A Restorative Last Mile Towards The Erasmus Medical Center, Rotterdam

Improving the quality of last mile reachability and arrival,
by assessing societies opinion on urban stress and restoratives,
and digitally researching scenarios by the use of personas.

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Erasmus MC

TU Delft

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Research studio
City of the Future

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Date
June 2022

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Perspectives

2017: Internship Interior Architecture
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2014-2018: Bachelor of Arts, Interior Architecture
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2019-2020: Pre-master Architecture Urbanism and Building Sciences
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2021-2022: MSc Architecture Urbanism and Building Sciences
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1. Preface

Prior to starting my Master's in Urbanism I completed my Bachelor of Arts in Interior Architecture at the ArtEZ University of the Arts in Zwolle. During my Bachelor's, my interest for the movement of people through public space began to grow. For this I did 1:1 research on how we perceive differently from different speeds and from different vehicles. After, I wrote my bachelor thesis about mental reality and the filters that are between our brain and the physical world that make us perceive a situation differently than someone else does (figure 1). And finally, graduated with a public space design for the Grote Markt in Zwolle. The square draws the attention of moving people into the presence by 13 physical and mental experiences (figure 2).

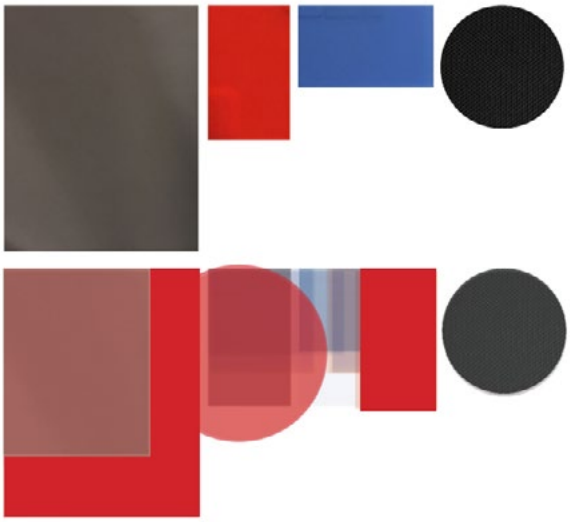


Figure 1, What there is and what we see (Author)

Figure 2, Bachelor Graduation project (Author)

My interest in the movement of people continues in my graduation internship at Erasmus MC Campus development in favor of this thesis. The research is done within the City of the Future studio to have the support of a multidisciplinary approach in relation to future mobility since there are also TIL students involved. It will give me the opportunity to explore other ways of researching data and the movement from a to b in cities than used in Urbanism.

2. Introduction

The Erasmus Medical Center (EMC) campus in Rotterdam is confronted with an intensification of functions (figure 3) resulting in an increasing number of people traveling in and out the campus in the coming decades. Mobility at and the reachability of the Erasmus MC campus itself is one of the biggest challenges due to its location in the city core of Rotterdam (figure 4).
This research thesis is commissioned by the EMC as a graduation internship in the department of Programma Integrale Bouw (PIB). This research position is needed because while the Erasmus MC campus is densifying and welcoming more people, an increase of parking spaces has to be avoided. Simultaneously, Rotterdam has a very dense city center and vehicles are further and further restricted to make the city more livable. This is being done by taking away carlanes and decreasing the speed. These facts make the EMC motivated to research further whether these scenarios impact their reachability, because people traveling to the hospital often don't have a choice to choose for an alternative type of transport than a private car. Lastly, recent patient journey research shows patients are the most worried during their trip. This raises the question whether there's a link with the city and their level of being worried. All these questions are further elaborated in this chapter.

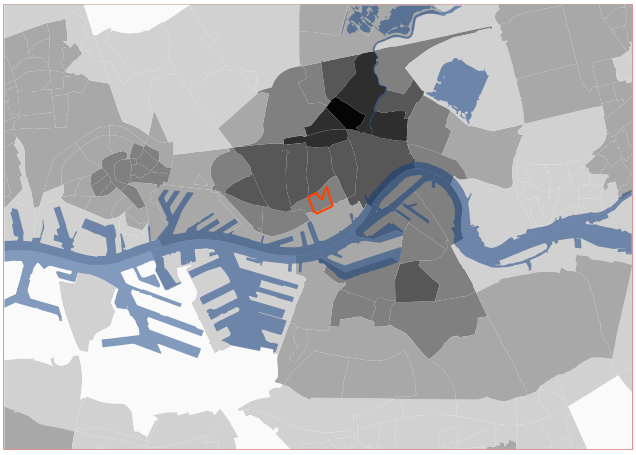


Figure 3. Location in Dense Rotterdam.
Data source: Kadaster, 2022. Edited by Author.

Figure 4. Address density in Rotterdam. Data source: Kadaster, 2022. Edited by Author.

Erasmus MC Campus: where healthcare meets the future

June 15, 2021

For decades we've been seeing a sharp rise in the ageing population. People are getting older and fatal diseases are turning into chronic Ilnesses. Even though these are great achievements, they leave a growing population in need of care while the number of health professionals stays the same. Simultaneously, personalized health care is rapidly replacing generic treatment methods.

In the long run, this is an unsustainable state of affairs. We should constantly innovate to maintain our high standards and keep a maturing population healthy. That is why Erasmus University Medical Center and the city of Rotterdam have initiated a campus where healthcare, technology and business come together. The development of the area will be a close collaboration with governments, institutes and the business community.

Convergence

The campus will be a place that facilitates future developments, with sufficient free space to respond to and adapt to new insights. The campus will also provide space to support the process of convergence with TU Delft and Erasmus University.

Connecting health and technology

At the Erasmus MC Campus we facilitate the full innovation cycle, from cohort research to business development and from prototyping to implementation. We do this in an urban environment, with a strong connection to the city and society.

We will house a diversity of organizations focused on health-tech. The ecosystem includes state-of-the-art co-facilities and optimal test sites, allowing residents to collaborate and put their innovations into practice, while the medical center benefits from the latest technological developments.

Based in Rotterdam and rooted in science, Erasmus MC Campus is a place for visionaries to come together. It is a place where innovators feel the freedom to answer the questions of tomorrow. A place for thinking, daring and doing.

Figure 5. Webarticle, Erasmus MC. (2021, June).

Densification leads to
an increase of 5000 employees and minor increase of parking

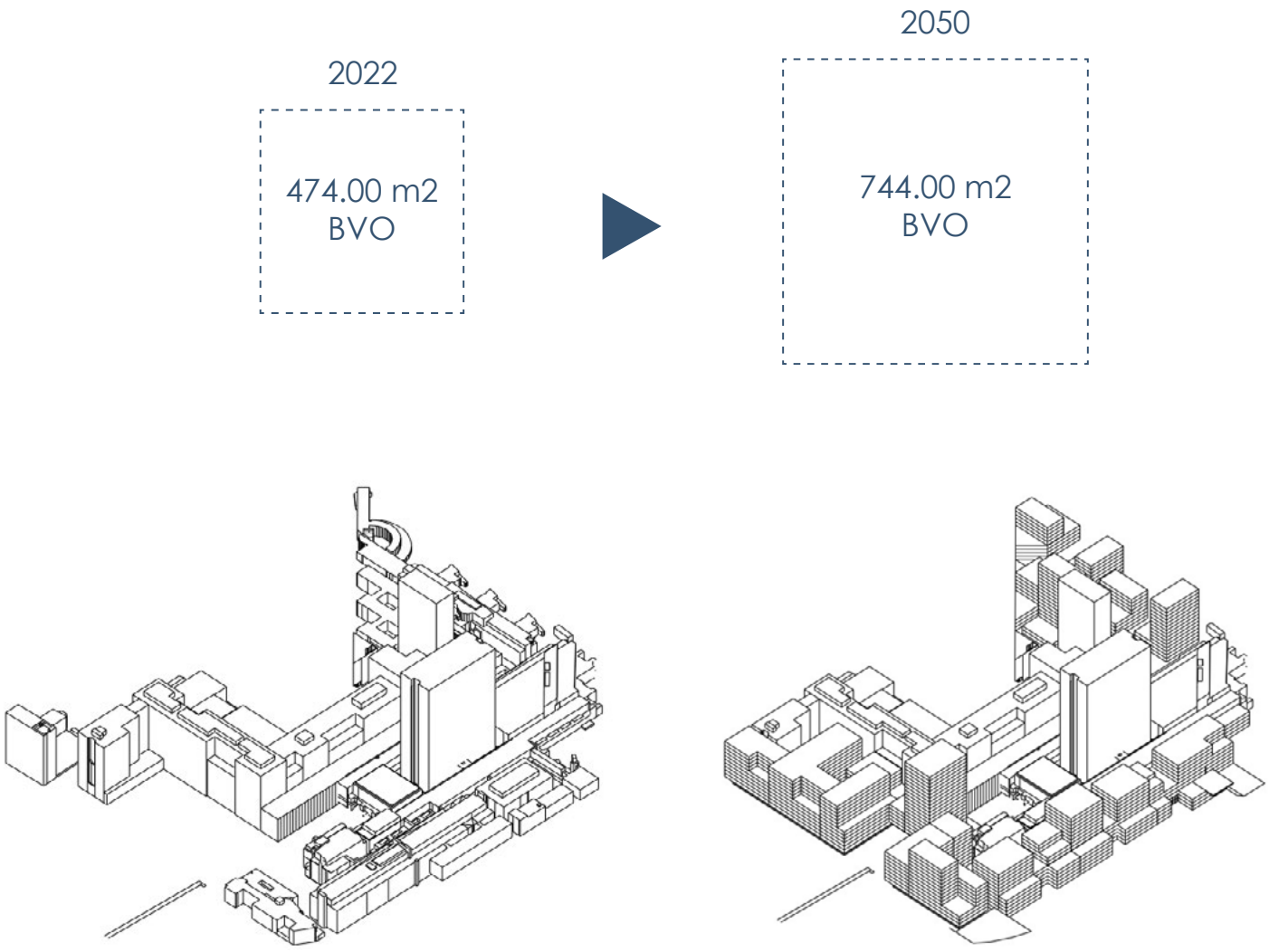
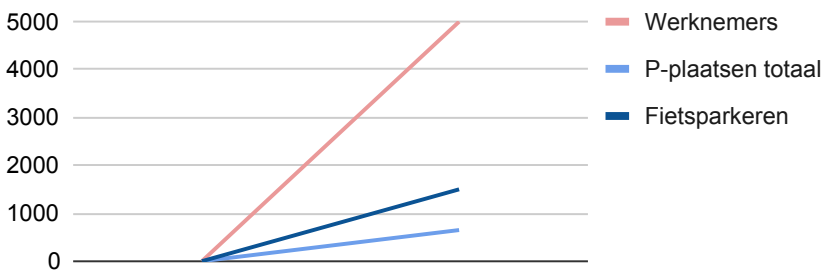
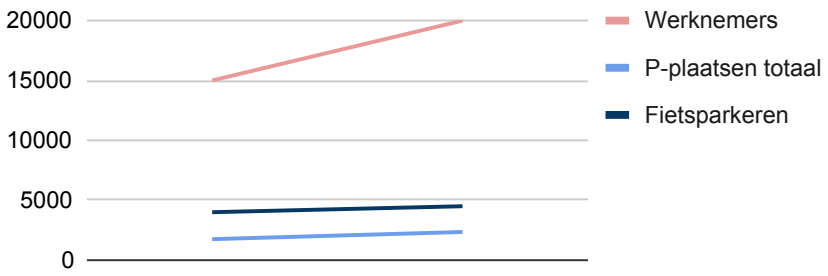


Figure 6. The growth of the EMC Campus (Masterplan, 2021, edited by Author)

Densification results into more people coming in and out the campus, while the aim is to not increase the amount of parking spaces. This could lead to a situation where the Erasmus MC Campus is less accessible by car. As shown in diagram 1 and 2. There is an increase of 5000 employees towards 2050 and only an increase of 650 parking spaces. In 2050 there will be a total of 20.000 employees and only 2500 parking spaces for cars (Masterplan, 2021). There are two ways to look at this problem. The first way is to reserve the parking spots for the disabled who really need it. The second way, which fits this research, is to approach it as a challenge to make it more attractive to travelers to take other ways of transport.



Graph 1. Increase towards 2050 (Masterplan, 2021, edited by author)



Graph 2. Total towards 2050 (Masterplan, 2021, edited by author)

Located in a
Dense city center with a decreasing car spead

Rotterdam is densifying as well and taking cars out of the city to improve livability. This eventually leads to a situation with not sufficient access roads towards the Erasmus MC Campus.

According to the traffic plan of the municipality of Rotterdam for 2030, less and less people will be using cars in the center of Rotterdam the upcoming decades (figure 8). "The demand for healthy travel is increasing and therefore stimulates sustainable mobility and innovative modes of transport. The car as status symbol is therefore subject to change" according to the traffic plan of the municipality of Rotterdam for 2030. (Gemeente Rotterdam, 2017)

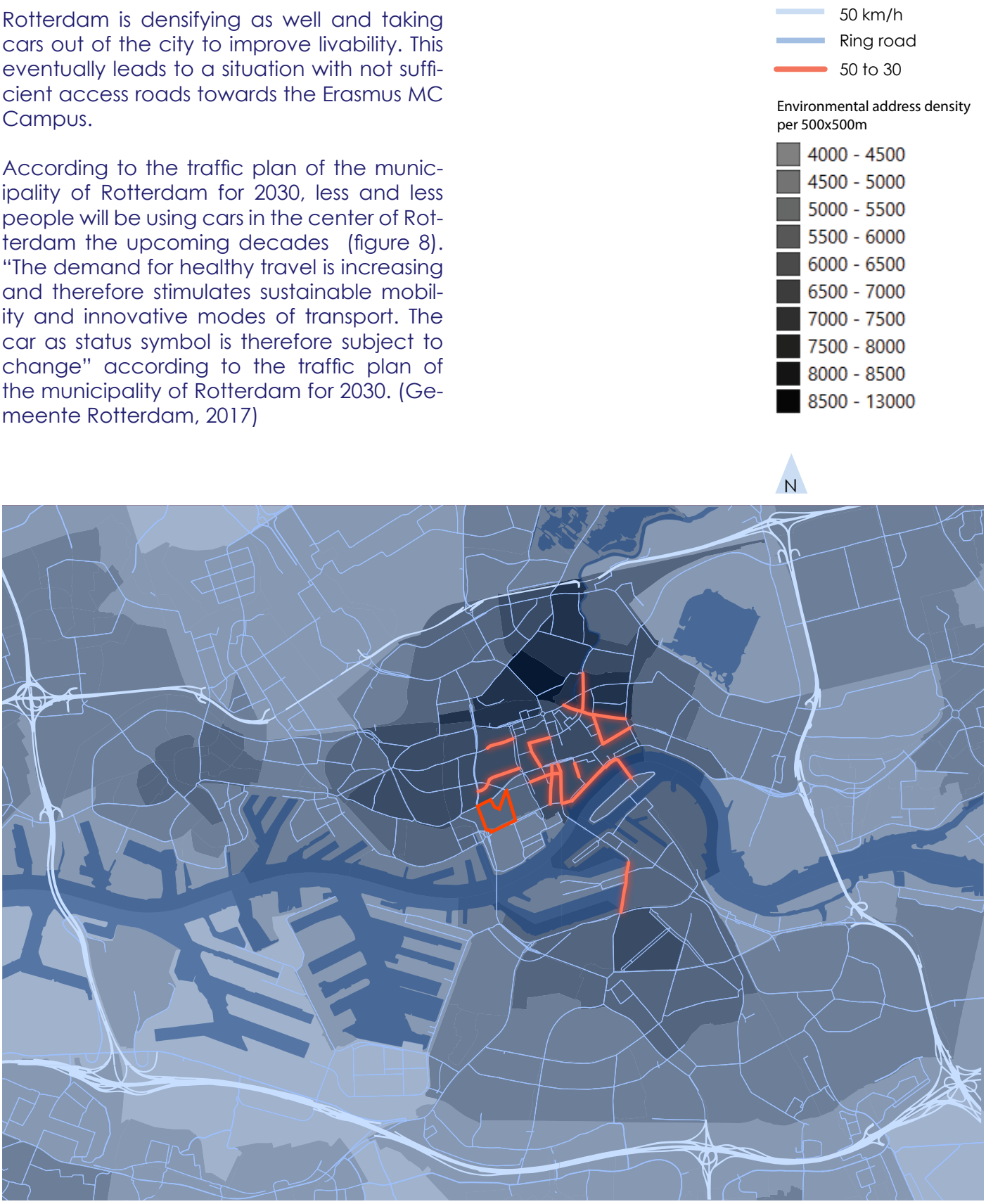


Figure 7. Address density in Rotterdam related to speed change. Data source: Kadaster, 2022. Edited by Author.

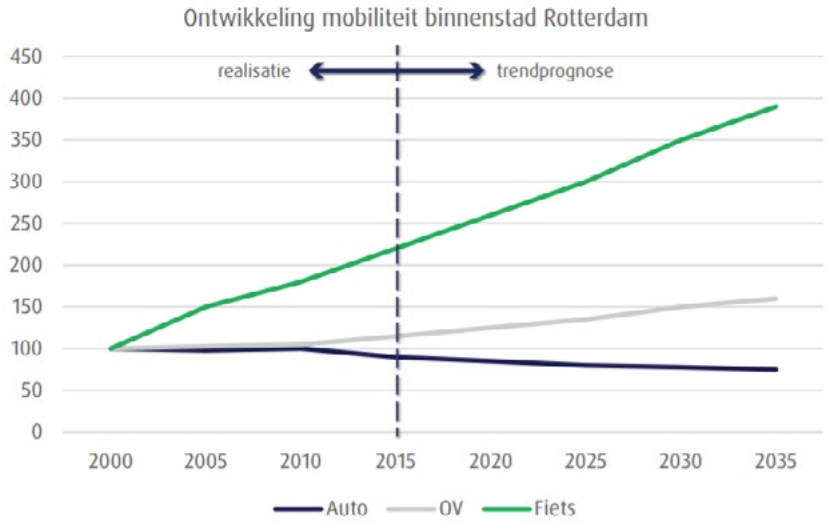


Figure 8. (Gemeente Rotterdam, 2017)

Bewoners willen minder auto's in heel Rotterdam: 'Weer doorgaand verkeer al aan rand van stad'

Doorgaand verkeer moet al aan de randen van de stad worden geweerd, in plaats van pas in het centrum. Dat kan door meteen na de afritten van de snelweg de grote wegen smaller te maken, bepleiten bewoners en (verkeers)organisaties. Alleen zo kiezen automobilisten vaker voor de Ring Rotterdam en wordt de hele stad rustiger.

Yvonne Keunen 24-06-21, 07:00 Laatste update: 24-06-21, 08:06

Figure 9. Artikel AD.nl (Keunen, 2021)

In the current situation

Patients are worried until they reach the main entrance door

Patients don't feel relieved by the current way of traveling towards the Erasmus MC. Arriving on time is stressful. The patient journey is rated average 5/10, which means patients are quite worried during their trip

1. Patients are quite worried during their travel and only 34 percent believe that Erasmus MC helps with the choice of the most ideal mode of transport.
2. Appointments are sacred, arriving on time is stressful. discomfort and unfamiliarity with

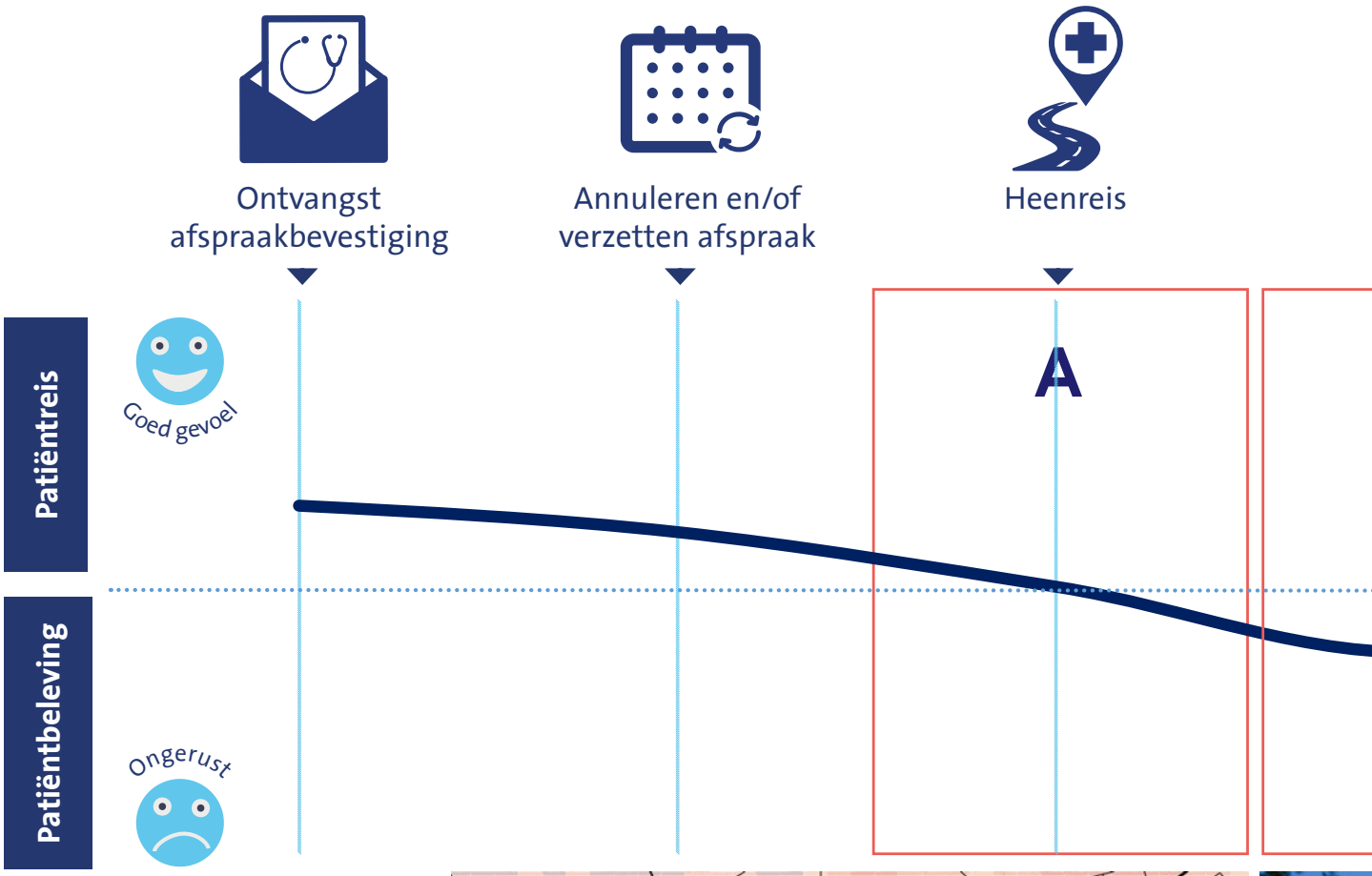
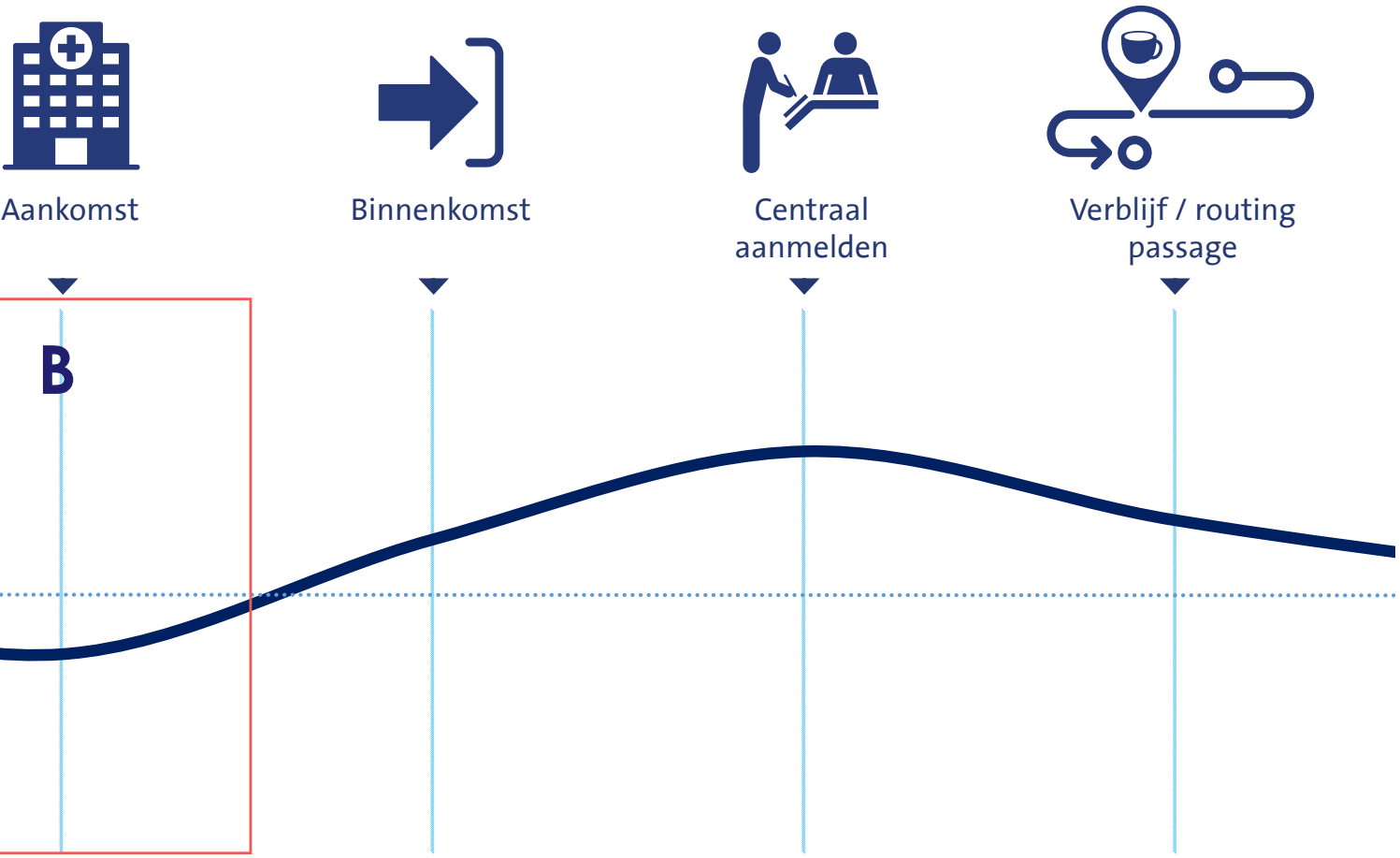


Figure 11. Rotterdam (Kadaster, 2022. Edited by Author)

Figure 12

parking fees, use public transport and P+R. On the next page all the conclusions of the research are summarized by the workgroup Patient Journey within the Erasmus MC.

Figure 10. Erasmus MC. (2020). Patient journey fieldwork research.



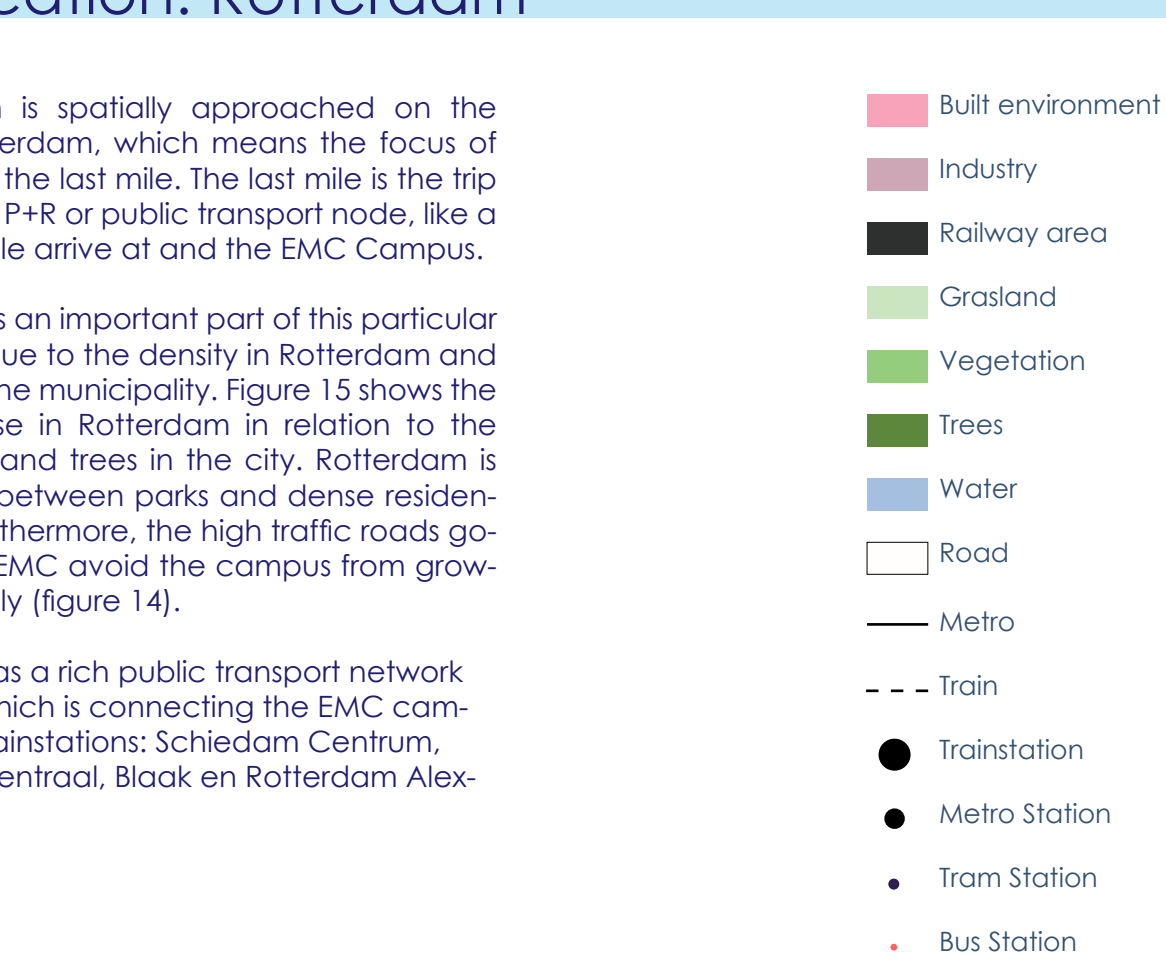
2. Atelier LEK - Erasmus Medisch Centrum. (2020)

2.2 Location: Rotterdam

This research is spatially approached on the scale of Rotterdam, which means the focus of the project is the last mile. The last mile is the trip between the P+R or public transport node, like a station, people arrive at and the EMC Campus.

The last mile is an important part of this particular assignment due to the density in Rotterdam and the plans of the municipality. Figure 15 shows the urban landuse in Rotterdam in relation to the Erasmus MC and trees in the city. Rotterdam is squeezed in between parks and dense residential areas. Furthermore, the high traffic roads going past the EMC avoid the campus from growing horizontally (figure 14).

Rotterdam has a rich public transport network (figure 16), which is connecting the EMC campus to all 4 trainstations: Schiedam Centrum, Rotterdam Centraal, Blaak en Rotterdam Alexander.



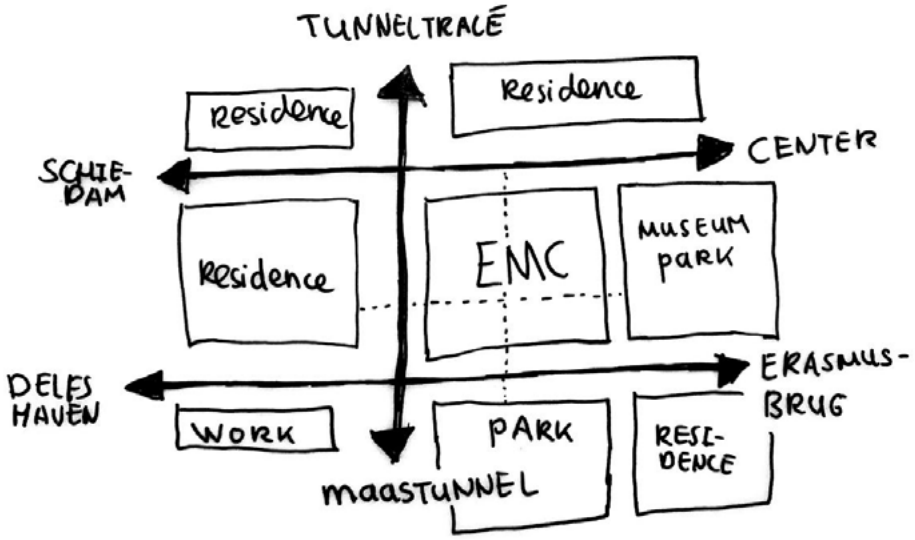
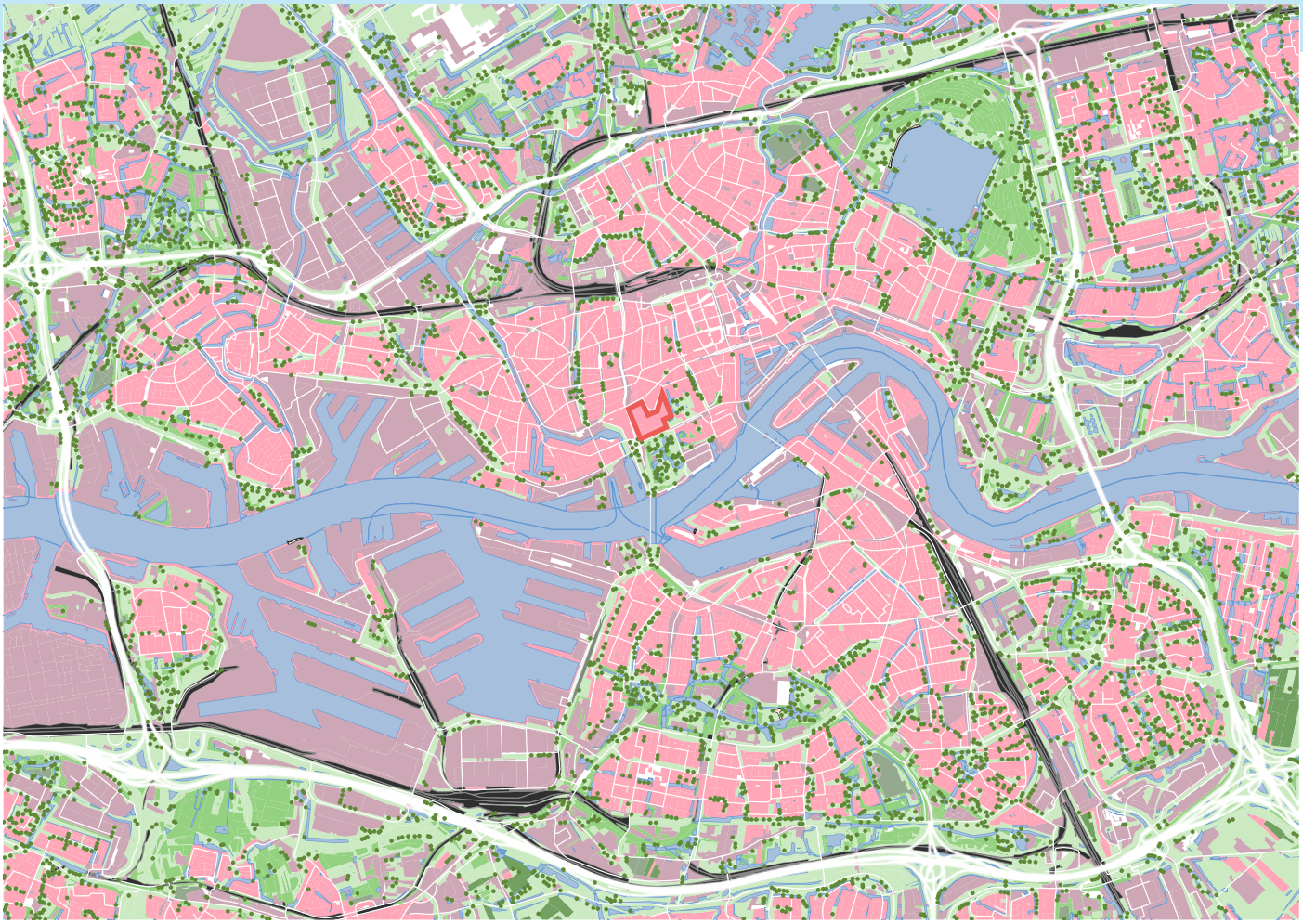
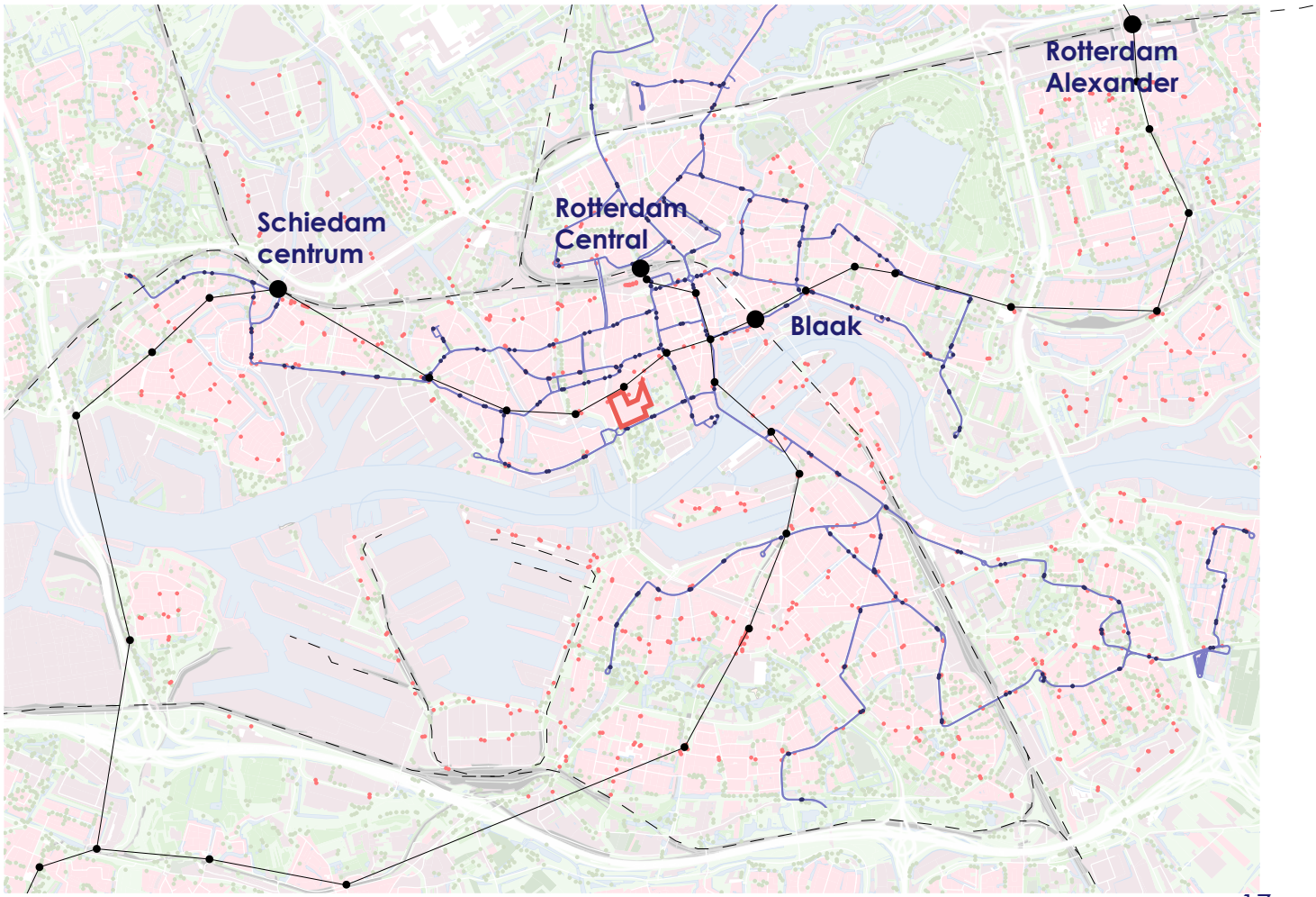


Figure 14, Rotterdam is squeezed inbetween high traffic roads (author)



1:50.000 N▲ Figure 15, Urban Land use in Rotterdam (Kadaster, 2022. Edited by Author)



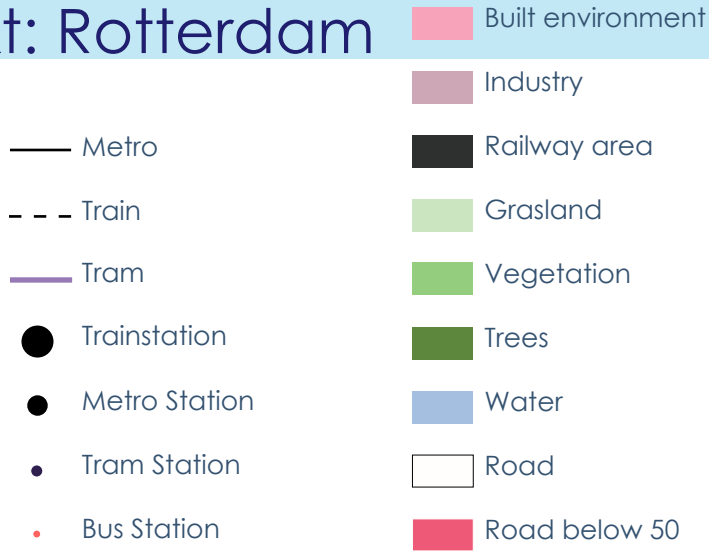
1:50.000 N▲ Figure 16, Public Transport in Rotterdam (Kadaster, 2022. Edited by Author)

2.3 Summarized context: Rotterdam

There are already not many roads above 50 km/u anymore connecting the EMC with the edge of the city (figure 17).

