Designing Cityzonas: A Design Tool For The Creation Of City-Centered Mobility Strategies

Master thesis
Strategic product Design
Levy Kösters

Author
Levy Kösters

Master thesis
MSc. Strategic Product Design
Faculty of Industrial Design Engineering
Delft University of Technology

Design lab
Seamless personal mobility lab

Graduation committee
Chair: Dr. Kim, E.Y.
Assistant professor Design for Dynamic stability
Department of Design, Organization and Strategy (DOS)

Preface

Dear reader,

This report shows you the work I have done in the past 20 weeks. For me this project is the symbol of taking a risk, exploring the unknown and creating a sense of order into chaos. The past five years of studying industrial design in both the Technological University in Eindhoven and in Delft had prepared me to be able to face these challenges. But I would have never gotten to this point without the help from teachers, friends and family. Therefore, I would like to mention some of them.

First of all, I would like to thank my supervisory team, Dr. Eui Young and Dr. Maarten Wijntjes. Thank you for the guidance and feedback during these past 20 weeks. Your opinions and advice often helped me to get new insights. Moving this project into the right direction. Besides that, I would like to thank you in your assistance during the development of my first academic paper that has been submitted during this project.

Secondly, I would like to thank all members of the seamless personal mobilty lab who were always willing to provide feedback or assistance. Special thanks to Dr. ir. Suzanne Hiemstra-van Mastrigt and MSc, Claudia Spaargaren for their mentorship and guidance.

Finally, I would like to thank all the experts and students that helped me during the data-collection and co-creation phases of this project. Specifically, I want to mention the people from The Cho Chun Shik Graduate School for Green Transportation, Dr. Sujin and Dr. Jinwoo who provided me parts of their data and gave feedback during numerous moments in the project.

Regards

Levy Kösters,

Executive summary

While most mobility providers likely have a sustainable or environmentally friendly goal at heart, a poor implementation strategy can do more harm than good within a city. The lack of awareness about the city's environmental, socio-demographic or socio-economic characteristics or the absence of a clear vision of the local government about how to deal with new mobility providers plays a crucial role in this. The design of a new tool called 'cityzona' can aid in creating a better connection between local government and mobility provider by making urban planners and/or designers more aware of the relations between variables influencing the modal split but also by improving the communication about the city between stakeholders. This project aims to take the first steps in the development of the cityzona (a persona that represents a group of cities instead of a group of users) by designing early versions of the cityzona in an iterative process. For the design of the cityzona quantitative data is used in combination with semi-structured interviews and co-creation sessions. The quantitative data largely originates from research in collaboration with the Cho Chun Shik Graduate School (KAIST) for Green Transportation and the TU Delft's people in transit department. Combining this data with a literature review revealed that there is a need for qualitative data in order to understand the city's mobility orientation on a deeper level. The qualitative interpretation of the data and literature review lead us to design early versions of the cityzona. These were used for semi-structured interviews. These interviews further validated the need for qualitative data in the form of traveler desires and/or needs. Furthermore, discussions led to the insight that the cityzona has potential to function as a tool to align stakeholders for the design of a long-term mobility strategy as well as a tool for exploring and reinventing city level services for the implementation in different types of cities. For the cityzona to be more 'inspirational' these qualitative elements were added by comparing and clustering mobility strategies and indices. Afterwards the co-creation sessions with novice designers showed insight into the differences in importance of the included variables when using the cityzona as either communication tool for local governments or as an explorative design tool for service providers. The service provider perspective seemed to require a focus on how the city's mobility is perceived by the travelers and the government in combination with the city's vision. On the other hand, for the cityzona to work as a communication tool the opinions were mixed. Only an emphasis on the availability of the different modes of transport was commonly agreed upon. Moreover, the concept to divide a cityzona in multiple zones was further validated for both functions as this was a recurring topic during the sessions. Regardless of the function, the cityzona provided most useful in the early stages of a design process. Still more research is needed on the use of cityzonas in practice to further validate the fit with these potential functions.

Content

Content

Introduction

Introduction

Context

The European green deal strives to achieve a 90% transport-related emission reduction and cities play a big part in this [1]. Therefore, topics like 'Mobility as a Service' and 'shared mobility' have been addressed frequently when talking about future mobility scenarios in urban areas [2]. Concepts like these are a part of possible solutions that could contribute to future scenarios of sustainable urban transport. While, for example, the implementation of bike sharing services in Amsterdam by the Dutch Railway (NS) company was a relative success, China had a lot more issues [3]. A huge over-supply of bikes resulted in vandalism and the so-called graveyard bikes. The mismatch between the capacity of the existing infrastructure and the implementation of the bikes resulted in an inundation of city centers with shareable bikes [3]. Moreover, the lack of vision and strategy from the local government led to a missing regulatory framework. This made it possible for copy-cat businesses to implement bikes as well. Creating an even bigger surplus of bikes. This problem occurred due to a mismatch on different levels. The implementation strategy did not fit with the government strategy, the existing infrastructure as well as the travel behavior of the citizens [3]. This example argues for a tool to design strategies that includes a better connection between these aspects. For both local governments as well as mobility service providers.

What are cityzonas?

