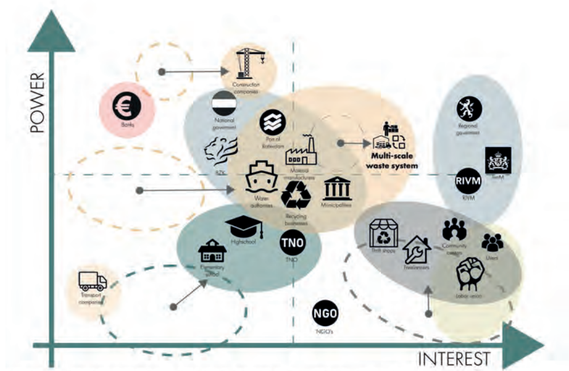
4.5. Stakeholders engagement

To implement our vision we are using strategies to create synergies among the different stakeholders. On the left u see the current power-interest diagram of the stakeholders involved. Many of the key stakeholders such as recycling businesses, manufacturers and construction companies currently have no big incentive to go circular. It's often expensive to transform businesses into circular ones and the economic system does not create a good profit as new materials are cheaper to produce. As already mentioned in the strategies sub-chapter we will implement multiple strategies that will increase profitability and create more interest among these stakeholders. We also include people from different communities and add educational facilities, thus creating an increased interest and power from these actors as well. Concluding the power-interest diagram after implementation is shown on the right.



POWER INTEREST DIAGRAM FOR THE STRATEGIC INTERVENTIONS (before implementation)

figure 4.30. Current stakeholder power interest, illustrated by authors



POWER INTEREST DIAGRAM FOR THE STRATEGIC INTERVENTIONS (after implementation)

figure 4.31. Proposed stakeholder power interest, illustrated by authors

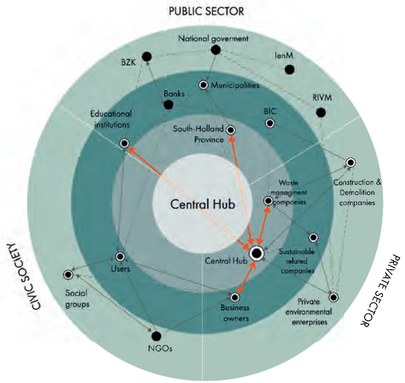


figure 4.32. Stakeholder analysis of central hubs, illustrated by authors

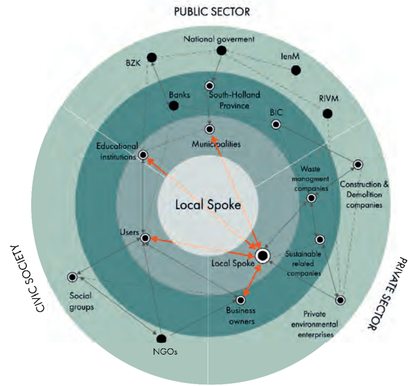


figure 4.33. Stakeholder analysis of local spokes, illustrated by authors

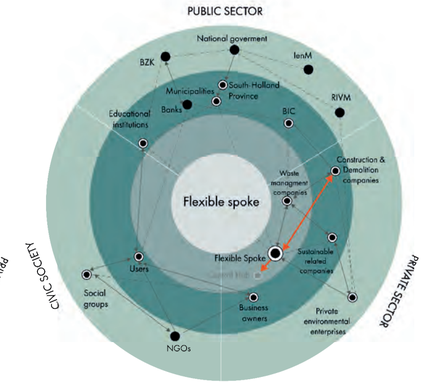
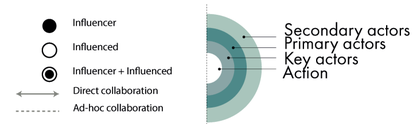


figure 4.34. Stakeholder analysis of flexible spoke, illustrated by authors

In addition to the power-interest diagram we created 3 stakeholder diagrams focusing each on an individual scale. In these diagrams it's visible that for each scale different stakeholders are key-stakeholders and that including all stakeholders in the process is necessary to create a successful strategy. This is because without one of the scales the whole system won't work as all parts have their own specialty.
The central hub is the main logistics center where big loads of bulk demolition waste, as well as company waste will be collected. To keep good track of all the big material flows in the region, the waste management companies and the province of South Holland are key stakeholders here that need to be involved. For the added functions such as makerspaces and educational facilities, schools and local business owners also should be involved in the decision making process.
The flexible spokes function as remote collection and sorting facilities on construction or demolition sites. So the construction and demolition companies are key stakeholders here. After sorting the materials for the hubs, they will be transported to the central hub or to an external treatment facility.



The local spoke will have increased connection with the surroundings by including start-ups, schools and social communities to the place. To achieve this the municipality, schools, local business owners and future users of the facility need to be included in the planning face. The combination of waste collection and social functions is already happening in small projects in the Netherlands, but to implement it on a large scale here needs to be an early approach to key-stakeholders to talk about the possibilities.

4.6. Strategy phasing

The transition to a circular system will be implemented with the help of the strategic goals, which are: Achieving a circular material flow, increasing citizen participation and stakeholder engagement, creating job opportunities and raising social awareness, integration and equality. These goals contribute to our strategy to rejuvenate the waste system. The timeline (fig x.) shows the stages in which each of the goals will be implemented towards the year 2050.
The phasing will begin with a planning phase, followed be a transition/ implementation phase and finalized with a consolidation phase.

Planning phase:

The planning of the transition will begin with gathering data of the existing waste treatment and collecting stations, demographic information and stakeholders that will also be engaged throughout the whole process of the waste system rejuvenation. This phase will also include a prototype station that will be implemented to strengthen the social awareness and integration goals, the purpose of this prototype will be to introduce and include people in the future system.
This phase will also be the beginning of retraining existing and new workers of the construction sector to start transforming businesses into the circular system.

Transition/implementation phase:

After gathering data, it is time to start implementing the three scales of the new rejuvenated system: Central hubs, local spokes, and flexible spokes. The implementation of this multi-scale system will also indicate the start of the multi-functions of the system such as: implementing material passport, educational facilities, social functions, makerspaces for entrepreneurs, and recycling related jobs.

he central hub will be the first to be implemented due to the fact that it will contain the major material flows and will help create space for the transition of the local spoke thereafter. The flexible spokes will move around as the construction- and demolition sites will also change location over time.
Based on the location specific matrix chapter (X), in case it is not accessible by infrastructure and does not contain 4000 m2 land available. the implementation of the central hub could mean a possible relocation of the hub. Manufacturers will get access to the information of the material passport from the beginning of the transition phase, stakeholders will implement subsidies for recycled materials and taxes to raw material with the purpose of creating incentive for the recycling businesses and manufactures to move and transform into hubs or spokes, therefore leading to the expansion of the project to the rest of the Netherlands that will continue in the consolidation phase.
In the process of implementing the central hub, local spoke and flexible spoke, companies will start using the innovative recycled products that are created within the hubs and scales.

Consolidation phase:

From the moment the transition and implementation phase starts, the preparation to spread knowledge about the circular systems starts and continues throughout the consolidation phase. In order to use and introduce the hubs and spokes on the larger scale and to a wider audience, there will be collaboration with temporary big events (local or national) to showcase or sell recycled products in public spaces.

Recycling jobs and stakeholders engagement along with the use for recycled innovative products are goals that go for the longer term in the consolidation phase to maintain the circular transition.