The EMC Campus can be seen as a city on its own with several buildings. The passage in the middle is connecting Little C with the Museumpark from 2040 (figure 18).

Figure 18 also shows the relation between the interior and exterior and how the hospital is part of the urban fabric. Interviews with professionals within the EMC has turned out that no matter which building on which corner of the campus you have to be. You can always use all entrances. That is why the roads inside of the campus, interior and exterior have a high connectivity. There is a strong connection with the Museum park, even having its own entrance and there's a less strong connection with the Park on the Maas. This is due to the Westzeedijk, a large road separating these locations.



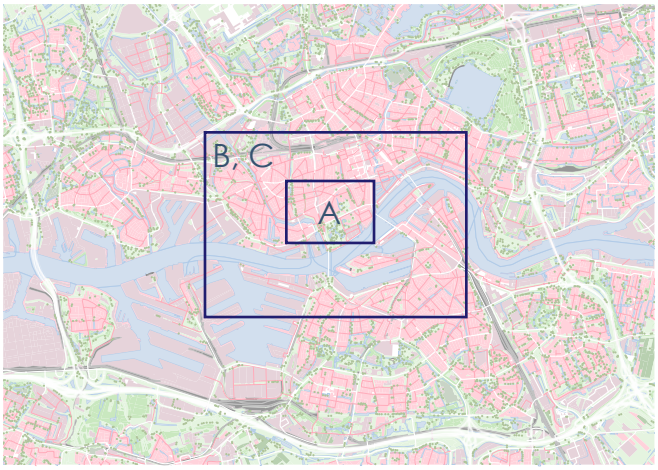


Figure 17, Location of Zoom in 9 (Author)

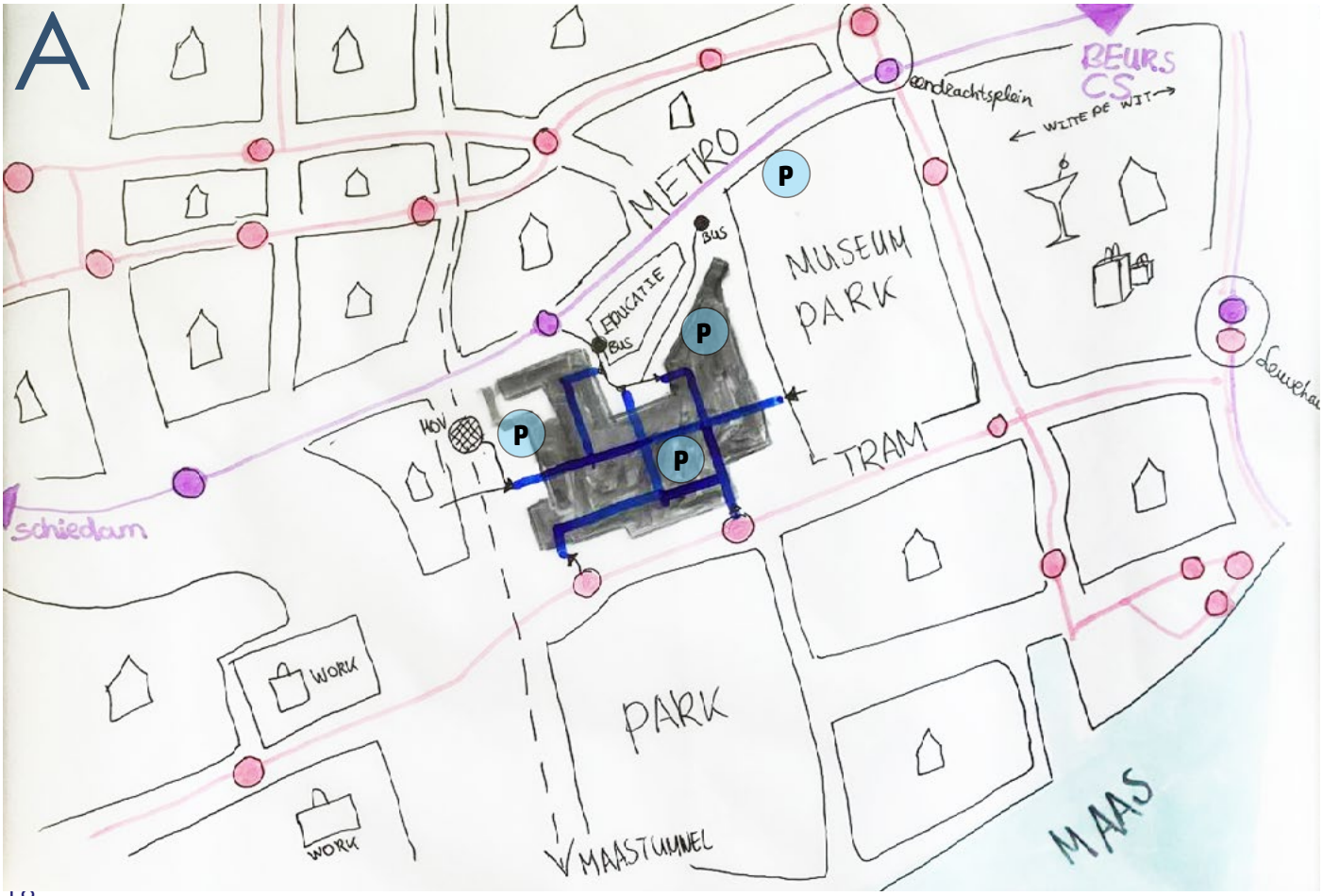
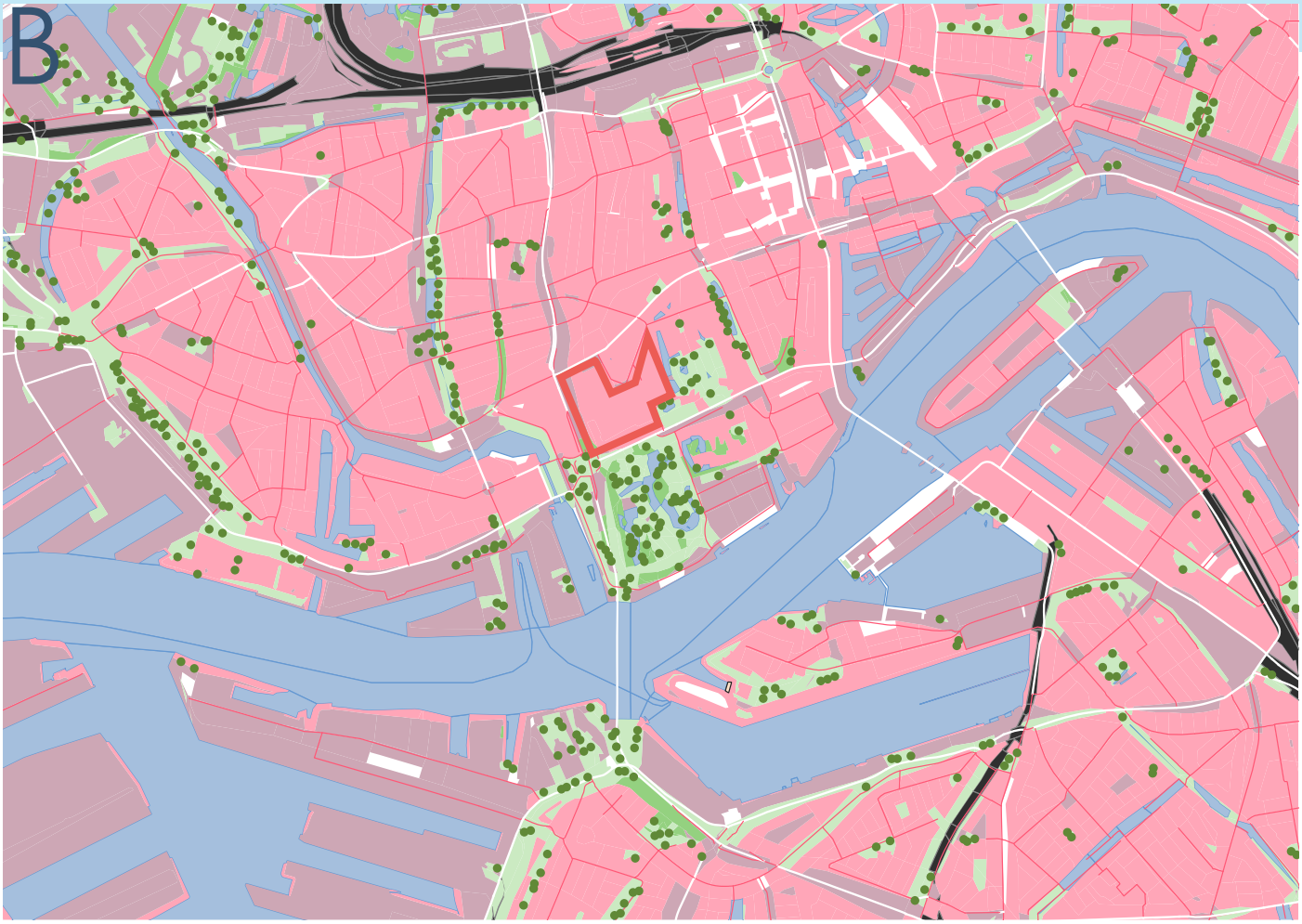
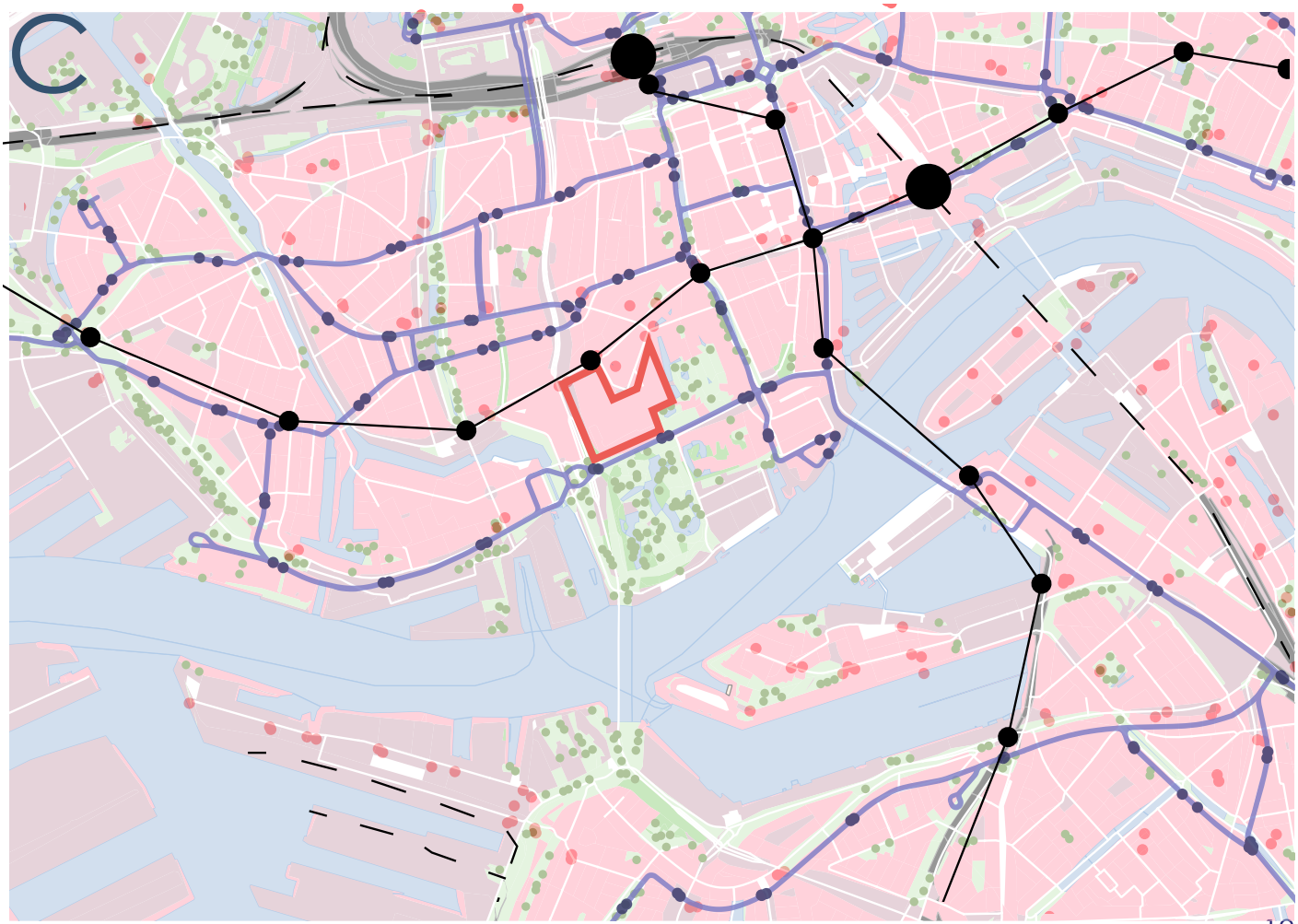


Figure 18, Situation sketch interior connections



1:20.000 N▲ Figure 19, Context of the campus (Kadaster, 2022. Edited by Author)



1:20.000 N▲ Figure 20, Connectivity of the campus (Kadaster, 2022. Edited by Author)

2.4 Location: EMC Scale

This specific entrance square will be further researched mainly because the patient journey research is done at this location. This research showed how people arrive worried untill they are inside the building. Also, this entrance is a problem to many employees at the EMC. It includes a large public space, shared with cars and there's no clear space function distribution and bikes are parked in places they shouldn't be. Lastly, this square is mainly used for passengers arriving by public transport. Traveling by public transport instead of car is one of the problem statements and it would be interesting to find out the value of the main entrance square in the perception of people traveling to the EMC. In the early stages of the project a fieldwork analysis has been performed for the main entrance of the EMC (figure 22). The analysis observes people flows and concludes the entrance and exit itself is already not a relieving place by causing confusing situations. Such as unclear directions and obstacles.

Figure 21, Location of the Main Entrance

How do people move around the Erasmus MC main entrance?

Student: Rosalie Moesker 4898613

At the main entrance of the Erasmus MC the same research is conducted and several peoples paths have been followed. In this location my interest was between people arriving and people leaving. Due to covid there were different entrances being used to enter and exit the building. Also, the building heights numbers have been added to the map.

The people entering the building at entrance 2 all took the same lineal route. It was a logic route coming from the metro station Dijkzicht or the busstop.

A The people leaving the building at exit 3 were confronted with a confusing situation. Where it would be most logic to follow the sidewalk, an opening in the green parks on the parking lot seems to look inviting and people choose to walk straight forward through this opening. After, they end up on a parking lot and have to walk around the parkinglot barrier. They all have this same problem.

B **Observation 1**: The opening in the greenery straight behind the exit is inviting people to take the wrong route.

The people using entrance/exit 1, had to use a stairs and they all took the exact same line on these stairs. When they came downstairs they approach an obstacle, the terrace of the coffeebar. There is not a straight line from here towards the metro Dijkzicht and the busstop.

C **Observation 2**: There is no space saved in the urban design for a terrace, the walking direction is going straight through it

In relation to my project of researching the mobility towards the Erasmus MC, this could bring valuable insights on reflecting on the current masterplan and the connection between the masterplan and the pedestrian mobility in the city.

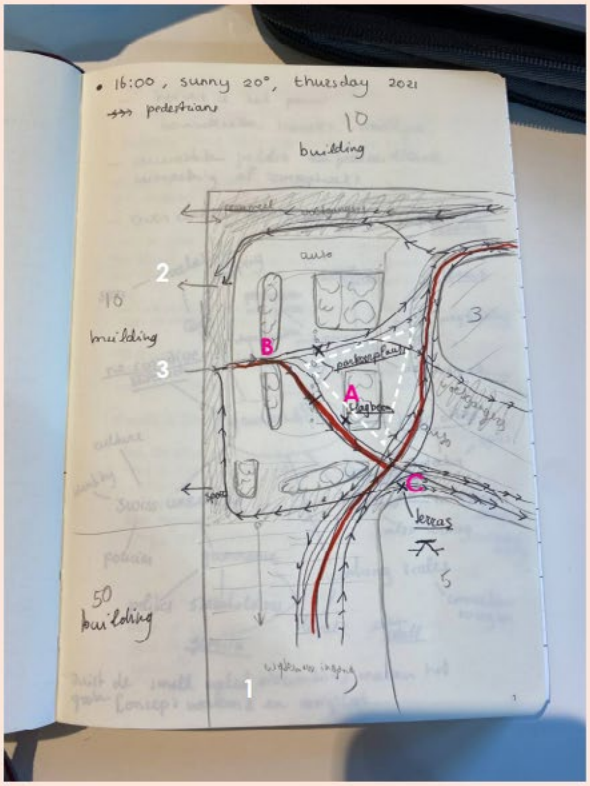


Figure 22. Fieldwork (Author)

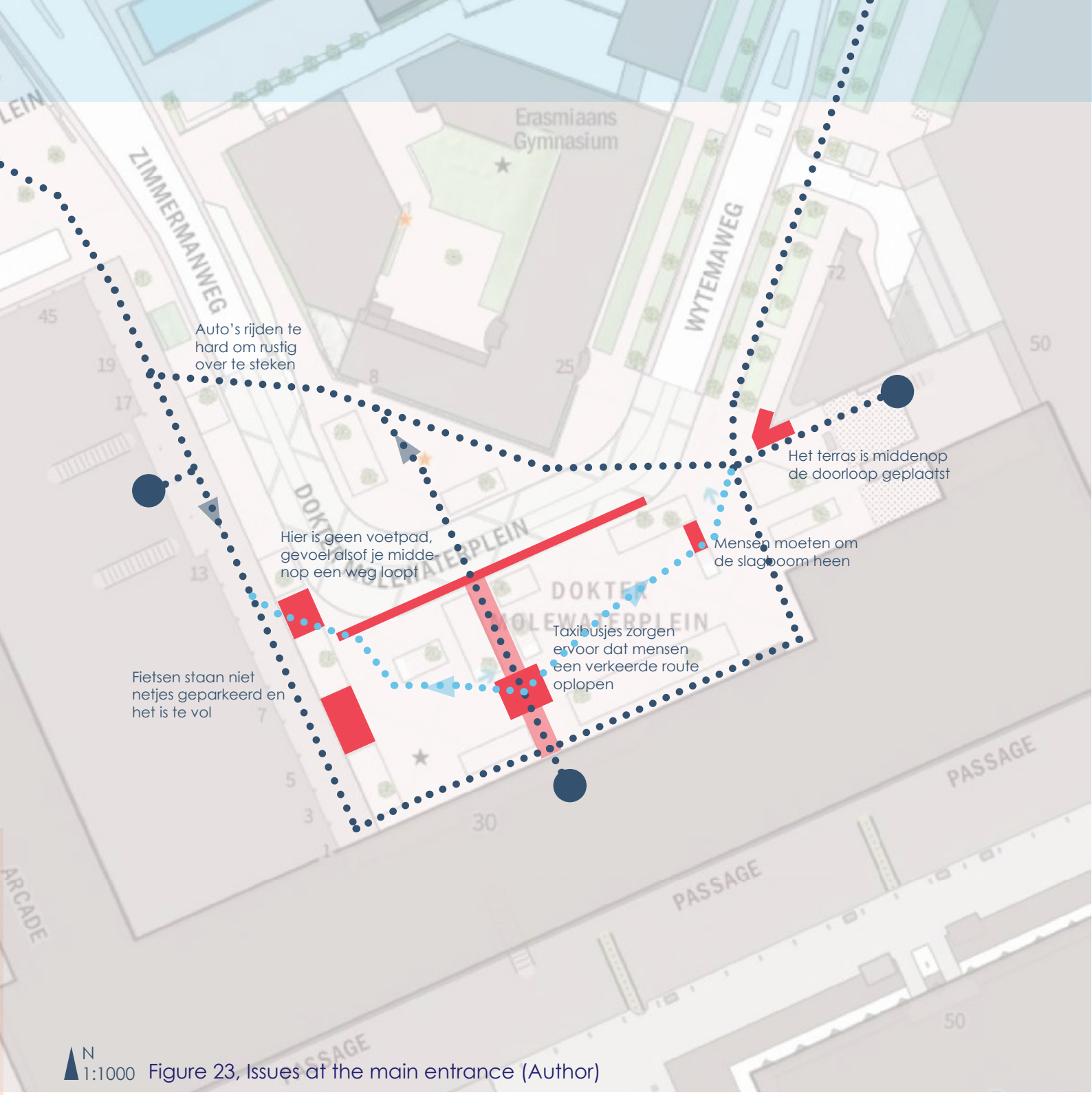


Figure 23, Issues at the main entrance (Author)

There is too little space for bikes and it is not clear where else to locate them when it is full.

Parked taxi busses in front of the entrance door blocking the way.

It is not clear what is pavement or a cycling path. Cars are everywhere and even the ambulance has a lane.

Figure 24, parked bikes (Author)

Figure 25. parked taxi busses (About EMC, 2022)


Figure 26. Overview. (Erasmus MC, 2022)

2.5 Research Questions

Main research question
Which mobility scenarios are possible and suitable for an inclusive accessibility the future EMC Campus, and how can spatial interventions relieve stress on the last mile and arrival?

Subquestions

- What are the most suitable and preferred routes based on urban aspects and individual motivations?

M1 M2 M3

- How are the mobility personas defined traveling to the EMC defined to provide inclusivity?

M4 M5

- What aspects in the city influence mental health and what spatial requirements can be advised to minimize urban stress?

M6

2.6 Methods

M1

Method 1. The use of a digital parametric model
By using OSM. data in Houdini

In this model, the preferred route and mode of transport can be predicted by connecting the preferences of personas to attributes. Secondly, it can be used as a tool to test the suitability of a specific route, and finally, it can test changes by design.

M2

Method 2. Test by using personas
By using Data from data analytics EMC, interviewing and theories

Because of the large scale of this project, using personas is more suitable than conducting 1:1 research with real people.

M3

Method 3. Scenario planning
Different options to move from A to B, mapping, scenariofield

Scenario planning is important to not end up in tunnel vision. According to recent research each exercise of scenario planning should be completely different in its context (Stojanovic et al., 2014).

M4

Method 4. Theoretical research
Read literature to research methods and research to built further upon

M5

Method 5. Survey
Learn more about how society experiences stress and extract actual values

M6

Method 6. Test by design
By adding spatial interventions in the model. Travelers will make different choices in choosing their transport mode and route.

2.7 Methodological Framework

Main research question
Which mobility scenarios are possible and suitable for an inclusive accessibility the future EMC Campus, and how can spatial interventions relieve stress on the last mile and arrival?

• How are the mobility personas defined traveling to the EMC defined to provide inclusivity?

• What are the most suitable and preferred routes based on urban aspects and individual motivations?

• What aspects in the city influence mental health and what spatial requirements can be advised to minimize urban stress?

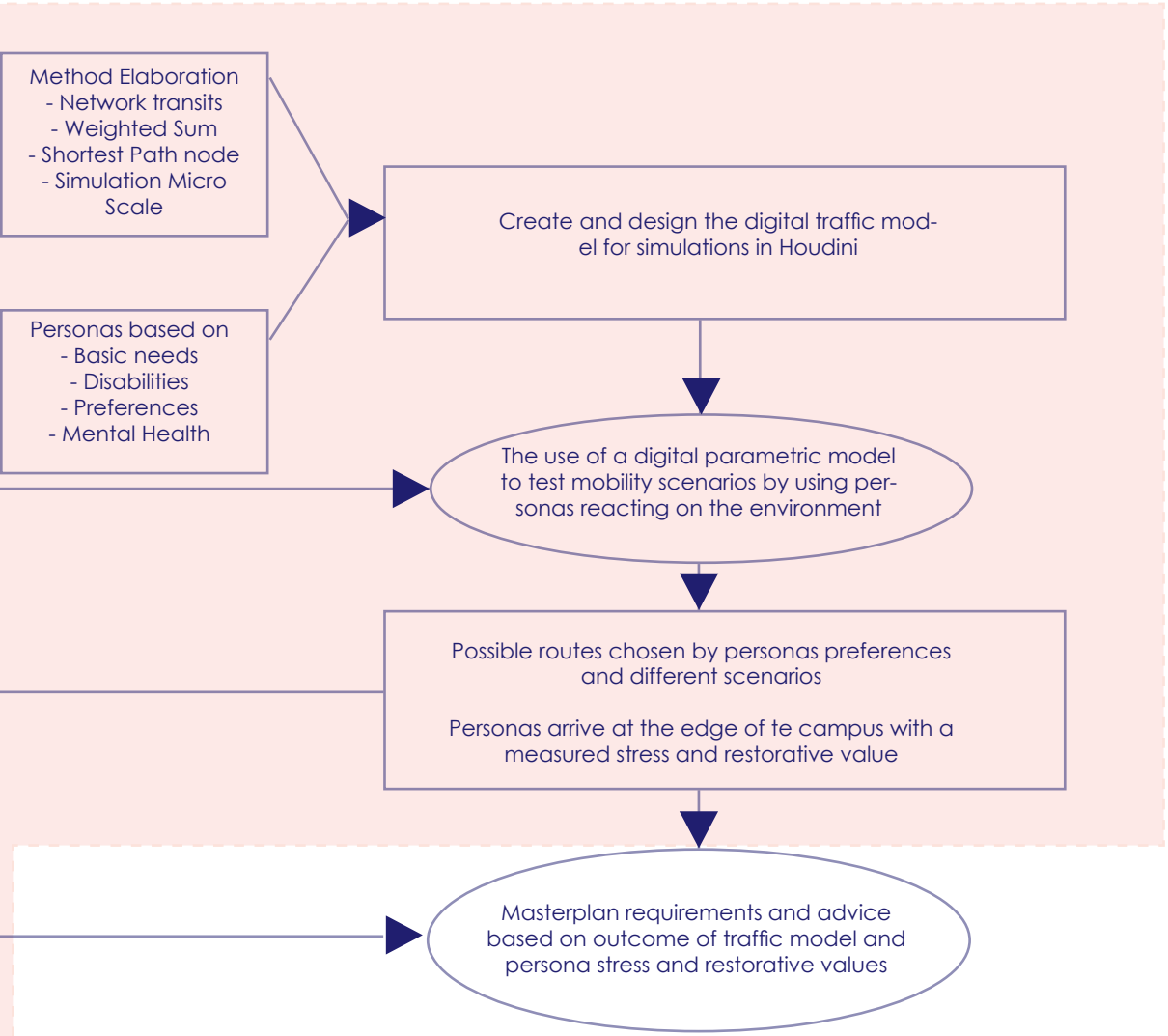
- Theoretical research on doing persona based research and on stressors and restoratives

- A survey with edited images based on theory of stressors and restoratives to define values as input for the model

Survey data

After this thesis, the Erasmus MC can explore short term changes that could be made on the scale of Rotterdam to make the logic routes most restorative. Survey data can be used to evaluate at the qualities of elements along the route. (Research based)

Research



The method and goal of this graduation project is mainly research based. At the end preliminary program requirements for the Erasmus Medical center masterplan are made to improve the arrival. These requirements can serve as a guide for the further design proces. The main method will be a digital model in Houdini. This method is chosen because it can say something about all aspects that are integrated into such a model.

It says more than a map because it also takes vertical things into account and more than a person would be able to comprehend or explore in the given time of this thesis. The digital model is not about geometry anymore, but the ultimate integration of data. (Zlatanova, 2021)
This is exactly what the project needs. A very elaborated digital replica to predict the output of scenarios and prefered route of personas.

3. Theoretical Framework

PURPOSE

Improving the quality of the routes towards th
urban stress for specific

RELIEVING TRAVELERS

City (Rot

PREVIOUSLY DONE THEORY THIS THESIS BUILDS UPON

Relieving by implementing restorative enviroments

Restorative Cities
Layla McCay
Mental health can be influenced positively by creating restorative environments.
The study builds upon how places can recover mental fatigue, depression, stress and anxiety.

Relieving by taking away urban stressors

Urban Stressors
Marijke Koene
Koene elaborated a list of urban stressors and explained how this urban stress can be reduced through urban design.

INCORPORATION OF THESE THEORIES IN THIS THESIS

The restorative and stressor theories from McCay and Koene are being used as a base for the survey to gather more concrete evidenced theory to measure the routes with.

MAIN RESEARCH QUESTION

Which mobility scenarios are possible and suitable for c
ventions relieve

City (Rotterdam) scale

CONCLUSIONS AND FINAL PRODUCTS

- Prefered routes on network based on persona simulation
- Data on which personas end up at which destination
- Measured stress value on the city scale

SCIENTIFICAL ADDITIONAL VALUE OF THIS THESIS

Future research on mental health in cities can use the preliminary results of stress and restorative values from different elements in the city as a base or inspiration.

Secondly, the
ital health ca
ital model ca

e EMC by digitally researching future mobility scenarios and relieving
personas traveling towards the EMC campus.

tterdam) and Micro (EMC) scale

BEST SCENARIOS FOR PERSONAS

Create specific MOBILITY personas for the EMC Campus

Tangible futures: Combining scenario thinking and personas - A pilot study on urban mobility

In this research they used the following 3 theories to define their persona's reacting on mobility situations. (Vallet et al., 2020)

Avoid retorical research conclusions and explore motivation

Maslow's Hierarchy of Needs
A. Maslow
According to Maslow there are at least 5 basic needs: physiological, safety, love, esteem, and self-actualization. These needs are at the base of our decision making. (Maslow, 1943)

All persona's have 3 filters. The 1st filter is **4 different personalities** based on the researches by Vallet et al. and Barth et al. The second is specific **disability** data provided by the Data analytics department from the EMC and the third is based on **basic needs behavior** according to Maslow.

an inclusive accessibility the future EMC Campus, and how can spatial inter-
e stress on the last mile and arrival?

Micro (EMC) scale

- Urban Design advice on the Masterplan to support mental relieve differently for different personas

e method of creating a system where digre personas are making choices in a dign be used as a base or a lesson for future similar research. Mainly the reflection of this thesis on the model saves time for future research to not struggle with the same discussions.

3.1 Social and scientifical Relevance

Restorative cities by Roe and McCay and the thesis of Marijke Koene about Urban Stressors are the base of the theoretical framework. Their research is being summarized into a survey to rate the theories and collect and compare them on the same scale. Future research on mental health in cities can use the preliminary results of stress and restorative values from different elements in the city as a base from my survey. Secondly, the method of creating a system where digital health care personas are making choices in a digital model can be used as a base or a lesson for future similar research. Mainly the reflection on the simulations in the model saves time for future research to not cope with the same discussions. Furthermore, new insights on restorative and stresscosts while moving through a city can assist and inspire designers making decisions to improve general mental health.

The project is socially and scientifically relevant from several perspectives besides the Erasmus MC. For example, own research points out how the academic hospitals in Bristol and Essen are twins of the problem. With a comparable fabric typology, density, number of inhabitants, located in a dense location and no space for cars. These academic health care campuses can also learn from this research and adapt it to their situation.

Development projects such as a master plan of the Erasmus MC are an opportunity to simultaneously improve city mobility networks for surrounding neighborhoods of the Erasmus MC as well. The research and model can show how high-quality connectivity in Rotterdam with low urban stress and implementing healing environments can be achieved.

3.2 Travelers Preferences for mobility scecarios

In order to research preferences, personas need to be made to measure them. In this research they used the following 3 theories to define their persona's reacting on mobility situations:

"*•The sociology-based Social Practice Theory (SPT) (Reckwitz, 2002; Shove, Pantzar, & Watson, 2012) describing the basic components of everyday routines,*

•The Sinus Milieu approach developed in market research (Bertram & Berthold, 2012), which relates to the idea that behavior is influenced by general values, beliefs and viewpoints,
•The Behavior Change Model (BCM) introduced in Persuasive Design Research (Fogg, 2009), focusing on preconditions for encouraging behavior change." (Vallet et al., 2020 p.7)

Even though these 3 theories are not all fully interesting for mobility aspects, they did all have a few aspects which could be extracted for the persona's in this research. In figure 16 and 17, the personas conducted from these 3 theories are further elaborated. (*Vallet et al., 2020)*

Interesting about this research is how it combines mobility scenarios with certain personas. The different mobility scenarios are defined for these specific personas, which could be a way to also approach the research for the Erasmus MC.