Derived from the concept of personas, a cityzona will be a fictive city that represents cities with similar mobility characteristics. This actionable method should help practitioners (e.g., designers and urban planners) increase the focus on the relation between the aspects that could influence or are the result of the modal split of the city. Enabling designers and urban planners to create strategies that fit the contextual environment of a city and will facilitate effective communication between stakeholders about the target group(s). Moreover, these cityzonas should inspire them to envision future mobility scenarios for the creation of user centered cities.
Klinger et al (2013) did research on a similar topic. They used the concept of urban mobility cultures to understand how factors like travel behavior, government strategy and infrastructure can influence each other and the use of the available modes of transport in cities, also known as the modal split [4]. These mobility cultures can be applied to cities with similar characteristics to provide representative recommendations for a modal shift towards sustainable transport. However, from a design perspective these mobility cultures lack a narrative or inspiration to design new strategies. This paper therefore argues for a new concept that, to an extent, builds upon the urban mobility cultures which we call a 'cityzona'.

Introduction

The design process

This paper aims to take the first steps in the development of the cityzona by designing early versions of the cityzona in an iterative process. For the design of the cityzona quantitative data is used and the results are qualitatively interpreted for the creation of the cityzona concept. This data largely originates from Sujin et al's paper in which 46 cities were analyzed to identify which variables have the biggest impact on the modal split of a city (34). Between these cities three clusters can already be made based on a relatively high share of the use of a specific transport mode (bike, car, metro) in comparison with the other cities (5, 34). One cluster represents cities with relatively high bike usage, one cluster represents the cities with a high use of public transit (train, metro, tram, bus) and one cluster that contains the city with a high use of private cars. These clusters will function as a starting point for the design of cityzonas (see table 1). While designing the cityzona three questions are addressed:

Which variables are relevant to include in the cityzona design?

How should the visual form of a cityzona look like in order to be inspiring for designers and urban planners?

In which use cases could the use of a cityzona potentially make a beneficial impact?

The first question is answered by conducting literature review about two separate topics. First, a review has been done about factors that are a cause of the modal split or factors that are a result of the modal split. The decision for including only these kinds of factors was made in order to create a scope in which can be designed. As a city is a complex ecosystem, many variables can be included within such a cityzona. So, limiting ourselves to the modal split will provide some guidance to start with. Furthermore, the research of KAIST provided a brief start in identifying which variables are relevant to include. Next to that, comparing the KAIST data with literature would to an extent further validate the variable selection for the cityzona. Besides looking at the factors that affect or are affected by the modal split, a literature review will be done about the topic personas. The cityzona concept is derived from the idea of a persona. Therefore, recognizing the the core aspects and functionalities of a persona can provide insight into what functionalities or properties the cityzona should have.

The second and third question will be answered due to an iterative process. Conducting interviews with designers and urban planners to determine the requirements of the visual representation of the cityzona. These requirements should be met from two kinds of perspectives. On the one hand, it should accommodate the needs of urban planners. Emphasizing the variables that are the most insightful when designing or redesigning the mobility landscape. On the other hand, the cityzona should be inspiring. Much like a persona, a cityzona should inspire designers to design services or strategies that are tailored to the identified mobility landscape (or user group for a persona). Next to that, the interviews are used to determine how the design process of a mobility strategy and an implementation process functions. This in order to determine where a cityzona could be most useful,

Introduction

according to the interviewees. Moreover, these interviews support in validating the identified variables used for the cityzonas. For these interviews early iterations are designed which will be used for the interviews with urban planners, mobility design experts and service providers.
Additionally, co-creation sessions with novice designers are organized to validate the visual layout of the cityzona and how the cityzona could change its layout based on the identified functions for the cityzona.

Afterwards early iterations will be designed that can potentially be used for the interviews with urban planners, mobility design experts and service providers. Like mentioned previously, these interviews will be used to understand how the cityzona can be inspiring enough to be beneficial in the design of either mobility strategies or the design of implementation strategies. The results from the interviews will provide new directions for further iterations of the cityzona. Additionally, the interviews will give us an idea on where in the design process the cityzona can be beneficial for these practicians.
Finally, co-creation sessions will be held with novice designers. For these sessions a workshop will organized to explore how the visual lay-out of a cityzona would differ based on which functionality it serves. The sessions can further validate the lay-out of the current iteration of the cityzona or can support in defining directions for further steps in the design process of the cityzona

Identification of relevant factors

Identification of relevant factors

Process

A literature review is conducted to identify characteristics of a city which influence the modal split, to answer the research question: **'which variables are relevant to include in the cityzona design?'**. The eventual selection of variables is based on the identified factors of Sujin et al's paper (see figure 1) and the review of other related literature, which will be elaborated on in the following sections (34). These factors are underlying variables that influence the modal split and can tell us more about the characteristics of the city.
Initially, an exploration of variables and their relations are given. After this, the selection of specific variables is discussed. The identified variables will be discussed by looking at different categories or dimensions this follows the division of Sujin et al's paper (34), the identified factors are divided between socio-demographic, planning and environmental factors (see figure 1) Socio-demographic factors contain characteristics of the population. Planning factors contain variables that can be controlled by the local government or other stakeholders (e.g., policies or interventions). Finally, the environmental characteristics illustrate the context of the city. Including uncontrollable variables such the average temperature, average rainfall and population density. The modal split is a distinct characteristic on its own and will be used in the development of the cityzona as well.