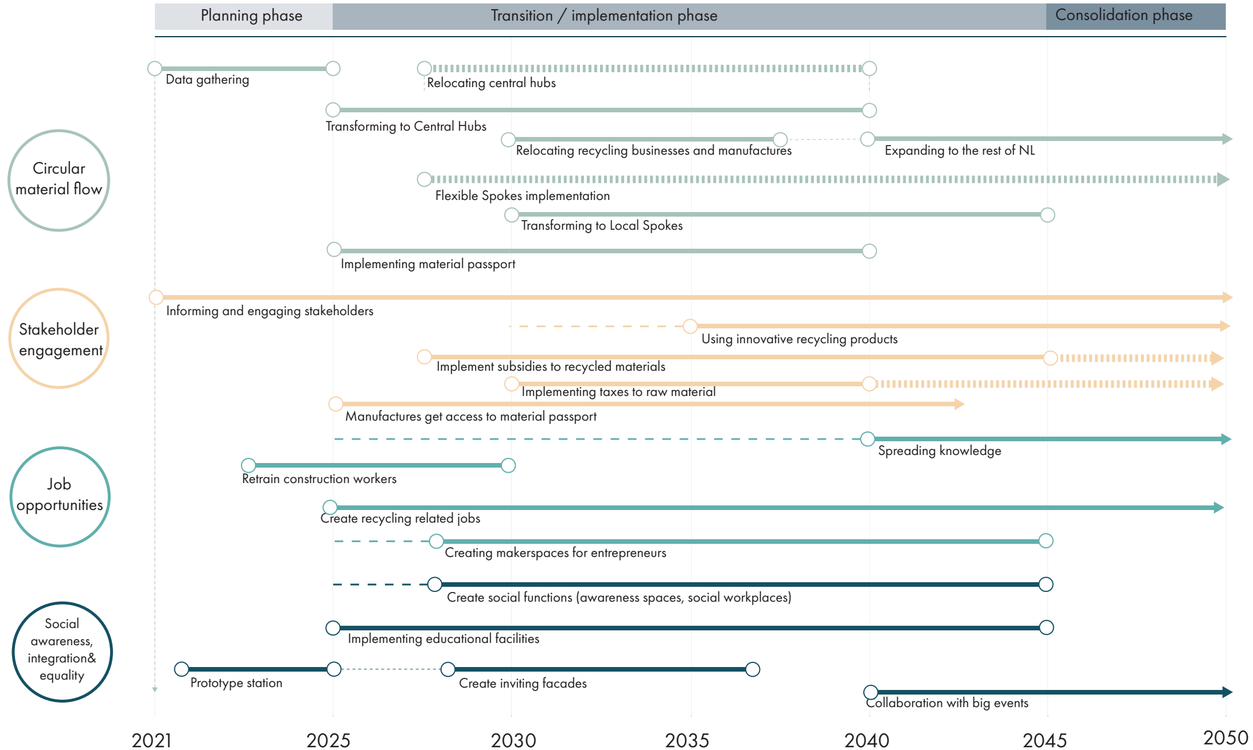


figure 4.35. Implementation phasing, illustrated by authors

4.7. Case studies on different scales

4.7.1. Central Hub - Zoetermeer

We will look at the waste station in Zoetermeer first. The waste station is currently located in an existing dense business area. We picked this location as it is next to a new and partly undeveloped area in the centre of the province of South Holland, which is marked by Zoetermeer as a new innovative center for distribution businesses that connect to the circular economy. It also connects really well to the rest of the province by rail and road. It also provides space for a lot of regional warehouses. There is a new Randstadrail connection with the Rest of Zoetermeer and the Hague. This new line connects to the existing train track between Utrecht and the Hague.

The good connection to the existing infrastructure, together with the location that adds to a wide and evenly distribution of hubs makes this place suitable to become a central hub. We mapped the location and its surroundings and marked the location to where we want to locate the current waste station, which will only be about a 100 meters and will provide the hun with much more available vacant land to integrate multiple facilities.

On the map you see that within close radius there are many elementary schools and high schools. This creates a possibility to add an educational facility. Due to the scale and the hazardness of the central hub we will not connect this facility to elementary schools, since it will be difficult to create an extra safe environment for young kids. However the multi-functional facility will be a great place to learn for kids of higher age that go to high schools in the area to visit and learn about the circular economy.

There are also multiple recycle businesses in close radius. With strategies that will increase efficiency in the hubs and create interest among stakeholders to integrate with the facility we hope that multiple of these businesses will move to the central hub as well. This also creates hard needed space on the already densely filled businesses area they are in currently.

Finally we see multiple thrift shops in the area that can function as sales markets for products made in makerspaces. Zoetermeer has a high percentage of entrepreneurs and freelancers (CBS, 2018) and with the addition of a makerspace the facility can provide workplaces for these people and increase re-use of materials brought to the hub.

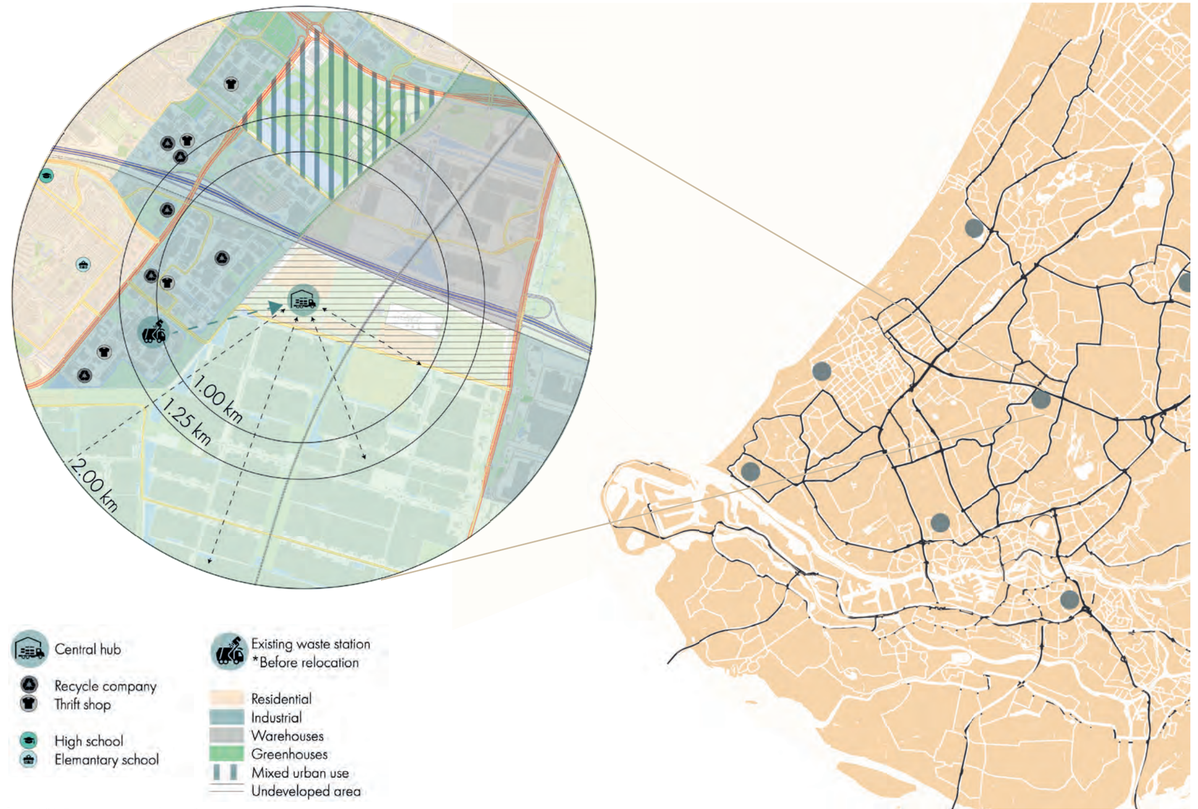


figure 4.36. Zoetermeer case study map Basemap: snazzymaps.com and milvusmap.eu

4.7.1. Central Hub - Zoetermeer

- Relocating and upscaling current waste collection facility.
- Implementing a material passport office to register materials.
- Relocating and integrating nearby recycling, manufacturing and construction companies.
- Adding an educational facility, as it is in close proximity to a highschool.
- Adding social workplaces, as the waste station is near low-income neighbourhoods.