Figure 29 shows the workflow of combining scenarios and personas. The scenarios are not built for the personas, but they are mapped with the personas. (*Vallet et al., 2020)*

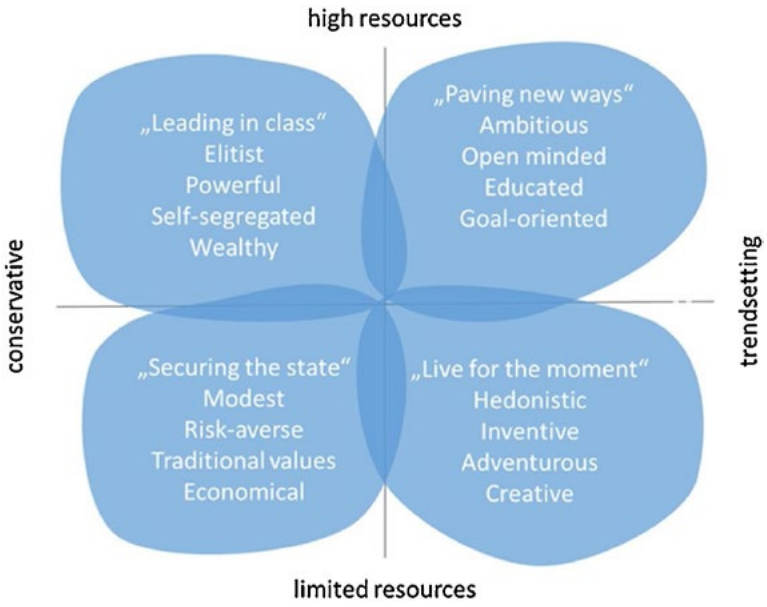


Figure 27. Mobility profiles defined by combinations of availability of resources and general attitudes. (Vallet et al., 2020)

Profile	Social characteristics	Mobility characteristics
Securing the state	Conservative milieu of residents living in rural or low income urban neighborhoods, traditional values are important (family, religion, honesty, modesty). Novel developments (new/other social groups, technological developments, political changes) are met with skepticism. People are very much based in routines and do not like changes. They prefer to stay among themselves.	Mobility is a necessity; it needs to be affordable, safe and efficient. In rural areas, the car is dominant; in urban areas public transport can be an alternative, if it is deemed safe enough. The activity radius is quite narrow.
Leading in class	Highly influential conservative elite, wealthy and established in society; feeling of social responsibility, but preserving or expanding the status and influence has priority. Novel developments are accepted, if they support their conservative attitudes. Due to their societal status, they have also the power to influence (support or hinder) future developments.	Mobility is also a means for displaying the status. Far-distance travelling is common for business and leisure. Transport modes allowing (hierarchical) separation from other groups (exclusive car, business/first class in trains and aircrafts) are preferred.
Paving new ways	Young modern performers and individualists, interested in new developments and devices, but at the same time very pragmatic (goal-oriented); like everything supporting their goals and their self-esteem; take calculated risks if success is likely. Intensive use of digital media (for fun and for specific purposes, e.g. efficiency and career).	Mobility is a means of getting somewhere and is viewed pragmatically, although "new" and trendsetting options are more interesting than others. Services offering a notion of coolness along with ease of use and flexibility are very attractive (e.g. Uber).
Living for the moment	Hedonistic milieu, try to make the most of limited resources. Status and fun are important, hence savings are sometimes used for expensive car/smartphone/body-art, even if the regular life (residence, food etc.) needs to be cut down for it. Interested in new things and willing to take risks, creative and adventurous, therefore often seed for disrupting ideas.	Mobility is fun, either through the experience provided by the means of transport itself or by the chance to provoke reactions from other people (e.g. colorful or self-build longboards, tuned up cars), risky behavior is possible. Financial limitations determine their options.

Figure 28. Prototypical traveler profiles. (Vallet et al., 2020)

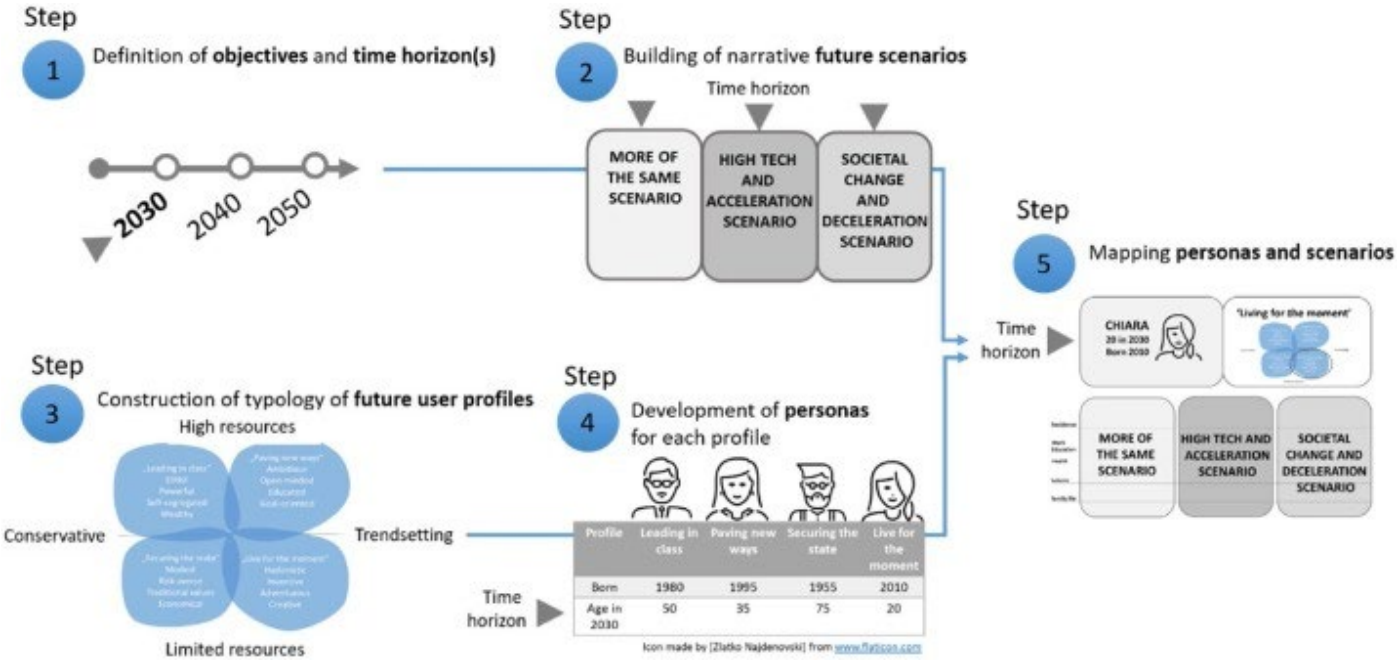


Figure 29. Workflow of the Scenario Personarrative Method (Vallet et al., 2020)

3.3 Mental health and the environment

There are many theories on healing environments for our physical health, yet also for our mental health. A recent study by Engineer includes eight articles of theories to support the connection between design and health. Interesting findings are for example the gender difference in one of the articles. Namely the relation between green space and cardiovascular risk factors. High green density has a positive effect on females, but not for males. Another research points out the relation beween open spaces and adult renal function. (Engineer et al., 2020)

"The results reveal that a lower prevalence of chronic kidney disease is associated with proximity to open space among adults in Taiwan without hypertension or impaired fasting glucose." (Engineer et al., 2020, p.2)

The 8 articles are showing chances of realizing healing public spaces around the EMC, which are part of the last mile towards the hospital and the first mile to travel back home.

Kornelia Dimitrova created a design on the intersection of mental health and sustainable development for a GGZ area. This is a good reference for the small-scaled interventions, because of the healing environmental values and the integral approach. (Dimitrova, 2020)

Dimitrova discusses how it is important for mental health to also create *attractive urban parks with diverse activities, ambiances, and visitors* (Dimitrova, 2020).

Relieving patients is the main focus of this mobility research. This does not only translate in mobility principles, like making sure there is plenty of mobility choices, its reliance and qualitative transits. Yet, it also translates into creating environments that are as relieving as possible.

According to the book Restorative Cities, mental health can be influenced positively by creating restorative environments. This means mental health, welness and quality of life is at the forefront of urbanism. The study builds upon how places can recover mental fatigue, depression, stress and anxiety. This restorative city concept is a contributor in a larger framework together with the regenerative city and the resilient city, together contributing to mental health. (Roe & McCay, 2021)

Two theories are elaborated to describe the impact in a restorative experience. According to the ART Model by Kaplan and Kaplan there are 4 successive stages:

1. Clearing the head
2. Recovery of directed attention capacity
3. Process of contemplation or 'cognitive quiet'
4. Deeper state of restauration
    - -Reflect on life
    - -Priorities
    - -Possibilities
    - -Action and goals

To achieve this restaurative environment, natural environments have the strongest evidence according to research by Staats. (Roe & McCay, 2021)

In this specific research the duration of staying/moving through the space is rather short. Which could result in not reaching all 4 stages. Yet, reaching stage 1 and 2 is already in line with the ambitions of this research. Clearing someones head and taking their attention away from being at a hospital, could be a solution in this research.

The second theory is the SRT by Ulrich, which is focused on the like-dislike response based on preferences. This immediately triggers the body stress response (heart rate, blood pressure and stress hormones). (Roe & McCay, 2021)

A positive trigger in the body stress response could lead to a more positive overall feeling for patients. Not only wild nature creates a positive response on our stress levels. There is no difference between managed natural environments in an urban environ-

ment like greenways, green spaces, and arboretums. This effectively copies the characteristics of wild nature that people find appealing, aesthetically pleasing, and restorative. Also the short-time visits show positive effect and even when seen from a window the benefits are still counting. In the book 7 principles in restorative cities are being elaborated based on the following framework. This happens on the city scale, for infrastructure and mobility, and happens on the local scale for everyday life. (Roe & McCay, 2021)

The applicability on different scales connects well to the research, since this is also being done on both of these scales. The larger networks and the impact of the small scale.

Figure 30. 7 restorative elements
(Roe & McCay, 2021)

Since one of the main problems is the amount of stress patients experience during their trip. Taking care of urban stressors could be a way to relieve patients. Koene elaborated on how urban stress can be reduced through urban design (Koene, 2018). From a long list of urban stressors she extracted the folllowing ones. These are chosen because they are actually influencable by urban design (Koene, 2018).

"Urban Environment Stressors
01. Density (Zipjet, 2017)
02. Crowding (Van den Berg, 2007; Van Dorst, 2005; Stokols, 1972; Evans & Cohen, 1987)
03. Boring megascapes (Weintraub, 2015)
04. Garbage, graffiti and disrepair (Montgomery, 2014)
05. Sharp architectural angles (Montgomery, 2014)
06. Traffic (jams) (Levy-Leboyer, 1892; Montgomery, 2014; Zipjet, 2017)
07. Parking problems (Levy-Leboyer, 1982)
08. Accessibility & availability of green (Burton, 1990; Zipjet, 2017)
09. High-rise (Gifford, 2007)
10. Public transport (Montgomery, 2014; Zipjet, 2017)
11. Perception of security (Zipjet, 2017; Burton, 1990)
12. Lay-out of architecture and urban design (Burton, 1990)

Social urban stressors
16. Gender inequality (Zipjet, 2017)
17. Race inequality (Zipjet, 2017)
20. Lack of social support networks (Burton, 1990)

Stressors from urban conditions
21. Sunshine hours (Zipjet, 2017)
22. Air pollution (Zipjet, 2017; Evans & Cohen, 1987)
23. Noise pollution (Zipjet, 2017; Evans & Cohen, 1987; Burton, 1990)
24. Light pollution (Zipjet, 2017)

Health stressors
31. Physical health (Zipjet, 2017)
37. Lack of exercise (Burton, 1990)"
(Koene, 2018, P.29)

On the next pages these theories are further elaborated and images have been created to visualize the restorative value or stressor. In order to be able to compare the stressors and restoratives with each other, a survey is done along a broad peer group. In the survey the same personas are used as for the simulation of the mobility choice. This means we can learn something about the correlation of lifestyle and stress/restorative influence.

1. Stressors: Urban Design Aspects

The following 8 spatial urban stressors are applicable on the Erasmus Medical Center. These are categorized into 2 categories, namely: Urban Design Aspects and City Life.

Images of the location are edited to show the visual difference between different stressors and to make the survey more accessible and clear.

1.1. Density (Zipjet, 2017) (Koene, 2018)

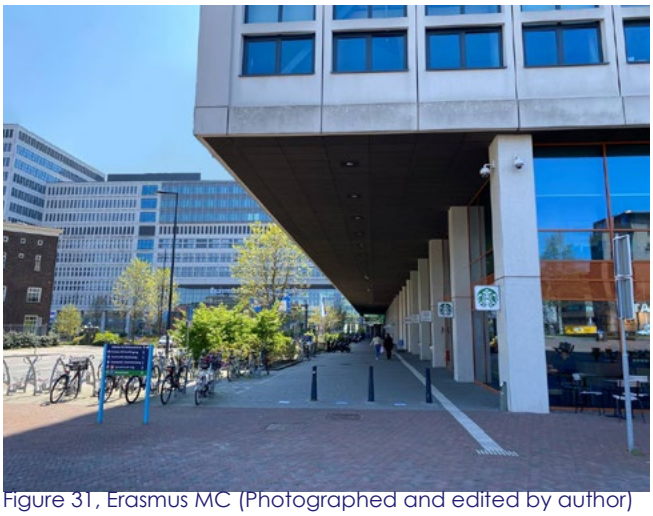


Figure 31, Erasmus MC (Photographed and edited by author)

1.2. Round architectural edges (Added for survey comparison)

Figure 32, Erasmus MC (Photographed and edited by author)

1.3. High-rise (Gifford, 2007) (Koene, 2018)

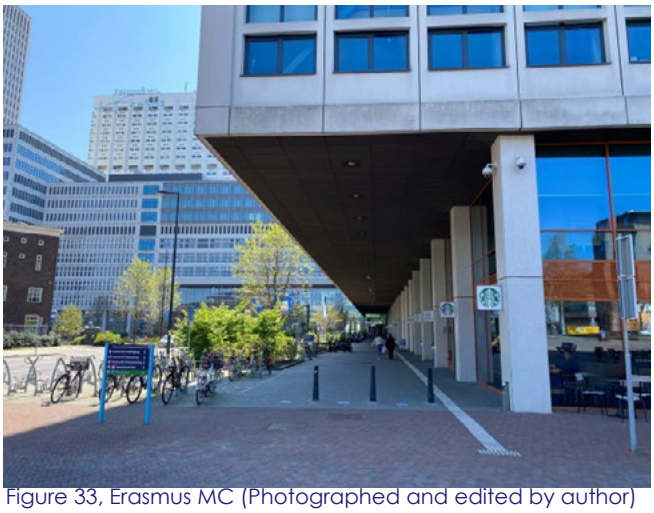


Figure 33, Erasmus MC (Photographed and edited by author)

1.4. Sharp architectural angles (Montgomery, 2014) (Koene, 2018)

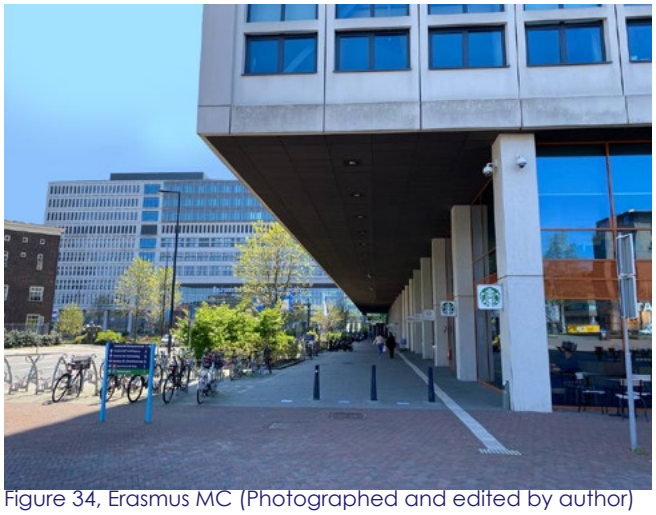


Figure 34, Erasmus MC (Photographed and edited by author)

2. *Stressors: City Life*

The second category, City Life, is not spatial like the first category. Urban Designers can not influence these aspects directly by implementing certain typologies and visual shapes. Yet, Urban Designers can invite people to behave in a certain way by the design of public space.

2.1. Crowding (Van den Berg, 2007; Van Dorst, 2005; Stokols, 1972; Evans & Cohen, 1987) (Koene, 2018)

Figure 35, Erasmus MC (Photographed and edited by author)

2.2. Garbage (not neat) (Montgomery, 2014) (Koene, 2018)

Figure 36, Erasmus MC (Photographed and edited by author)

2.3. Space without added stressors (added for survey comparison)

Figure 37, Erasmus MC (Photographed and edited by author)

2.4. Traffic (jams) (Levy-Leboyer, 1892; Montgomery, 2014; Zipjet, 2017) (Koene, 2018)

Figure 38, Erasmus MC (Photographed and edited by author)

A. Restoratives: program around water

A1. The unedited version of the image below without blue water (survey comparison)
A2. High quality clean water (p.49, Roe & McCay, 2021)

Figure 39, Westersingel (Baljon, 2022. edited by author)

A3. Attractive planting around water p.59 (Roe & McCay, 2021)

Figure 40, Westersingel (Baljon, 2022. edited by author)

A4. Crashing waves, dramatic waterfalls vs static green scene with water (p.44, Roe & McCay, 2021)

Figure 41, Westersingel (Baljon, 2022. edited by author)

A5. Attractive seating around water (p.59) (Roe & McCay, 2021)

Figure 42, Westersingel (Baljon, 2022. edited by author)

B. *Restoratives: types of urban parks*

B1. Simple urban park with a few trees and no green facades (Added for survey comparison)

Figure 43, Pocket Park (Photographed and edited by author)

B2. Tree cover (canopy) of at least 30 percent(p. 32, Roe & McCay, 2021) Street trees, pocket parks (p. 32, Roe & McCay, 2021)

Figure 44, Pocket Park (Photographed and edited by author)

B3. Rich inbiodiversity like animal species (p. 33, Roe & McCay, 2021)

Figure 45, Pocket Park (Photographed and edited by author)

B4. Green walls (p. 37, Roe & McCay, 2021)

Figure 46, Pocket Park (Photographed and edited by author)

C. *Restoratives: sensory paving*

C1. Aesthetics (symmetry, scale, proportion, order, etc.) serve wayfinding by use of color organization etc. (p. 87, Roe & McCay, 2021)

Figure 47, Blaak (Photographed and edited by author)

C2. One fully monochrome square paving with no separated functions (added for survey comparison)

Figure 48, Blaak (Photographed and edited by author)

C3. Cycle tracks separated from pedestrian and vehicular traffic (p. 131, Roe & McCay, 2021)

Figure 49, Blaak (Photographed and edited by author)

C4. Textural variation, including nature based structures (p. 86, Roe & McCay, 2021) C.4. Pedestrian surface structure (p. 85, Roe & McCay, 2021)

Figure 50, Blaak (Photographed and edited by author)

D. Restoratives: elements of facades

D1. Monochrome facade with one large storefront (added for survey comparison)

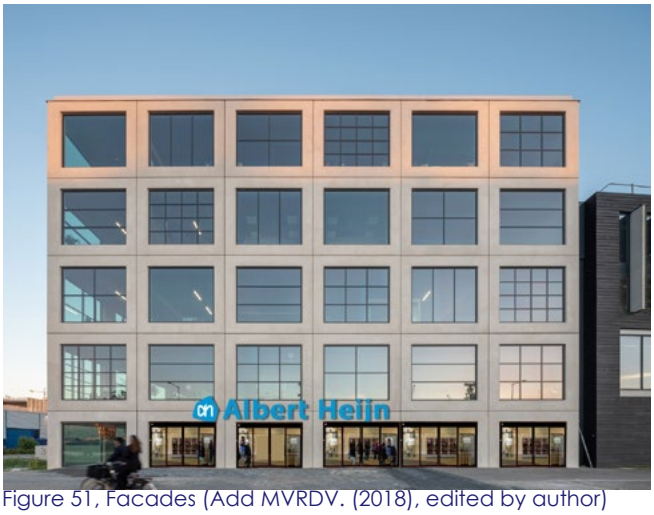


Figure 51, Facades (Add MVRDV. (2018), edited by author)

D2. Fine-grain storefronts (p. 87, Roe & McCay, 2021)

Figure 52, Facades (Add MVRDV. (2018), edited by author)

D3. Varied facades (p. 87, Roe & McCay, 2021)

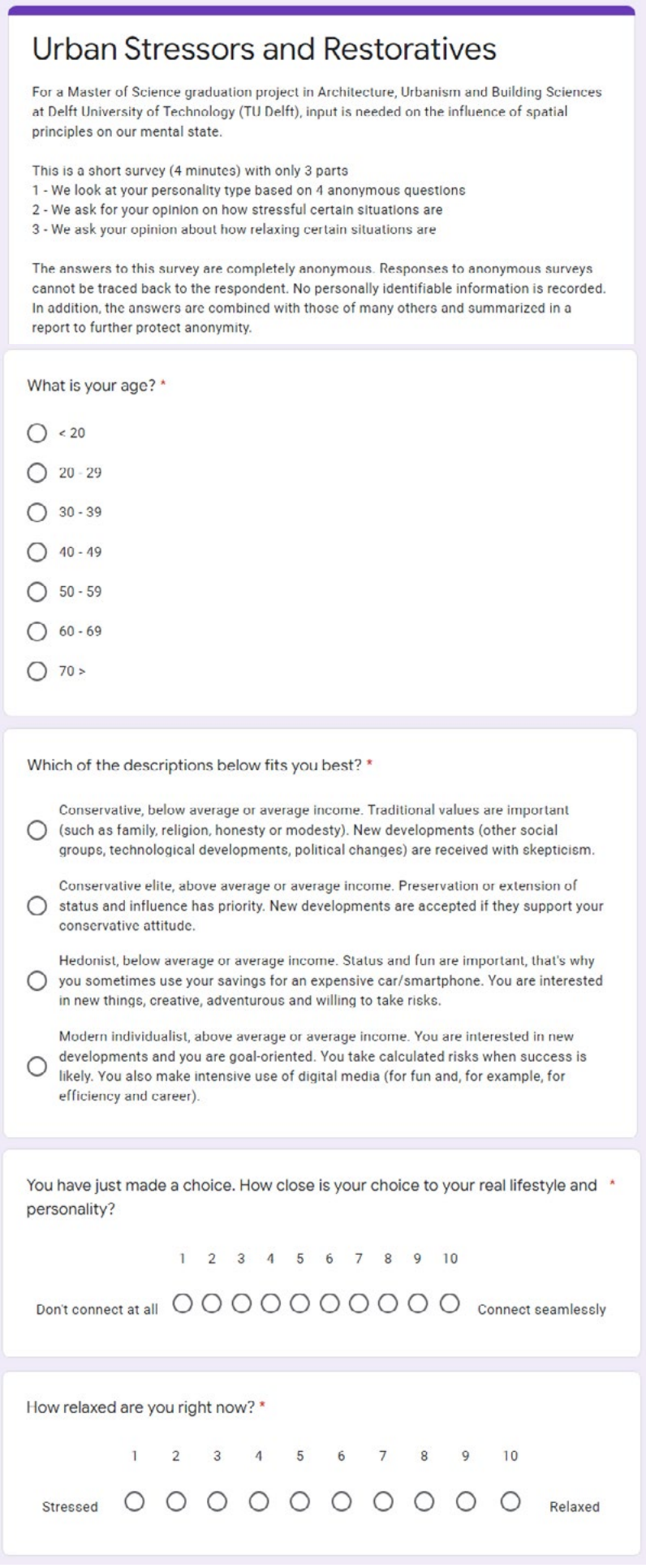
Figure 53, Facades (Add MVRDV. (2018), edited by author)

D4. Aesthetics serve local character (p. 87, Roe & McCay, 2021) B.4. Historic fascination, urban environments with interesting building facades (p. 25, Roe & McCay, 2021)

Figure 54, Facades (Add MVRDV. (2018), edited by author)

4 Society research

What is missing in the theories of McCay and Koene is that they do not add a value on the quality of the urban aspects. To be able to compare the theories to each other and research mental health aspects on routes in a digital model, survey data is needed. The same 4 personality types as drawn from the previous theory are also used in the survey.



Urban Stressors and Restoratives

For a Master of Science graduation project in Architecture, Urbanism and Building Sciences at Delft University of Technology (TU Delft), input is needed on the influence of spatial principles on our mental state.

This is a short survey (4 minutes) with only 3 parts
1 - We look at your personality type based on 4 anonymous questions
2 - We ask for your opinion on how stressful certain situations are
3 - We ask your opinion about how relaxing certain situations are

The answers to this survey are completely anonymous. Responses to anonymous surveys cannot be traced back to the respondent. No personally identifiable information is recorded. In addition, the answers are combined with those of many others and summarized in a report to further protect anonymity.

What is your age? *

- < 20
- 20 - 29
- 30 - 39
- 40 - 49
- 50 - 59
- 60 - 69
- 70 >

Which of the descriptions below fits you best? *

- Conservative, below average or average income. Traditional values are important (such as family, religion, honesty or modesty). New developments (other social groups, technological developments, political changes) are received with skepticism.
- Conservative elite, above average or average income. Preservation or extension of status and influence has priority. New developments are accepted if they support your conservative attitude.
- Hedonist, below average or average income. Status and fun are important, that's why you sometimes use your savings for an expensive car/smartphone. You are interested in new things, creative, adventurous and willing to take risks.
- Modern individualist, above average or average income. You are interested in new developments and you are goal-oriented. You take calculated risks when success is likely. You also make intensive use of digital media (for fun and, for example, for efficiency and career).

You have just made a choice. How close is your choice to your real lifestyle and personality? *

1 2 3 4 5 6 7 8 9 10

Don't connect at all ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ Connect seamlessly

How relaxed are you right now? *

1 2 3 4 5 6 7 8 9 10

Stressed ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ Relaxed

A variable is created to create a scale and define the difference between the 4 used personas.

How stressful would you find the situation? *

1

2

3

4

	1 - not stressful	2	3	4	5 - very stressful
Situation 1	○	○	○	○	○
Situation 2	○	○	○	○	○
Situation 3	○	○	○	○	○
Situation 4	○	○	○	○	○

How relaxing would you find the situation? *

1

2

3

4

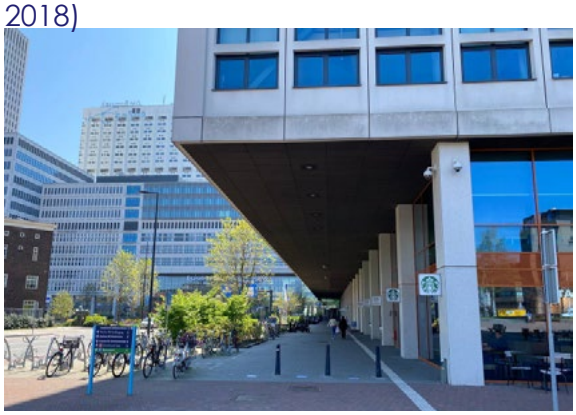
	1 - not relaxing	2	3	4	5 - very relaxing
Situation 1	○	○	○	○	○
Situation 2	○	○	○	○	○
Situation 3	○	○	○	○	○
Situation 4	○	○	○	○	○

4.1 Comparing Urban Stressors

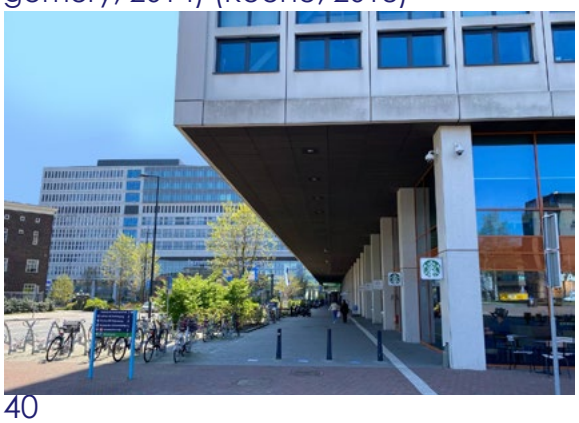
1.1. Density (Zipjet, 2017) (Koene, 2018)

1.2. Round architectural edges (Added for survey comparison)

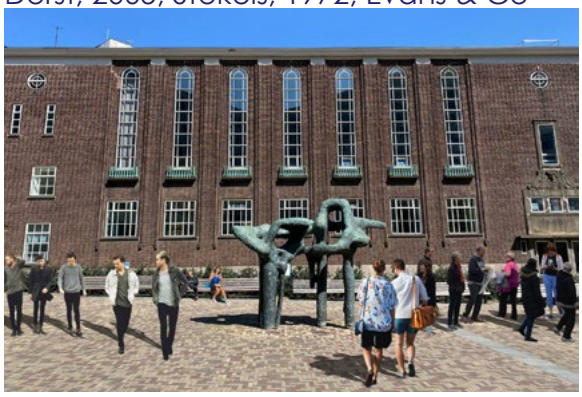
1.3. High-rise (Gifford, 2007) (Koene, 2018)



1.4. Sharp architectural angles (Montgomery, 2014) (Koene, 2018)



2.1. Crowding (Van den Berg, 2007; Van Dorst, 2005; Stokols, 1972; Evans & Co-

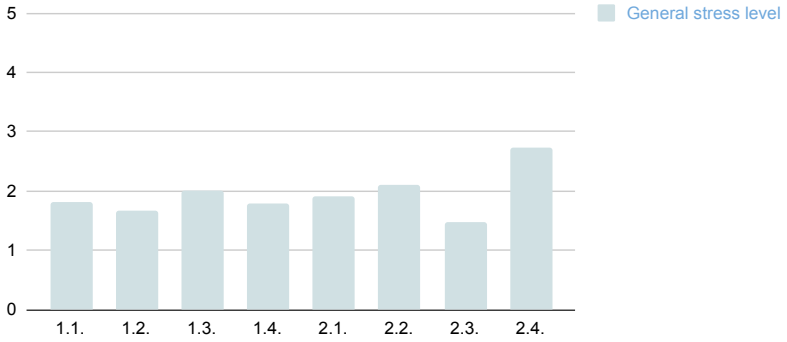


2.2. Garbage (not neat) (Montgomery, 2014) (Koene, 2018)

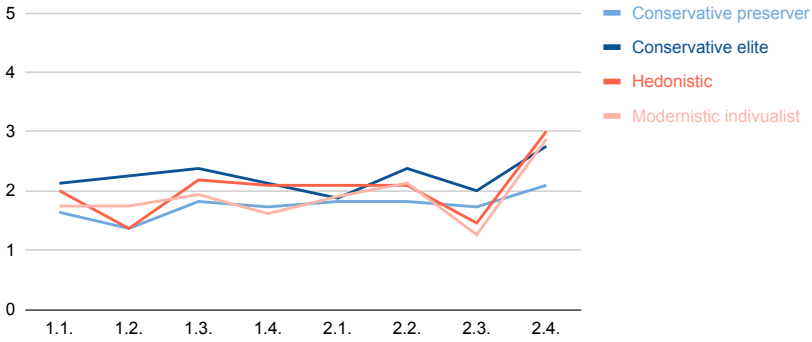
2.3. Brick public space without added stressors (added for survey comparison)

2.4. Traffic (Levy-Leboyer, 1892; Montgomery, 2014; Zipjet, 2017) (Koene, 2018)

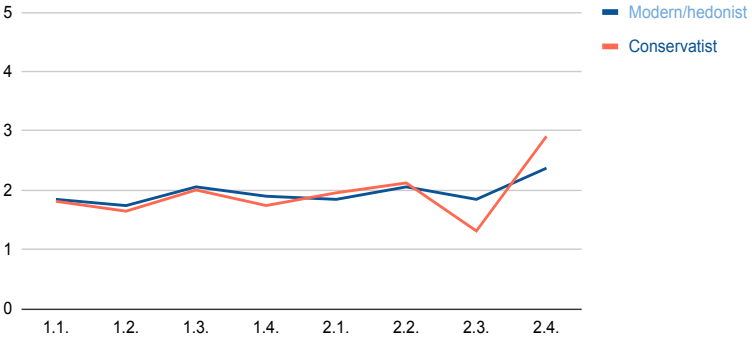
How stressful would you find the situation?



Graph 3, General stress levels according to survey (Appendix I)



Graph 4, Stress levels per lifestyle group according to survey (Appendix I)

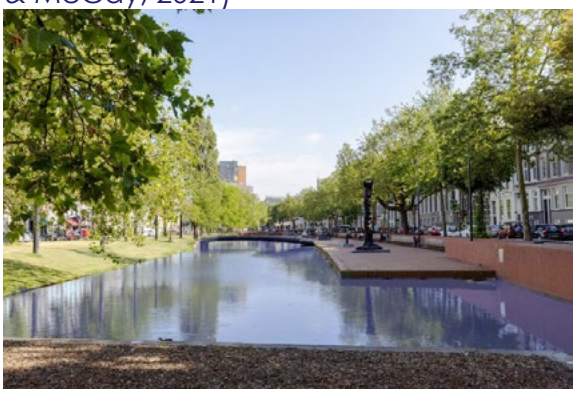


Graph 5, Stress levels per social group according to survey (Appendix I)

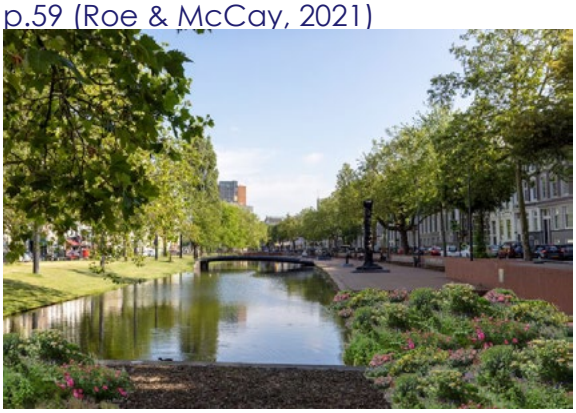
Several conclusions are made from the general results of the research survey. Firstly, objects far away in distance, such as the amount and height of buildings at the end of a street, do not have a significant influence on the stress value given by survey participants. Participants seemed to be more influenced by what is happening in front of them. This for example includes, the black taxi busses. These busses are the only stressor that is significantly higher then the stress value of not neatly parked bikes, crowding or urban design elements.