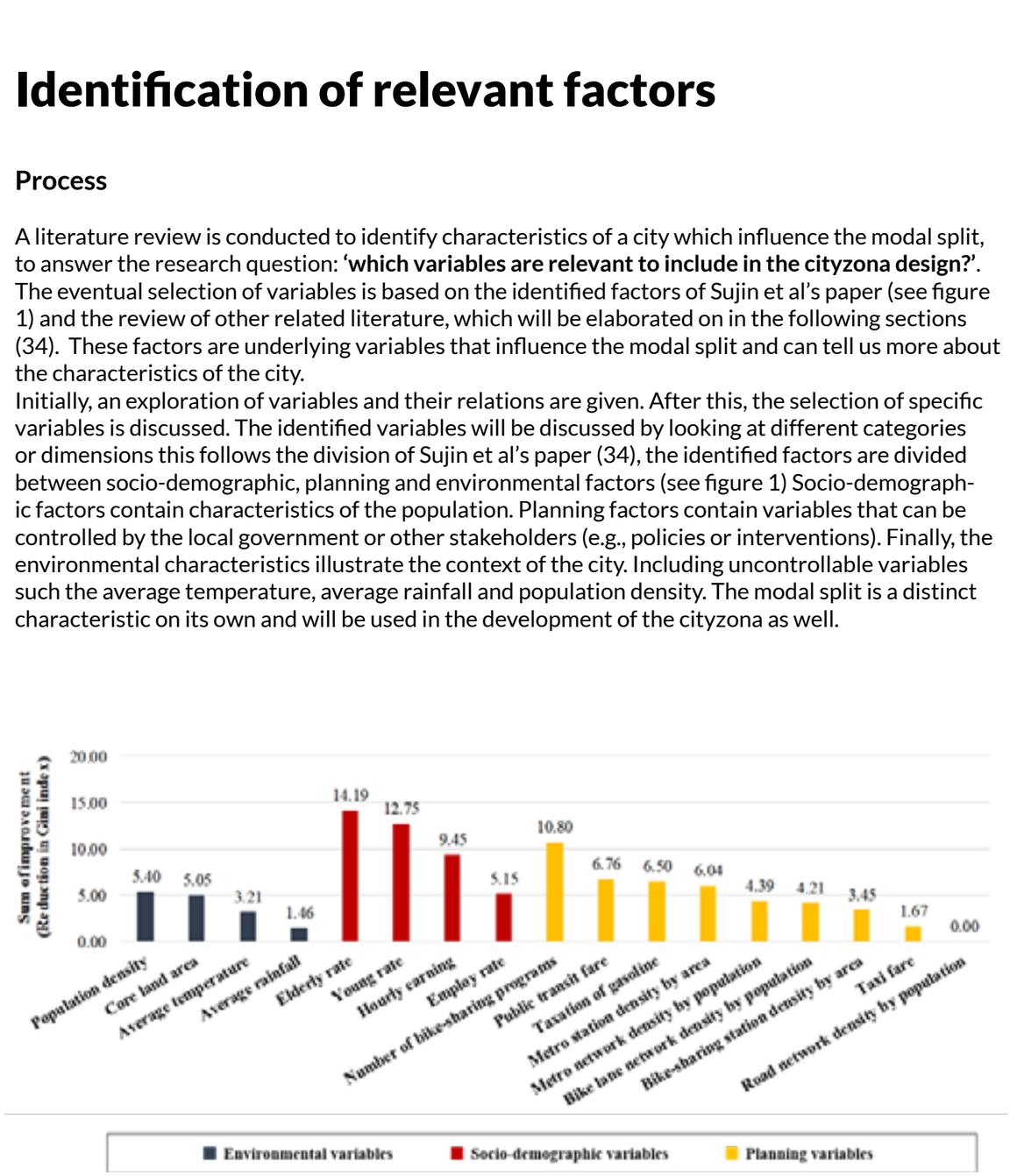

figure 1 identified variables and their importance for the clustering (34)

Identification of relevant factors

KAIST study

The start of this research was in close collaboration with the research of Sujin et al (34). They conducted research to elucidate the relation between city variables and the modal split. Like mentioned previously, data from 46 cities was collected. By doing this, three clusters could already be identified based on the use of three kinds of transport modes: private vehicles, bikes, public transit. This functioned as a starting point for the design of the cityzona. For public transit, mainly variables regarding the metro network are used. Meaning that this also applies for the data that will be included in the cityzona. Furthermore, Sujin et al created a hierarchical structure based on the impact of each variable on the modal split of a city (see figure 1). Results showed that the young and elderly rate have the biggest influence on the city type. Therefore, these variables will be included in the cityzona. However, the relation between these variables is still relatively unclear. Therefore, the literature review will help in providing insights into how these variables can have an impact on the modal split.

Socio-demographic factors

Research shows that socio-demographic factors have a significant impact on the modal split. The average hourly earnings and employment rate play a big part in this. Santos G. et al's (2013) paper showed that there is a positive relation between the GDP per capita and the share of cars in the city. Furthermore, Ko, J. et al (2019) explains that policies have different impacts based on the citizens' income [6,7]. High-income commuters showed a tendency to use a car more frequently. The same applies to people that have a self-assessed high social class. These groups can be considered as habitual car users and are therefore less sensitive for moderate interventions to shift the modal split [6, 8]. On the other hand, middle-income commuters are much more receptive towards such interventions [6, 9]. Besides the hourly income, the elderly and young rate of the population has an impact on the modal split as well. While the elderly population currently is more inclined to use public transit or walking [10], it is expected that this will change in the future due to an increased mobility and trip frequency of elderly [11]. This could lead to a higher use of private cars in the future [12]. Moreover, a positive relation was found between the number of students in universities (and further education) and the use of all modes of transport except car use [13]. These papers do not only show that socio-demographic factors affect the modal split of a city, but it also shows that there is a close relation with the successfulness of government policies and strategies for a modal shift and the socio-demographic characteristics of the city [6, 14]. Government policies and strategies, from now on called planning factors, can have a positive impact on the modal split but the effectiveness stands with the fit to the socio-demographic character of the city. Hence, the impact of planning factors cannot be assessed without context. Presumably showing the need for a concept such as a cityzona.