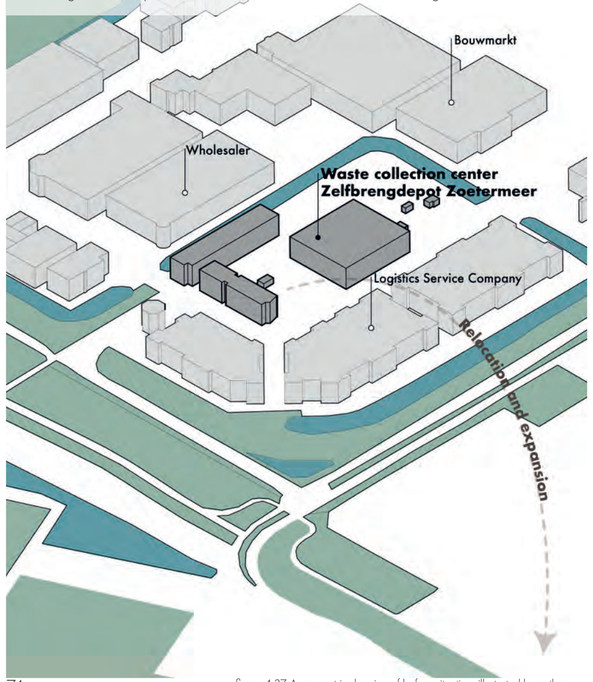


figure 4.37. Axonometric drawing of before situation, illustrated by authors

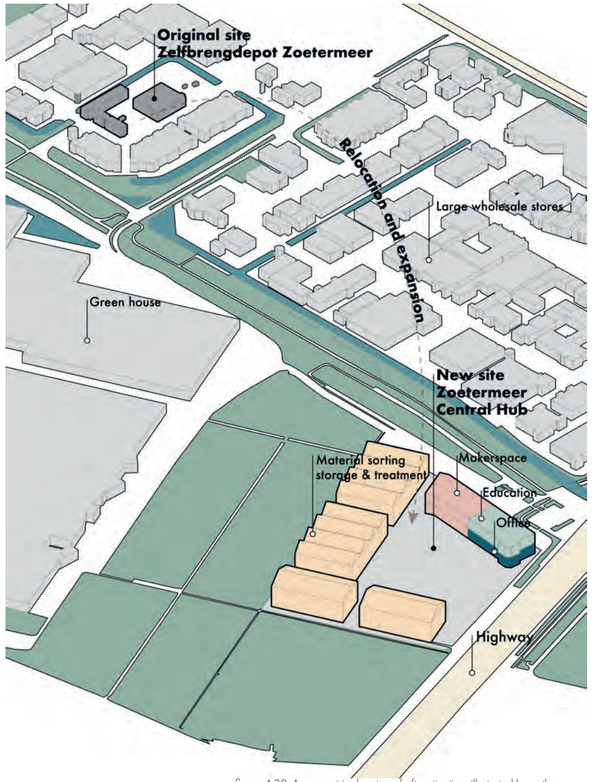


figure 4.38. Axonometric drawing of after situation, illustrated by authors

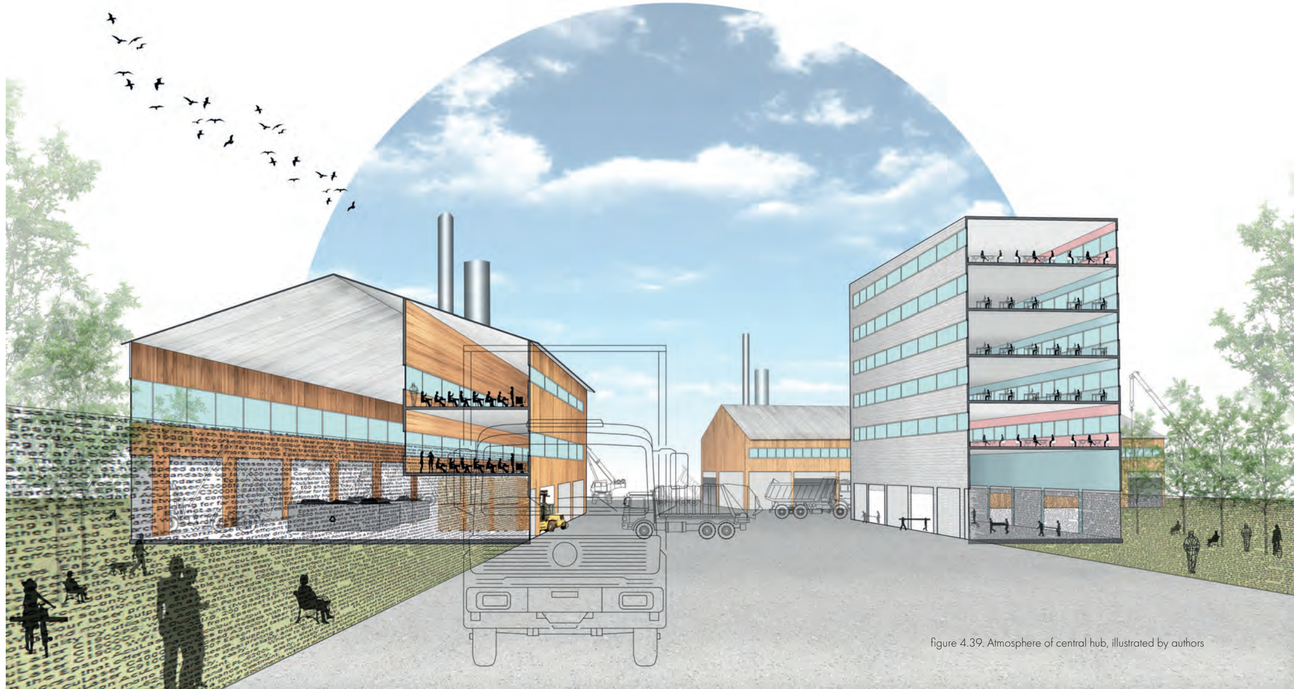


figure 4.39. Atmosphere of central hub, illustrated by authors

4.7. Case studies on different scales

4.7.2. Local Spoke examples - Delft & Leiden

For the local spoke case studies we will focus on 2 locations. This is because all local spokes can have different combinations of functions which are picked by using the matrices described in chapter 3. We picked one location that's near a residential area with an average low-income and one in a relatively high-income area.