4.2 Comparing Green and Blue Restoratives

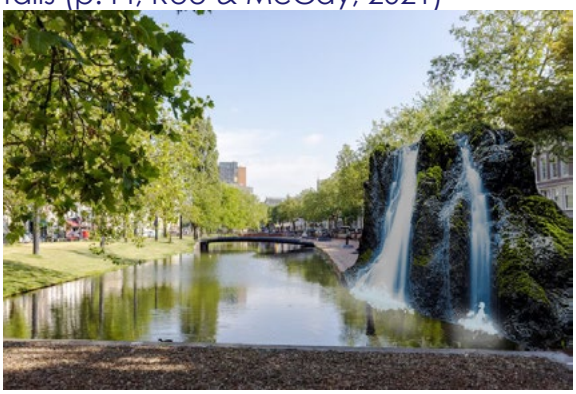
A1. Without blue water (comparison)
A2. High quality clean water (p.49, Roe & McCay, 2021)



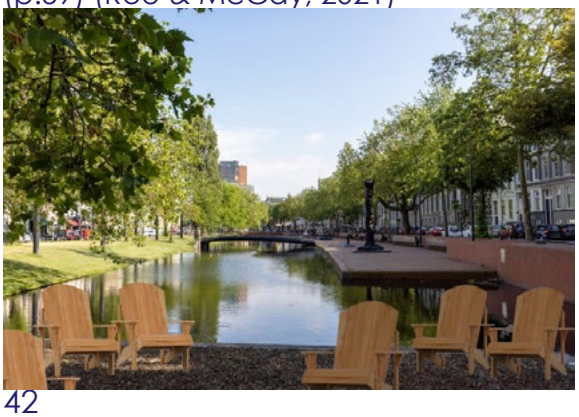
A3. Attractive planting around water p.59 (Roe & McCay, 2021)



A4. Crashing waves, dramatic waterfalls (p.44, Roe & McCay, 2021)



A5. Attractive seating around water (p.59) (Roe & McCay, 2021)



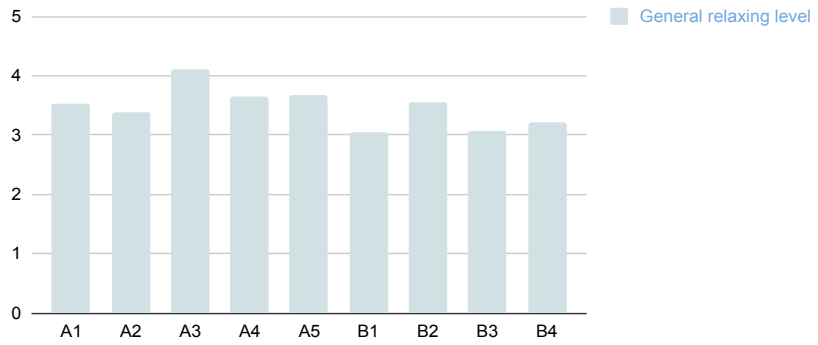
B1. Simple urban park with a few trees and no green facades (Added for survey comparison)

B2. Tree canopy of at least 30 percent (p. 32, Roe & McCay, 2021)

B3. Rich inbiodiversity like animal species (p. 33, Roe & McCay, 2021)

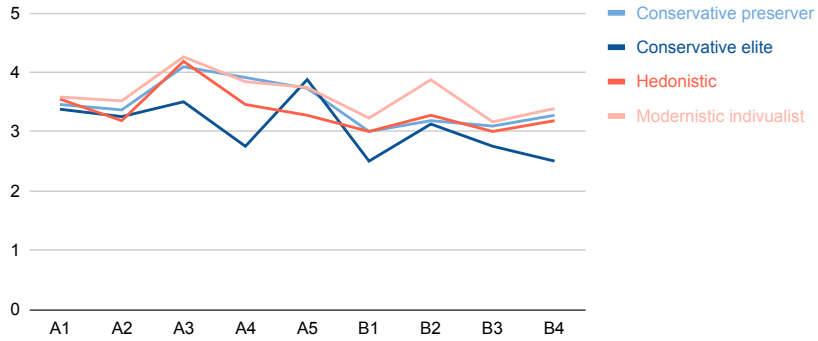
B4. Green walls (p. 37, Roe & McCay, 2021)

How relaxing would you find the situation?

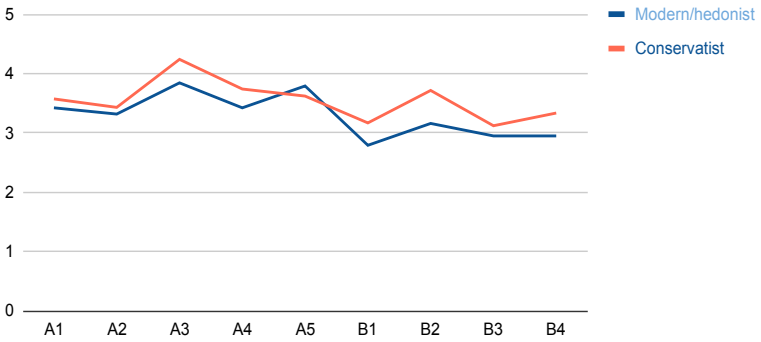


Graph 6, General stress levels according to survey (Appendix I)

Adding attractive planting makes water significantly more relaxing then clear water, waterfalls or attractive seating. Furthermore a tree canopy of at least 30% is most beneficial for the quality of a restorative urban park.



Graph 7, Stress levels per lifestyle group according to survey (Appendix I)



Graph 8, Stress levels per social group according to survey (Appendix I)

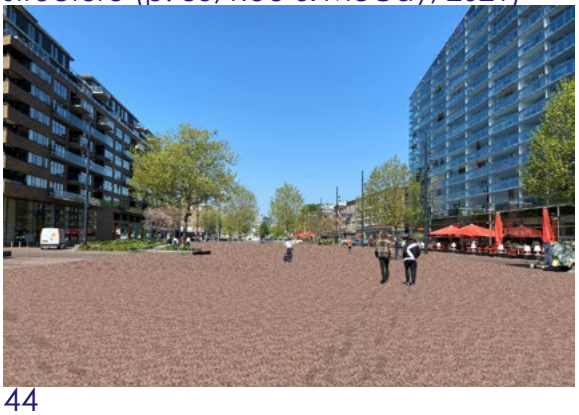
4.3 Comparing Sensory Restoratives

C1. Wayfinding by use of color organization etc. (p. 87, Roe & McCay, 2021)

C2. Paving without separated functions (added for survey comparison)

C3. Cycle tracks separated from other traffic (p. 131, Roe & McCay, 2021)

C4. Textural variation (p. 86) and surface structure (p. 85, Roe & McCay, 2021)

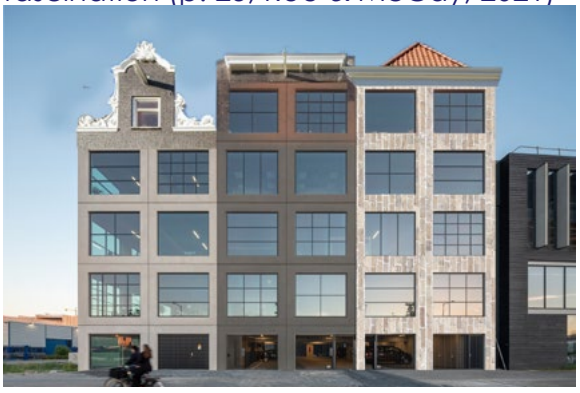


D1. Facade with large storefront (added for survey comparison)

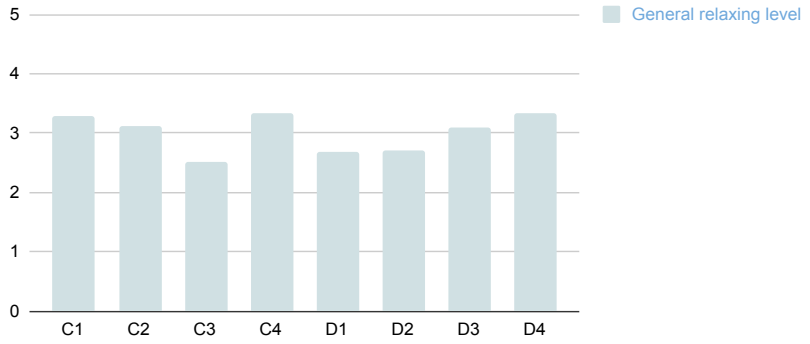
D2. Fine-grain storefronts (p. 87, Roe & McCay, 2021)

D3. Varied facades (p. 87, Roe & McCay, 2021)

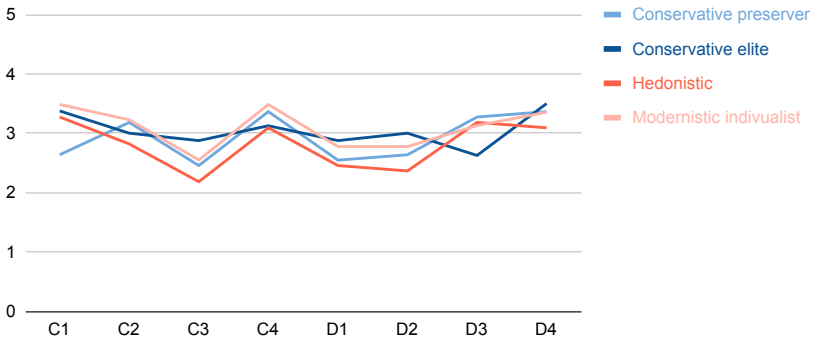
D4. Local character (p. 87) and historic fascination (p. 25, Roe & McCay, 2021)



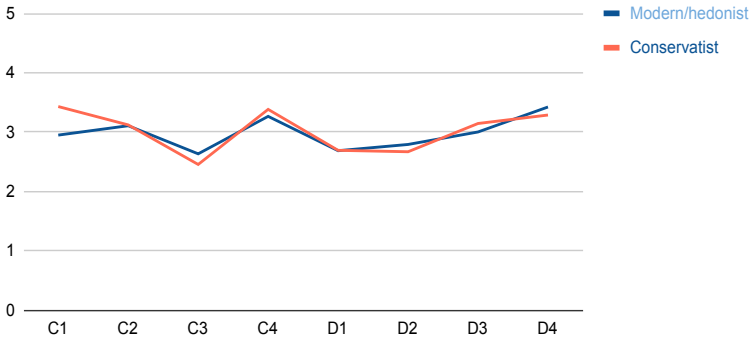
How relaxing would you find the situation?



Graph 9, General stress levels according to survey (Appendix I)



Graph 10, Stress levels per lifestyle group according to survey (Appendix I)

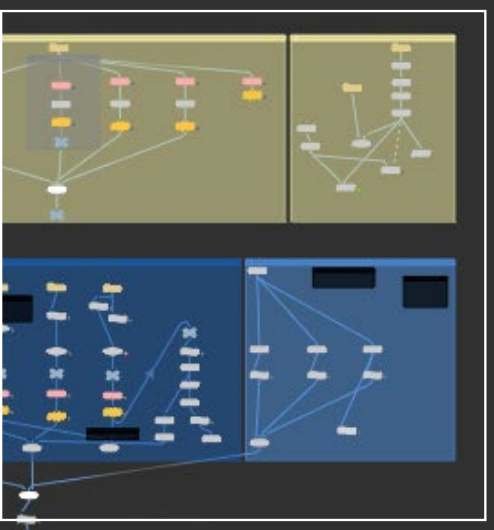


Graph 11, Stress levels per social group according to survey (Appendix I)

An interesting insight is found between different personas. The conservative elite is showing contrasting values in each of the graphs towards the other lifestyle groups. By concluding their line is flat, the assumption could be made they are used to driving in a car a lot, which makes nearby objects in the public space not influence their well being as much as it does to other groups.

5. Building The Digital Model For Route Calculations

There are 3 kinds of input, scenarios, personas and the environment.
This chapter will elaborate on how this input is collected.



Creating input network data

Input network data

Creating personas used for simulation

Importing Public Transport data

Preparing network and add values su as road l and vari for speed segment etc.

Base for Micro scale simulation (can be combinedu to-wards P5)

Calculate total restorative and stress value at arrival

Simulation Rot terdam scale

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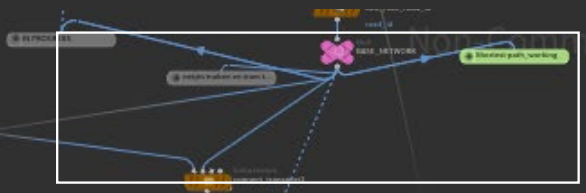
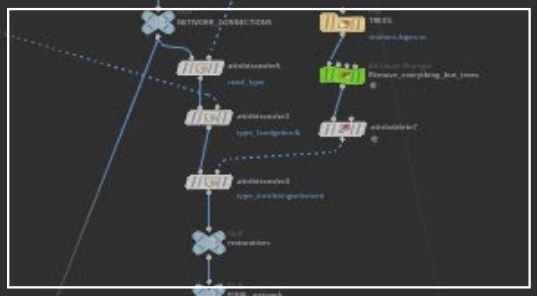
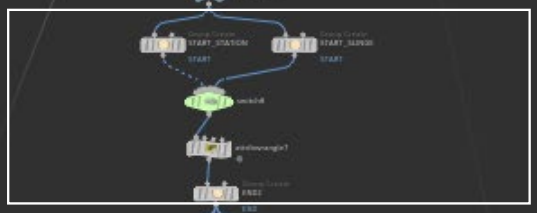


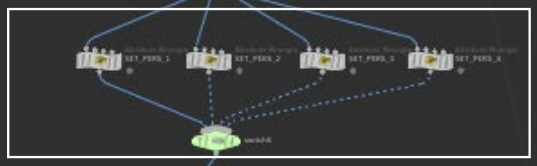
Input network



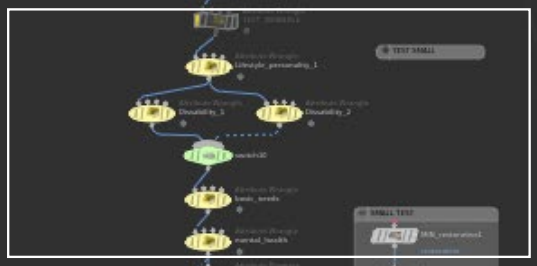
Transfer urban aspects with stress or restorative values on the network



Define start and end points

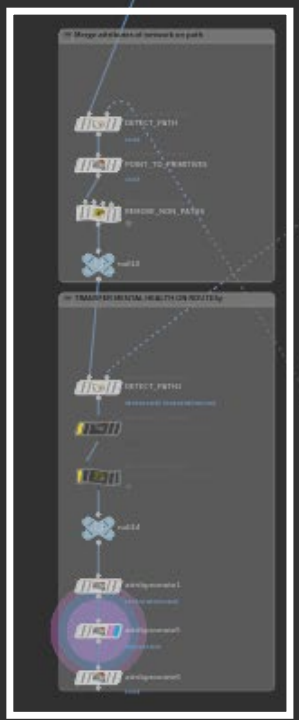


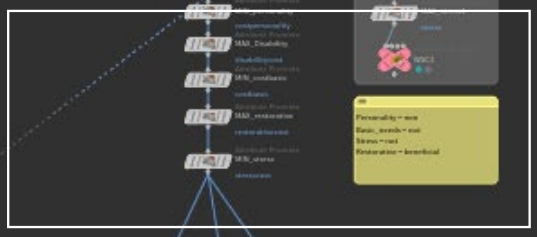
Switch between 4 persona preferences



Codes calculating the routes are added here according to the Weighted Sum Method

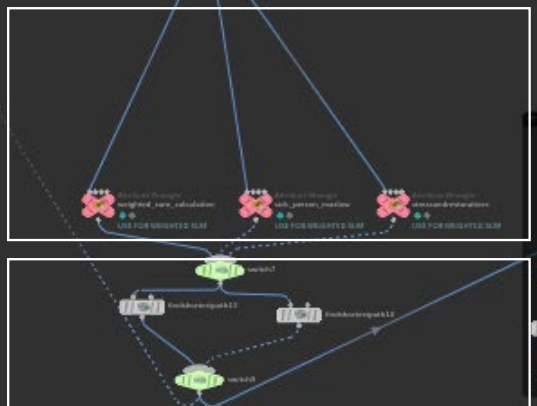
Calculate total restorative and stress value at arrival





Defining max and min values for calculating the Weighted Sum

Calculate pathcost with the Weighted Sum Method. (personas take the path with the lowest cost).



Simulate routes by calculating the lowest cost for the entire path

Visualize route

Creating individual choices by persona based modeling

Now the workflow of the model is explored, the personas are needed to be elaborated. As described in the theoretical chapter, personas have been created to react on mobility aspects. Specific personas can be created to match specific scenarios (*Vallet et al., 2020). The following 4 principles are being used.* In this research they used the following 3 theories to define their persona's reacting on mobility situations (figure 22). (Vallet et al., 2020)

	Model Goal	Weight
• Stress or restorative level	Avoid or Attract	0.13
• Disability	Mode is possible or not	0.18
• Lifestyle Personality	Personal Preference	0.23
• Necessity of life	Fastest route	0.46

Method 1.

	Value	Type of motivation	Model event
Image	0.0473	• Stress level and restorative	Avoid or attract
Accessibility PT system	0.074	• Dissability	Mode is possible or not
Travel comfort	0.0871	• Stress level and restorative	Avoid or attract
Travel information	0.093	• Necessity of life	Fastest route
Passenger Safety	0.104	• Dissability	Mode is possible or not
Punctuality	0.1126	• Lifestyle Personality	Preference
Ticket price	0.1201	• Lifestyle Personality	Preference
Operational speed	0.1784	• Necessity of life	Fastest route
Frequency	0.1835	• Necessity of life	Fastest route

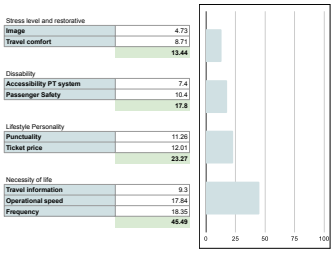


Table 1, Creating weights by the theory of Brispat, P. ,2017 (edited by author)

The weighted sum method is used for this multi criteria analysis. The weighted Sum Method is using more than one criteria decision method in which there will be multi-alternatives and we have to find the best answer based on many criteria. The advantage of the weighted sum method is to identify a single unique solution for implementation (Ooi et al., 2017).
Brispat recently did research on the weight people give to different travel motivations (Brispat, P. ,2017). Brispats' concluded values are copied in table 1 and2 and compared to the research data in this thesis to define values. Both comparison methods concluded the same values.

Method 2.

	Value	Value copy	Multiply to make 1	New value	Shortened	Type of motivation	Model event
Image	0.0473	0.0473	2.58535	0.122287055	0.12	• Stress level and restorative	Avoid or attract
Accessibility PT system	0.074	0.074	2.58535	0.1913159	0.19	• Dissability	Mode is possible or not
Travel comfort	0.0871	0.0871	2.58535	0.225183985	0.23	• Lifestyle Personality	Preference
Travel information				0			
Passenger Safety				0			
Punctuality				0			
Ticket price				0			
Operational speed	0.1784	0.1784	2.58535	0.46122644	0.46	• Necessity of life	Fastest route
Frequency				1.00001338	1		
	0.3868						

Table 2, Creating weights by the theory of Brispat, P. ,2017 (edited by author)

Before P5 the calculations will also be writted as a mathematical equation for everyone to understand.

The code on the right is elaborated at the end of the simulation. This basically calculates the cost of one network segment. For example, a piece of road or subwayline between 2 points. The shortest path node in Houdini is used after to calculate the path with the lowest total cost to the Erasmus MC. Since the pathcost takes the path with the lowest value, the benefit / non-benefit value will be turned around. This means that stress is a 'benefit' for the height of the cost, creating a higher cost value. Restoratives are non - beneficial for the height of the cost, keeping the cost value low.
Making the cost lower: MIN(Value)/Value
Making the cost higher: Value/MAX(Value)

```
//personality lifestyle
@sum_personality =
(@min_personality/@costpersonality) * 0.23;

//basic needs
@sum_basicneed =
(@min_basic/@costbasic) * 0.46 ;

//disabilities
@sum_disability =
(@disabilitycost/@max_disability) * 0.18;

//mental
f@sum_stress =
(f@min_stress / f@stresscost) * 0.065;
f@sum_restorative =
(f@restorativecost/f@max_restorative) * 0.065;

@pathcost =
sum
(@sum_personality +
@sum_basicneed +
@sum_disability +
f@sum_stress +
f@sum_restorative);
```

Important to mention about the simulation is how the persona preferences are incorporated. They do not not only have their own code calculating the pathcost according to their personality, they also create different perceptions in the calculation for mental health.

Below is an example of a part of the code calculating the weighted sum. This crucial fragment will be explained to make the next pages easier to read.

```
if (@personality == 1){
        if (s@type_inrichtingselement == "boom"){
        f@boomcost = 2.7;
        }
}
```

In english this would translate to:

```
if (@personality == 1){
```
If the personalitytype is 1, the following statement is applicable.

```
if (s@type_inrichtingselement == "boom"){
```
If there are trees adjacent to the road segment

```
f@boomcost = 2.7;
```
The restorative tree value is 2.7

The symbol } means that the statements are applicable until here.

For each persona type the stress and restorative values and the travel motivations are different. That is why in each aspect of the weighted sum, all personas have their own values to create different routes.

5.2.1. Basic needs

The Maslow pyramid is a hierarchy of needs theoricing the psychology of human motivation based on the pursuit of differents categories of needs. There are 5 main levels of needs from the most basic to the most advanced according to Maslow. (Maslow, A. H., 1943)
Physiological Needs
Safety Needs
Love and Belonging Needs
Esteem Needs
Self-Actualization Needs
(Maslow, A. H., 1943)

In recent research by Gromule et al. these levels of needs are shown in relation to mobility (Gromule et al., 2017). Safety, security and reliability as a base, whereafter come speed, convenience, comfort and experience (Gromule et al., 2017).

Below is the written code and the goals of the basic needs in the model. Everything with @ is an aspect with values that is on the networklines. Basically like a variable value in math. Perimeter means the length of a roadsegment.

Goal: Choose a most efficient route based on the shortest time and least amount of transits

```
f@costbasic;

if (@speed != 0){
   f@timecost = (@perimeter * @speed);
}
else {
   @timecost = (@perimeter * 5);
}

if (@transit == 1){
   @transitcost = 2;
}
else {
   @transitcost = 1;
}

f@costbasic = sum(@timecost + @transitcost);

if (@costbasic == 0){
      @costbasic = 1;
}
```

If, the speed is not 0, time is equal to length x speed. If 0 (it is a walking path) which means length times 5.

Figure 55 (Gromule et al., 2017)

5.2.2. Personality Preference

The values used for personality preference are created by a recent study which combined theories to define persona's reacting on mobility situations. (Vallet et al., 2020)

The description texts by Vallet et Al., are translated into numbers from 5 to 1 describing the likelyness a given decision is being made. **The closer a value is to 5, the less likely it is this route will be taken.**

To clarify, these are the same personalities as researched in the survey, so the travel preferences can be connected to the stress value.

	lifestyle and social characteristics	mobility choice behavior
1	Conservative milieu of residents living in rural or low-income urban neighborhoods, traditional values are important (family, religion, honesty, modesty). Novel developments (new/other social groups, technological developments, political changes) are met with skepticism. People are very much based in routines and do not like changes. They prefer to stay among themselves.	Mobility is a necessity; it needs to be affordable, safe and efficient. In rural areas, the car is dominant; in urban areas public transport can be an alternative, if it is deemed safe enough. The activity radius is quite narrow.
2	Highly influential conservative elite, wealthy and established in society; feeling of social responsibility, but preserving or expanding the status and influence has priority. Novel developments are accepted, if they support their conservative attitudes. Due to their societal status, they have also the power to influence (support or hinder) future developments.	Mobility is a means for displaying the status. Far-distance travelling is common for business and leisure. Transport modes allowing (hierarchical) separation from other groups (exclusive car, first class in trains and aircrafts) are preferred.
3	Young modern performers and individualists, interested in new developments and devices, but at the same time very pragmatic (goal-oriented); like everything supporting their goals and their self-esteem; take calculated risks if success is likely. Intensive use of digital media (for fun and for specific purposes, e.g. efficiency and career).	Mobility is a means of getting somewhere and is viewed pragmatically, although "new" and trendsetting options are more interesting than others. Services offering a notion of coolness along with ease of use and flexibility are very attractive (E.g. Uber).
4	Hedonistic milieu, try to make the most of limited resources. Status and fun are important, hence savings are sometimes used for expensive car/smartphone/body-art, even if the regular life (residence, food etc.) needs to be cut down for it. Interested in new things and willing to take risks, creative and adventurous, therefore often seed for disrupting ideas.	Mobility is fun, either through the experience provided by the means of transport itself or by the chance to provoke reactions from other people (e.g. colorful or self-build longboards, tuned up cars), risky behavior is possible. Financial limitations determine their options.

Table 3 (Vallet et al., 2020. P8. , edited by Author)

Personality 1
Conervative Maintainer
Separate Car Calculation: Yes

```
if (@personality == 1){

//CHOOSE MODE
   if (@road_type == 2){ //fiets
      @costmode = 5;
   }

   if (@road_type == 3){ //auto
      @costmode = 1;
   }

   if (@road_type == 4){ //tram
      @costmode = 1;
   }

   if (@road_type == 5){ //metro
      @costmode = 1;
   }

//NO TRANSIT ABOVE TIME?
   if (@transit == 1){
      @costtransit = 2;
   }

   if (@perimeter > 50){
      if (@transit == 1){
         @costwalk = 5;
   }
      else
         @costwalk = 1;
   }

}
```

Personality 2
Conservative Elite
Separate Car Calculation: Yes

```
if (@personality == 2){

//CHOOSE MODE
   if (@road_type == 2){ //fiets
      @costmode = 5;
   }

   if (@road_type == 3){ //auto
      @costmode = 1;
   }

   if (@road_type == 4){ //tram
      @costmode = 5;
   }

   if (@road_type == 5){ //metro
      @costmode = 5;
   }

//NO TRANSIT ABOVE TIME?
   if (@transit == 1){
      @costtransit = 5;
   }

   if (@perimeter > 50){
      if (@transit == 1){
         @costwalk = 5;
   }
      else
         @costwalk = 5;
   }

}
```

Personality 3
Modern Individualist
Separate Car Calculation: No

```
if (@personality == 3){

//CHOOSE MODE
   if (@road_type == 2){ //fiets
      @costmode = 1;
   }

   if (@road_type == 3){ //auto
      @costmode = 5;
   }

   if (@road_type == 4){ //tram
      @costmode = 4;
   }

   if (@road_type == 5){ //metro
      @costmode = 4;
   }

//NO TRANSIT ABOVE TIME?
   if (i@transit == 1){
      @costtransit = 1;
   }

   if (@perimeter > 50){
      if (i@transit == 1){
         @costwalk = 2;
   }
      else
         @costwalk = 1;
   }

}
```

Personality 4
Hedonistic
Separate Car Calculation: Yes

```
if (@personality == 4){

//CHOOSE MODE
   if (@road_type == 2){ //fiets
      @costmode = 1;
   }

   if (@road_type == 3){ //auto
      @costmode = 1;
   }

   if (@road_type == 4){ //tram
      @costmode = 5;
   }

   if (@road_type == 5){ //metro
      @costmode = 5;
   }

//NO TRANSIT ABOVE TIME?
   if (i@transit == 1){
      @costtransit = 1;
   }

   if (@perimeter > 50){
      if (i@transit == 1){
         @costwalk = 2;
   }
      else
         @costwalk = 1;
   }

}
```

Calculate the stress and restorative cost

```
@costpersonality = sum(@costmode + @costtransit + @costwalk);

if (@costpersonality == 0){
      @costpersonality = 1;
}  // Cost can not be 0
```

5.2.3. Disabilities

For the disability input, complications of actual EMC patients have been considered. Data Analytics provided data on the amount and kind of dissability. These are for the current model translated into 2 values that have impact on mobility.

Disabilities such as bad sight and wheelchair use are not being calculated in the weighted sum, since it is not a motivational reasoning, but a restriction on certain transits. This means that in the procedural model, the wheelchair and tactile paving characteristic of a transit are already being filtered before connecting the networks together.

Nauseous patient

```
//NAUSEOUS
@disability = 1;
i@disabilitycost;
i@nauseous;
i@speednauseous;

if (@road_type == 1 | | 2 | | 3){
   @nauseous = 5;
}

if (@speed > 30){
   @speednauseous = 4;
}

@disabilitycost = sum(@nau-
seous + @speednauseous);
```

Weakened Patient,
Small activity radius

```
//SMALL ACTIVITY RADIUS
@disability = 2;
i@disabilitycost;
i@notransit;
i@walkdistance;

if (@road_type == 1 | | 2){
   i@walkdistance = 4;
}

if (@transit == 1);{
   i@notransit = 5;
}

@disabilitycost = sum(@walkdis-
tance + @notransit);
```

5.3.4. Restoratives and stressors

More categories here will be added and further elaborated towards P5. The added categories are shown in the data input environment chapter. The values are used from the survey research with the same personality types. According to McCay and Roe, stressors and restoratives also work on our mental health when seen from a window (Roe & McCay, 2021). Connecting to this, it is important to mention that urban stressors and restoratives are not being perceived from the metro and are also not being calculated in the model.

		STRESS		RESTORATIVE GREEN	
		Urban aspects	City life	Water	Urban park
1	Conservative maintainer	1.636363636	1.863636364	3.709090909	3.136363636
2	Conservative elite	2.21875	2.25	3.35	2.71875
3	Modern individualist	1.758064516	2.040322581	3.787096774	3.411290323
4	Hedonistic	1.909090909	2.159090909	3.527272727	3.113636364

Table 4, Research data on Stressors and Restoratives (Author)

Personality 1 Conervative Maintainer

```
if (@personality == 1){
  if (s@type_landgebruik ==
“bebouwd gebied”){
      f@stresscost1 = 1.64;
  }
    if (s@type_landgebruik ==
“spoorbaanlichaam”){
      f@stresscost2 = 1.64;
  }

   //RESTORATIVE GREEN
  if (s@type_landgebruik ==
“grasland”){
      f@parkcost = 3.13;
   }

   if (s@type_inrichtingselement
== “boom”){
      f@boomcost = 3.13;
   }

  if (@water == 1){
      f@watercost = 3.71;
  }

}
```

Personality 2 Conservative Elite

```
if (@personality == 2){
  if (s@type_landgebruik ==
“bebouwd gebied”){
      f@stresscost1 = 2.2;
  }
     if (s@type_landgebruik ==
“spoorbaanlichaam”){
      f@stresscost2 = 2.2;
  }

   //RESTORATIVE GREEN
  if (s@type_landgebruik ==
“grasland”){
      f@parkcost = 2.7;
   }

   if (s@type_inrichtingselement
== “boom”){
      f@boomcost = 2.7;
   }

  if (@water == 1){
      f@watercost = 3.35;
  }

}
```

Personality 3 Modern Individualist

```
if (@personality == 3){
  if (s@type_landgebruik ==
“bebouwd gebied”){
      f@stresscost1 = 1.76;
  }
     if (s@type_landgebruik ==
“spoorbaanlichaam”){
      f@stresscost2 = 1.76;
  }

   //RESTORATIVE GREEN
  if (s@type_landgebruik ==
“grasland”){
      f@parkcost = 3.4;
   }

   if (s@type_inrichtingselement
== “boom”){
      f@boomcost = 3.4;
   }

  if (@water == 1){
      f@watercost = 3.79;
   }

}
```

Personality 4 Hedonistic

```
if (@personality == 4){
  if (s@type_landgebruik ==
“bebouwd gebied”){
      f@stresscost1 = 1.91;
  }
     if (s@type_landgebruik ==
“spoorbaanlichaam”){
      f@stresscost2 = 1.91;
  }

   //RESTORATIVE GREEN
  if (s@type_landgebruik ==
“grasland”){
      f@parkcost = 3.11;
   }

   if (s@type_inrichtingselement
== “boom”){
      f@boomcost = 3.11;
   }

  if (@water == 1){
      f@watercost = 3.53;
  }

}
```

Calculate the stress and restorative cost

```
f@stresscost = sum(@stresscost1 + @stresscost2);
f@restorativecost = sum(@parkcost + @boomcost+ @watercost);

if (@stresscost == 0){
      @stresscost = 1;
}
if (@restorativecost == 0){
      @restorativecost = 1;
}
if (@road_type == 5){ //in the metro it is not possible to perceive used restoratives and stressors
      @stresscost = 1;
}
if (@road_type == 5){ //in the metro it is not possible to perceive used restoratives and stressors
      @restorativecost = 1;
}
```

//When a value is 0 it is not possible to use the weighted sum method. When trying to multiply 0 by the weight, the model didn’t work/ make simulations anymore.

5.3 Input Data

In the current research the survey data is made more abtract by using averages to calculate stressors and restoratives. This means the quality of the aspect is not being taken into account. As earlier drawn from the survey results, a tree canopy of at least 30 percent is more restorative than just a few scattered trees. In a future model this can be measured by multiplying the length of the roadsegment and the amount of trees adjacent to it. When there is a cluster of at least 30 percent tree canopy on a street, the canopy restorative value should be used as shown in table 5. When there are just some trees in a street, the tree value can be used.

Persona	Tree	Canopy
1	3.00	3.18
2	2.50	3.13
3	3.00	3.27
4	2.23	3.87

Table 5, Survey values on tree and canopy. A canopy is more relaxing.

B.1.

Figure 56, Example used to retrieve survey data

Figure 57, Trees in a street example (Author)

B.2.

Figure 58, Example used to retrieve survey data

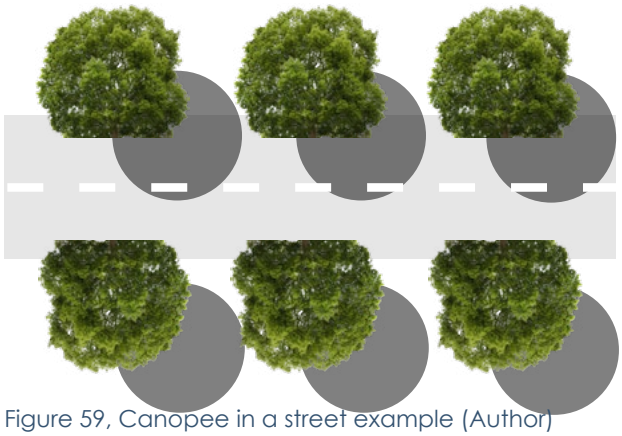


Figure 59, Canopee in a street example (Author)

In figure 60, trees are shown in relation to roadsegments. When a cluster in a certain radius is detected the canopy value is overtaking the tree value.

Other aspects that this project found evidence on and could be further elaborated in the weighted sum:

- Neighborhood density
- Building height
- Crowding

Tree

Road segment

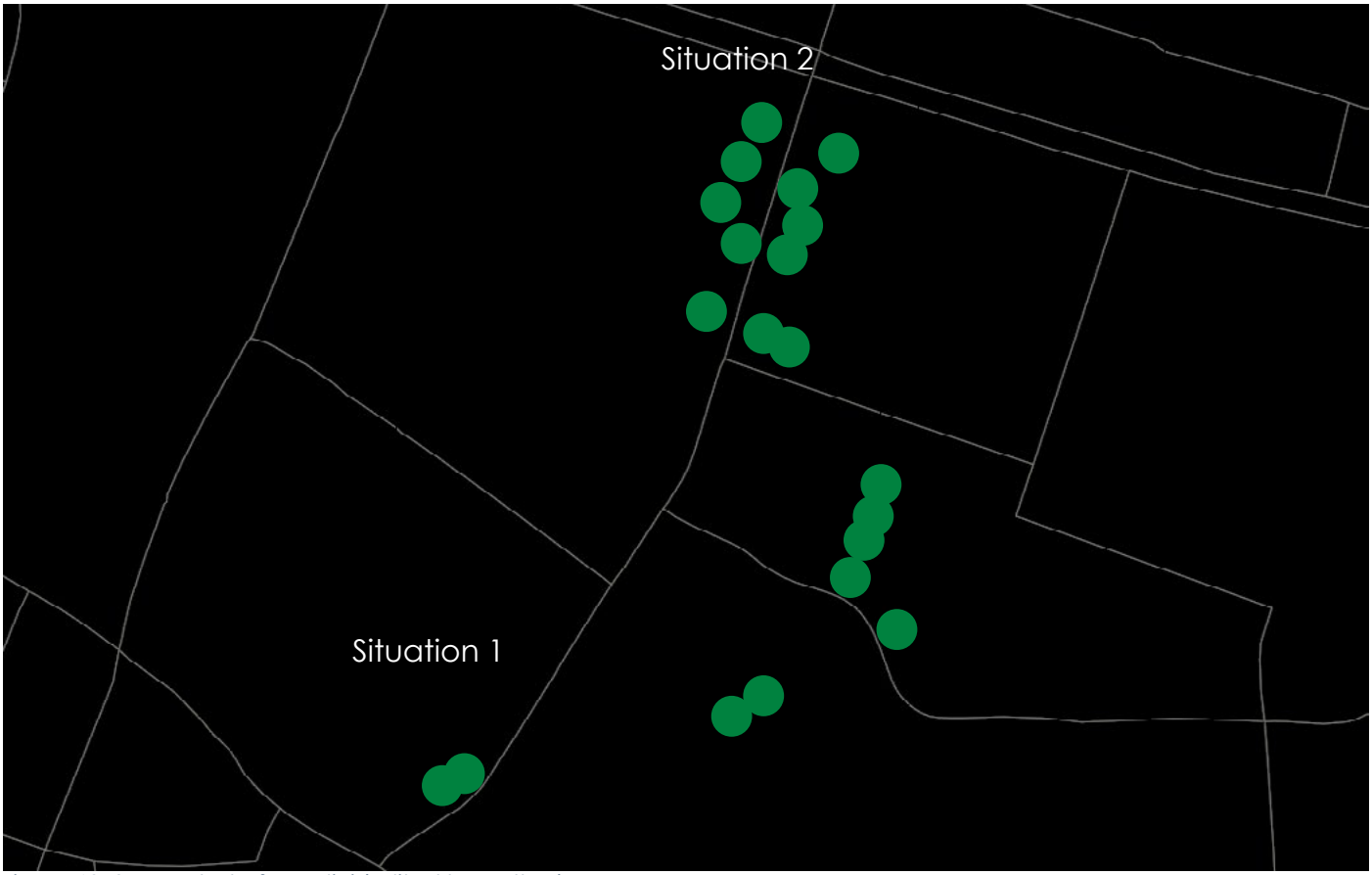


Figure 60, Screenshot of Houdini (Edited by Author)

5.3.1. Mobility Planning in Rotterdam

In the traffic circulationplan for Rotterdam in 2050, specific plans are described for how Rotterdams mobility network will develop. This is important to include in the creation scenarios, since this is the most probable scenario. Ideally, in the end, network advice or changes will be proposed on these interventions (Table 7).