Identification of relevant factors

Environmental factors

The population density of a city can have a big influence on the modal split. The higher the population density, the lower the average distance between residences and the downtown area and the center [20]. This means that the average distance of trips is relatively short. Promoting walking, biking and the use of public transport [6, 21]. Furthermore, in dense urban area's streets tend to be narrower with less space for parking [22]. Next to this, the weather affects the modal split as well. Scholars generally found that precipitation leads to an increased use of cars at the expense of other modes like cycling [23]. The temperature, on the other hand, has some parabolic relation to the use of active modes of transport [24]. Suggesting that a higher temperature increases the use of active modes of transport at the expense of car use while barely affecting the public transport use [23. However, when the temperature exceeds a specific threshold of 25-30 degrees Celsius the use of active transport modes tends to decline.

Planning factors

Despite the previously mentioned relation we want to have a better understanding of what planning factors can play a role in the modal split. These planning factors have a relatively wide scope. Meaning that unlike the other dimensions, many variables can be assigned to planning factors. Research showed that enhancing both quality and quantity of the infrastructure of a specific transport can play a role in increasing the number of users. This applies to both public transit by adjusting the built environment to improve accessibility [15, 16, 17]as well as for private car use by expanding the road infrastructure [18]. Same applies to bike use where there is a positive relation between the amount of bike lane network and bike use [19]. For this reason, we look at both the accessibility and the capacity of the three different transport modes. This means that variables like the bike lane network, road network and metro network in kilometer per square kilometer are used to define the accessibility of transport. In order to include bike-sharing initiatives, the amount of bike sharing stations per square kilometer is taken into account as well. The capacity on the other hand provides an indication on whether the current infrastructure of each mode of transport is able to serve the population. Therefore, for the capacity the amount of bike lane, metro and road network is divided through the population. The variables for public transit are initially focused on the metro network since this mode of transport is present within the 46 cities. However, public transit entails many more modes of transport and the availability of these different options can provide resilience to the use of public transit. Delivering a sense of security when the preferred mode has, for an example, a delay [4].
Finally, the government policies are taken into account. The government attitude can reveal how involved the local government is in promoting a sustainable modal split. Buehler et al's (2011) comparison between German and American cities on their citizens' travel behavior identified variables that have an impact on the modal split. They identified factors that could explain the more frequent use of motorized vehicles in American cities. What is found in Buehler, R et al's (2011) paper is namely that the American tax rates on gasoline and Diesel are relatively lower. Same applies to the price of parking fees [19]. Additionally, the price of monthly public transport fares has a negative relation with the use of public transit [13].

Identification of relevant factors

Orientation

For the design of cityzonas inspiration is taken from the concept of mobility cultures, which is the concept first introduced in Klinger, T. et al's (2013) paper and can be understood as 'an integrative approach incorporating both habitual practices, including underlying preferences and lifestyles, as well as rather objective and structural components such as infrastructure and spatial characteristics' [4, 25]. Klinger et al. (2016) argue that for a proper understanding of the travel behavior and patterns a combination between objective data and subjective data, like lifestyle and perceptions about transport, is needed. Further research on the topic of mobility cultures found factors that contributed to a change of transport made after the relocation of residents to cities with different mobility cultures [26]. This research compared the use of a private car, public transport and the use of bikes. Results showed that car use is the only mode that is affected by urban form, socio-economic factors and accessibility. Cycling on the contrary is related to the overall orientation of cycling and walking [27]. Meaning that if many residents already bike, the relocated resident is more likely to start biking as well.
Even though the cityzona includes quantitative data, it is to some extent necessary to include citizens' perception about certain modes of transport. However, since this paper is limited to quantitative data, substitute variables need to be used that can tell us something about how these three modes are perceived. Therefore, for biking the perceived danger of biking is used. While for public transit and car use variables are used that explain the current situation of these modes. For the variables 'hours lost in congestion' and 'the average commute time with public transit' is used.

Variable selection

The previously explained literature review provides an indication of how the modal split can be influenced. Enabling us to create a selection of variables that can be used to identify different types of cityzonas. However, in order to make the cityzona not overcrowded with data the identified factors need to have a variable importance higher than three (see figure 1) to be included in the selection. This leaves us with the socio-demographic factors: percentage of elderly people (above 65), percentage of young people (below 25), average hourly income and the employment rate.
For the planning factors there is a more comprehensive selection made. Because planning factors is a broad category that includes different aspects, sub categories are made. These categories are accessibility, capacity, resilience and push/pull methods. The accessibility measures how easy it is to get to the infrastructure of one of the transport modes, the capacity says something about how well the current infrastructure is divided over the population, the resilience says whether it is possible to take an alternative transport mode if the preferred mode is late or not available and finally the push/pull methods are the variables that tell us more about what measures the local government takes to promote a modal shift.
The environmental factors leave us with three variables. The average temperature, the population density and the size of the city. The size of the city was extra included to create a better image of the city in respect to the scale.
Finally, the orientation factors have been included in a way that each transport mode is represented. This results in the variables hours lost in congestion, percentage of people that perceive biking as dangerous and the average commute time with public transit.