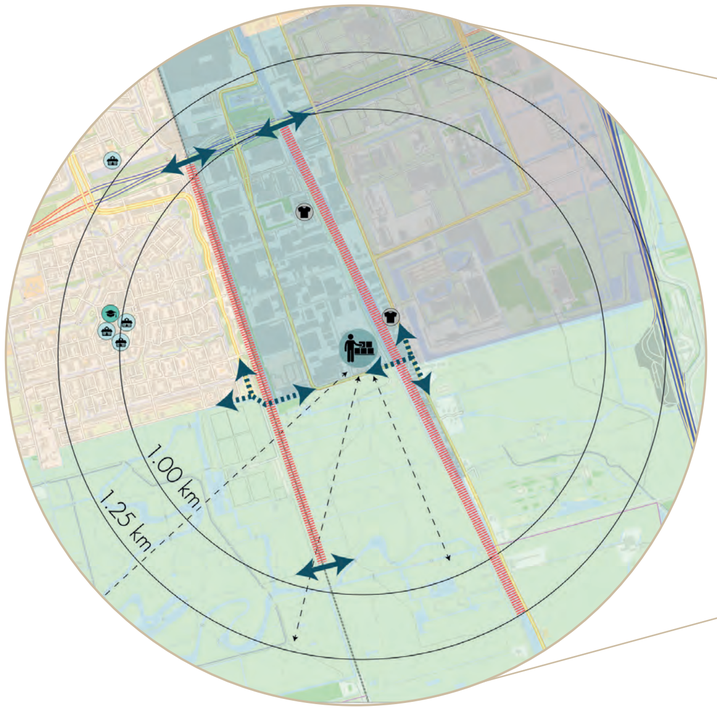


figure 4.40. Delft case study map Basemap: snazzymaps.com and milvusmap.eu

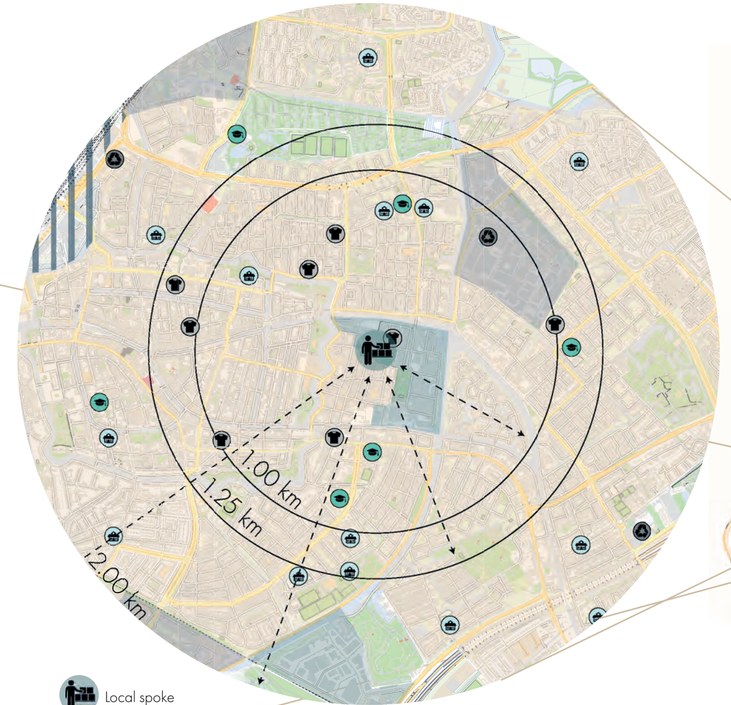


figure 4.41. Leiden case study map Basemap: snazzymaps.com and milvusmap.eu

4.7.2. Local Spoke examples - Delft & Leiden

The first example is the waste station in Delft. It is located on the edge of the city in a small industrial area between a residential area and a business and education area. The residential area is too close, which means the location is unsuitable to become a large central hub and will be transformed to a local spoke. It's well connected by road and waterway and it has the spatial capability to expand. However the area is bordered by the Schie canal and a railroad which function as barriers. To connect the local spoke with its added social functions better to its surrounding areas, changes have to be made to improve accessibility. A tunnel below the railroad to the residential area or a bridge over the Schie could function as possible new connections.

On the map u see that multiple schools are within close radius and they could access the local spoke within 15 minutes if a connection underneath the railroad is being realised. Due to these nearby schools this local spoke is a good location for both an elementary and highschool facility, according to the matrix.

In the surrounding residential areas the average income is low compared to the provincial average. For this we want to add a social workplace to the local spoke. Here people who are unable to find a job can learn the Dutch language better, work on labor skills or connect with employers at the local spoke. In this way the local spoke can contribute to social justice. In the area are also 2 thrift shops that could sell products made in the social workplaces.

- Transforming the current waste station into a local spoke.
- Implementing a material passport office to register materials.
- Adding educational facilities, as it is in close proximity of elementary- and highschools
- Adding social workplaces, as the waste station is near low-income neighbourhoods.
- Create awareness space to exhibit recycled products.

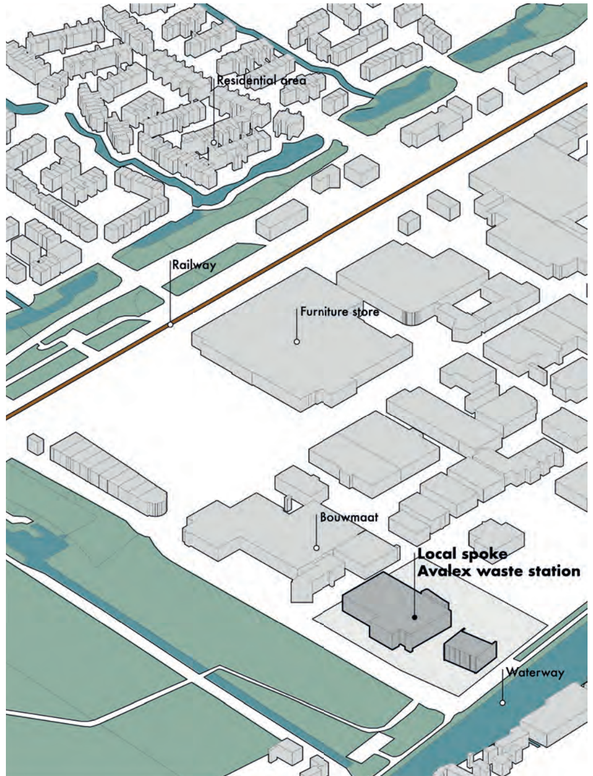


figure 4.42. Axonometric drawing of before situation, illustrated by authors

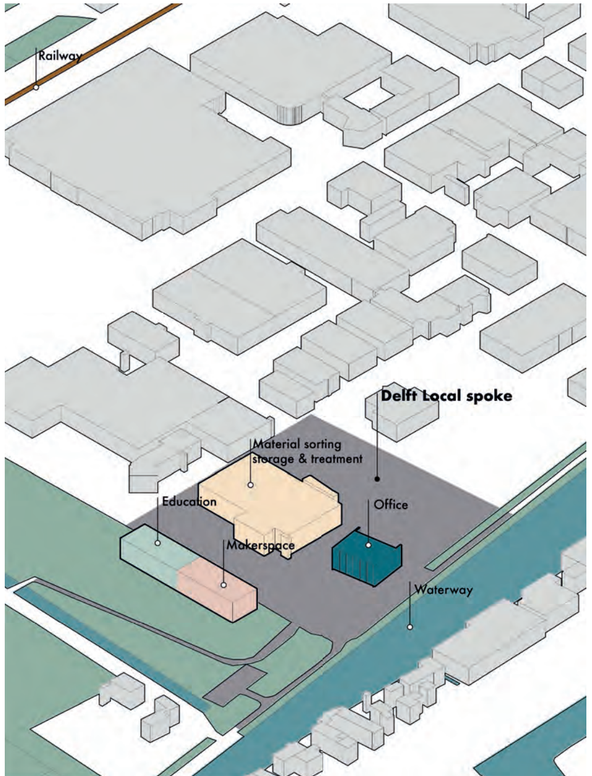


figure 4.43. Axonometric drawing of after situation, illustrated by authors

4.7.2. Local Spoke examples - Delft & Leiden

The second local spoke case study is about a waste station in Leiden. It's relatively close to the inner city, located in a small business area within the city. People in this area earn a high average income. Due to the lack of connection to high capacity roads, waterways or railroads and its close proximity to dwellings its unsuitable to become a central hub. It would also not improve the distribution of central hubs as we already located another one near Leiden.

There are a large number of schools in the area. Most of them within 15 mins travel radius. This means the location is perfect to accommodate educational facilities for both elementary and high schools. The central location within the city also automatically connects it to most cycle and walk infrastructure making it easy to safely go to this spoke.

We also see a large amount of thrift shops and second hand retailers in the area that could sell second hand products or products made out of recycled materials. Because of this advantage, makerspaces can be integrated in the spoke to accommodate workplaces for freelancers, startups and entrepreneurs that work with the recycled materials from the spoke.

- Transforming the current waste station into a local spoke.
- Implementing a material passport office to register materials.
- Adding educational facilities, as it is in close proximity of elementary- and highschools
- Adding makerspaces, as there are many freelancers and start-ups in the area.
- Create awareness space to exhibit recycled products.