	Locatie	Maatregel
Stadsproject	Hofplein	Herinrichting met verblijfsplein, meer ruimte voor fietsers en voetgangers en optimalisatie omliggende kruispunten en snelheidsverlaging toeleidende wegen
	"Blaakpark Westblaak - Blaak"	Herinrichting met Blaakpark, meer ruimte voor fietsers en voetgangers, 2x1-wegprofiel, kruispunten met 2 opstelstroken van Eendrachtsplein tm Mariniersweg, geen onderdoorgang Churchillplein, Westblaak geen linksaf naar Coolsingel.
	Schouwburgplein	Autoluw voor Doelen en Schouwburg, opheffen zuidelijke parkeer-entree
	Maashaven / Rijnhaven	Herinrichting en snelheidsverlaging met meer ruimte voor fietsers en voetgangers en 2x1-wegprofiel Maashaven oostzijde en Hillelaan
Groene en gezonde Boulevards	's Gravendijkwal - Henegwouwerlaan	inpassing vrijliggende baan HOV op wegvakken en kruispunten
	Vasteland	Meer ruimte voor fietsers en voetgangers door 1 rechtsaffer naar Erasmusbrug
	Schiedamsedijk	Snelheidsverlaging
	Boompjes	Betere oversteekbaarheid door 2x1-wegprofiel en snelheidsverlaging
	Mariniersweg	Meer ruimte voor fietsers en voetgangers door snelheidsverlaging en 2x1-wegprofiel
	Goudsesingel	Snelheidsverlaging
	Burgemeester Van Walsumweg	Snelheidsverlaging
	Weena	inpassing HOV Henegouwerlaan-Conradstraat en meer ruimte voor fietsers en voetgangers door aanpassing kruispunten en wegvakken
	Pompenburg	Meer ruimte en snelheidsverlaging voor fietsers en voetgangers door aanpassing kruispunten en wegvakken
	Schiekade	Meer ruimte voor fietsers en voetgangers vanaf kruispunt Stadhouderswerg door 1 rijstrook per richting
Levendige en veilige stadsstraten	West Kruiskade	Snelheidsverlaging
	Nieuwe Binnenweg Centrum	Snelheidsverlaging
	Westersingel - Mauritsweg	Maatregel om autoverkeer te beperken op het Kruisplein en Eendrachtsplein
	Jonker Fransstraat	Snelheidsverlaging
Aantrekkelijke binnenstads-kwartieren	Meent	Maatregel om autoverkeer te beperken ter hoogte van Delftsevaart
	Witte de Withstraat	Snelheidsverlaging en maatregel om autoverkeer te beperken
	Karel Doormanstraat - Aert van Nesstraat	Snelheidsverlaging en maatregel om autoverkeer te beperken ter hoogte van Van Ghentstraat
	Schiedamse Vest	Snelheidsverlaging en maatregel om autoverkeer te beperken ter hoogte van bassischool 't Landje
	Glashaven	Snelheidsverlaging
Bereikbare rivier	Toegankelijke kades, oversteekbare boulevards	Oversteekbaarheid Boompjes, Stieltjesstraat, Parkhaven, Parkkade
	Lopen langs de rivier	Meer verblijven, lopen en fietsen langs Nieuwe Maas, Rotte, Schie

	Locatie	Maatregel
Knooppunten en hoogwaardig ov	Beurs	Comfortabele overstap en aantrekkelijke stationsomgeving voor voetgangers en fietsers en aanbod alternatieve vervoerswijzen incl. deelmobiliteit
	Blaak station	Comfortabele overstap en aantrekkelijke stationsomgeving voor voetgangers en fietsers en aanbod alternatieve vervoerswijzen incl. deelmobiliteit
	Centraal Station	Uitbreiding aanbod alternatieve vervoerswijzen incl. deelmobiliteit en fietsenstallingen
	ErasmusMC, Dijkzigt / Hoboken	Toevoegen HOV-halte, comfortabele overstap en aantrekkelijke stationsomgeving voor voetgangers en fietsers en aanbod alternatieve vervoerswijzen incl. deelmobiliteit
	HOV-verbinding Pleinweg - 's Gravendijkwal	Hele traject 2x1 en busbaan met kruispunten 1 rijstrook rechtdoor
	HOV-verbinding Zuidplein - Stadionpark - Kralingse Zoom	Conform Pre-verkenning oeververbinding Regio Rotterdam
	Bestaand metro-, tram-, busnetwerk	Fequentieverhoging
Nieuwe en bestaande oever-verbindingen	Nieuwe oeververbinding Feijenoord - Kralingen	2x1 stadsbrug, aanlanding Olympiaweg
	Maastunnel	Inpassing vrijliggende baan HOV
	Willemsbrug - Van der Louwbrug	2x1-wegprofiel en snelheidsverlaging
Fietsparkeren	Centraal Station, Schouwburgplein, Coolsingel 75, Beursgallery, Hart010, Bibliotheek	Toevoeging / uitbreiding fietsenstallingen
Verandering 50-weg buiten centrum	Delfshaven (snelheidsverlaging)	Claes de Vrieselaan, Vierambachtsstraat - 1e en 2e Middellandstraat, Beukelsdijk tot aan Mathenesserplein (ook van Cittersstraat), Mathenesserlaan, Schiedamsedijk, Heemraadsingel
	Noord (snelheidsverlaging)	Bergweg, Bentincklaan, Walenburgerweg, Zaagmolenstraat, Heer Bokelweg, Zwartjanstraat (ook eenrichtingsverkeer naar oosten), Van Aersenlaan, Rodenrijselaan
	Kralingen-Crooswijk (snelheidsverlaging)	Crooswijksestraat, Nieuwe Boezemstraat - Boezemstraat, Linker Rottekade, Vondelweg, Warande, Pompenburg oost, Oostzeedijk-Honingerdijk (incl. knip thv Slaak)
	Overschie (snelheidsverlaging)	GK van Hogendorpweg vanaf kruispunt Van der Duijn van Maasdamweg (van 70 km/h naar 50 km/h)
Parkeren	Meijersplein	500 extra plaatsen
	Kralingsezoom	500 extra plaatsen
	Minder parkeren centrumgebied	Afname 2.000 parkeerplaatsen

In referentie	Coolsingel heringericht
	GJ de Jonghweg heringericht
	Willem Buitewechstraat heringericht en 30 km/h
	Posthumalaan heringericht met 2x1
	Roseknoop heringericht
	Bosdreef verlegd en heringericht met 2x1-wegprofiel
	Doortrekking A16
	Blankenburgtunnel

Table 7. Verkeerscirculatieplan (Gemeente Rotterdam, 2021)

5.3.2. Traffic Model Rotterdam

There was close contact with the municipality of Rotterdam to retrieve realtime valuable big data flows in the city. The counting points (figure 61) on all main roads in Rotterdam, cars per hour, are received. Yet, this data had the limitation that it doesn't have a future perspective. This research is helped a lot by the future traffic prediction model which is showing intensities on roads in the whole network of Rotterdam for 2030. These roads are being used as a base for the entire roadnetwork and diferences can be seen in connection of the network to the EMC Campus.

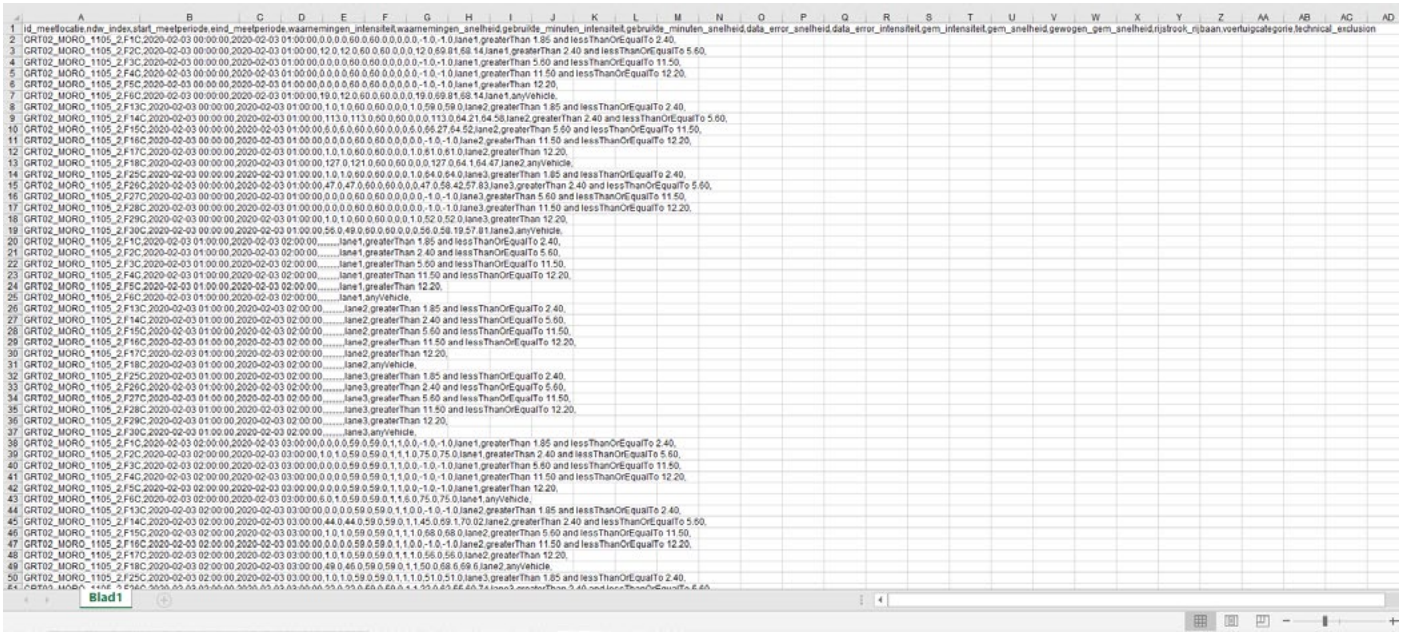


Figure 61. Point data, cars per hour (Gemeente Rotterdam, personal communication)

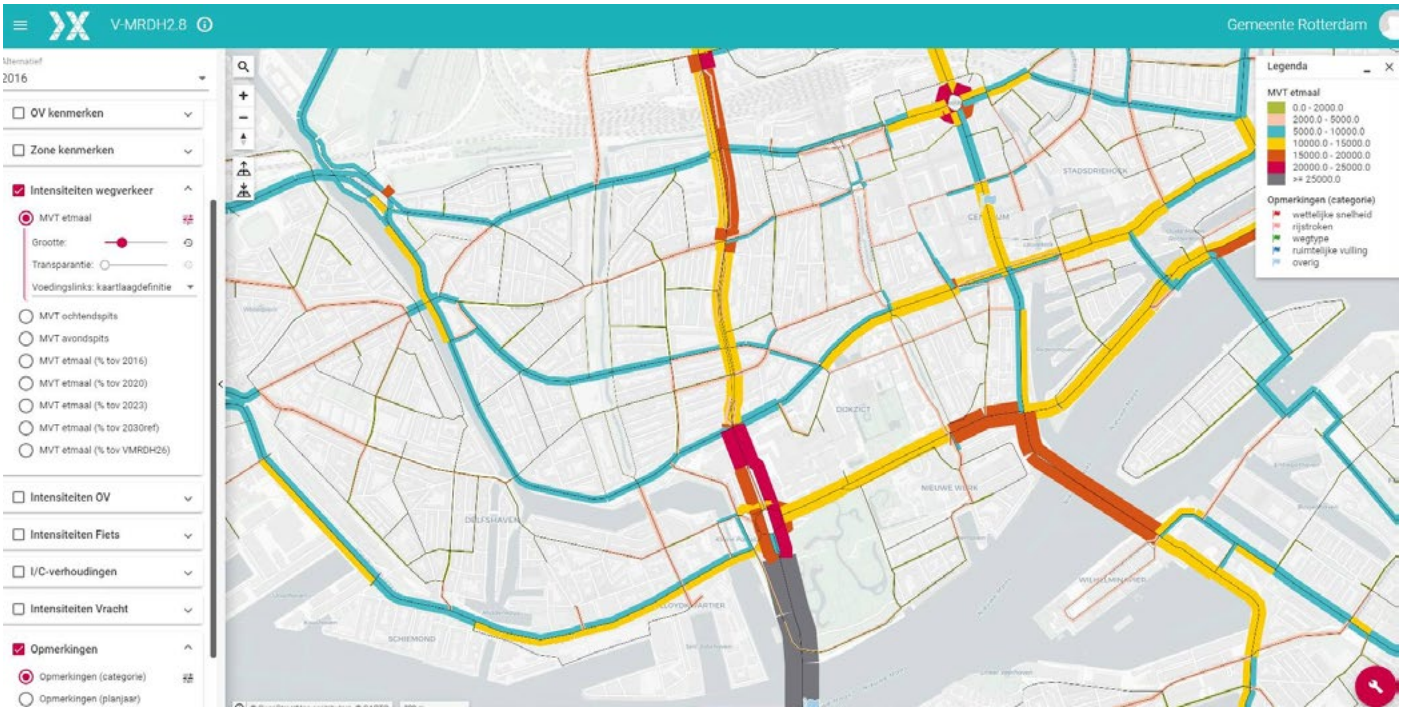


Figure 62. Mobility traffic model options (Gemeente Rotterdam, personal communication)

5.3.3. Landuse and Road Segments

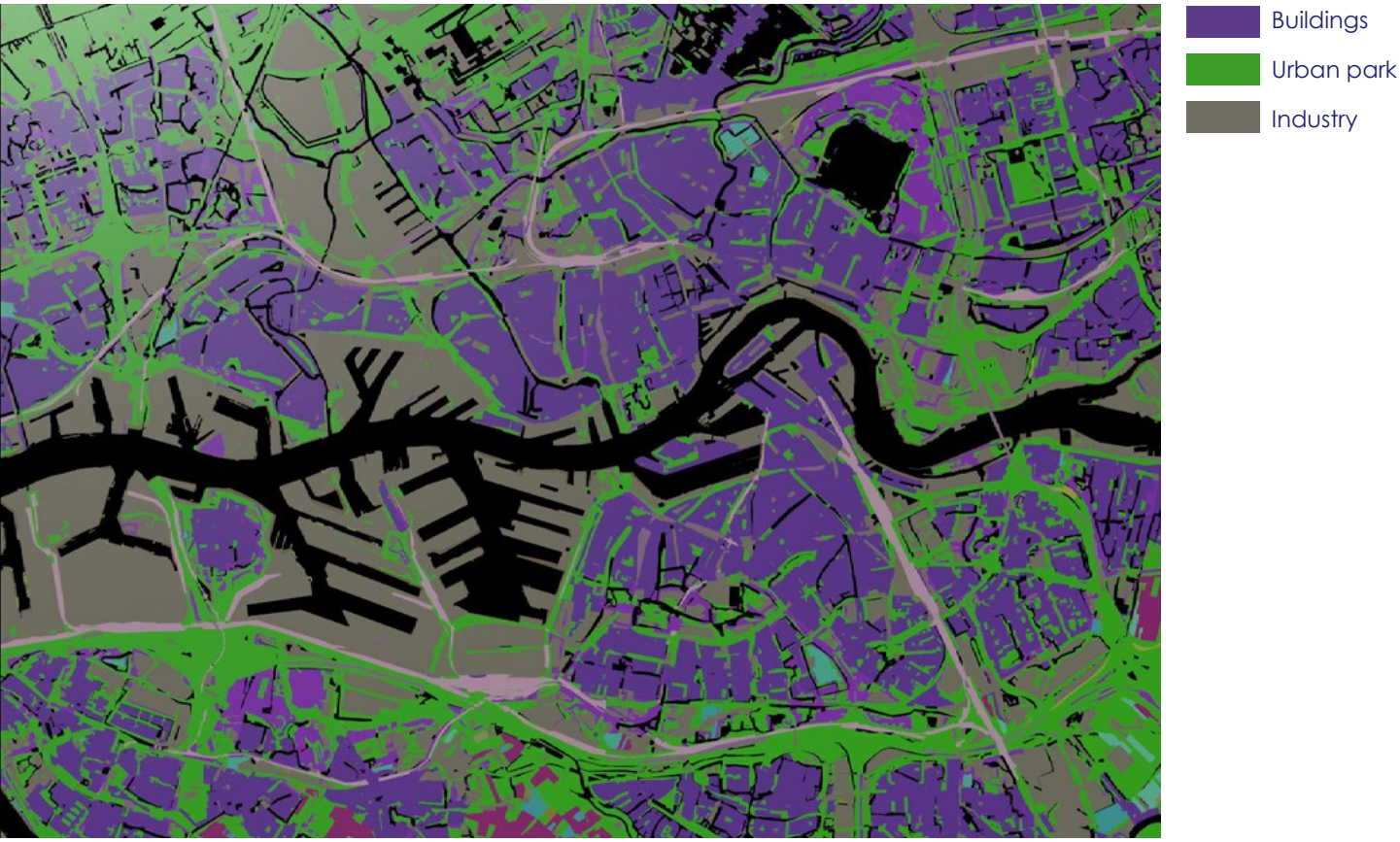


Figure 63, Screenshot Houdini (Kadaster, 2022. Edited by Author)

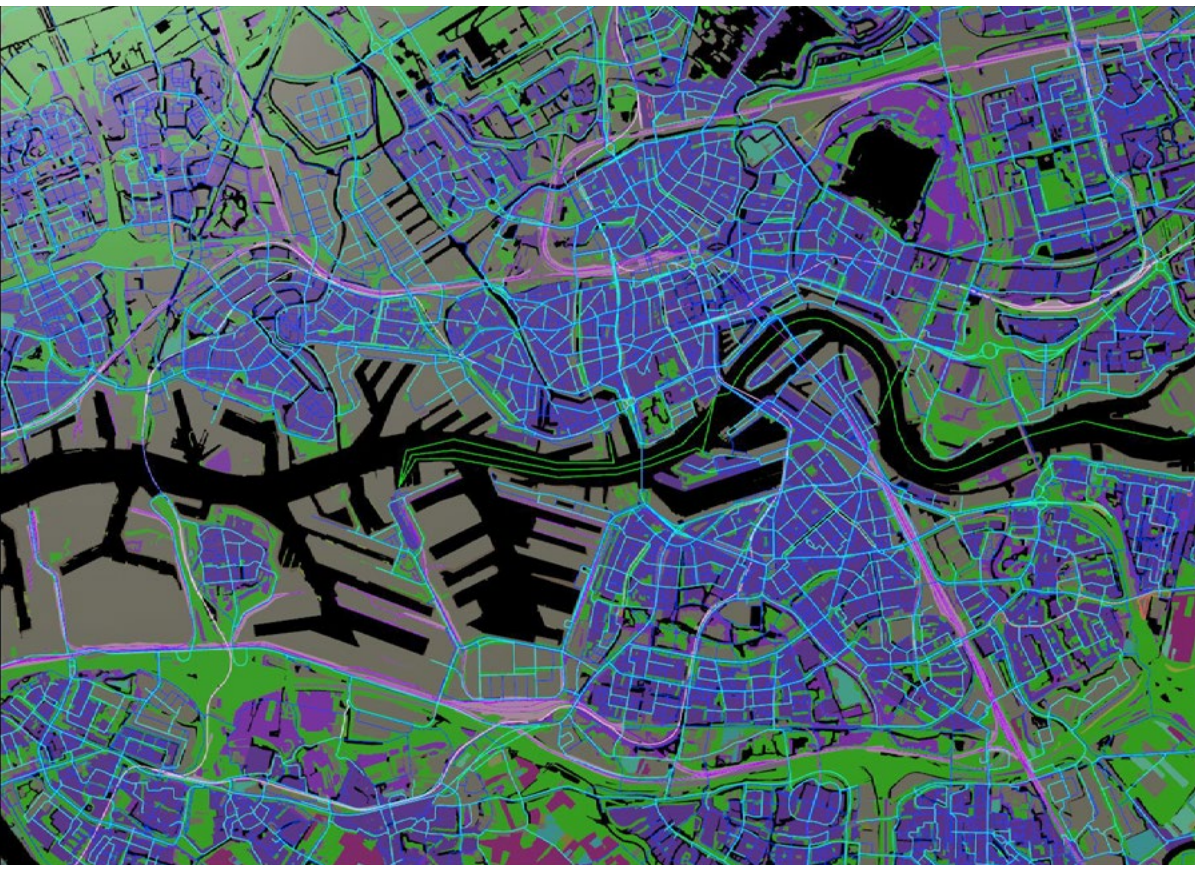


Figure 64 Screenshot Houdini (Kadaster, 2022. Edited by Author)

5.3.4. Trees and Water

- Trees

Figure 65, Screenshot Houdini (Kadaster, 2022. Edited by Author)

Figure 66, Screenshot Houdini (Kadaster, 2022. Edited by Author)

5.3.5. Accessible and Sensory Tram- and Bus Stops

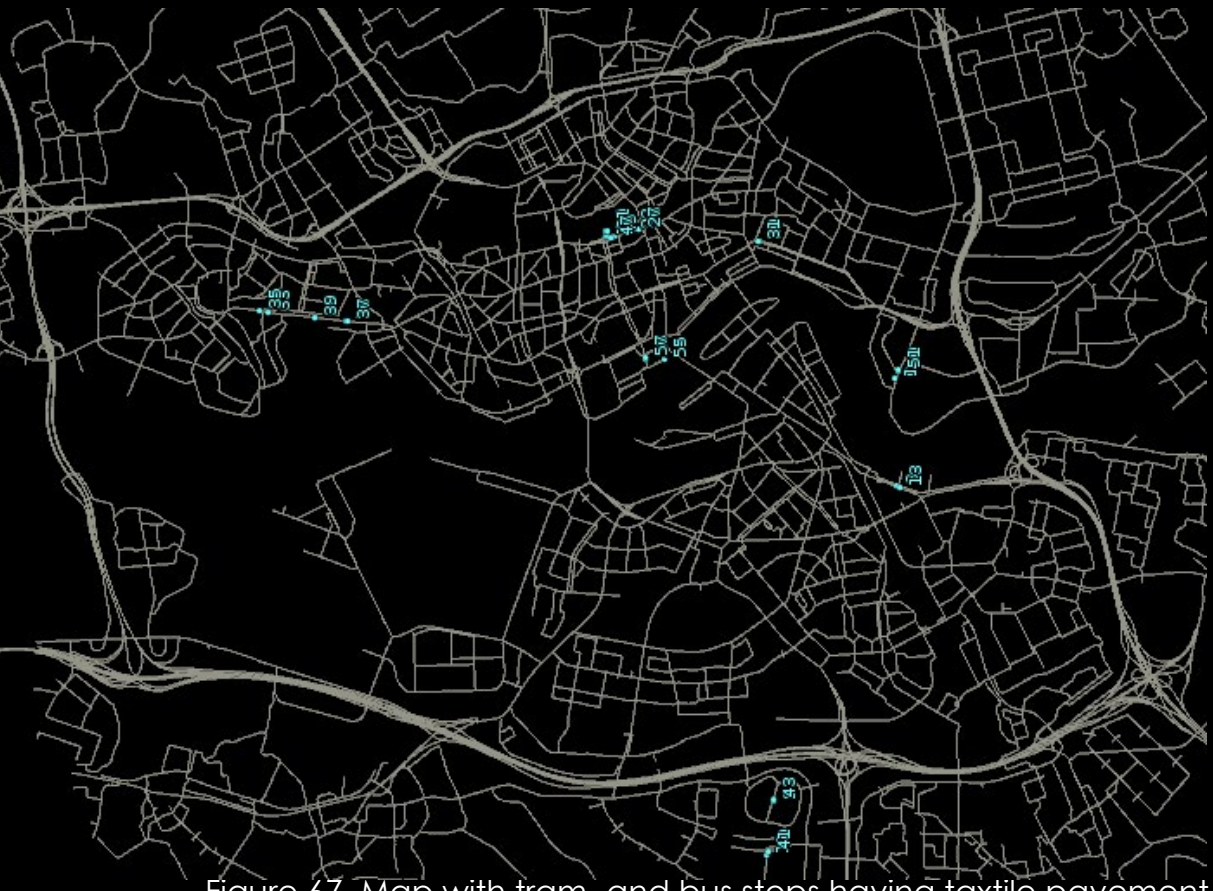


Figure 67, Map with tram- and bus stops having taxtile pavement for the visually impaired

Figure 68, Map with wheelchair accessible tram- and bus stops

6 Calculations

6.1 Example Calculation

The tool in Houdini used for giving weight to paths is called the pathcost. It is looking at the value it costs to take a certain path. This pathcost is inserted in the shortest path node, which calculates the path that costs the least. Before immediately diving into the large mobility network of Rotterdam, a vey simplified version of the network and the calculation of the shortest path is elaborated in this chapter to understand and show the basics of this method.

Figure 69 shows the base paths. 2 lines connecting in the middle. In this example only the type of transport (mode) will be used as weight. The mode itself is not a cost, but different disabilities and preferences determine a cost based on the mode.

This example takes a look at 2 example personas with a different disability and shows a single criteria analysis. In the first case the metro is chosen as a road and in the second case the persona chose to transit.

What if there are more costs on one line, creating multiple motivations for the personas? For example its urban surroundings, like pocketparks, trees or buildingtypes.

To determine the cost value based on more than one motivation, the weighted sum method has to be used.

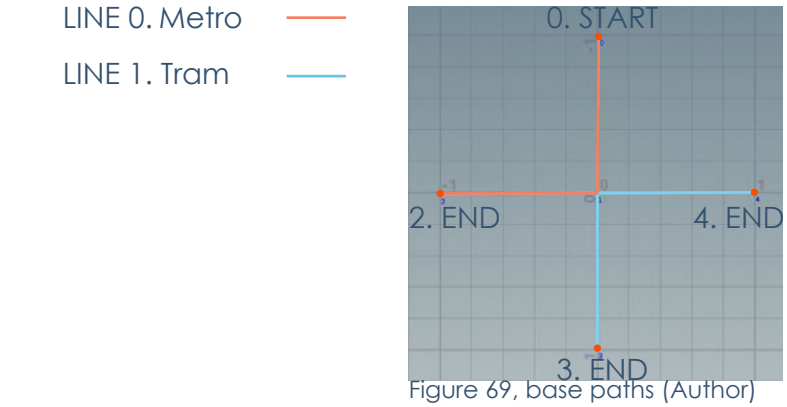


Figure 69, base paths (Author)

VEXpression

```
1  @roadid = @primnum;
2
3  i@pathcost;
4
5  if (@roadid == 0){
6      @pathcost = 5;
7  };
8
9  if (@roadid == 1){
10     @pathcost = 10;
11 };
12
```

Figure 70, shortest path 1 (Author)

VEXpression

```
1  @roadid = @primnum;
2
3  i@pathcost;
4
5  if (@roadid == 0){
6      @pathcost = 10;
7  };
8
9  if (@roadid == 1){
10     @pathcost = 5;
11 };
12
```

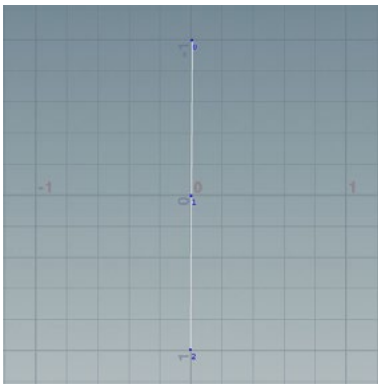
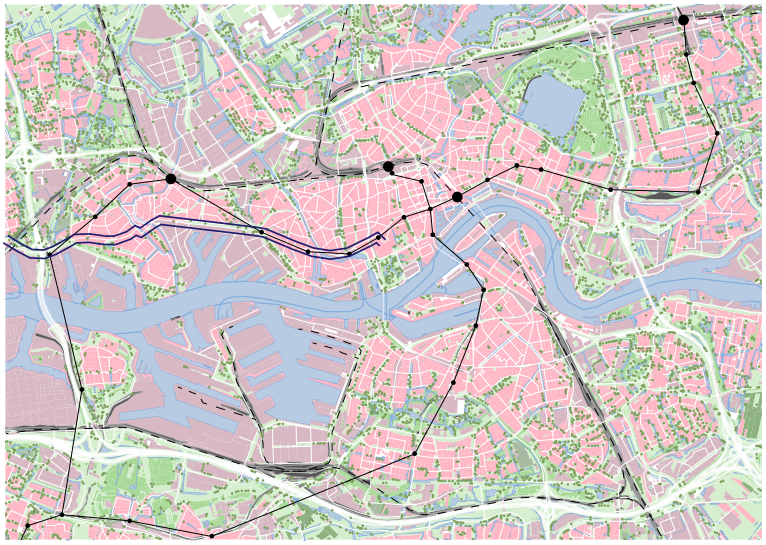


Figure 71, shortest path 2 (Author)

After the tests, in this chapter the route calculations are being tested. Each persona is traveling twice from the same location to the front square of the Erasmus MC. First, according to the weighted sum standard and secondly, according to mental health. The weighted sum standard means the research is done according to the values explained in the previous chapters. When the method is mental health, the route is fully decided by looking at the route with the lowest mental cost according to the model. The values from the survey are used as a base for the second method, creating design requirements for the masterplan and frontsquare.

6.2. Testing Calculating Routes



1.1. Settings
PERSONA: 1
DISSABILITY: 1
METHOD: Weighted Sum Standard
SCENARIO: 50 km/u

In this before scenario a very logic route is taken. It is efficiënt and highly restorative. Yet, when the scenarios changed to 30 km/h, in the next simulations, the difference between stress and restorative were less significant.

Figure 72, Calculated Route (Author)

total_restorativ	224.81
total_stress	157.44

1.1. Settings
PERSONA: 1
DISSABILITY: 1
METHOD: Weighted Sum Standard

30 km/u

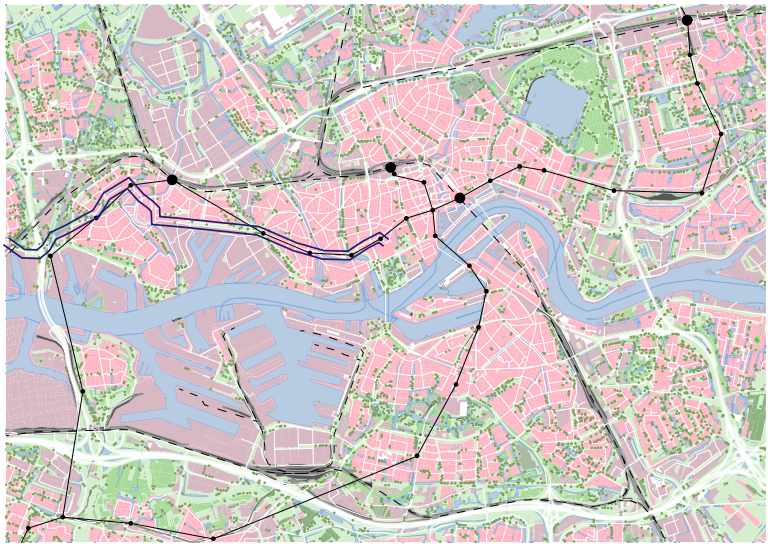


Figure 73, Calculated Route (Author)

total_restorativ	274.16
total_stress	248.24

1.2. Settings
PERSONA: 1
DISSABILITY: 1
METHOD: Mental Health

30 km/u

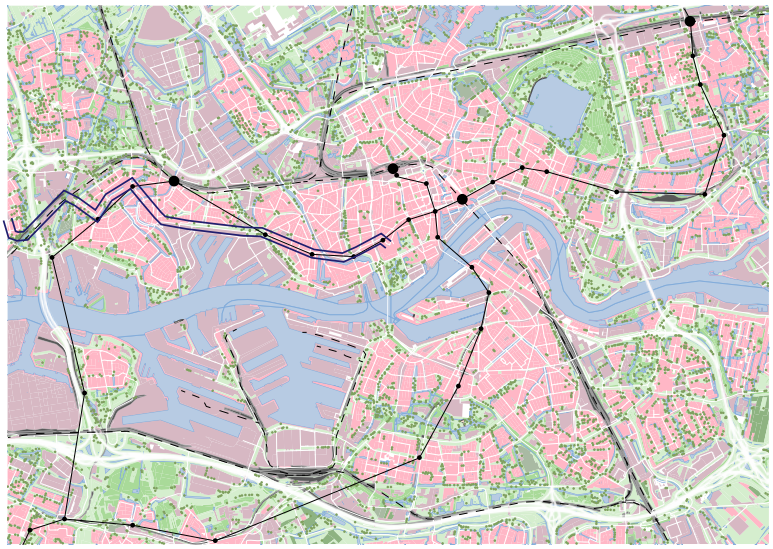


Figure 74, Calculated Route (Author)

total_restorativ	280.03
total_stress	250.76

2.1. Settings
PERSONA: 2
DISSABILITY: 1
METHOD: Weighted Sum Standard

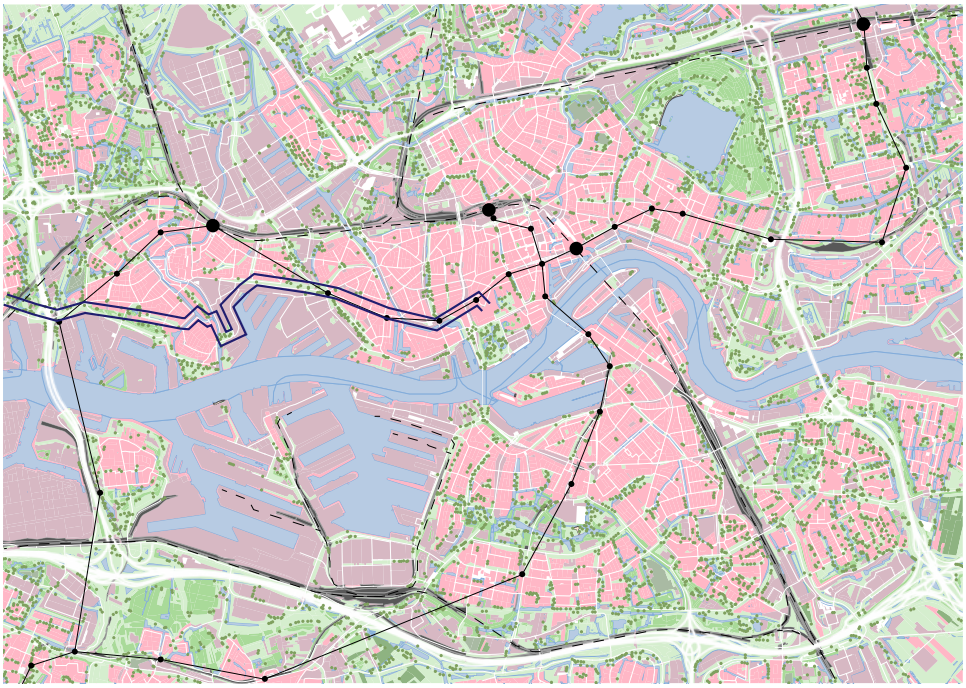


Figure 75, Calculated Route (Author)

total_restorativ	260.4
total_stress	286.4

2.2. Settings
PERSONA: 2
DISSABILITY: 1
METHOD: Mental Health

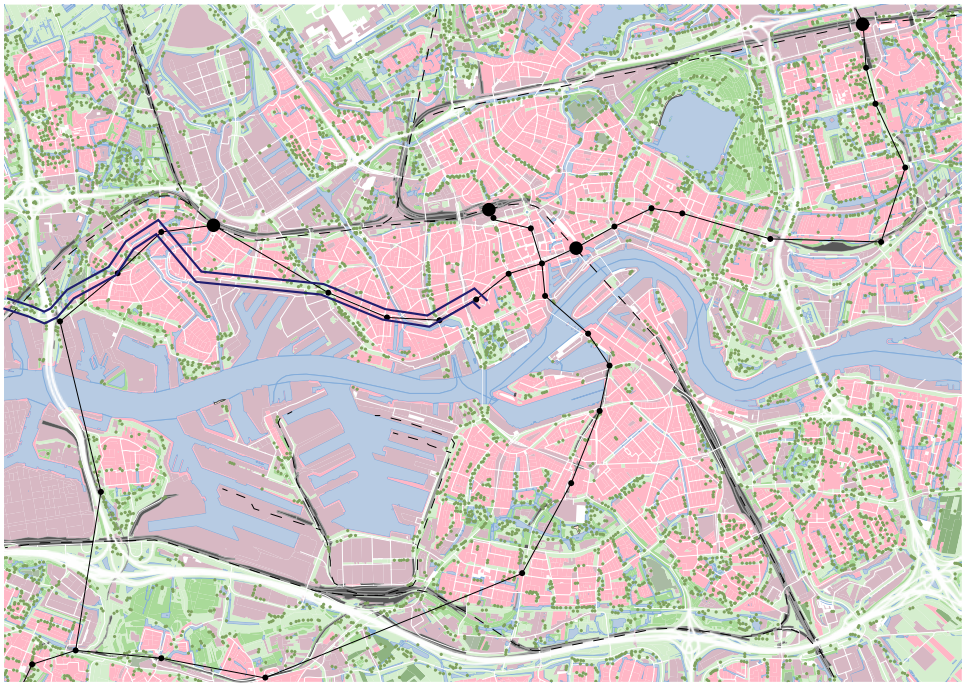


Figure 76, Calculated Route (Author)