Identification of relevant factors

Socio-demographic factors

Percentage of elderly population
Percentage of young population
Average hourly income
Employment rate

Planning factors

Accessibility
Metro station density per square kilometer
Road network density per square kilometer
Bike lane network per square kilometer
Bike sharing tation density per area

Push/Pull methods
Public transit fare
Tax on gasoline
Parking fees

Capacity
Bike lane network per population
Metro network density per population
Road network density per population

Resilience
Other services than bus or metro

Environmental factors

Population density

Average temperature

Identification of relevant factors

Orientation

Perceived danger of bike sharing

Hours lost in congestion

Average commute time public transit

The design of the visual layout

The design of the visual layout

Process

After making a selection of the relevant variables and coming a step closer to answering the question: 'Which variables are relevant to include in the cityzona design?' attention is spent on the second question which is: 'How should the visual form of a cityzona look like in order to be inspiring for designers and urban planners?'. In order to answer this, from the selection of variables, the ones that trigger the most inspiration need to be identified. This applies not only for the selection of variables but also how they are visualized within the cityzona. Therefore, a literature review about persona design has been done. Comparing the persona design to a cityzona enables us to translate the essential functionalities of a persona to a higher level cityzona. So, for this section a literature review on persona design is conducted. After this, interviews are used to discuss early designs of a cityzona concept. During the interviews not only the visual layout and level inspiration is discussed. Also, the potential functions are discussed by understanding the design process of mobility or implementation strategies. Finally, the interviews will serve as a further validation for the identified variables. Afterwards a refined version of the cityzona will be made.

Persona: A literature review

Since the citzona concept is derived from the persona, a cityzona inherently fulfills the same functions as a persona. Personas are a well-known design tool being used to get a detailed and as lively as possible description of the target group [28]. This means that a persona should provide insight into behavioral patterns that connect to behavioral variables. Meaning that these variables can be placed on ranges or axis that segment the way a product/service is used [29].
For the cityzona to remain close to the concept of a persona the core elements of a persona should be present within the cityzona. These elements can be explained by three parts. First you have the identity of the user. These normally consist of a combination of regular data like age, sex, place of residence and data relevant for the product or service that one is designing for (e.g., hobbies, profession e.g.). Translating this to the cityzona, the identity of the city would be appropriate. For this the socio-demographic factors can be used. Secondly, a persona explains the attitude towards the product or service that is being designed. Since, the cityzona is not about a specific service or product (yet), we consider the attitude towards the available mobility within the city. Therefore, the planning factors would be appropriate as it says something about how the local government is dealing with the mobility of the city. Furthermore, the orientation factors can say something about how travelers perceive the different transport modes. Finally, a persona normally describes the context in which the product or service is being used. For a city level scale, the context would be the environmental factors (see figure 4).

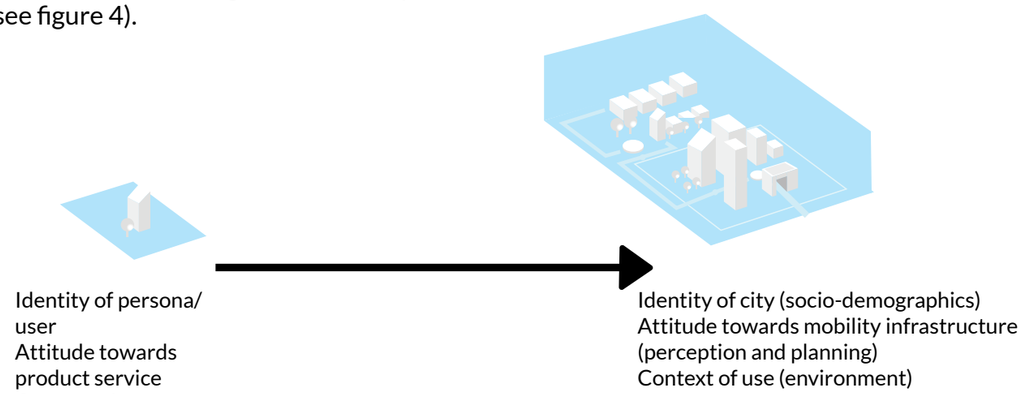

figure 4 Translating elements from a persona to a cityzona

The design of the visual layout

From an individual to group persona

Creating a persona for a city poses a challenge. It means that one must go from an individual persona to a cityzona that contains many stakeholders that influence each other and other elements shaping the characteristics of a city. Research has been done about the notion of both group personas as well as persona ecosystems [30]. Considering the holistic nature of the cityzona the concept of a persona ecosystem would be a better match. This is because a persona ecosystem would approach the city as one entity with a goal that is being influenced by the characteristics and goals of the roles within that entity [28]. A group persona on the other hand, approaches it by defining multiple individual personas. Focusing more on the specific interaction between these individual personas (see figure 2).