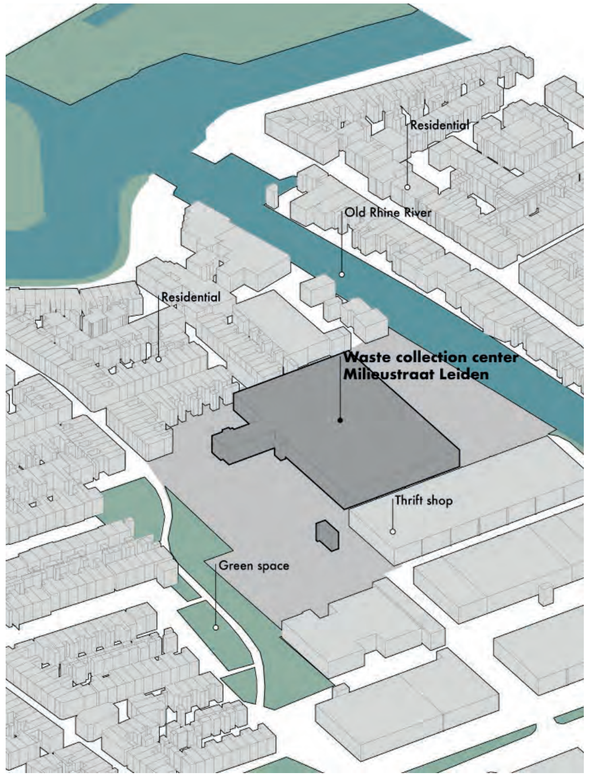


figure 4.44. Axonometric drawing of before situation, illustrated by authors

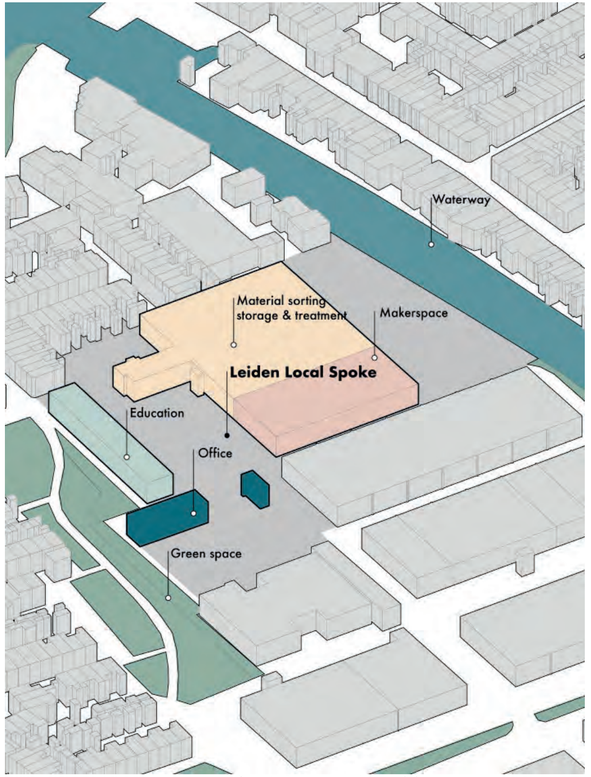


figure 4.45. Axonometric drawing of after situation, illustrated by authors

figure 4.41. Atmosphere of local spoke, illustrated by authors

4.7. Case studies on different scales

4.7.3. Flexible Spoke

The last case study is about the flexible spokes. As we explained in chapter 3 the flexible spoke exists of modular units that can be moved to large construction- and demolition sites. Since these sites only last as long as the construction or demolition takes, the locations of this will change and the modular units can be moved from one to another site, making the spoke itself part of a circular system as well. This case study will be less specific to a location, but will be more about the process around the flexible spoke.

When planning a new construction or demolition site the matrix can be used to determine if a site is suitable for a flexible spoke. The main criteria are the amount of available space to put the modular units and the timespan of the construction or demolition. For shorter periods it might not be worth it to move the modular units and then the positive effect of reducing transport and increasing efficiency of the circular waste process might not outweigh the transport and construction of the modular units. For sites with a longer lifespan however it will outweigh the relocation of the modular units.

After assessing the effectiveness the modular units will be moved to the construction site and there all the waste will be collected and sorted. The flexible spoke wil transport the sorted materials to the nearest central hub where the materials get processed and get their material passport. However when materials can not be processed in the central hub they will be transported directly from the flexible spoke to an external recycling facility, reducing transport movements. This could be the case for materials that need heavy industry complexes to be recycled, such as metals or concrete. When the construction or demolition finishes, the modular units will be disassembled and moved to a new site.

Beside the logistical process, these flexible spokes can also be a location to house awareness spaces where recycled- or reused products can be showcased. Also educational facilities can be added to educate people on location about the process of the circular construction- and demolition industry.