total_restorativ	266.7
total_stress	283.8

3.1. Settings
PERSONA: 3
DISSABILITY: 1
METHOD: Weighted Sum Standard

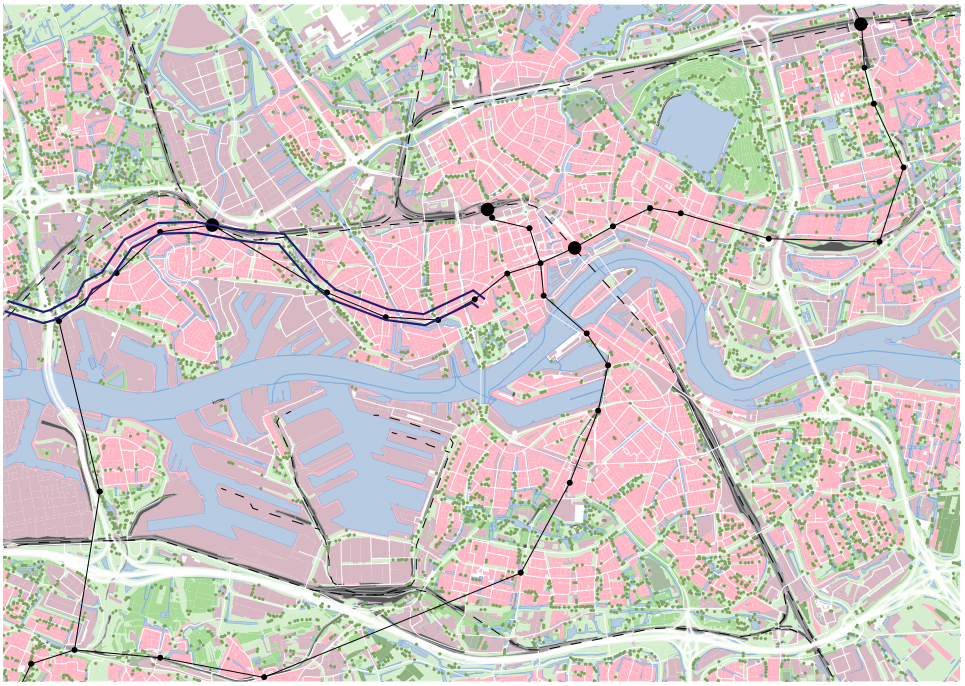


Figure 77, Calculated Route (Author)

total_restorativ	219.4
total_stress	195.76

3.2. Settings
PERSONA: 3
DISSABILITY: 1
METHOD: Mental Health

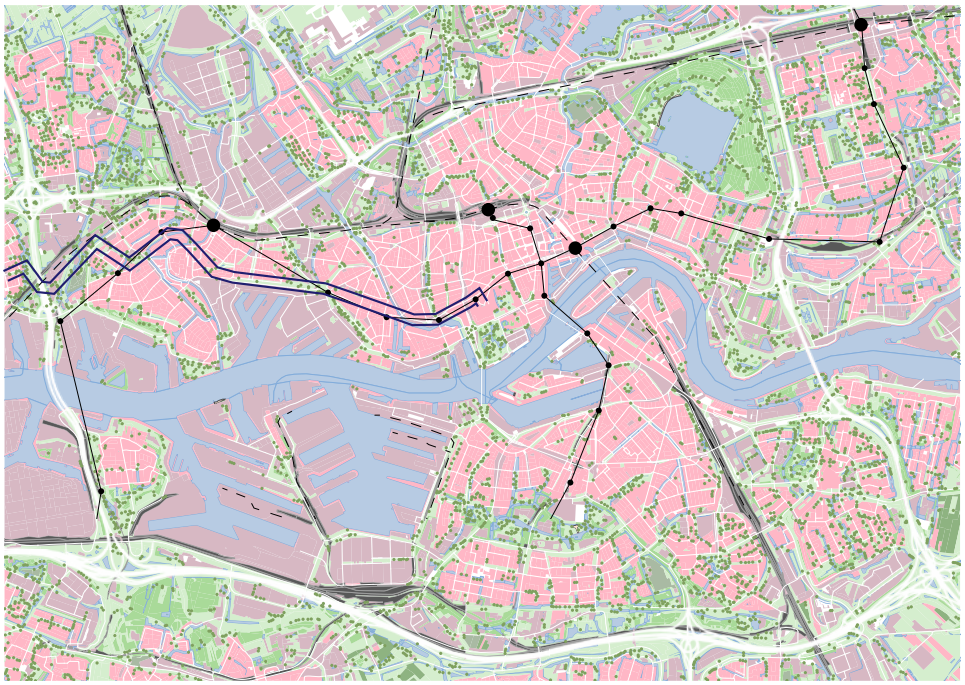
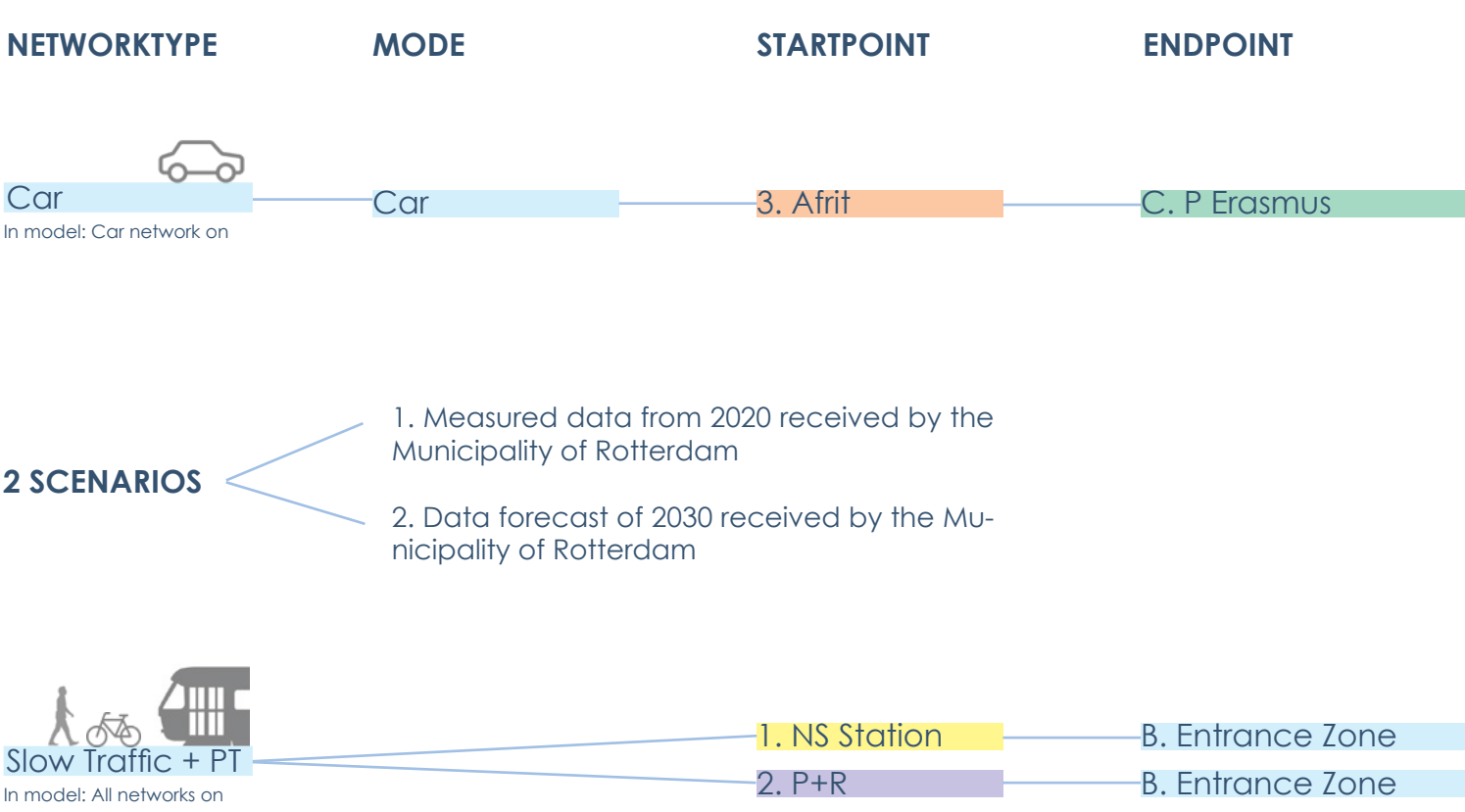


Figure 78, Calculated Route (Author)

total_restorativ	288.4
total_stress	257.84

6.3 Calculations Workflow



The disabilities are not being calculated in the weighted sum, since it is not a motivational reasoning, but a restriction on certain transits. This means that in the procedural model, the wheelchair and tactile paving characteristic of a transit are already being filtered before connecting the networks together.

The model settings below show athedifferent aspects that can be researched separately from each other. Such as personalities and startpoints, to create more focused conclusions and requirements.

Model settings

NETWORK	Public transport + Slow Traffic | Car
STARTPOINTS	NS Stations | P+R | Afrit
DESTINATIONS	Entrance Zone | Parking EMC Campus
DISABILITY	No | Low activity range
PERSONALITY	1 | 2 | 3 | 4

6.3.1. Start- and End Points

START POINTS

1. NS Station
2. P+R
3. Afrit

END POINTS

B. Entrance Zone EMC
C. P Erasmus
D. Bike Parking

In total there are 9 different start to endpoint simulations in the model. The goal is to show at which destination a persona will arrive.

Each of the 3 startpoints and 4 endpoints shown on the left are created as grouped points on the network. In the shortest path calculation a persona can choose for any of the endpoints connected to the specific group. For example, if a persona is programmed to travel from NS Station to the Entrance of EMC, it can choose between all 7 entrances in combination to choosing its route according to its motivations.

On the next page the start points are visualized.

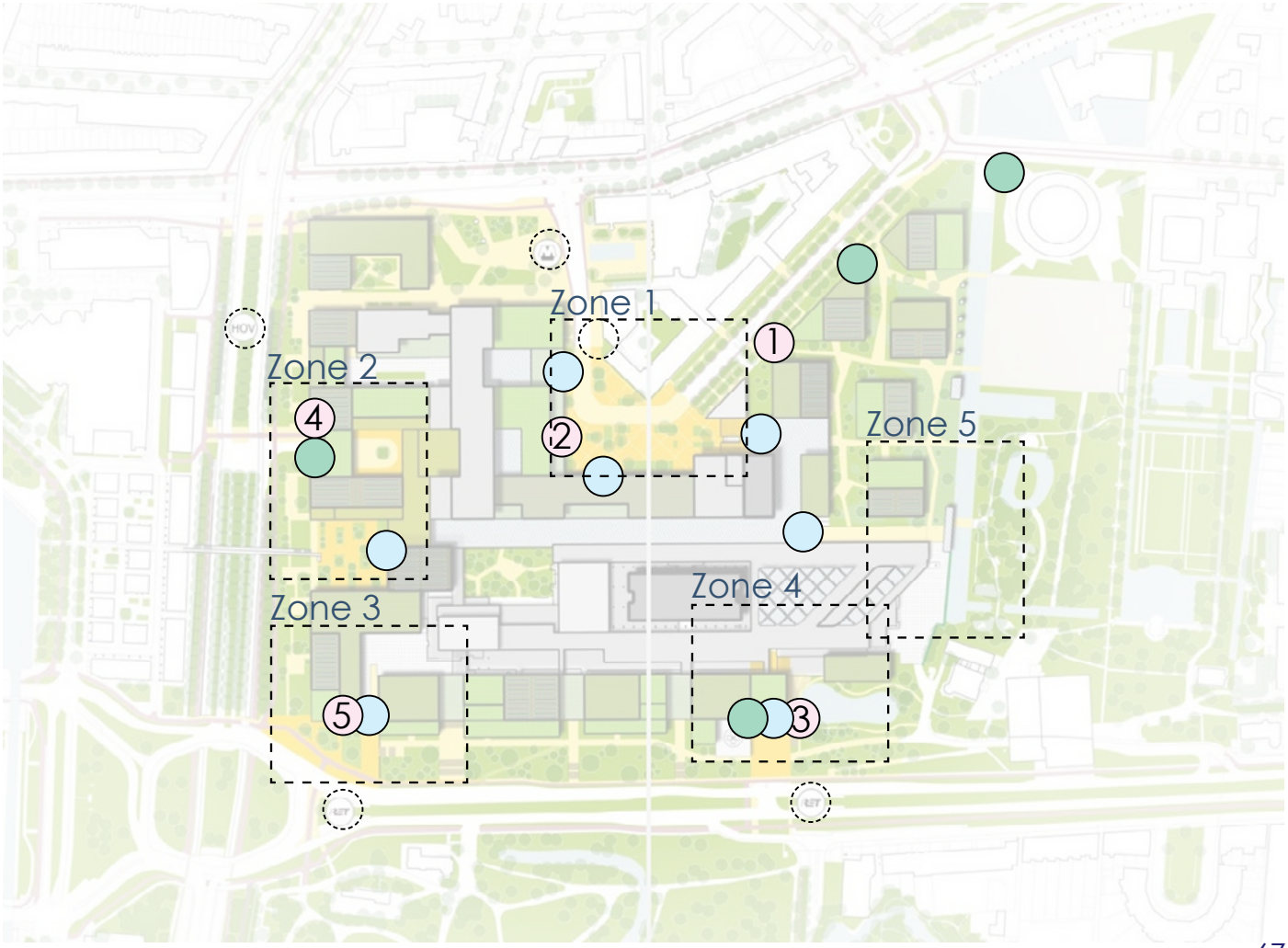


Figure 79, Start Points (Erasmus MC, 2021a, edited by Author)

Start points visualized

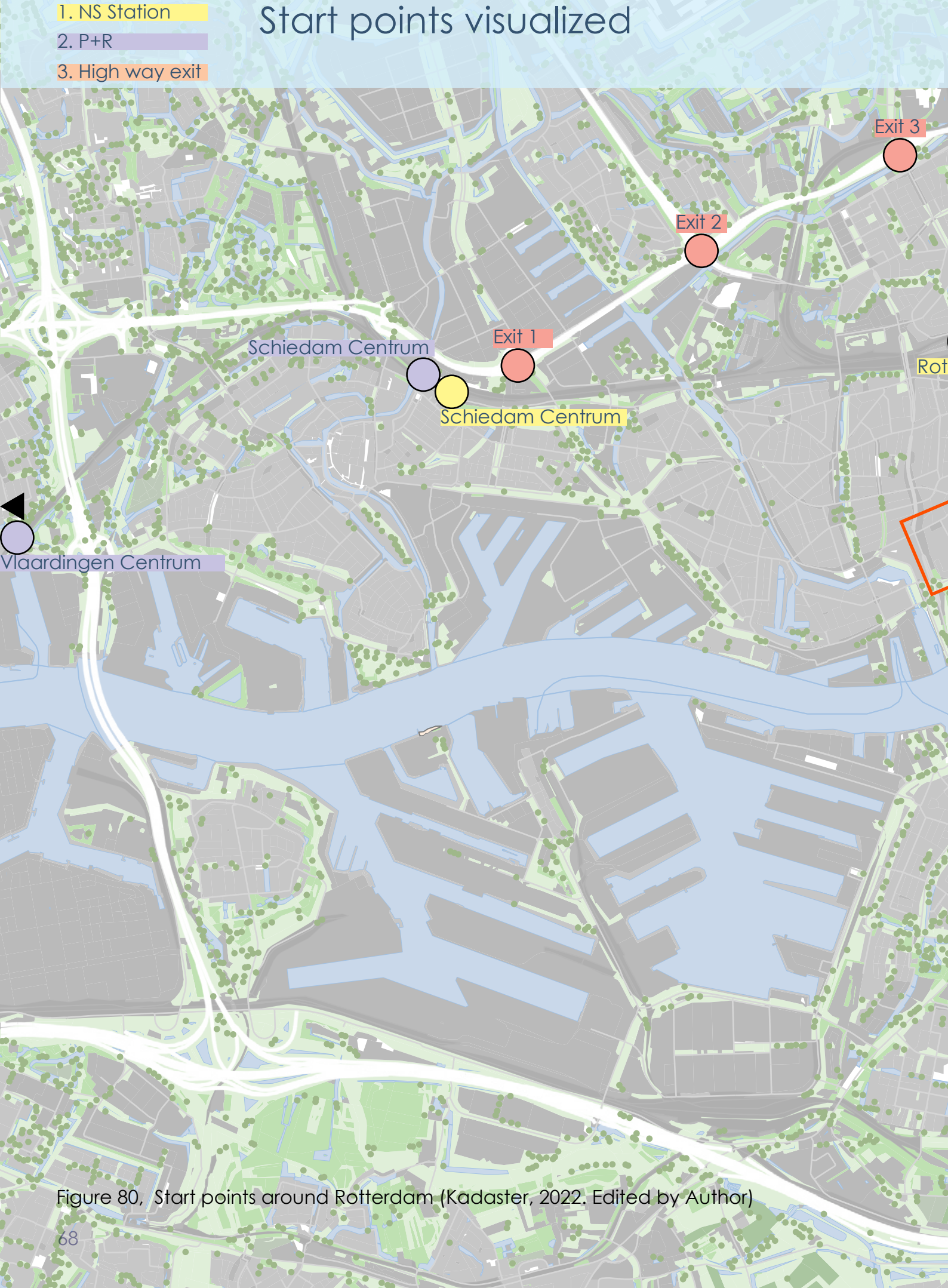
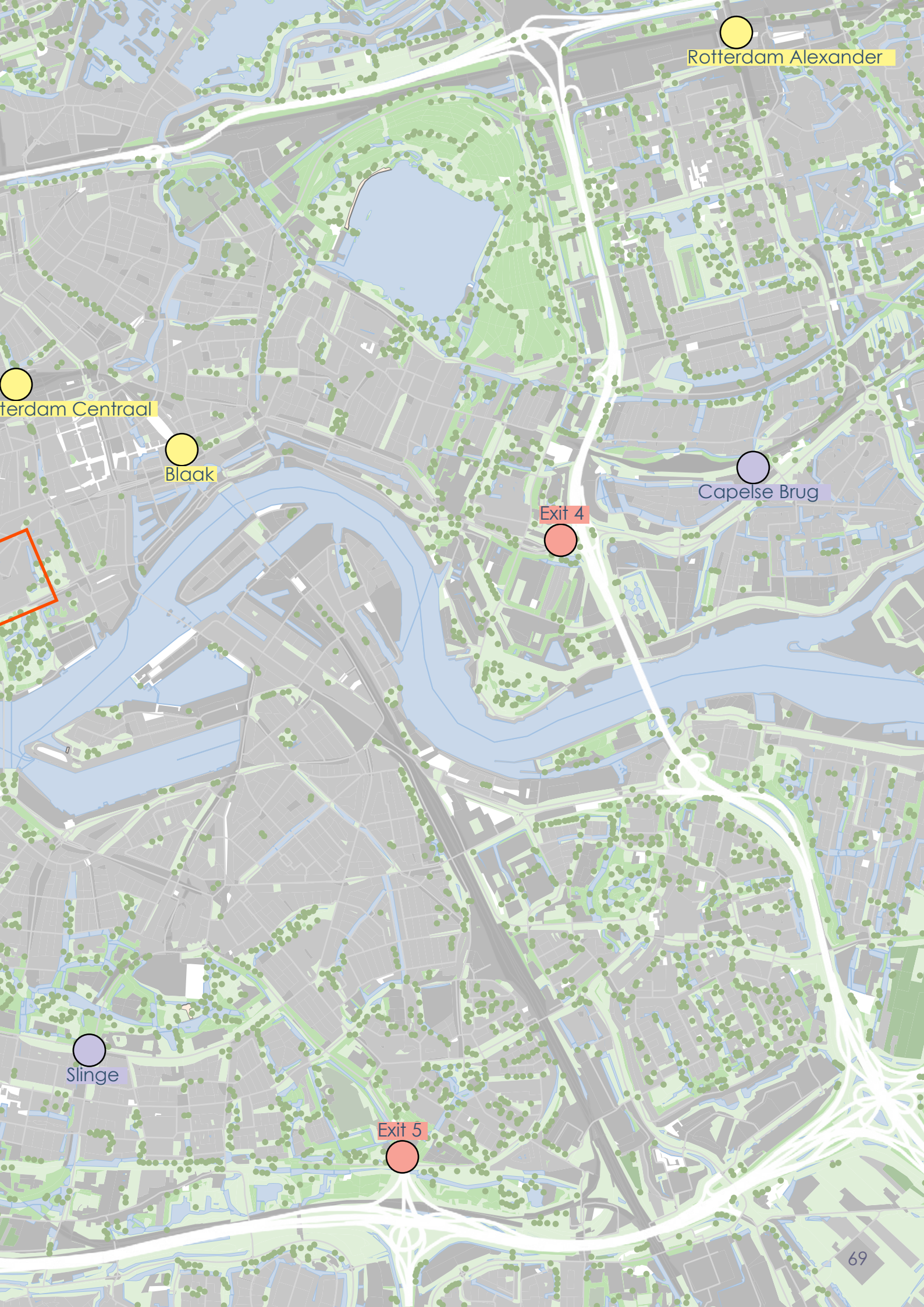


Figure 80, Start points around Rotterdam (Kadaster, 2022. Edited by Author)


Rotterdam Alexander
terdam Centraal
Blaak
Capelse Brug
Exit 4
Slinge
Exit 5

6.4 Final Calculations

6.4.1 Public Transport and Slow Traffic

Model settings

NETWORK	Public transport + Slow Traffic | Car
STARTPOINTS	NS Stations | P+R | Afrit
DESTINATIONS	Entrance Zone | Parking EMC Campus
DISABILITY	No | Low activity range
PERSONALITY	1 | 2 | 3 | 4

Persona 3 and 4 take the same routes

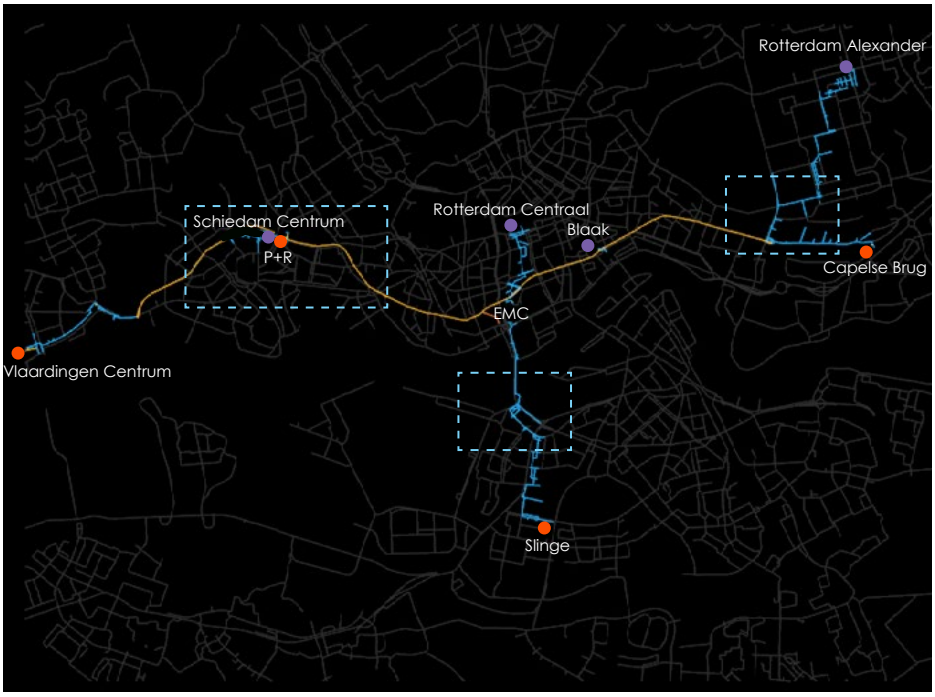


Figure 81, Calculation of routes (Author)

Model settings

NETWORK	Public transport + Slow Traffic | Car
STARTPOINTS	NS Stations | P+R | Afrit
DESTINATIONS	Entrance Zone | Parking EMC Campus
DISABILITY	No | Low activity range
PERSONALITY	1 | 2 | 3 | 4

Persona 1 and 2 take the same routes

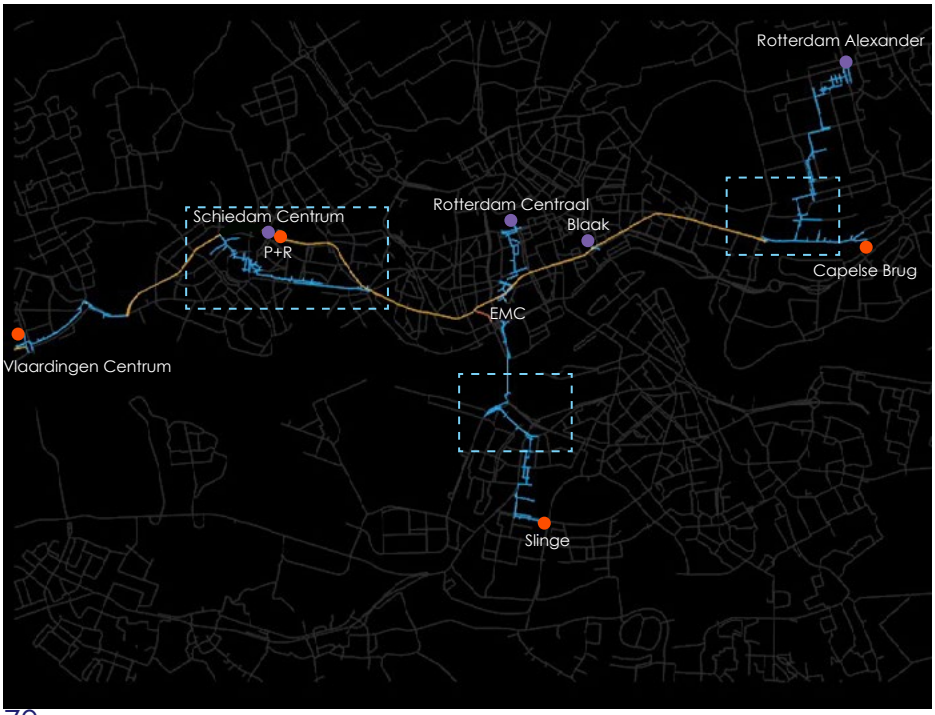


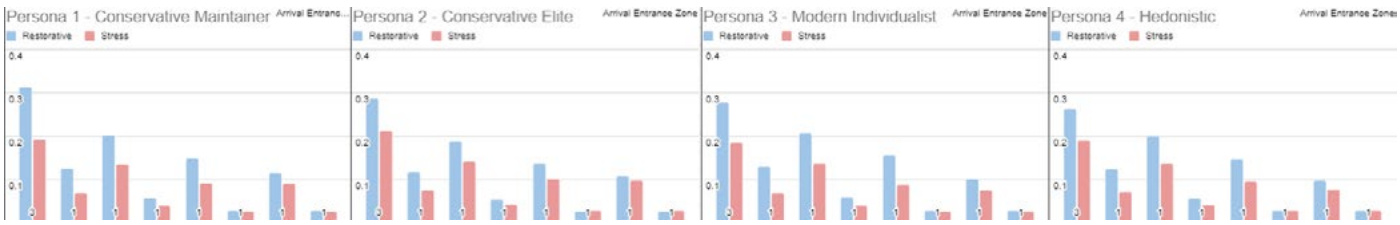
 Figure 82, Calculation of routes (Author)

The routes differences between different personas are shown in the rectangle boxes on figure 81 and 82. Yet, when calculating with the weighted sum method using the 4 elaborated motivations, destinations stay the same at the end of the route. When researching what is the most restorative and least stressful route, which is insightful for patients to be advised on, it does show a change in entrances based on persona preferences drawn from the survey. This is further elaborated on the next pages.

The short lines connecting to the segments below are also being shown and calculated in the Weighted Sum Analysis, since they are seen and experienced from the route. This does not count for the metro since aboveground restoratives are not perceived from the metro.

Different personalities do seem to prefer a different part of a route every now and then according to the public transport + slow traffic analysis, but at arrival it always chooses the entrance easiest to reach.

Each arrival has a higher restorative level than stress level on the graphs. This does not mean de stress is balanced out now. Secondly, mentionable is the lowest values at entrance 3 and 1 are metro travelers, who have not been influenced by the values as much.



Graph 12. Different stress and restorative levels for personas (Appendix 2)

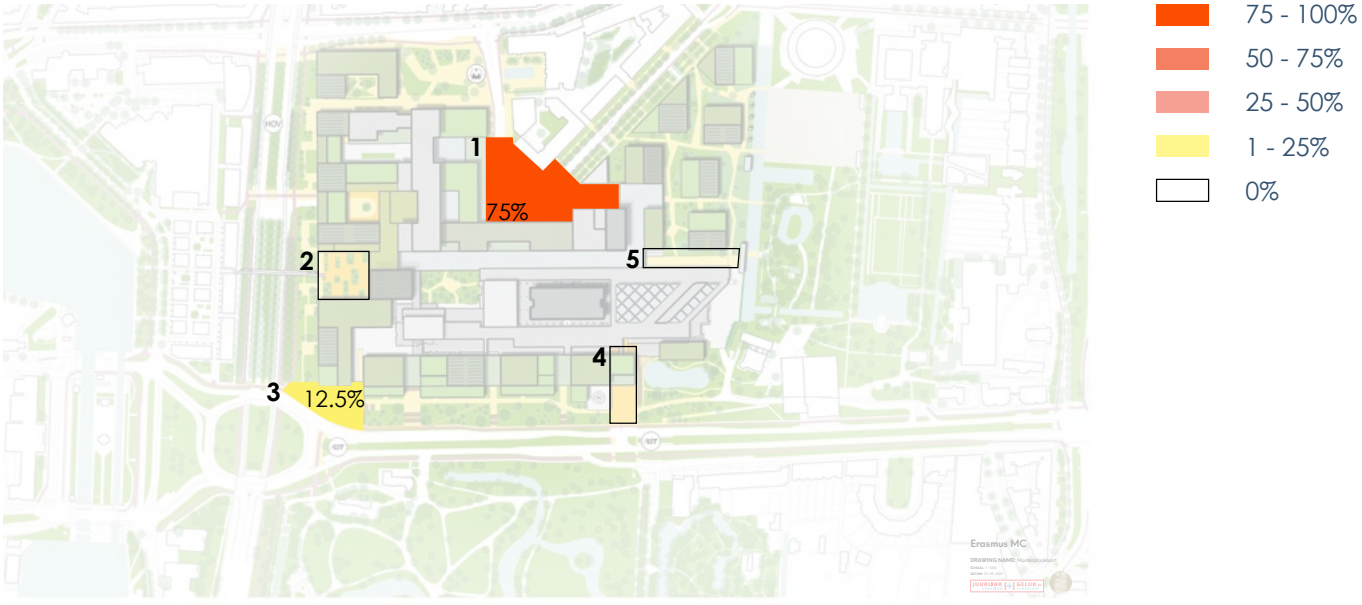


Figure 83, Most used entrances (Erasmus MC, 2021a, edited by Author)

6.4.2 Public Transport and Slow Traffic - Mental Health

Model settings

NETWORK	Public transport + Slow Traffic | Car
STARTPOINTS	NS Stations | P+R | Afrit
DESTINATIONS	Entrance Zone | Parking EMC Campus
DISABILITY	No | Low activity range
PERSONALITY	1 | 2 | 3 | 4

Persona 2, 3 and 4

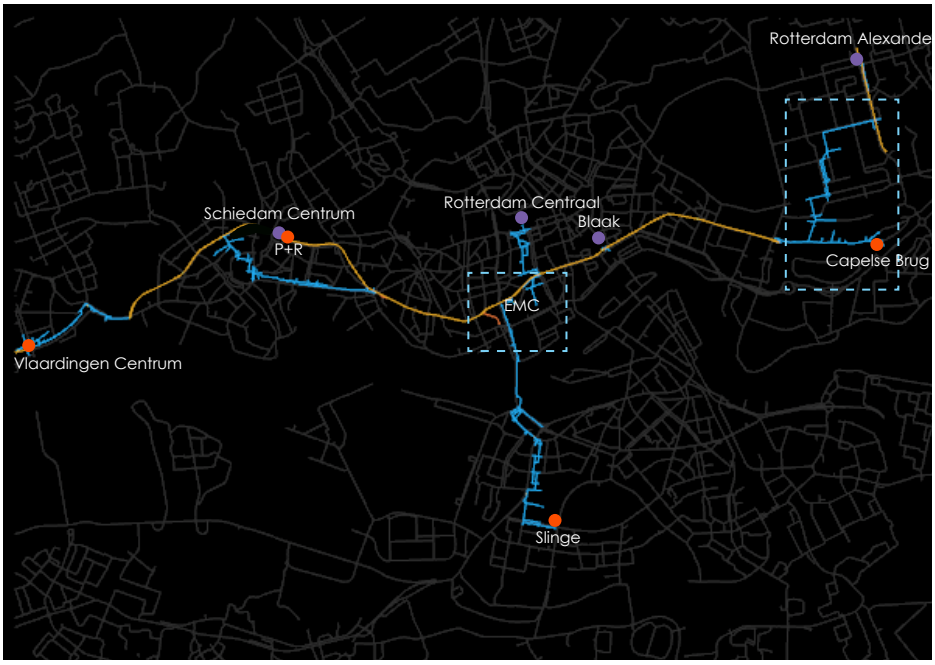


Figure 84, Calculation of routes (Author)

Model settings

NETWORK	Public transport + Slow Traffic | Car
STARTPOINTS	NS Stations | P+R | Afrit
DESTINATIONS	Entrance Zone | Parking EMC Campus
DISABILITY	No | Low activity range
PERSONALITY	1 | 2 | 3 | 4

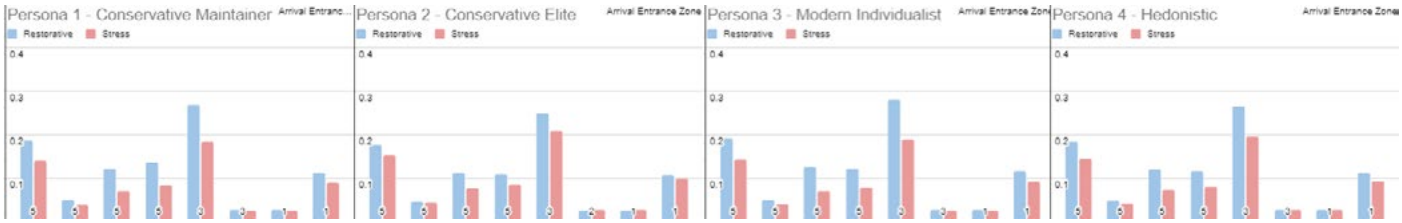
Persona 1

 Figure 85, Calculation of routes (Author)

Like in the earlier test example, also here is the same approach excecuted with only mental heatlh motivators. An Interesting aspect of the metro having no restorative or stressor values in this model is that personas choose to get out of the subway and go for a walk for part of the road. This could also happen because it is an environment with many trees, green and water. Persona one chooses prefers a different stop than personas 2, 3 and 4.

Visible is how entrance 4 has a very high stressor and restorative value compared to the others. This it not because the road is longer, because these values are calculated by dividing it by the length of the segment.

Secondly, persona 2 arrived at a different entrance than the other personas and even perceived a higher stress than restorative level because of this.