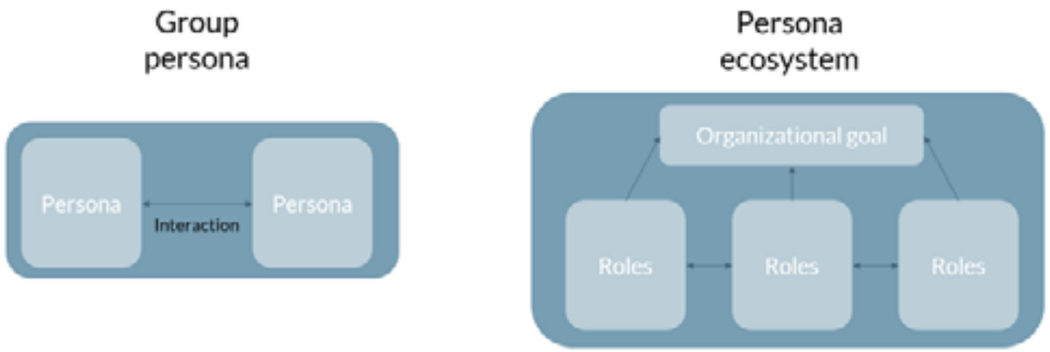

figure 2 Difference between persona ecosystem and group persona— In our paper, we aimed at considering the holistic nature of the cityzona the concept of a persona ecosystem

Quantitative vs Qualitative

Besides this, the cityzona is designed using quantitative data. This brings advantages but also downsides (see figure 3). The benefits are that quantitative data makes the designed persona more representative while the downside is that a quantitative persona might lack the rich information that can inspire designs [31]. Salminen et al., (2020) found that the quantitative persona templates with the richest information had narratives intertwined with the data [31].
However, practitioners found these personas difficult to use (see figure 3). This evidences the importance of considering the layout and categorization of information in accordance with the needs of the researcher or practitioner [32]. Therefore, we hypothesize that the design of the layout of the cityzona should be in close collaboration and interaction with both designers as well as urban planners.

The design of the visual layout

figure 3 Comparison between quantitive and qualitative personas

Insights from the literature review

What can be concluded from the literature review is that for the design of the cityzona three challenges need to be tackled. First of all, the cityzona should convey an image of the city that is detailed enough to be able to imagine how a product/service would be used differently in different cityzonas. Yet, the cityzona should be abstract enough to be able to be representative for multiple cities. This challenge of balancing the design also applies for the type of data that is included. Like mentioned previously, quantitative data can result to an accurate description of the type of city but can lack the depth and richness to be able to design innovative solutions for the mobility landscape. On the other hand, having a too much of a qualitative approach can greatly reduce the representativeness of the cityzona. Especially considering the complex ecosystem of a city, creating a specific narrative of the city will run the risk of leaving out factors that have a high impact on the modal split. Highlighting only a part of the total picture. Therefore, a balance needs to be found between these two elements. Finally, translating an individual persona to a collective cityzona poses the question of how one should look at the cityzona. Perceiving the cityzona as an entity with a vision or goal that is being influenced by other factors or behaviors is for now the most fitting option but has to be further validated during interviews.

The design of the visual layout

First iterations

Before the actual interviews with experts, a set of iterations for the cityzona are made. These iterations explore the balance between the amounts of narrative and quantitive data. The iterations are discussed and altered based on the received feedback during collective meetings with novice and expert designers working in the field of mobility.

he first iteration (see figure 5) focused on visualizing the cityzona purely on quantitative data. Using icons to resemble the different factors. The different layers represent the different dimensions (socio-demographic, planning etc.) that are included in the cityzona. The purpose of this visualization is to make the data of the cityzona easy to interpret by providing a clear overview of each layer and its corresponding data. The hierarchy of the different layers follows the logic of going from the big, the environmental factors, to the small, the individual traveler or the socio-demographic factors. In between there are below environmental factors, the planning factors and below that the orientation factors.

The feedback on this first iteration was that the amounts of symbols reduced the ability to have a clear overview of the data. Furthermore, the levels of hierarchy might not have a logical order. Since the environmental factors might not have the biggest impact. Nevertheless, making it the top layer gives off the impression that it might be the most impactful factor.

For the second iteration (see figure 6) more narrative was provided to the data. Explaining what impact the shown data has on the modal split. Also, the hierarchy was removed. Instead, the four dimensions surround an image of how the city would look like.
Despite, including more narrative the level of 'inspiration' was not yet present according to novice designers working within mobility projects. Potentially indicating that there is a lack of qualitative data in the cityzona. The way the data is presented might be too specific as well. Replacing numbers with indicators of how high or low this factor is might be a good alternative. It could help preventing people to focus too much on the numbers.