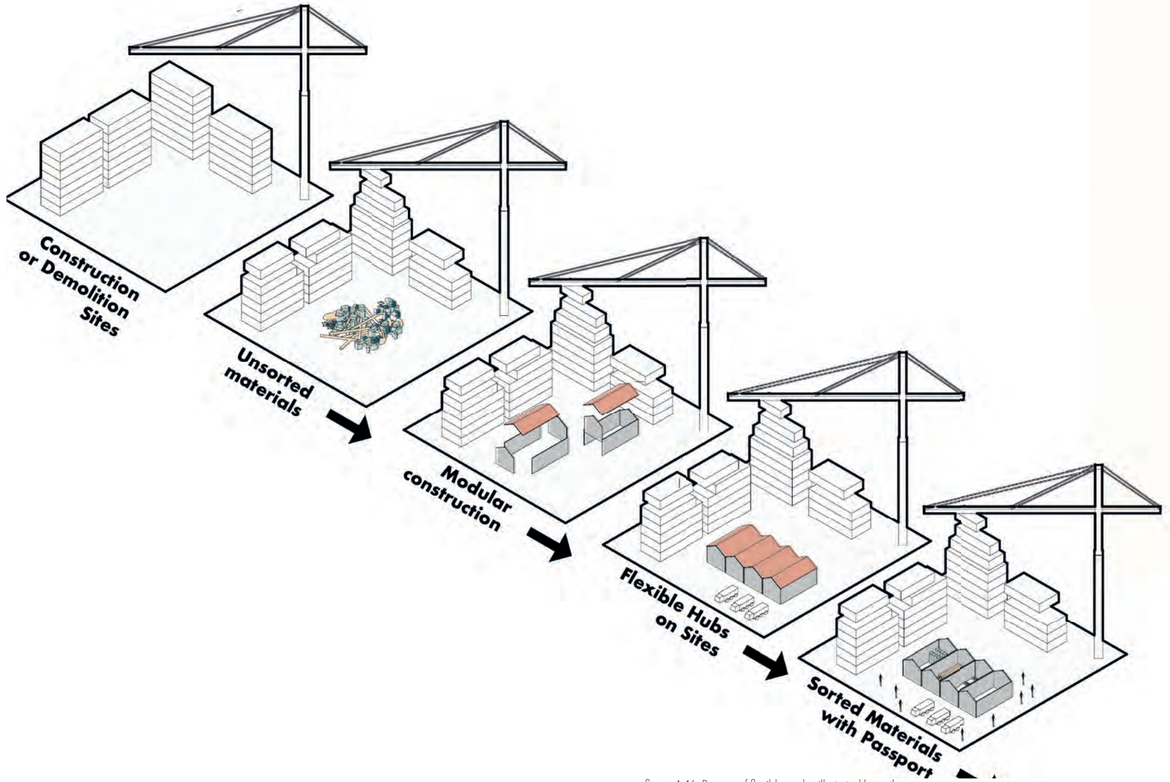


figure 4.46. Process of flexible spoke, illustrated by authors

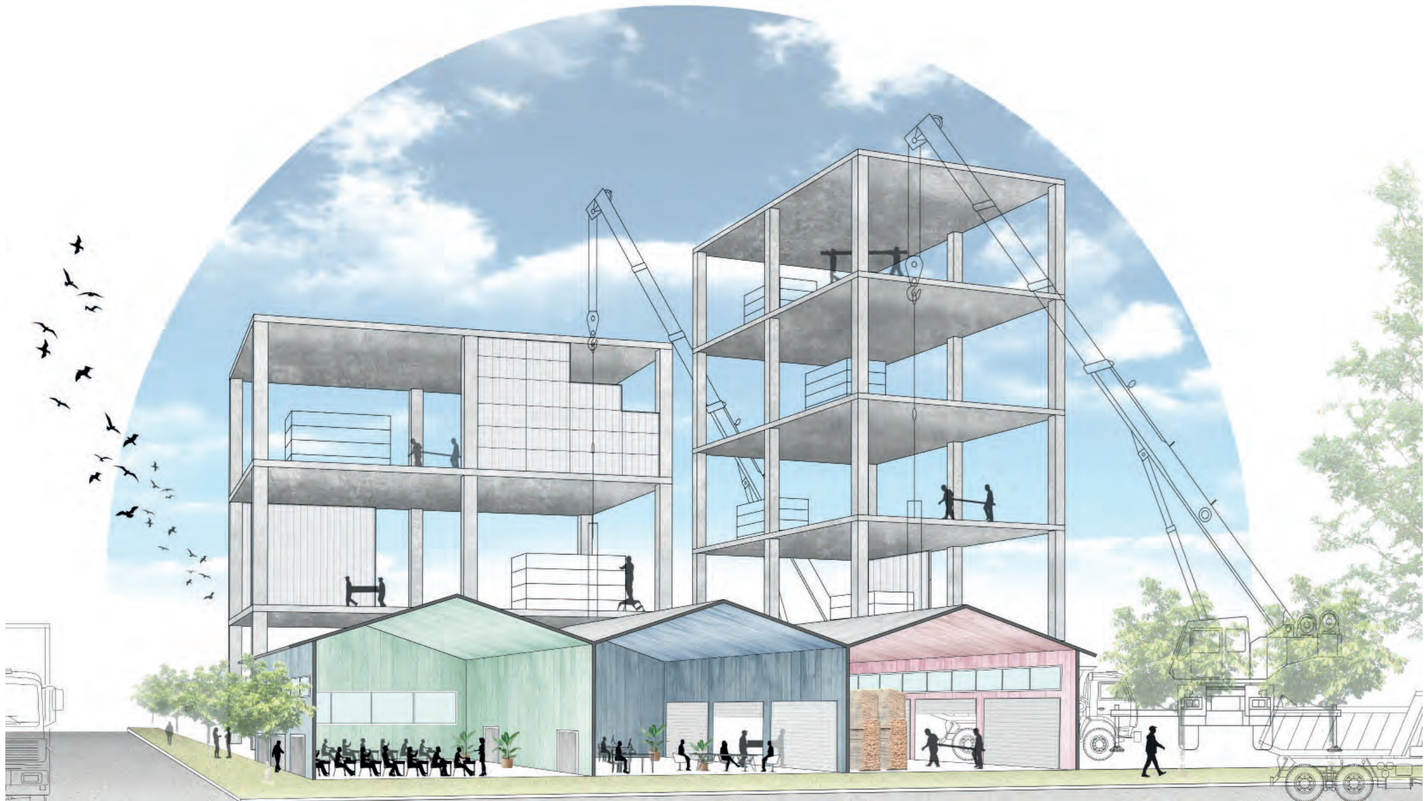


figure 4.47 Atmosphere of flexible spoke, illustrated by authors

CHAPTER FIVE

CONCLUSION

This section recalls the problems studied and reflects on the research process. The evaluation and synthesis of the results leads to the conclusion and recommendations for policies and further research.

5.1. Conclusion

This project was established in order to achieve a circular economy in the construction- and demolition sector in South Holland by responding to and rejuvenating the waste system. The contemporary Dutch waste system consists of collection and treatment facilities which are spatially segregated and lack integration of socio-spatial aspects. This set-up leads to (waste) materials making excessive transport movements, a lack of social awareness and limited involvement of citizens and stakeholders. Together, this does not contribute to stimulating the circular flow of materials.

In order to analyze this problem and lay the foundation for defining a vision and strategy, a mixed methods approach has been applied. Through mapping, stakeholder analysis, literature reviews and (online) field visits it became clear that the Dutch waste system has a solid base in orderliness and equal access through the even distribution of the nodes. Therefore, most ground was to be gained in the fields of optimizing the topological structure and achieving social awareness through involving citizens and stakeholders.

These methods gave a broad insight into the elements and went beyond the obvious technical characteristics. However, they provided less insight into precise statistical analysis, which is also more challenging for certain social aspects.

Nevertheless, the extensive initial analysis produced the decision matrix, which in turn was used for further analysis and strategy formation. This matrix responded to the aforementioned potentials of the waste system and ultimately resulted in the final product, of which several components were highlighted in the form of case studies. This final product is a hub-and-spoke based waste network of South Holland, whereby the waste stations are transformed into multifunctional nodes. The composition of these functions is different for each specific node, depending on location, scale and neighbourhood characteristics. On a spatial and logistical level, the functions optimise logistical operations, the tracking of material flows and integration into the urban fabric. In terms of social aspects, the nodes have functions that increase knowledge, labour skills and social equality. Together, these interventions contribute to stimulating a circular flow of materials and creating social awareness. The increased involvement of citizens and stakeholders gives the transition to a circular economy an extra push, making it possible to realise it over time with the help of policy interventions. A concrete suggestion for a policy intervention that could support this integral strategy is to position at least the new waste stations in such a way that they could easily be integrated into the urban fabric. In the end, however, a fully circular economy does not merely rely on the waste system and thus, this strategy can serve as one of several to obtain a fully circular construction- and demolition sector in the province of South Holland by 2050. If the strategy and the application of the decision matrix prove to be successful, they can also be well applied to areas outside the province's borders in the years to follow after.

In light of scrutinizing and valuing this strategy in general, it is important to mention its strong, but also its weaker features. The strongest features of this strategy are that it goes beyond policy planning and behavior regulations. The integration of social aspects draws on the power of the commons and their capacity to create a movement. This feature is not ubiquitous in current policies and could consider this strategy to be unique in this field. However, this strategy takes less account of implications for stakeholders who base their activities on current linear models. In addition, no precise calculations have been made of the actual impact on absolute material flows. Therefore, it might be interesting to conduct future research on how to mitigate the negative consequences for affected stakeholders and what the absolute impact on material flows of this strategy would be.

CHAPTER SIX

REFERENCES

References

Albrechts, L. & Lievois, G. (2004). The Flemish Diamond: Urban network in the making? European Planning Studies, 12(3), 351-370.

Antea Group (2020). Upcycle Centrum Almere: van milieustraat tot grondstoffen-hub [from waste station to material hub]. Retrieved on February 18th, 2021 from: https://anteagroup.nl/nieuws-media/nieuws/upcycle-centrum-almere-van-milieustraat-tot-grondstof-hub. Heerenveen: Author.

AREA Cleaning (2020). Wat gebeurt er met het afval dat ik naar de milieustraat breng [what happens with the waste that I bring to the waste station]? Retrieved on February 18th, 2021 from: http://www.afvalscheidtumee.nl/wat-gebeurt-er-met-het-afval-dat-ik-naar-de-milieustraat-breng/#:~:text=Ook%20dit%20afval%20wordt%20zoveel,verschillende%20gespecialiseerde%20bedrijven%20voor%20hergebruik. Emmen: Municipality of Emmen.

Batty, M., Besussi, E., Maat, K. & Harts, J.J. (2004). Representing Multifunctional Cities: Density and Diversity in Space and Time. Built Environment, 30(4), 324, 337.

Bleizo (2021). Een locatie met historie [a location with history]. Retrieved on April 1st, 2021 from: https://bleizo.nl/over-bleizo. Bleiswijk: Author.

Bosch, F.A.J. van den, Hollen, R.M.A., Volberda, H.W. & Baaij, M. (2011). The strategic value of the Port of Rotterdam for the international competitiveness of the Netherlands: A first exploration. Single Release. Rotterdam: Erasmus University.

Bouwend Nederland (2018). Circulair bouwen [Circular building] Retrieved on April 1st, 2021 from: https://www.bouwendnederland.nl/actueel/onderwerpen-a-z/circulair-bouwen. Zoetermeer: Bouwend Nederland.

Boels, M. (2018). Van milieustraat naar hippe hub voor grondstoffen [from waste station to trendy hub for materials]. Single release. Haarlem: IPR Normag.

Casabella, N. & Frenay, P. (2009). Regional planning choices: comparing the RER in Brussels (BE) and the Stedenbaan in South-Holland (NL). The New Urban Question – Urbanism beyond neo-liberalism. Delft: International Forum on Urbanism.

Drift & Metabolic. (2018). Zuid-Holland Circulair: Verkenning van Grondstofstromen en Handelingsopties voor de Provincie [Circular South Holland: Exploration of Raw Material flows and Trade options for the Province]. Single Release. Rotterdam: Authors.

Ellen MacArthur Foundation (2015). Towards the circular economy. Economic and business rationale for an accelerated transition. Single release. Cowes: Author.

European Commission (2020). Communication from the commission to the European Parliament, the Council, the European Economic and Social Committee of the regions: a new Circular Economy Action Plan for a cleaner and more competitive Europe. Single Release. Brussels: Author.

Fazal, S., Geertman, S. & Toppen, F. (2012). Interpretation of Trends in Land Transformations: a Case of Green Heart Region (The Netherlands). Natural Resources, 3(3), 107-117.

Goess, S., Jong, M. de & Meijers, E. (2016). City branding in polycentric urban regions: identification, profiling and transformation in the Randstad and Rhine-Ruhr. European planning studies. 24(11). 2036-2056.

Gladek, E. (2017). The Seven Pillars of the Circular Economy. Retrieved on March 15th, 2021 from: https://www.metabolic.nl/the-seven-pillars-of-the-circular-economy. Amsterdam: Metabolic.