Graph 13. Different stress and restorative levels for personas

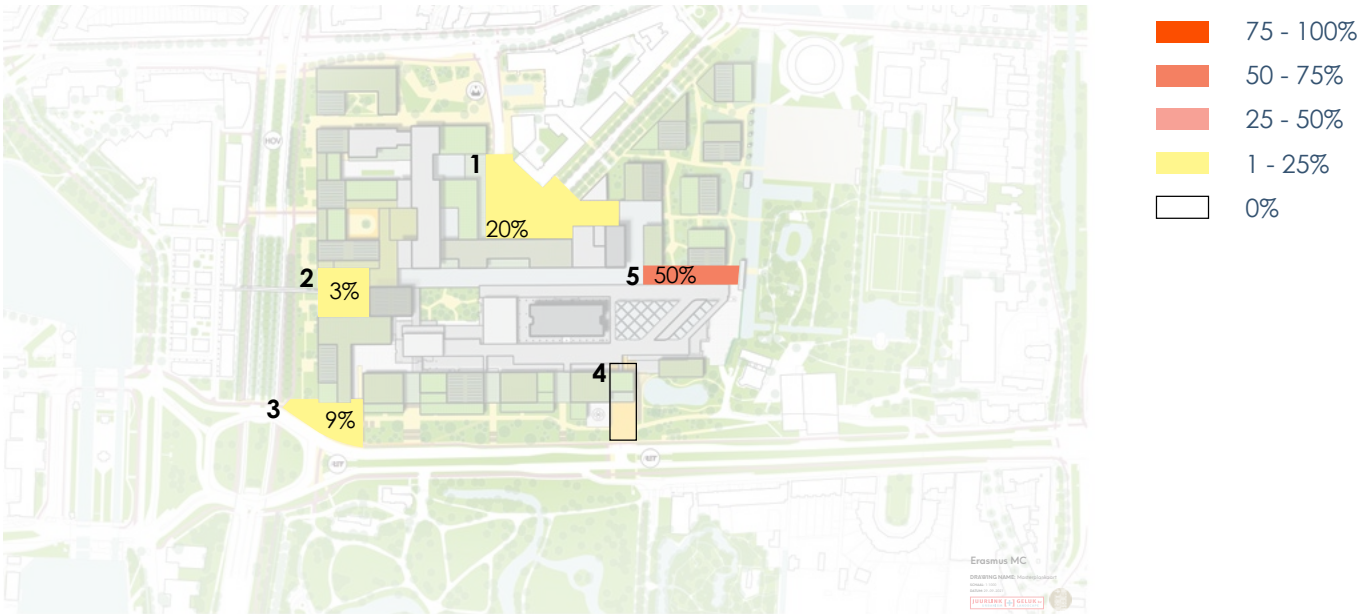
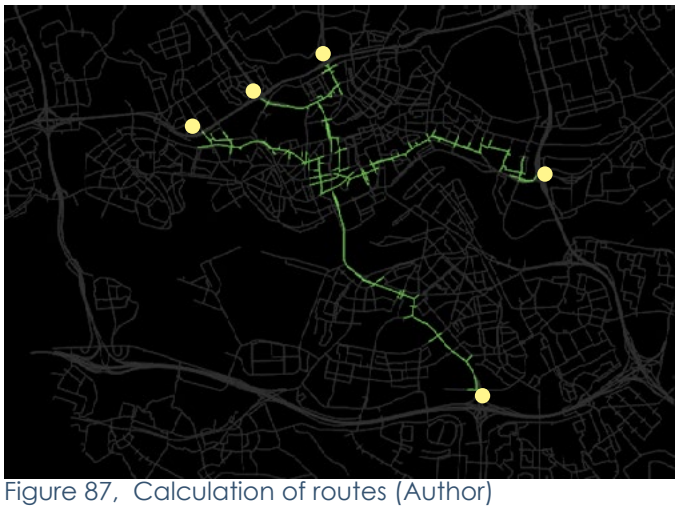


Figure 86, Most used entrances (Erasmus MC, 2021a, edited by Author)

6.4.3 By Car in 2022

Model settings
NETWORK Public transport + Slow Traffic | Car
STARTPOINTS NS Stations | P+R | Afrit
DESTINATIONS Entrance Zone | Parking EMC Campus
PERSONALITY 1 | 2 | 3 | 4

Persona 1 - 2022



Model settings
NETWORK Public transport + Slow Traffic | Car
STARTPOINTS NS Stations | P+R | Afrit
DESTINATIONS Entrance Zone | Parking EMC Campus
PERSONALITY 1 | 2 | 3 | 4

Persona 2 - 2022

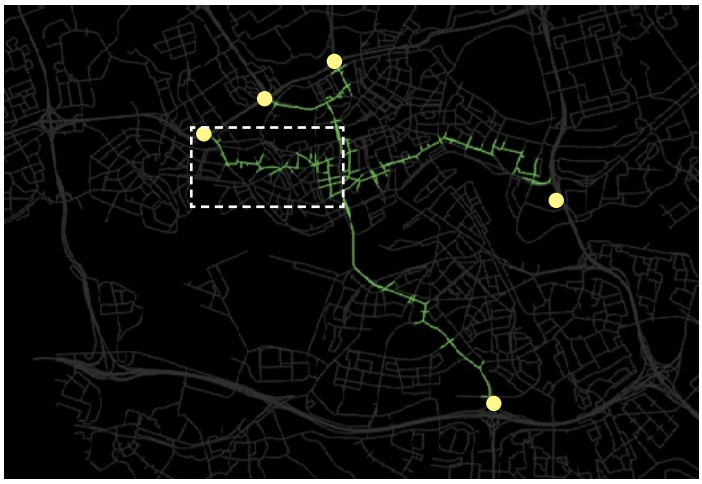
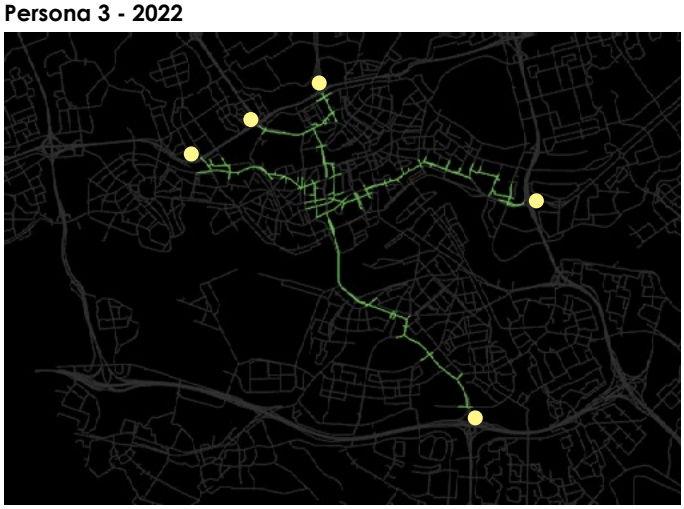


Figure 87, Calculation of routes (Author)

- Highway Exit
- Car

Model settings
NETWORK Public transport + Slow Traffic | Car
STARTPOINTS NS Stations | P+R | Afrit
DESTINATIONS Entrance Zone | Parking EMC Campus
PERSONALITY 1 | 2 | 3 | 4

Persona 3 - 2022



Model settings
NETWORK Public transport + Slow Traffic | Car
STARTPOINTS NS Stations | P+R | Afrit
DESTINATIONS Entrance Zone | Parking EMC Campus
PERSONALITY 1 | 2 | 3 | 4

Persona 4 - 2022

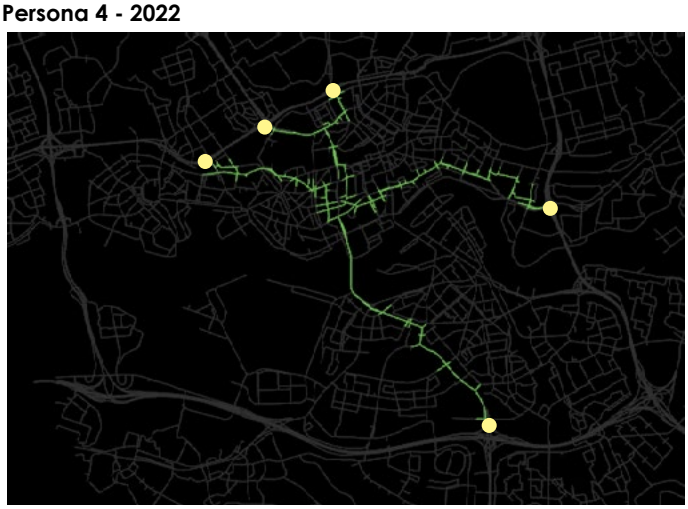
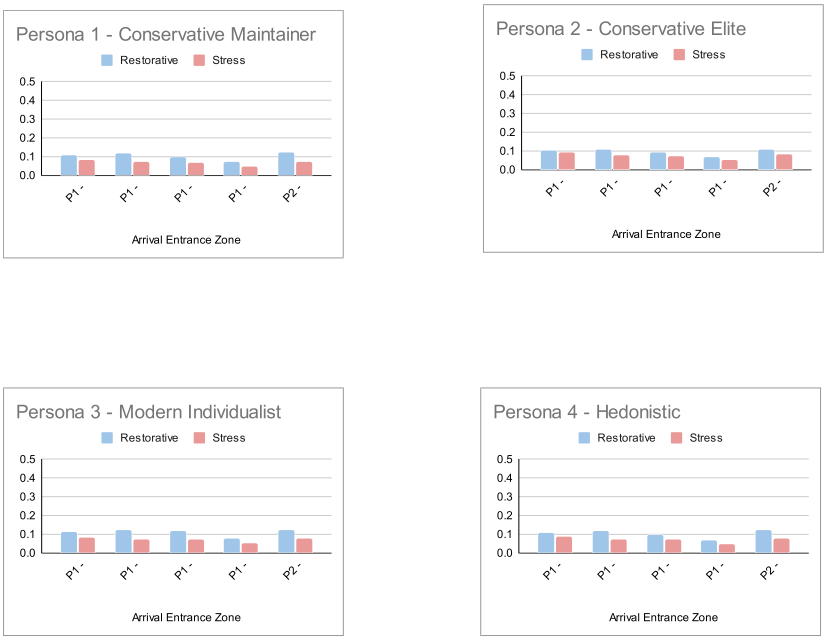


 Figure 88, Calculation of routes (Author)

Parking 1: 80%
Parking 2: 20%
Parking 3: 0%
Parking 4: 0%

One of the issues the Erasmus MC is facing the following decades are the mobility developments in Rotterdam. For cars this makes mainly a diference in the parking garaga personas prefer. In 2022 most of the people went to the museum park garage and in 2030, most of the people went to the new entrance on the side of Little C.



Graph 14. Different stress and restorative levels for personas

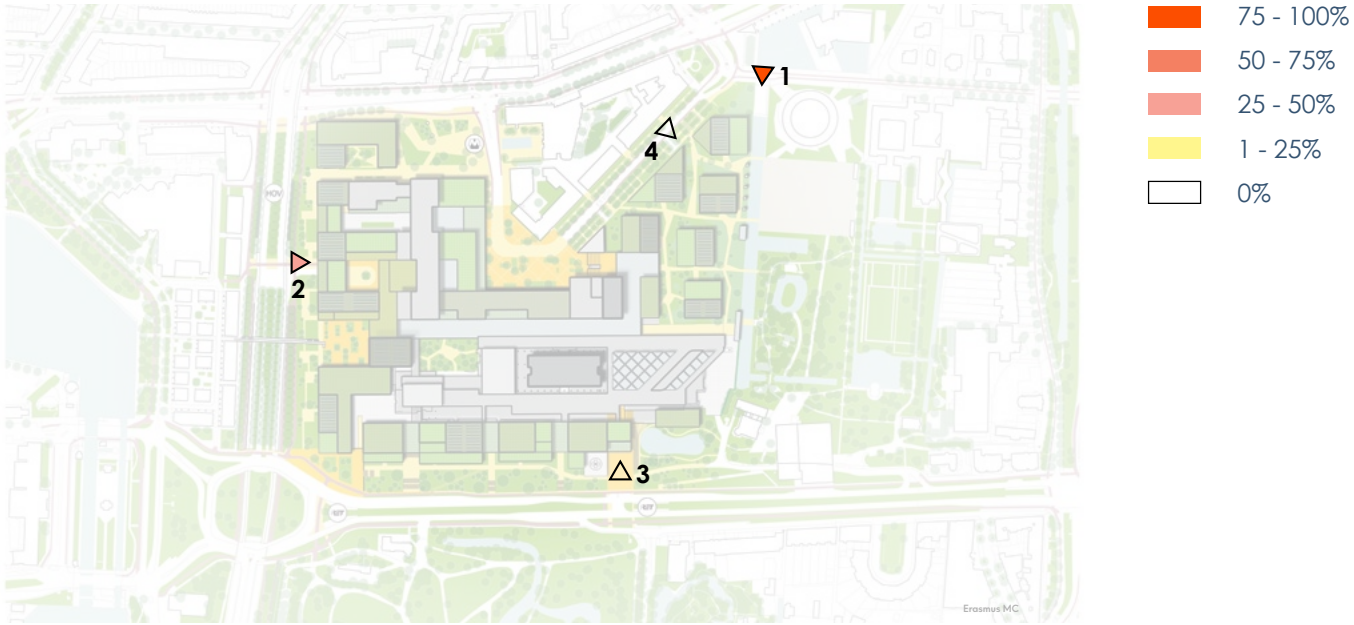


Figure 89, Most used entrances (Erasmus MC, 2021a, edited by Author)

6.4.4 By Car in 2030

Model settings
NETWORK Public transport + Slow Traffic | Car
STARTPOINTS NS Stations | P+R | Afrit
DESTINATIONS Entrance Zone | Parking EMC Campus
PERSONALITY 1 | 2 | 3 | 4

Persona 1 - 2030

Model settings
NETWORK Public transport + Slow Traffic | Car
STARTPOINTS NS Stations | P+R | Afrit
DESTINATIONS Entrance Zone | Parking EMC Campus
PERSONALITY 1 | 2 | 3 | 4

Persona 2 - 2030

Figure 90, Calculation of routes (Author)

- Highway Exit
- Car

Model settings
NETWORK Public transport + Slow Traffic | Car
STARTPOINTS NS Stations | P+R | Afrit
DESTINATIONS Entrance Zone | Parking EMC Campus
PERSONALITY 1 | 2 | 3 | 4

Persona 3 - 2030

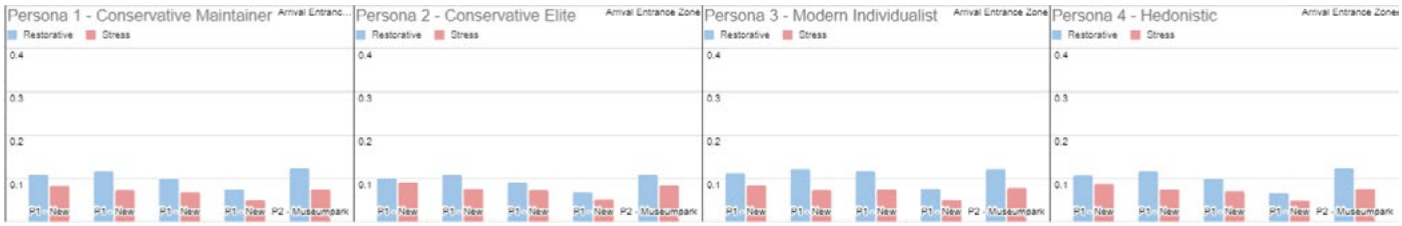
Model settings
NETWORK Public transport + Slow Traffic | Car
STARTPOINTS NS Stations | P+R | Afrit
DESTINATIONS Entrance Zone | Parking EMC Campus
PERSONALITY 1 | 2 | 3 | 4

Persona 4 - 2030

 Figure 91, Calculation of routes (Author)

Towards 2030 there is an increase in the use of P4 according to the model. This is in line with the EMC developing a parking garage in this specific location.

Visible is how drivers drive further around from the center area ending up on this specific side of the campus. The most used slow traffic entrance is the main entrance and the main used parking entrance is the new parking garage next to Little C.



Graph 15. Different stress and restorative levels for personas

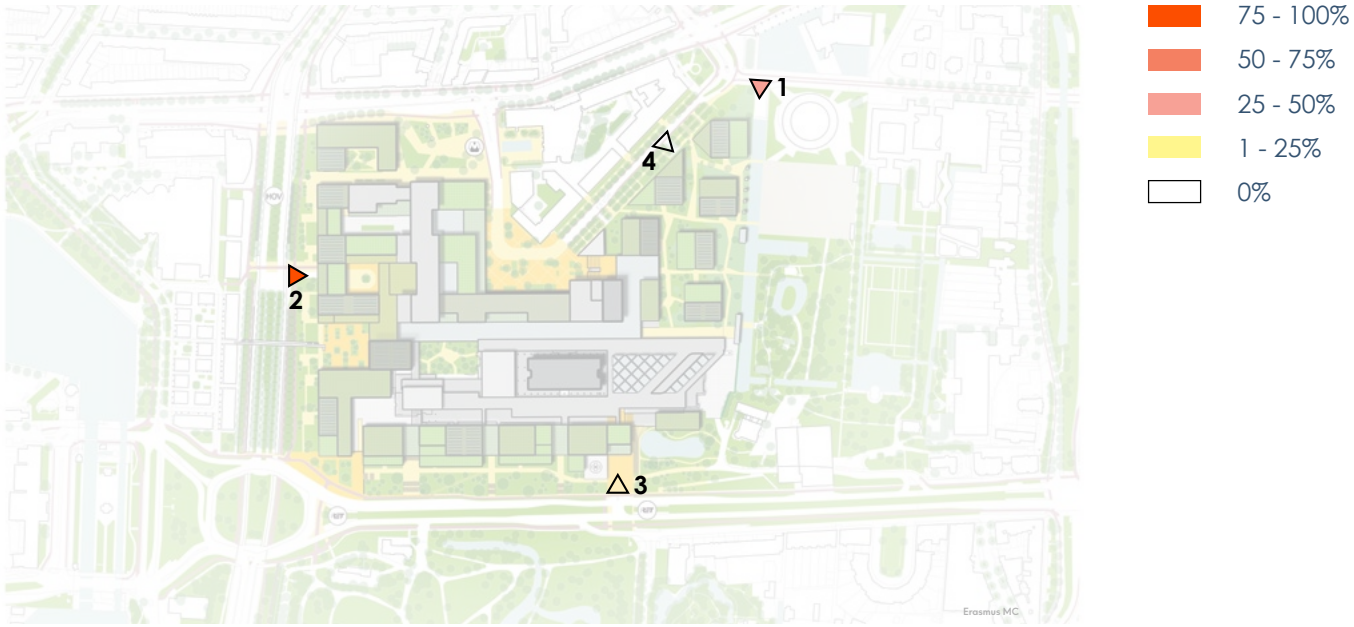


Figure 92, Most used entrances (Erasmus MC, 2021a, edited by Author)

7 Design Requirements

Based on the conclusions and observations drawn from the route calculations, in this chapter requirements are given for the masterplan. Due to the scope of the project the requirements are preliminary, but have a few important restrictions in order to make them work. Therefore concept sketches are made to show these aspects. Also, the project is diving further into the front square in this chapter. The front square is chosen to be further researched in its potential, because the patient journey research is excecuted at the main entrance and perceived very stressful.

If certain groups perceive the environment differently than others, design requirements can also be based on this.

7.1 Tree Canopy

Figure 93, Example of Implementation (Author)

Figure 94, (Picture by Author)

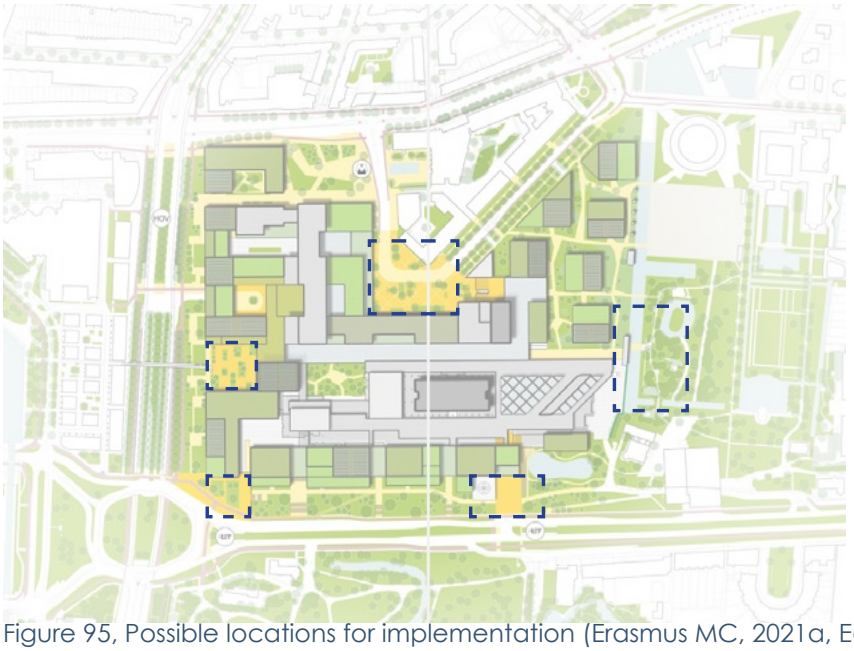
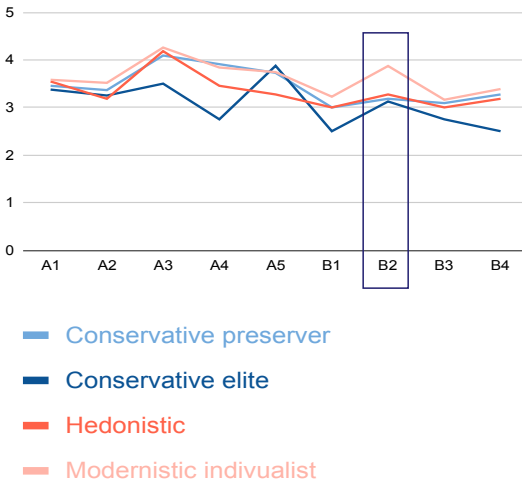


Figure 95, Possible locations for implementation (Erasmus MC, 2021a, Edited by Author)

A room made of trees folds around the people walking over the square, for a relaxing walk towards the hospital.



All lifestyle personality groups agree about one thing and that is the value of a tree canopy. A tree itself is not the reason for creating a restorative environment, it is the cozy canopy it creates. There are some green spaces around the campus nowadays, but is is not designed in a way that it significantly gives a higher restorative value. A room made of trees folds around the people walking over the square, for a relaxing walk towards the hospital.

7.2 Facade Aesthetics

Figure 96, Example of Implementation (Author)

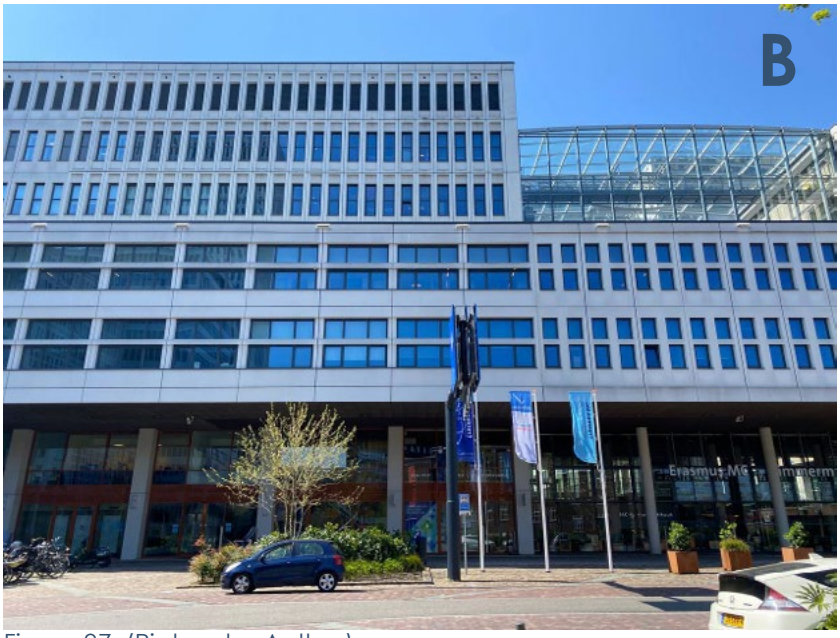


Figure 97, (Picture by Author)

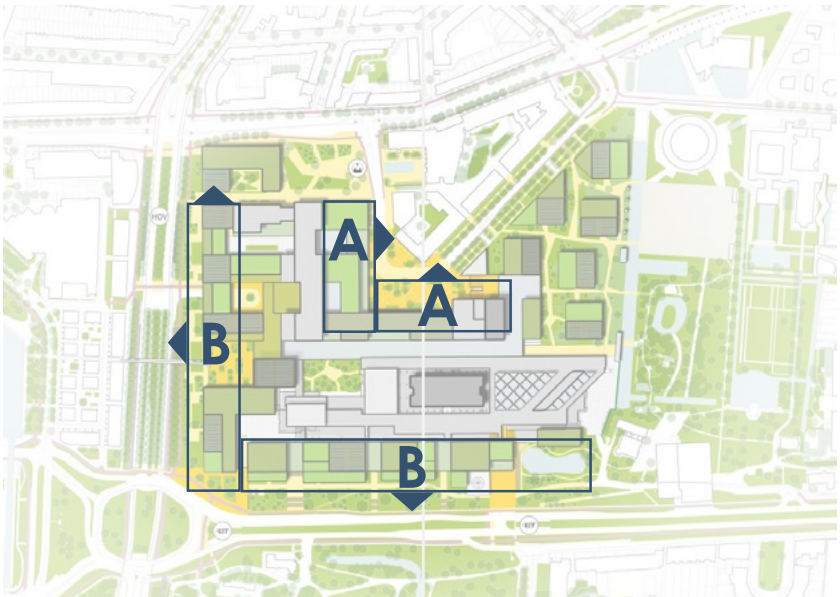
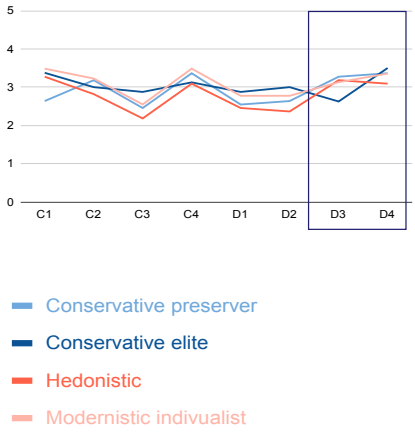


Figure 98, Possible locations for implementation (Erasmus MC, 2021a, Edited By Author)

Facades B could be more beneficial for people arriving by car, since they are not approaching the building by foot. Facade A could be more beneficial for people arriving by public transport and approaching the campus by foot.



The conclusions from the route simulation on the scale of Rotterdam also concludes which travelers arrive at which side of the campus based on their preferences. When looking at what is known so far (the conservative elite arriving at parking garages) facades B could be more beneficial for people arriving by car, since they are not approaching the building by foot. Facade A could be more beneficial for people arriving by public transport and approaching the campus by foot.

7.3 Attractive Water

Figure 99, Example of Implementation (Author)

Figure 100, (Picture by Author)

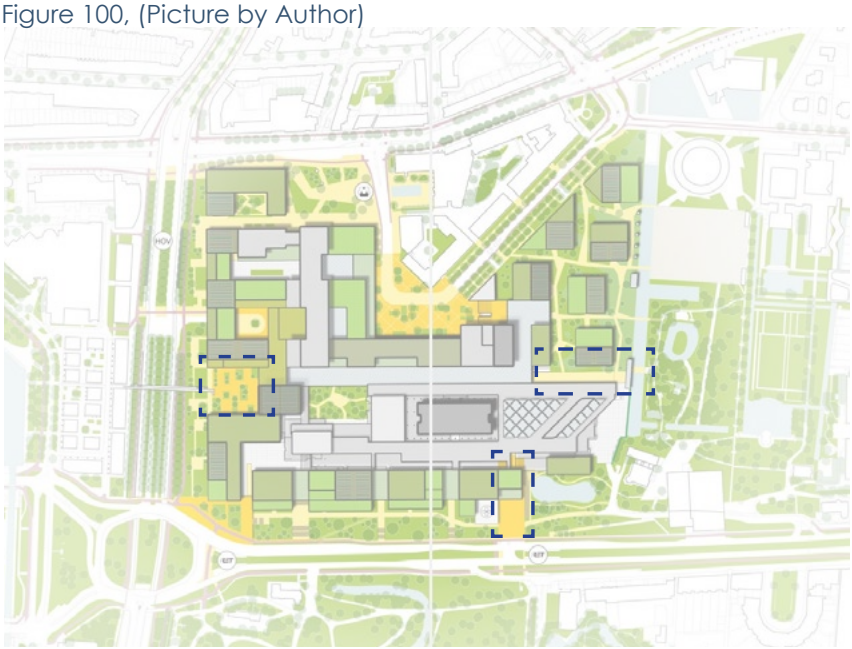


Figure 101, Possible locations for implementation (Erasmus MC, 2021a, Edited By Author)

- Adding attractive planting makes water more relaxing then clear water, waterfalls or attractive seating

7.4 Design Requirements Summarized

Important for designers of the area is to know that adding all restoratives, does not mean it will work on peoples mental heatlh. It needs attention and the quality is most important.

On this page a suggestion of different themes is being made.

The **green canopee forests** are placed at the most stressful arrivals due to the model research. For the canopee forest it is important minimum 30% of the square is a roof made of trees places together. Other vegetation at eye height should not be added to ensure visibility towards important points such as the entrance. Here also a sightline towards the entrance should stay clear from trees.

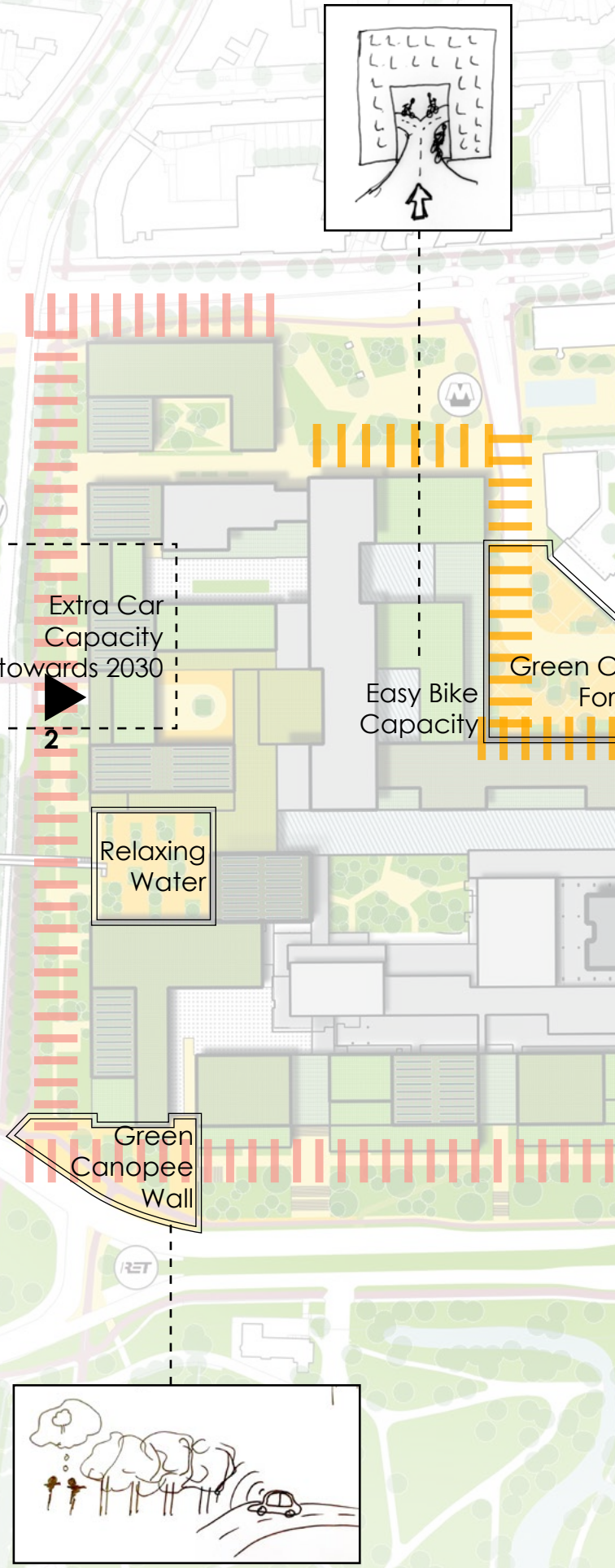
The **green canopee wall** is a wall of trees to create a border between the road and the public space. Again, also here no other eye height vegetation should be added to avoid unsafety in the evening. The patient journey research has pointed out people feel unsafe at night when leaving the EMC Campus. Eyes from the road on the public space are needed for a social secure feeling.

The **relaxing water areas** are a space to sit and relax next to nature looking water. The quality of the seats should be ergonomic and wood to create a warm ambience with high quality seating. Around the water colorful planting needs to be embedded to make the water area visually attractive.]

- Make bikestalling inviting and easy to enter to avoid crowded not neat parked bike in front of the entrance.

- Monochrome facades could be beneficial at entrances of parking garages to create a clear view from far.

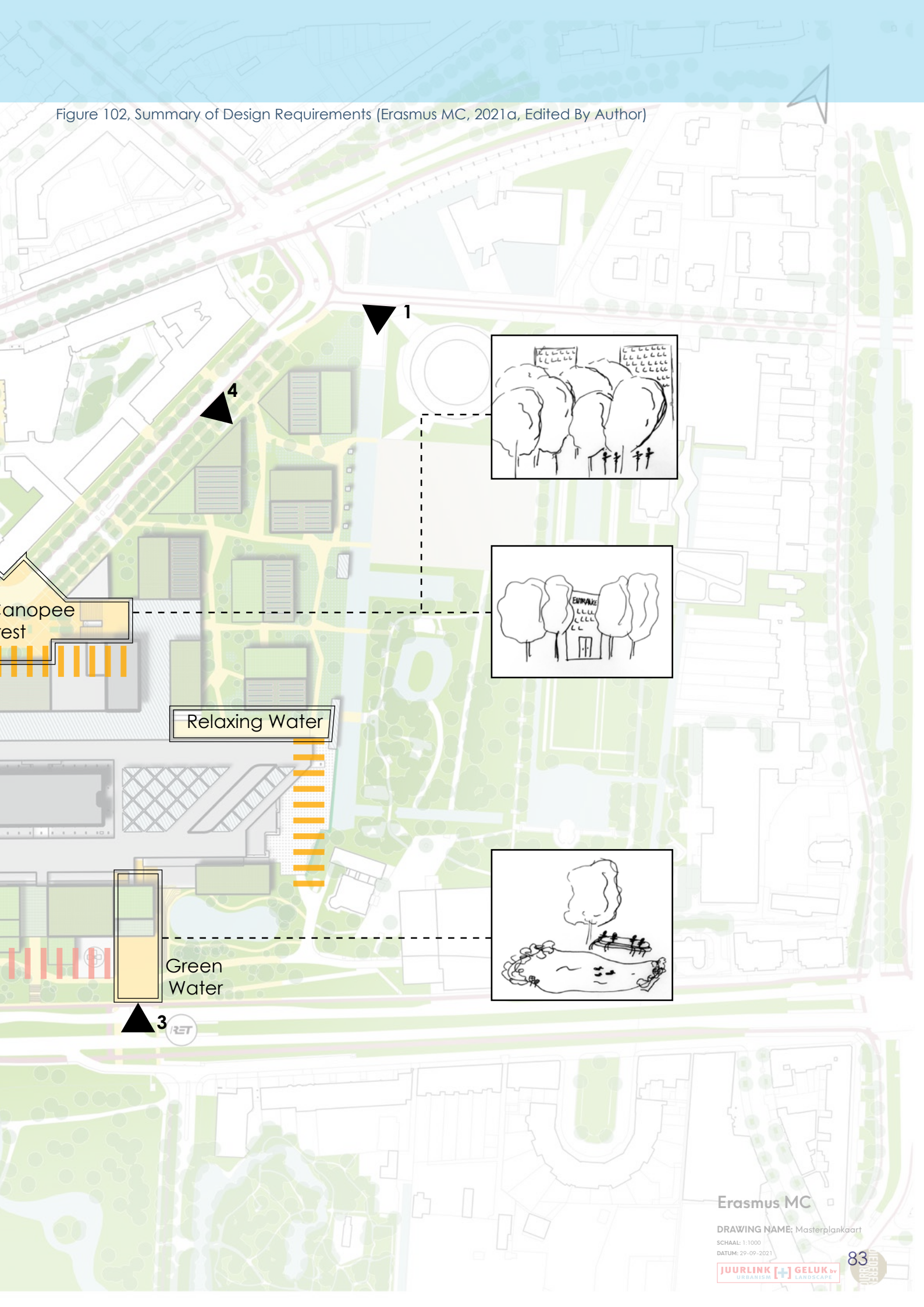
-Fine grain facade to benefit slow traffic



Small grain facade

Monochrome facade

Figure 102, Summary of Design Requirements (Erasmus MC, 2021a, Edited By Author)



Erasmus MC

DRAWING NAME: Masterplankaart

SCHAAL: 1:1000

DATUM: 29-09-2021

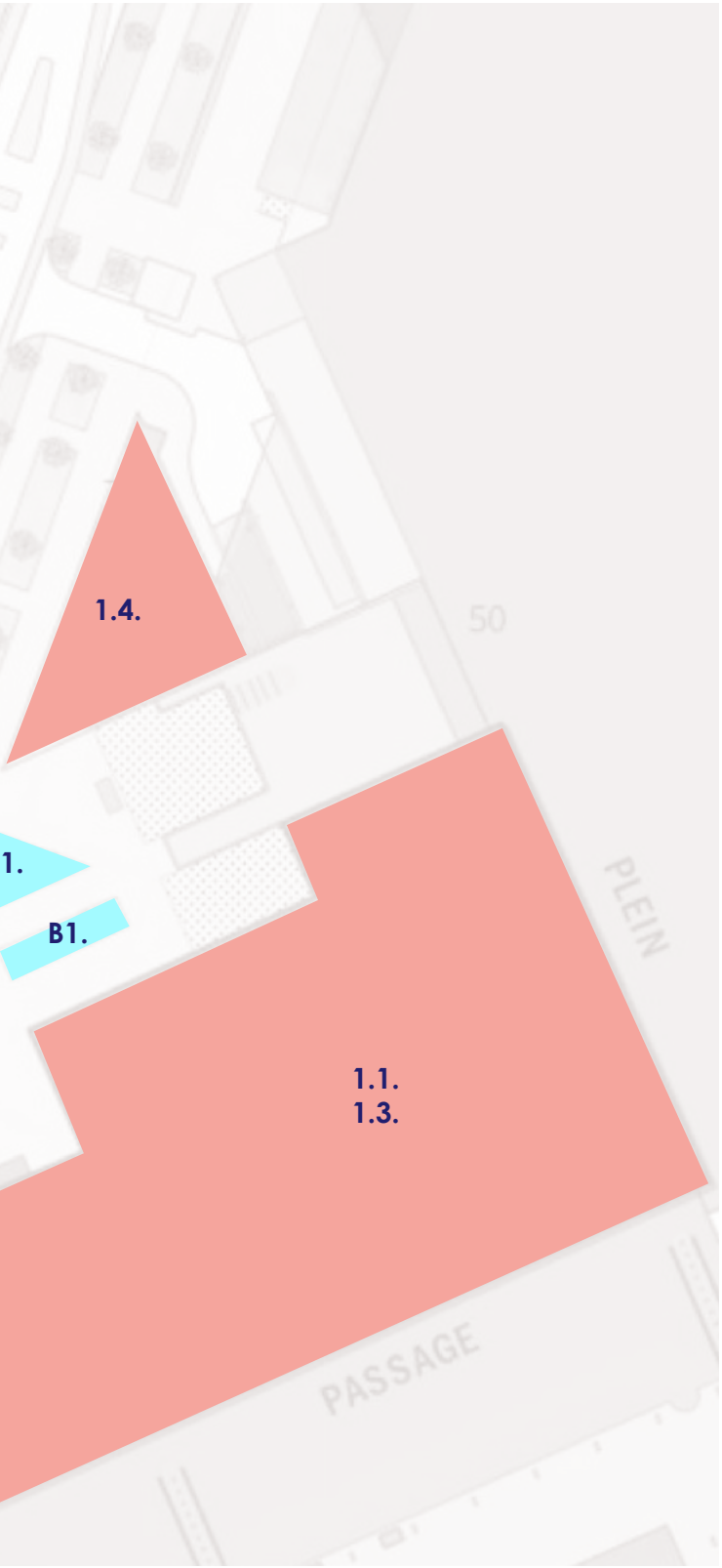
JUURLINK [+] GELUK by URBANISM LANDSCAPE

7.5 Zoom in: Main Entrance Current Situation

Stressors and restoratives are analyzed on the mainsquare to research its potential.