The design of the visual layout

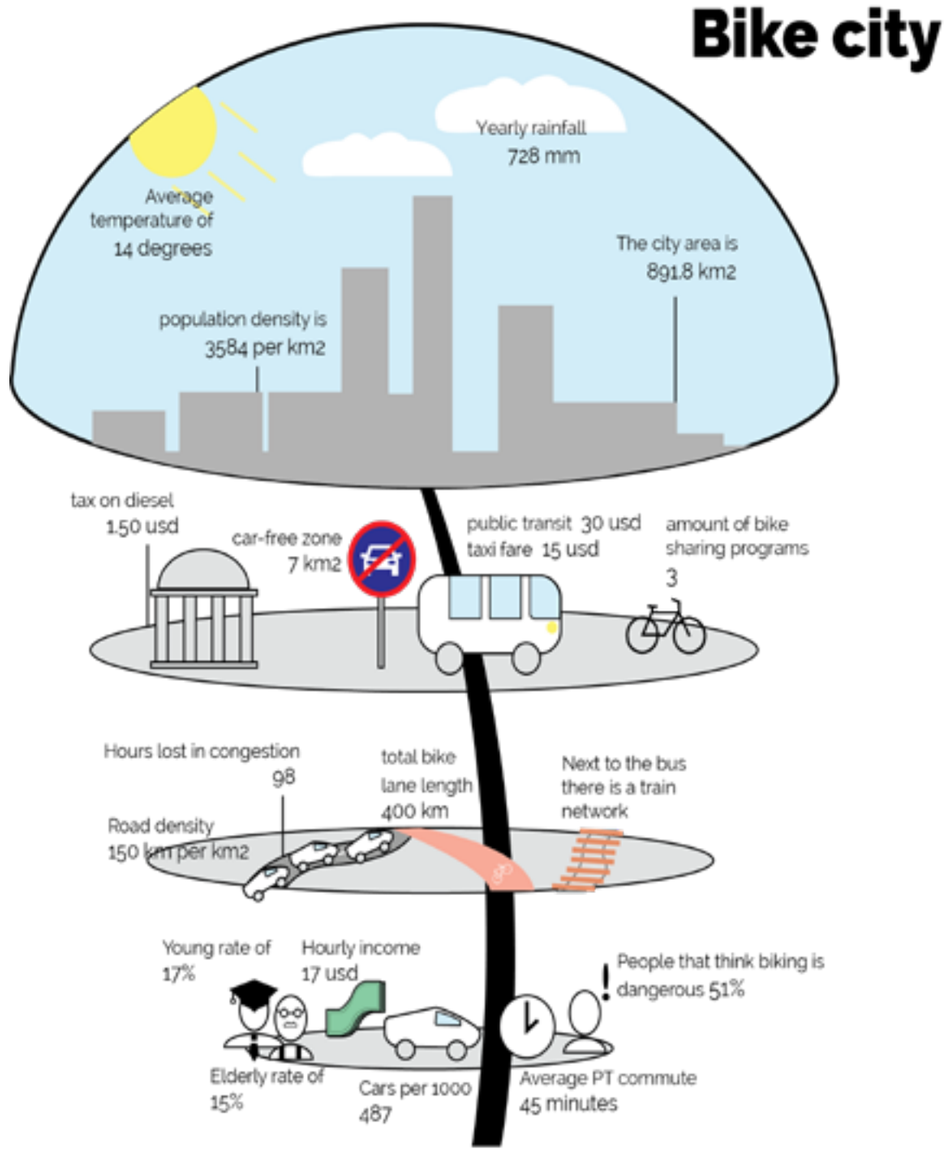

figure 5 the first iteration of the cityzona

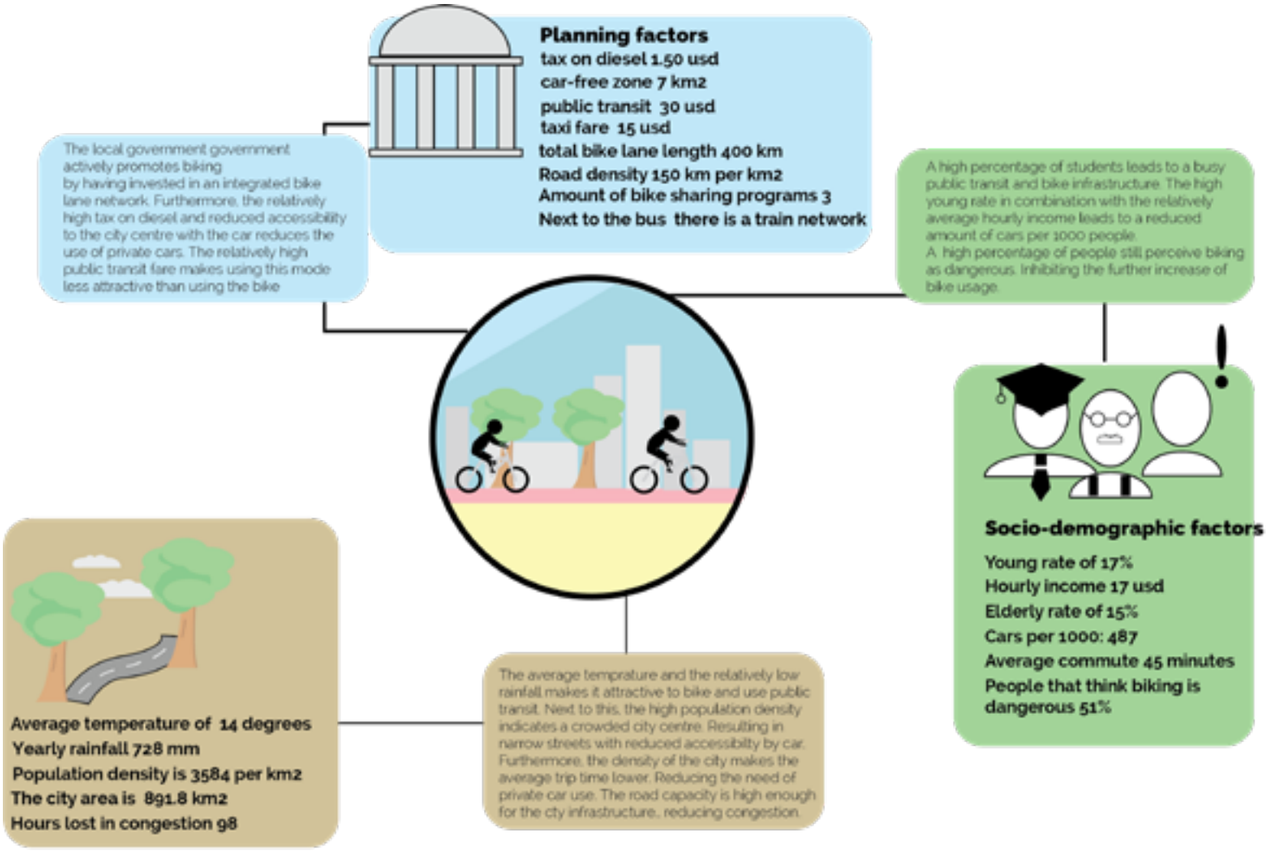

figure 6 the second iteration of the cityzona. Focusing more on including narrative

Interview method

The purpose of these interviews was to initially find where in the process of designing a mobility or implementation strategy this cityzona could have the most potential and actionable impact. Furthermore, the visual layout was discussed to see what kind of data visualization then was the most inspiring for these participants. Finally, the proposed variables were reviewed by the participants, which functions partly as validation. The other part involved exploration to see which kind of data these participants would add if they were to use this cityzona.
For the interviews different versions are made based on a template of the lastest iteration of the cityzona. This, to provide a more conrete image of how this cityzona could look like. The interviews included a 15 to 20 minutes talk about the participants process of designing a mobility strategy. Additionally, there was a discussion of around 15 to 20 minutes about the cityzona.
The interviews have been semi-structured. Meaning that an interview guide has been used during the interviews. However, dependent on the background of the participant different emphasize was placed during some of the interviews.

Participants

We conducted 6 interviews with experts from different fields in mobility and city planning. For the interviews three kinds of perspectives are taken in which the participants can be divided. The first group is called the city planners and local government. This group consists of three participants. One mobility strategist working at a regional level government institute, one urban planner working at a local government that is a part of the region of the previous participant and one urban planner that works at a completely different local government. The second perspective is from the service provider point of view. For this a participant is asked that was working on a long-term implementation strategy for a technical service provider. The third perspective is from the design perspective. For this, two participants are recruited. One participant is involved in the design of holistic city level systems (e.g., the city of things) while the other participant has an expertise in conducting mobility related design projects. Including multiple perspectives was done to explore where and to whom the cityzona could be of most use. Moreover, it provided a way to address both the possible functionalities of the cityzonas as well as discussing the level of inspiration the cityzona would trigger.

Results