International Council on Monuments and Sites (ICOMOS) (2007). Risk Preparedness – Heritage at Risk. Volume 1. UNESCO-ICOMOS Documentation Centre, Paris: Author.

Involve (2005). People & Participation: How to put citizens at the heart of decision-making. Single release. London: Author.

Lawson, N., Douglas, I., McGrath, C. & Garvin, S. (2001). Recycling construction and demolition wastes: a UK perspective. Environmental Management and Health, 12(2), 146-157.

Lieder, M. & Rashid, A. (2016). Towards circular economy implementation: a comprehensive review in context of manufacturing industry. Journal of Cleaner Production. 115, 36-51.

Ludwig, V. (2020a). Participation and Cross-border Circular Economy (SCRCE). Retrieved on March 26th, 2021 from: https://epale.ec.europa.eu/de/node/151185. Brussels: European Commission.

Ludwig, V. (2020b). Transition to Circular Economy: the role of education from youth to higher education. Retrieved on March 25th, 2021 from: https://epale.ec.europa.eu/en/blog/transition-circular-economy-role-education-youth-higher-education. Brussels: European Commission.

Merriënboer, S. & Rondaij, A. (2020). Impact bouwhubs op leefbaarheid steden regio Zuid-Holland [Impact construction hubs on livability of cities in region of South-Holland]. Single release. The Hague: Netherlands Organisation for Applied Scientific Research.

Metabolic (2018). Circulaire Indicatoren: Een verkenning voor de provincie Zuid-Holland [Circular Indicators: An exploration for the province of South Holland]. Amsterdam: Author.

Ministry of Infrastructure and Environment (2016). Nederland Circulair in 2050 [The Netherlands Circular in 2050]. Single Release. The Hague: Author.

Morton, S., Pencheon, D. & Squires, N. (2017). Sustainable Development Goals (SDGs), and their implementation: A national global framework for health, development and equity needs a systems approach at every level. British medical bulletin, 124(1), 1-10.

NLW Groep (2021). Sociale werkplaats [Social workplace]. Retrieved on April 2nd, 2021, from https://nlw.nl/sociale-werkplaats. Venray: Author.

Oxfam (2018). Nederland verliest terrein in de strijd tegen ongelijkheid [The Netherlands loses ground in the battle against inequality]. Retrieved on March 10th, 2021 from: https://www.oxfamnovib.nl/kenniscentrum/blog-kenniscentrum/nederland-verliest-terrein-in-de-strijd-tegen-ongelijkheid. The Hague: Author.

Program team Circular South-Holland (2019). Circulair Zuid-Holland, samen versnellen [Circular South-Holland, accelerating together]. Single release. The Hague: Province of South-Holland.

Royal HaskoningDHV (2017). Verkenning Circulaire Economie Provincie Zuid-Holland [Expoloration Circular Economy Province of South-Holland]. Single release. Amersfoort: Author.

Raworth, K. (2017). A Doughnut for the Anthropocene: humanity's compass in the 21st century. The Lancet Planetary Health, 1(2), 48-49.

Rodrigue, J.P. (2020). The Geography of Transport Systems. Fifth Edition. New York City: Routledge.

Singh, J.A. (2015). The Sustainable Development Goals: The Role of Ethics. Single Release. New York City: United Nations.

State of South-Holland (2017). Bevolkingsontwikkeling [Population development]. Retrieved on March 17th, 2021 from: https://staatvan.zuid-holland.nl/portfolio_page/bevolkingsontwikkeling2/. The Hague: Author.

Statline (2016-2018). Ontwikkeling hoeveelheden gescheiden afval [Development amounts of separated waste]. Retrieved on March 10th, 2021 from: https://www.cbs.nl/nl-nl/nieuws/2019/26/nauwelijks-meer-afval-beter-gescheiden. The Hague: Central Agency for Statistics.

Statline (2019). Regionale kerncijfers; nationale rekeningen [Regional core numbers; national accounts]. Retrieved on March 24th, 2021 from: https://www.cbs.nl/nl-nl/cijfers/detail/84432NED?q=regionale%20indelingen. The Hague: Central Agency for Statistics.

Straalen, F.M. van, Janssen-Jansen, L.B. & Brink, A. van den (2014). Delivering planning objectives through regional-based land-use planning and land policy instruments: an assessment of recent experiences in the Dutch provinces. Environment and Planning C: Government and Policy , 32(3), 567–584.

Thomsen, A., Frank S. & Kohler, N. (2011). Deconstruction, demolition and destruction. Building Research & Information, 39(4), 327-332.

United Nations. (2015). The 17 Goals. Retrieved on March 30th, 2021 from: https://Sdgs.Un.Org/. New York City: Author.

Youmatter (2020). Circular Economy: Definition, Principles, Benefits and Barriers. Retrieved on March 31st, 2021 from: https://youmatter.world/en/definition/definitions-circular-economy-meaning-definition-benefits-barriers/#:~:text=Following%20the%20circular%20economy's%20principles,toxic%20substances%20and%20climate%20change. Paris: Youmatter.

Youtie, J. & Shapira, P. (2008). Building an innovation hub: a case study of the transformation of university roles in regional technological and economic development. Research Policy, 37(8), 1188-1204.

Sources for vision collage:

https://www.amazon.in/epause-construction-dumper-truck-Multi/dp/B08KJK-PHFR
https://www.constructionfeeds.com/brick-masonry-construction-tips/
https://www.jansochor.com/photo-blog/child-labour-el-salvador
https://interestingengineering.com/everything-you-need-to-know-on-how-to-become-a-demolition-contractor
https://pixabay.com/photos/construction-site-building-vantaa-1205047/
https://www.iconeye.com/design/features/item/9653-reincarnation-machine-bottle-recycling-factory
https://matchness.com/2018/01/10/47-best-garden-walkway-envy-visitor/
https://idighardware.com/2011/12/1000-door-building-by-choi-jeong-hwa/
https://www.travellerspoint.com/photos/stream/photoID/2263614/users/adtamo/#size=l

CHAPTER SEVEN

APPENDICES

7.1. Personal Reflection

Ydze Rijff - 5435749

For me, developing this regional strategy has been a fantastic learning experience. As a student of the Master of Metropolitan, Analysis, Design and Engineering, I am not part of the regular group of MSc Urbanism students and this led to a nice challenge. As a multidisciplinary team, we had to work together and combine our skills & competencies to come up with a strategy for transforming a complex system such as the construction- and demolition sector in an entire province. During this process, I experienced how essential this collaboration and different input of qualities is. In contemporary times it is becoming increasingly clear that it is impossible to combat most societal and/or spatial issues by consulting the knowledge of just a single discipline. And his I have seen in practice throughout this project. For example, when we established the decision matrix for each site's characteristics, it was crucial to hear the voices of all disciplines within our team. The planners among us particularly stressed how all the nodes should be logistically connected, while others emphasised that the nodes should be adapted to the characteristics of the neighbourhood on a place-by-place basis. Not to mention the designers' plea to upgrade the aesthetics of these places and integrate them into the urban fabric. This interaction has led to the establishment of our socio-spatially integrated matrix that aims to cover the situation as holistically as possible.

However, the multidisciplinarity of the group also presented some obstacles and learning moments. So to say, it was sometimes difficult to stay on the same page together. Because we all have different study backgrounds, we sometimes thought or reasoned in a different way. In addition, we had to deal with four different nationalities and native languages among the group members. This diversity required the right co-ordination and mutual agreements. It is clear that everyone has their own valuable contribution, but the trick is to bring it out in everyone. Willingness to listen, openness, empathy and patience are key for finding guidance in such a complex coherence. At the end of the day, I think our team did very well, but there is always room for improvement by adhering more to these principles in a future collaborative project.

With regards to the learning curve of this project in general, the most important aspects for me personally are as follows. Firstly, I have learned a lot in the field of urban design. Because it was common to me, but also because I had less 'hard skills' for making visualisations, I actually predominantly tried to describe my plans and ideas by speech and written text. The cooperation with the urbanism department taught me in what situations a visual drawing can make a message many times stronger than by merely using words.

For future projects on tackling complex (metropolitan) challenges, I would like to further develop my hard skills in visualisations and pay more attention to serving as a coordinator for group dynamics. As mentioned before, smooth cooperation brings out the best in everyone. As a (technical) spatial planner, I have been educated broadly to act as a 'spider in the web', bringing together the various disciplines. I see it as a nice challenge to perform this role better every time.