Figure 103 , Zoning of stress and restoratives current situation (Author)

Urban Stressors



Urban Design Aspects
1.1. Density
1.2. Round architectural edges
1.3. High-rise
1.4. Sharp architectural angles

City Life
2.1. Crowding
2.2. Garbage (not neat parked bikes)
2.3. Brick public space
2.4. Traffic

Very Stressful

Not Stressful

Restoratives

Water
A1. Without blue water (comparison)
A2. High quality clean water
A3. Attractive planting around water
A4. Dramatic waterfalls
A5. Attractive seating around water

Green
B1. Urban park with a few trees
B2. Tree canopy of at least 30 percent
B3. Rich biodiversity like animal species
B4. Green walls

Sensory Paving (category by author)
C1. Wayfinding by color organization
C2. Paving without separated functions
C3. Cycle tracks separated (functions)
C4. Textural variation, surface structure

Elements of Facades (category by author)
D1. Facade with large storefront
D2. Fine-grain storefronts
D3. Varied facades
D4. Local character, historic fascination

Very Relaxing

Not Relaxing

7.5.1 Improved Zoning

The following stressors are limiting improvement:
- The ambulance lane going straight through public space

- Taxi buses that need a space in front of the entrance. These should have their own space and not be in a shared space with pedestrians.

Restoratives

Water
A1. Without blue water (comparison)
A2. High quality clean water
A3. Attractive planting around water
A4. Dramatic waterfalls
A5. Attractive seating around water

Green
B1. Urban park with a few trees
B2. Tree canopy of at least 30 percent
B3. Rich biodiversity like animal species
B4. Green walls

Sensory Paving (category by author)
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Elements of Facades (category by author)
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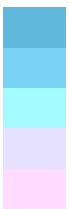
D3. Varied facades
D4. Local character, historic fascination



Urban Stressors

Urban Design Aspects
1.1. Density
1.2. Round architectural edges
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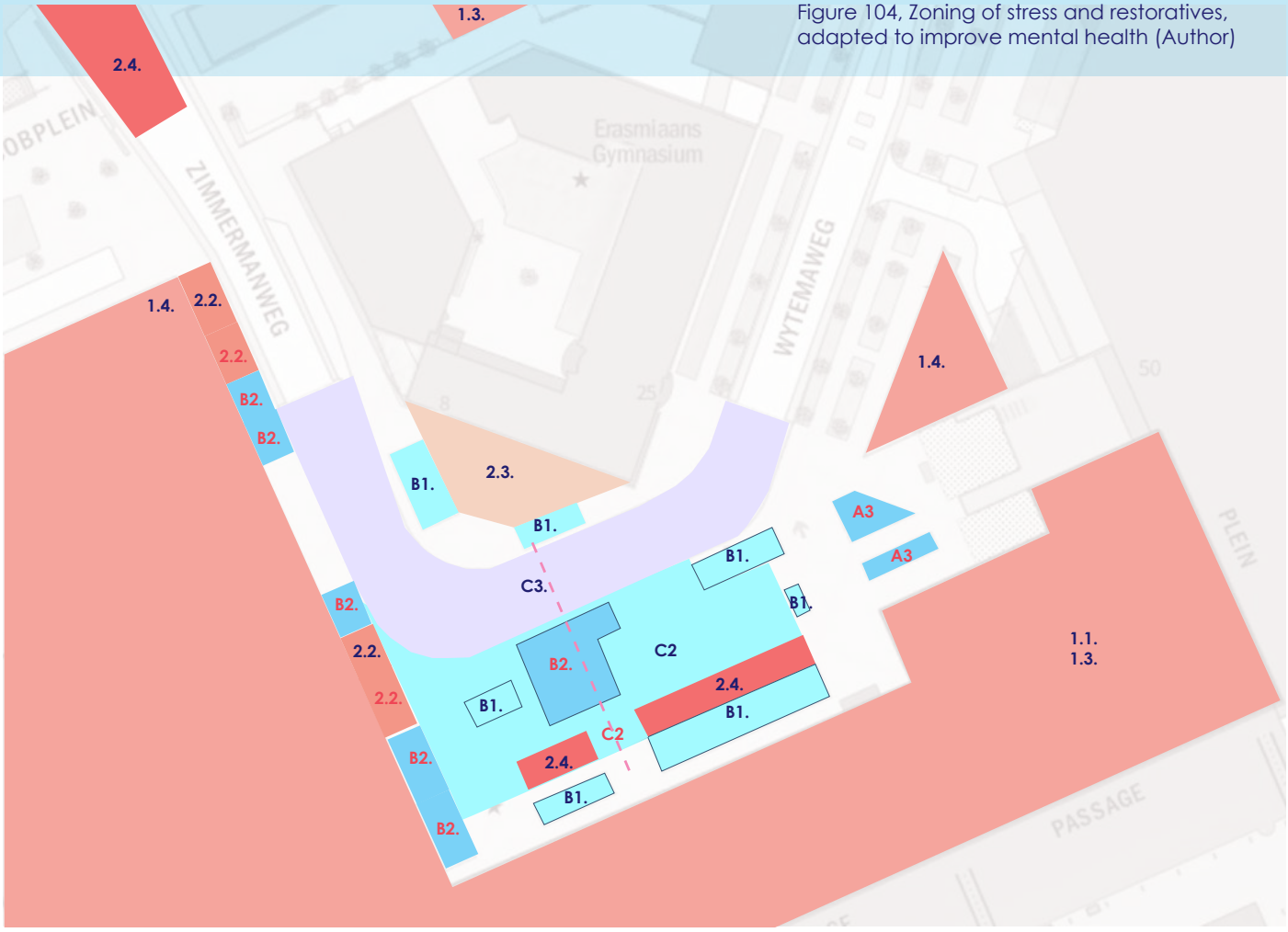

Figure 104, Zoning of stress and restoratives, adapted to improve mental health (Author)

Figure 105, Zoning of stress and restoratives, adapted to improve mental health (Author)

8. Conclusion

The position of this research functions as a bridgebuilder between designers and computer based modeling. When looking back at the research question: which mobility scenarios are possible and suitable for an inclusive accessibility the future EMC Campus, and how can spatial interventions relieve stress on the last mile and arrival? It can be concluded that driving by car gives the least chance on a restorative or stressful experience based on this research. Walking in between the station and the tramstop can bring more stress than the whole cardrive from the highway exit towards the campus by car. Therefore, it is important how urban stressors and restoratives are not only abstractly researched on the large network scale, yet also, concretely applied on the microscale. This is the bridge this research tried to built. Besides mobility scenarios, inclusivity and accesibility is also an important part of this research. Accesibility is added as a restriction on transits, when a transit is not wheelchair accesible or doesnt have tactile pavement for the visually impaired it has been removed from the network. Yet, Rotterdam is developed in such an advanced way that doing this did not change any final results. Furthermore, besides accesibility, inclusivity has been implemented by discussing different personality traits and lifestyles in motivating routes. Finally, which mobility scenarios are possible is purely based on the actions of the municipality of Rotterdam. When changing the data to the 2030 traffic plan, immediately other parking locations around the campus became more popular in the research model. In future research by using more individual data on personas, more specific answers can be given on who arrives at which entrance to optimize arrival it in the most restorative way possible.

8.1 Limitations

Due to its complexity and the short time frame for this project, there are a few limations to be considered in further research. These aspects are present in this project as well, but in an abstract manner. By making the following aspects more concrete, the research results can be more refined.

Model limitations

1. The weighted sum method does not take coincidences in account and mathematically calculates the sum of the entire route. This means, a persona is already looking at the stresslevel of arrival, when leaving from home. Familiarity of the route is needed to achieve this result. Yet, looking at the fact many people unfortunately do not visit the Erasmus Medical Center only once, this does not make the conclusion less valuable.

To solve this, it is possible to add another layer to the model research and connect the simulation method as discussed earlier to create a situation where not only the whole route has a motivation, but also the smaller decisions on a junction along the way. Aspects to implement here are for example events like a crossing child. Also, spontaneous stressors like crowding or a restorative such as choosing a sunny street above a shadow street, could be implemented in such a method. In the current model it means

2. The current model is not a traffic model and only uses the data of a traffic model. This means waiting time, delays, at a trafficlight for example is not taken into account in a literal sence. It is only calculated in the capacity data that is used, which is part of the motivation in the Weighted Sum Method. The impact of changing this to a more direct approach would be an elaboration of the event in a simulation method as mentioned in limitation 1.

3. The interweaving between 2 models and the impact on the results at the low scale level (the EMC Campus) and the transport model is not a common practice yet. Firstly, Houdini itself is a limitation in the sense that it is not naturally made for this purpose. Houdini is used to make the tool to do this research with, which needs a lot of coding. The 2 languages of design and the digital model could be interweaved much further with a prorgram supporting such research. The interweaving between the digital model and the design requirements model requires more innovations in other to form a solid base for an urban design.

Input limitations
4. Persona groups, this research categorized personas into only 4 groups, but according to the Sinus Praxis theory there are more than 12 personagroups. (Barth et al., 2017). When adding more detail the current conclusions would not change, but more conclusions can be added.

In future research the most ideal situation would be to not work with personas, but with solely a hybrid field of human characteristics. All individual wishes can be taken into account to show a richer relation between people characteristics and mobility motivation or mental health.

5. The persona demographics data is not retrieved from the Erasmus MC. In the current research it is a limitation how these are generic numbers. This is because of the possibility of familiarity. Where someone lives also has something to do someting with the stress level. From geodemographic data it can be retrieved where and how that person experiences the environment.

This method can also be applied for other healthcare institutions. For Example, the Ikazia Hospital in Rotterdam. The larger its urban scale, the more sufficient it will work. The scale of the Erasmus MC Campus is a good comparison. The Ikazia hospital in Rotterdam would also work for this method because of two reasons. It is approachable from different directions and there is more than one building. Another aspect to take into account when applying this method on another location is the amount of entrances to the campus space.

8.3 Reflection

The graduation project focuses on improving the quality of last mile reachability and arrival, by assessing societies opinion on urban stress and restoratives, and digitally researching scenarios by the use of personas.

Relation to Urbanism, City of The Future and MSc AUBS

The relation between the master track Urbanism and the thesis is the evaluation of spatial interventions influencing route preferences of people. Whereafter, the relation to Urbanism mostly translates into a few urban and architectural design requirements. These are concluded for the masterplan based on the sum of urban stressors and restorative data during the last mile of traveling towards the Erasmus MC Campus. The multidisciplinary approach in the City of The Future studio, gave the opportunity to explore other ways of researching data and the movement from a to b in cities than used usually in Urbanism. Also, the discussions with architecture students about the masterplan requirements and influences of stress based on architectural elements are insightful. Furthermore, the relation between researching the reachability of the future Erasmus MC Campus and the City of the future studio is that there were many discussions, seminars, and workshops based on thinking about what the city looks like in the upcoming decades. Lastly, related to the entire master program MSc AUBS, this project is related in a way to geomatics and architecture as well. The link with geomatics can be made by the use and building of a digital model as a main research tool. The link with architecture is mostly the scale of the small-scaled spatial requirements.

Relevance

The book, restorative cities by Roe and McCay and the thesis of Marijke Koene about Urban Stressors are the base of the theoretical framework. Their research is being summarized into a survey to rate the theories and collect and compare them on the same scale. Future research on mental health in cities can use the preliminary results of stress and restorative values from different elements in the city as a base from my survey. Secondly, the method of creating a system where digital health care personas are making choices in a digital model can be used as a base or a lesson for future similar research. Mainly the reflection on the simulations in the model saves time for future research to not struggle with the same discussions. Furthermore, new insights on restorative and stresscosts while moving through a city can assist and inspire designers making decisions to improve general mental health.

The graduation plan and proces

The first approach of my graduation plan was the use of a digital parametric model of the mobility network in Rotterdam in Houdini. This approach worked out to find the needed conclusions. I have had doubts along the process, since I had to built an entire traffic model, which is extremely complicated. Yet, first defining routes by a general traffic model and then afterwards adding values, would not meet the conclusions that makes this project special. Interesting is how with a selfbuilt model the preferred route and mode of transport can be predicted by connecting the preferences of personas. To connect the preference of specific personas to the choice of the route, this traffic model had to be built especially for the project. This finally worked out well, there are just a view points of discussion. With a weighted sum model it is being checked which route has the best value. Yet, with a weighted sum it only looks at the cost of the entire road. Given as feedback by mentors previously also, it would be of great value for my project to combine a simulation meth-

od with microscale decisions (like left or right on a junction). By doing this we can also predict the random decisions people might make. For example when the sun is shining in the one street and not in the other street, they might choose for the sunny street. Besides defining the route in the model, a second approach of my graduation plan was that the model can be used as a tool to test the suitability of a specific route. The suitability in my project has turned out not to be tested, but to define the route itself. The third approach was to test routes by using personas. While, in the final model the personas decide the route, instead of test it. These traveling personas are being created especially for the EMC by using Data from the data analytics department of the EMC and the support of general theories. During my project this developed into a field of personas and preferences by calculating all their different motivations with a Weighted Sum Model. Something that was not in the graduationplan, but is now making the story more complete, are the urban requirements for the masterplan based on the sum of calculations on urban stressors and restorative data. In terms of planning I have underestimated the unpredictability of creating a working simulating model with personas. At the beginning was assumed the research would include doing simulations and creating interventions. Yet, actually the building of the model has been the main part of research so far and a very complex one. Since I would like to go further with computational design after my graduation, it is highly insightful to have experience this project. With such a model you have to accept that it is never perfect or finished, it is an ongoing part of the project that should be growing together with the design requirements and conclusions on chosen routes until the final presentation.

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Appendix

1. Survey Results

2. Model Calculation Results

Appendix I. Survey Results

					1.1.	1.2.
Timestamp	Wat is je leeftijd?	Welk van de onderstaande omschrijvingen past het meest bij jou?	Zojuist heb je een keuze g	Hoe ontspannen ben je o	Hoe stressvol zou je de si	Hoe stressv
4/30/2022 11:43:15	20 - 29	Conservatieve behouder, onder modaal of modaal inkomen. Traditionele waarden zijn belang	8	9	2	
4/30/2022 11:53:28	30 - 39	Conservatieve behouder, onder modaal of modaal inkomen. Traditionele waarden zijn belang	8	9	1	
4/30/2022 12:15:36	50 - 59	Conservatieve behouder, onder modaal of modaal inkomen. Traditionele waarden zijn belang	4	7	1	
4/30/2022 12:52:38	20 - 29	Conservatieve behouder, onder modaal of modaal inkomen. Traditionele waarden zijn belang	7	6	1	
4/30/2022 16:20:57	60 - 69	Conservatieve behouder, onder modaal of modaal inkomen. Traditionele waarden zijn belang	8	9	2	
4/30/2022 21:17:15	20 - 29	Conservatieve behouder, onder modaal of modaal inkomen. Traditionele waarden zijn belang	5	10	1	
4/30/2022 21:39:26	20 - 29	Conservatieve behouder, onder modaal of modaal inkomen. Traditionele waarden zijn belang	8	8	1	
5/1/2022 10:23:18	50 - 59	Conservatieve behouder, onder modaal of modaal inkomen. Traditionele waarden zijn belang	6	8	2	
5/1/2022 10:49:10	50 - 59	Conservatieve behouder, onder modaal of modaal inkomen. Traditionele waarden zijn belang	6	5	2	
4/30/2022 15:52:52	20 - 29	Conservatieve behouder, onder modaal of modaal inkomen. Traditionele waarden zijn belang	7	10	4	
5/2/2022 15:21:31	30 - 39	Conservatieve behouder, onder modaal of modaal inkomen. Traditionele waarden zijn belang	4	7	1	
			6.454545455	**8**	**1.636363636**	
4/30/2022 12:18:57	30 - 39	Conservatieve elite, boven modaal of modaal inkomen. Behoud of uitbreiding van status en i	7	6	1	
4/30/2022 18:24:13	30 - 39	Conservatieve elite, boven modaal of modaal inkomen. Behoud of uitbreiding van status en i	5	8	1	
4/30/2022 19:28:33	70 >	Conservatieve elite, boven modaal of modaal inkomen. Behoud of uitbreiding van status en i	6	9	1	
4/30/2022 20:32:31	60 - 69	Conservatieve elite, boven modaal of modaal inkomen. Behoud of uitbreiding van status en i	4	8	5	
4/30/2022 20:37:59	60 - 69	Conservatieve elite, boven modaal of modaal inkomen. Behoud of uitbreiding van status en i	7	8	3	
4/30/2022 20:50:00	60 - 69	Conservatieve elite, boven modaal of modaal inkomen. Behoud of uitbreiding van status en i	7	8	3	
5/1/2022 20:05:13	30 - 39	Conservatieve elite, boven modaal of modaal inkomen. Behoud of uitbreiding van status en i	7	9	2	
5/1/2022 20:56:23	60 - 69	Conservatieve elite, boven modaal of modaal inkomen. Behoud of uitbreiding van status en i	6	8	1	
			6.125	**8**	**2.125**	
4/29/2022 16:10:40	20 - 29	Levensgenieter, onder modaal of modaal inkomen. Status en plezier zijn belangrijk, daarom g	4	6	1	
4/29/2022 17:28:35	30 - 39	Levensgenieter, onder modaal of modaal inkomen. Status en plezier zijn belangrijk, daarom g	8	7	2	
4/30/2022 11:39:33	20 - 29	Levensgenieter, onder modaal of modaal inkomen. Status en plezier zijn belangrijk, daarom g	5	5	1	
4/30/2022 13:11:32	60 - 69	Levensgenieter, onder modaal of modaal inkomen. Status en plezier zijn belangrijk, daarom g	5	8	4	
4/30/2022 16:51:43	20 - 29	Levensgenieter, onder modaal of modaal inkomen. Status en plezier zijn belangrijk, daarom g	6	8	2	
4/30/2022 16:55:49	20 - 29	Levensgenieter, onder modaal of modaal inkomen. Status en plezier zijn belangrijk, daarom g	7	6	1	
4/30/2022 21:33:10	40 - 49	Levensgenieter, onder modaal of modaal inkomen. Status en plezier zijn belangrijk, daarom g	8	9	1	
4/30/2022 23:49:48	40 - 49	Levensgenieter, onder modaal of modaal inkomen. Status en plezier zijn belangrijk, daarom g	7	7	2	
5/1/2022 15:03:42	40 - 49	Levensgenieter, onder modaal of modaal inkomen. Status en plezier zijn belangrijk, daarom g	6	8	3	
5/1/2022 16:03:01	20 - 29	Levensgenieter, onder modaal of modaal inkomen. Status en plezier zijn belangrijk, daarom g	6	7	2	
5/1/2022 13:28:26	20 - 29	Levensgenieter, onder modaal of modaal inkomen. Status en plezier zijn belangrijk, daarom g	7	8	3	
			6.272727273	**7.181818182**	**2**	
4/29/2022 17:47:49	20 - 29	Moderne individualist, boven modaal of modaal inkomen. Je bent geïnteresseerd in nieuwe c	7	8	1	
4/29/2022 17:49:53	20 - 29	Moderne individualist, boven modaal of modaal inkomen. Je bent geïnteresseerd in nieuwe c	7	8	2	
4/29/2022 17:55:35	20 - 29	Moderne individualist, boven modaal of modaal inkomen. Je bent geïnteresseerd in nieuwe c	7	5	1	
4/29/2022 18:15:05	20 - 29	Moderne individualist, boven modaal of modaal inkomen. Je bent geïnteresseerd in nieuwe c	6	7	4	
4/29/2022 22:27:42	60 - 69	Moderne individualist, boven modaal of modaal inkomen. Je bent geïnteresseerd in nieuwe c	8	9	1	
4/29/2022 22:36:38	20 - 29	Moderne individualist, boven modaal of modaal inkomen. Je bent geïnteresseerd in nieuwe c	8	6	2	
4/29/2022 22:36:42	20 - 29	Moderne individualist, boven modaal of modaal inkomen. Je bent geïnteresseerd in nieuwe c	8	6	2	
4/29/2022 22:39:52	50 - 59	Moderne individualist, boven modaal of modaal inkomen. Je bent geïnteresseerd in nieuwe c	8	8	1	
4/30/2022 9:12:35	50 - 59	Moderne individualist, boven modaal of modaal inkomen. Je bent geïnteresseerd in nieuwe c	7	8	1	
4/30/2022 11:02:59	50 - 59	Moderne individualist, boven modaal of modaal inkomen. Je bent geïnteresseerd in nieuwe c	3	4	3	
4/30/2022 11:06:50	60 - 69	Moderne individualist, boven modaal of modaal inkomen. Je bent geïnteresseerd in nieuwe c	7	8	1	
4/30/2022 11:14:04	60 - 69	Moderne individualist, boven modaal of modaal inkomen. Je bent geïnteresseerd in nieuwe c	5	10	1	
4/30/2022 11:28:01	60 - 69	Moderne individualist, boven modaal of modaal inkomen. Je bent geïnteresseerd in nieuwe c	9	10	1	
4/30/2022 11:28:34	50 - 59	Moderne individualist, boven modaal of modaal inkomen. Je bent geïnteresseerd in nieuwe c	7	10	1	
4/30/2022 12:12:22	40 - 49	Moderne individualist, boven modaal of modaal inkomen. Je bent geïnteresseerd in nieuwe c	8	5	1	
4/30/2022 12:37:45	50 - 59	Moderne individualist, boven modaal of modaal inkomen. Je bent geïnteresseerd in nieuwe c	8	8	3	
4/30/2022 13:33:36	30 - 39	Moderne individualist, boven modaal of modaal inkomen. Je bent geïnteresseerd in nieuwe c	7	8	2	
4/30/2022 18:54:46	60 - 69	Moderne individualist, boven modaal of modaal inkomen. Je bent geïnteresseerd in nieuwe c	7	9	2	
4/30/2022 20:18:15	20 - 29	Moderne individualist, boven modaal of modaal inkomen. Je bent geïnteresseerd in nieuwe c	8	7	1	
4/30/2022 21:14:00	40 - 49	Moderne individualist, boven modaal of modaal inkomen. Je bent geïnteresseerd in nieuwe c	7	8	3	
4/30/2022 22:45:35	50 - 59	Moderne individualist, boven modaal of modaal inkomen. Je bent geïnteresseerd in nieuwe c	7	8	3	
5/1/2022 0:05:51	20 - 29	Moderne individualist, boven modaal of modaal inkomen. Je bent geïnteresseerd in nieuwe c	7	7	1	
5/1/2022 8:54:45	30 - 39	Moderne individualist, boven modaal of modaal inkomen. Je bent geïnteresseerd in nieuwe c	6	8	1	
5/1/2022 12:29:25	40 - 49	Moderne individualist, boven modaal of modaal inkomen. Je bent geïnteresseerd in nieuwe c	4	8	1	
5/1/2022 14:01:34	20 - 29	Moderne individualist, boven modaal of modaal inkomen. Je bent geïnteresseerd in nieuwe c	8	7	1	
5/1/2022 16:07:22	< 20	Moderne individualist, boven modaal of modaal inkomen. Je bent geïnteresseerd in nieuwe c	7	7	1	
5/1/2022 17:16:33	40 - 49	Moderne individualist, boven modaal of modaal inkomen. Je bent geïnteresseerd in nieuwe c	7	6	3	
5/1/2022 18:04:47	20 - 29	Moderne individualist, boven modaal of modaal inkomen. Je bent geïnteresseerd in nieuwe c	8	7	3	
4/30/2022 22:28:59	20 - 29	Moderne individualist, boven modaal of modaal inkomen. Je bent geïnteresseerd in nieuwe c	9	5	1	
5/2/2022 10:47:26	30 - 39	Moderne individualist, boven modaal of modaal inkomen. Je bent geïnteresseerd in nieuwe c	8	7	2	
4/29/2022 15:59:00	20 - 29	Moderne individualist, modaal of boven modaal inkomen. Je bent geïnteresseerd in nieuwe c	7	7	3	
			7.096774194	**7.387096774**	**1.741935484**	
					1.819672131	

	1.3.	1.4.	2.1.	2.2.	2.3.	2.4.	C1	C2
ol zou je de si	Hoe stressvol zou je de si	Hoe stressvol zou je de si	Hoe stressvol zou je de si	Hoe stressvol zou je de si	Hoe stressvol zou je de si	Hoe stressvol zou je de si	Hoe ontspannend zou je	Hoe ontspannend zou je
2	3	3	4	2	1	4	3	4
1	1	1	2	1	1	1	2	2
1	1	1	1	1	2	2	3	2
1	1	1	2	2	3	2	4	4
2	3	2	2	2	3	2	2	2
1	1	1	1	1	1	1	5	5
1	1	1	1	1	1	1	4	4
2	2	2	1	2	1	2	2	3
2	2	2	2	2	2	4	1	3
1	4	4	2	4	1	3	1	5
1	1	1	2	2	3	1	2	1
1.363636364	**1.818181818**	**1.727272727**	**1.818181818**	**1.818181818**	**1.727272727**	**2.090909091**	**2.636363636**	**3.181818182**
1	1	1	1	1	1	1	2	2
1	3	1	1	1	1	2	5	5
1	1	1	1	3	1	2	4	4
5	5	5	5	5	5	5	4	4
3	3	3	2	3	2	4	3	3
4	3	3	3	3	4	2	4	3
2	2	2	1	1	1	4	1	1
1	1	1	1	2	1	2	4	2
2.25	**2.375**	**2.125**	**1.875**	**2.375**	**2**	**2.75**	**3.375**	**3**
1	1	1	2	1	1	2	3	2
1	2	2	1	2	3	3	3	3
1	1	1	3	1	1	3	5	2
3	4	4	3	4	2	4	2	1
1	3	1	3	1	1	2	5	5
1	1	4	1	4	1	4	4	3
1	1	1	1	1	1	1	3	4
1	2	2	1	1	1	2	2	2
2	4	2	2	2	1	4	3	4
1	2	1	3	2	1	3	3	2
2	3	4	3	4	3	5	3	3
1.363636364	**2.181818182**	**2.090909091**	**2.090909091**	**2.090909091**	**1.454545455**	**3**	**3.272727273**	**2.818181818**
3	4	2	1	1	1	4	2	3
2	3	1	3	4	2	5	3	2
1	1	1	2	2	1	3	4	4
3	2	3	3	4	3	2	4	4
1	1	1	1	1	1	2	2	2
4	2	2	4	2	1	3	5	2
4	2	2	4	2	1	3	5	2
1	1	1	2	3	1	4	4	2
1	1	1	1	1	1	1	5	5
3	3	3	1	2	3	4	1	1
1	1	1	1	1	1	1	3	3
1	1	1	1	1	1	2	3	3
1	1	1	1	1	1	1	2	3
1	1	1	2	1	1	3	5	5
1	1	1	1	3	1	3	4	2
3	4	2	1	2	1	4	3	4
2	1	2	2	3	1	3	2	4
2	2	2	2	2	2	2	3	4
1	1	1	1	1	1	2	3	3
1	4	2	1	3	1	4	5	4
2	4	3	4	3	2	4	3	4
1	1	1	3	3	1	3	5	5
1	1	1	1	1	1	1	4	2
1	2	1	1	1	1	2	5	5
1	1	1	3	2	1	3	3	3
1	1	1	2	3	1	2	5	4
3	3	3	1	3	1	4	3	4
2	3	3	3	3	1	4	5	4
1	1	1	1	1	1	1	1	1
1	2	2	3	2	1	4	2	3
3	4	2	2	4	2	5	4	3
1.741935484	**1.935483871**	**1.612903226**	**1.903225806**	**2.129032258**	**1.258064516**	**2.870967742**	**3.483870968**	**3.225806452**
1.672131148	2.016393443	1.786885246	1.918032787	2.098360656	1.475409836	2.737704918	3.278688525	3.114754098

Appendix II. Model calculation results

No disability, Weighted Sum Method

		Entrance (same)	Perimeter	Persona 1		Perimeter	Persona 2	
Rotterdam Centraal	> EMC Campus	5	4326	87	58	4326	81	61
Blaak	> EMC Campus	5	9865	56	37	9865	53	42
Schiedam Centrum	> EMC Campus	1	11395	30	28	11395	29	31
Rotterdam Alexander	> EMC Campus	5	19102	282	174	19102	261	191
P+R Slinge	> EMC Campus	4	8663	271	165	8663	248	183
P+R Capelsebrug	> EMC Campus	7	13432	169	91	13432	156	99
P+R Schiedam	> EMC Campus	1	11395	30	28	11395	29	31
P+R Vlaardingen	> EMC Campus	1	24106	274	213	23592	249	229
				Restorative	Stress		Restorative	Stress

Low activity radius on, Weighted Sum Method

		Entrance (same)	Perimeter	Persona 1		Perimeter	Persona 2	
Rotterdam Centraal	> EMC Campus	5	4326	87	58	4326	81	61
Blaak	> EMC Campus	5	9865	56	37	9865	53	42
Schiedam Centrum	> EMC Campus	1	11395	30	28	11395	29	31
Rotterdam Alexander	> EMC Campus	3	18168	272	158	18168	250	171
P+R Slinge	> EMC Campus	2	9294	277	165	8661	252	189
P+R Capelsebrug	> EMC Campus	7	13432	169	91	13432	156	99
P+R Schiedam	> EMC Campus	1	11395	30	28	11395	29	31
P+R Vlaardingen	> EMC Campus	1	23592	265	206	23592	249	229
				Restorative	Stress		Restorative	Stress

No disability, 100% Mental Health Motivated

Persona 2 gaat ineens vanuit Slinge naar entree 4		Entrance	Perimeter	Persona 1		Entree	Perimeter	Persona 2
Rotterdam Centraal	> EMC Campus	5	4147	77	58	5	4147	73
Blaak	> EMC Campus	5	9572	47	37	5	9572	44
Schiedam Centrum	> EMC Campus	**3**	11395	30	28	**2**	11395	29
Rotterdam Alexander	> EMC Campus	5	18904	257	157	5	19096	207
P+R Slinge	> EMC Campus	4	8947	240	164	4	8947	222
P+R Capelsebrug	> EMC Campus	5	13138	159	91	5	13138	147
P+R Schiedam	> EMC Campus	1	11395	30	28	1	11395	29
P+R Vlaardingen	> EMC Campus	1	24046	269	214	1	24046	254
				Restorative	Stress			Restorative

Car, no disabilities, 2020

		Destination	Perimeter	Persona 1		Entree	Perimeter	Persona 2
Exit 1	> EMC Parkings	P1 - New	9660	97	72	P1 - New	9386	95
Exit 2	> EMC Parkings	P2 - Museumpark	7477	71	54	P2 - Museumparl	7477	68
Exit 3	> EMC Parkings	P2 - Museumpark	8494	103	71	P2 - Museumparl	8494	96
Exit 4	> EMC Parkings	P2 - Museumpark	11353	140	83	P2 - Museumparl	11353	130
Exit 5	> EMC Parkings	P1 - New	10327	68	47	P1 - New	10327	63
				Restorative	Stress			Restorative

Car, no dissabilities, 2030

		Destination	Perimeter	Persona 1		Entree	Perimeter	Persona 2
Exit 1	> EMC Parkings	P1 - New	9386	101	77	P1 - New	9386	95
Exit 2	> EMC Parkings	P1 - New	7056	82	51	P1 - New	7056	76
Exit 3	> EMC Parkings	P1 - New	9935	98	67	P1 - New	9935	91
Exit 4	> EMC Parkings	P2 - Museumpark	11353	140	83	P2 - Museumparl	13302	144
Exit 5	> EMC Parkings	P1 - New	12821	94	63	P1 - New	12821	88
				Restorative	Stress			Restorative

Perimeter	Persona 3		Perimeter	Persona 4	
4326	89	59	4326	86	59
9865	58	38	9865	55	39
11395	30	28	11395	30	30
19215	298	166	19102	278	182
8948	247	164	8948	235	170
13432	174	92	13432	165	95
11395	30	29	11395	30	30
21468	216	157	21468	207	161
	Restorative	Stress		Restorative	Stress

Perimeter	Persona 3		Perimeter	Persona 4	
4326	89	58	4326	86	59
9865	58	38	9865	55	39
11395	30	29	11395	30	29
19071	296	179	19071	282	183
8661	287	173	8661	272	178
13432	174	92	13432	165	95
11395	30	29	11395	30	30
23592	274	211	23592	263	217
	Restorative	Stress		Restorative	Stress

	Perimeter	Persona 3		Perimeter	Persona 4	
63	4147	79	59	4147	76	60
42	9572	48	38	9572	46	39
31	11395	30	29	11395	30	30
162	19096	230	148	19096	219	153
186	8947	250	169	8947	238	175
99	13138	164	92	13138	156	94
31	11395	30	29	11395	30	30
239	24046	278	219	24046	267	225
Stress		Restorative	Stress		Restorative	Stress

	Entree	Perimeter	Persona 3		Entree	Perimeter	Persona 4	
84	P1 - New	9660	100	73	P1 - New	9660	96	74
60	P2 - Museumparl	7477	74	55	P2 - Museumparl	7477	71	57
77	P2 - Museumparl	8494	107	72	P2 - Museumparl	8494	102	74
87	P2 - Museumparl	11353	146	85	P2 - Museumparl	11353	139	85
50	P1 - New	10327	71	48	P1 - New	10327	68	45
Stress			Restorative	Stress			Restorative	Stress

	Entree	Perimeter	Persona 3		Entree	Perimeter	Persona 4	
85	P1 - New	9386	104	79	P1 - New	9386	100	81
54	P1 - New	7056	85	51	P1 - New	7056	81	52
72	P1 - New	9584	110	70	P1 - New	9935	97	69
110	P2 - Museumparl	13302	160	103	P2 - Museumparl	11353	139	85
66	P1 - New	12821	98	64	P1 - New	10327	68	49
Stress			Restorative	Stress			Restorative	Stress