Jochem Vellinga - 4686098

As a recently graduated bachelors student from the faculty of Architecture, Urbanism and Building Sciences it took a little time to get used to the way in which the master course is being taught. Where during the bachelor it was very common to have a clear list of products and goals to finish before reaching the end of the course, it was much more common now that you had to figure those steps out yourself. This freedom sometimes led to the feeling of not knowing what to do or what goals to work towards. However with time and support from group members I could quickly adjust and get started.

The exercise to develop a strategy to make the construction and demolition sector in the South Holland area circular was a very complex and large scale project which took a while to grasp. In the first weeks we had multiple sessions in which we tried to assess and discuss all the characteristics of the area and the industries related to the construction and demolition. This sometimes led to quite surprising discoveries, as we also worked in a group with 4 nationalities who all did not have English as their native language and some also did not live in the Netherlands. On the other side, having group members with different nationalities and educational backgrounds also helped in having an open mind towards the project. Where myself often focused on the logistical and spatial side of things, others emphasized the importance of the social side and to integrate social justice. This multidisciplinary approach, undoubtedly led to a much more complete strategy. Due to personal interest and educational backgrounds we also had different skills and knowledge which was very helpful. We used each other's skills and also helped each other gain skills we didn't have before.

I learned a lot about the waste system in the Netherlands throughout the project. Some things I thought were good, were instead quite bad. The numbers in which we measure the quality and scale of recycling is often biased and there is still a long way to go to achieve a complete circular system. However I also learned that we have a very extensive and well distributed network of waste stations and that our strength should be to improve what we have, instead of replacing it with something new.

As a group we worked very well. It was clear that everyone was motivated throughout the whole project and that we saw it as a duty to inspire the rest to stay motivated and make the project a little better every step on the way. We started the sessions with a small casual chat, checking if everyone was okay and to get to know each other better outside the project. This seems like an unimportant part, but in my opinion it contributed strongly to the group dynamics and helped some group members to get more involved in discussions.

7.1. Personal Reflection

Minyue Jiang - 5282055

For someone coming from an architectural background, this was my first exposure to regional design and I learnt a lot from working with my teammates and tutors through the process. I will explain how we found the core design concepts and logics in the process, and how we identified problems and solved them.

Although we were completely unfamiliar with the issues of regional design, the theme of construction and demolition, which was given in advance of the course, provided us with a number of topics and questions that could be developed. Starting with the theme of circular economy and spatially justice, we looked for things in the construction and demolition sector that would enable circularity and soon focused on the material flow. We noticed that this segment was not circular at present. We therefore came up with the idea of a material passport and a waste collection system to create a new form of closed-loop flow of materials. At the same time, in order to increase the interaction between the new system and the urban fabric and to attract citizens to visit it, we thought of adding some social added value, which coincides with the goals of spatial justice.

However, we also encountered some difficulties during the course. One of the most important is how to integrate the waste collection system we have designed into the whole region, in another way, how to integrate the vision and strategy with the actual context. As our logic started with an abstract material flow, there was no clear spatial identity or specificity in the beginning. I repeatedly thought about how to convince myself that the solution was an adaptation to local conditions, that the strategy was generated from the actual spatial problem. Rather than creating a new and attractive scheme out of nothing and then rigidly applying it to the subject of South Holland. For this reason we went back to the beginning and did a lot of mapping and analysis based on the regional itself, reconsidering the links between the strategy and the subject to make our story line more complete.

I am very grateful for the various rehearsal opportunities that have helped me learn how to better present our work in the presentations. We are a diversity team. Some of us are good at expressing and thinking in words, while others are used to expressing and thinking in graphic language such as maps. This sometimes makes it difficult for us to communicate and reach consensus, while this complementarity of skills allows the team to assign the right person to the right task. We had a variety of different products, and with the help of the teammates and the tutors, we were able to pick the right products out of the pile, organize them logically and find the story line and the end point. This was also a process of learning to work together as a team, to learn to complement each other's strengths, to find common ground and to make progress together. I have to say that I really enjoyed the whole course.

Panagiota Tziourrou (Patrisia) - 5391326

The project title clearly states that one of the main goals is to establish a dialogue between waste collection stations and cities in South Holland. But what does "a dialogue" mean for our project? And what common ground is required for communication between the waste collection system and the city? Did we achieve as group to identify these common factors that could be the transitional indicators? The following text intends to discuss the role of social awareness and common knowledge in the transition to a circular waste flow, in the field of construction and demolition. Furthermore, some challenges that the team encountered during the development of the project will be mentioned.

In South Holland, the existing recycling system is already advanced, with clean collection points. Nevertheless, these places are mono-functional urban enclaves, where people act specifically, unknowing the following process. Moreover, the lack of knowledge especially in the construction and demolition sector has as a result, the buildings are constructed to be demolished in the future. Thus, based on these two weaknesses, we identified different groups of stakeholders, who speak different "languages", failing to have a common dialogue and to coordinate. So, what we envision as group is to transform the existing waste collection system into a common field of synergy, integrating the different actors in scientific processes of circularity, through a multi-function system for "all". However, to achieve the operation of multiple programs in a common ground it is necessary to consider the life cycles of each operation separately and together. In this way, it will be determined to what extent the different processes could coexist symbiotically, something we did not take into account.

Regarding the strategic section, an agenda of goals and strategies is proposed. These strategies are divided into two groups based on the two main approaches, the circular economy, and social integration and social justice. The key strategies that seek the "dialogue" based on social awareness and common knowledge are the clustering of existing waste stations that allow different level of interaction with the city, the development of a common material passport database, the integration of different kind of functions such as education or social workplaces, the re-training of employees in construction-demolition sector, and the highlighting of recycling processes in public spaces. Nevertheless, in my opinion, the exploration of spatial characteristics and policies in extreme scenarios, such as social crises could strengthen the social goal for a dialogue with the city.

Finally, it is important to mention the challenges in group work, which is the result of the different cultures, backgrounds, or even the different native languages. Firstly, we often thought or reasoned in very different ways, coming up with different definitions of a word. Also, as a multidisciplinary team, it was sometimes difficult to identify the best solution between the different suggestions. Even the social perspective that had to be included in the project had a different meaning and value for each of us individually. However, it was fascinating how everyone very quickly gained their responsibilities within the team, while maintaining a participatory character in all the processes for the implementation of the project. For future projects, I would like to improve my communication skills and limit my enthusiasm for creating in the timeframes offered.

Zahra Agbaria - 4549538

It was very intriguing to start this course with choosing the main subject of focus. The choice of construction and demolition sector was the goal for me due to the fact that I originally come from a very dense city that is based on concrete construction. As the Netherlands is aiming towards building 1 million homes, I thought that the project would go in a specific direction of: how would the current material flow be part of building these homes?

The analysis stage took a whole other unexpected direction. Instead of thinking how would the material build homes, now we are thinking: when we build, where does the waste of these construction buildings (and even demolition) go? and what happens to them? Where are the people within this waste system?. This process of questioning the waste system instead of the building system became very interesting and led us to an interesting vision for South Holland that integrates waste systems, society's role in these systems and how we can make them sustainable. Besides, working on the scale of South Holland is a different scale than what we interpreted in the last few courses, so identifying another set of scales for the whole rejuvenated system of South Holland made it more interesting and challenging for the project.
This course was an educational adventure. Even though the connection between the design course and the methodology lectures was very strong, it was interesting to actually implement these lectures in our storyline and figure out a way to make it complete to propose.

Working Online with a group of five people with different backgrounds and different languages was a challenge, but a challenge that helped us put more trust in others and to be more open and transparent with each other. I personally learned alot from my fellow group mates in the sense of knowledge and improving my graphical language. It was a very interesting and strong element that group two in general had is the diversity of input from the teacher, and having two groups of the other sectors of focus. Everytime listening to their analysis, vision and strategy it raises some more questions such as: What if that connects also to our sector? So the learning experience also came from the other groups.

To conclude, creating the waste system rejuvenation vision and strategies on the South Holland scale is focusing on an unexpected problem field and I think it should be explored more in the further future for a sustainable and circular development in the region.