The interviews were held in Dutch and are transcribed manually. The quotes used in this section are therefore translated from Dutch. The transcriptions are analyzed using the grounded theory method [33]. In this analysis transcriptions are coded based on returning topics. These codes are iterated with the analysis of the other transcripts. This results in a hierarchical analysis based on the topics that are mentioned the most during the interviews (see figure 4). In order to make a clear distinction between different perspectives, the interviews are divided by the background of the interviewed participants. The results below are discussed in a similar matter.

The design of the visual layout

Urban planners and the local government

Figure 8 shows an overview of how the design process and execution of a mobility strategy looks like according to the interviews. For the sake of readability, the summary of the findings is highlighted in figure 9. The bottom part of the figure includes the coded quotes related to each phase of the process. The codes were categorized in the following topics: Phases of the mobility strategy design process, Stakeholder relations, struggles during stakeholder collaboration, struggles in the decision-making progress, Input used for the design process, Viewing mobility as an ecosystem, Variables and cityzona. The quotes related to 'Variables and cityzona' are analyzed in another figure (see figure 9) as this discussion was not necessarily related to the mobility strategy design process.

When discussing potential functions for the cityzona the topic of multi-stakeholder collaborations came to mind. As described by participant 1 collaborating with multiple stakeholders, specifically other municipalities, makes it difficult to align all stakeholders with the vision and solution direction: 'You need to have a common agreement to actually build something. You can write it in your agenda but that doesn't mean that it is guaranteed that it will be build'. Understanding each other's perspective on the vision can be beneficial, participant 2 explained: 'You have to deal with the fact that some parties benefit more from a specific policy than others. In some cases, you need to make a consideration and a choice with which not every party is happy'. Moreover, knowing the capabilities of the stakeholders you collaborate plays a big role in this. Not being able to agree on the defined vision with stakeholders can delay the process of executing the strategy. Participant 1 said: 'When we get stuck, we need to expand our scope again and re-determine our goal and see if it can be solved in another way'. Also, the collaboration with mobility providers was discussed. Participant 3 mentioned that working with mobility providers is very much a learning process. It forced municipalities to imagine what goal they want to achieve with these mobility providers, participant 3: 'We needed to think what purpose do we have with this. And how much (bike sharing programs) do we want and to which standards should they (mobility providers) live up to? That they make sure that the vehicles are not scattered around in the public space. That they will not hang next to a lamp post. That is when agreements or some borders were made for new entrees'.. The variables used in the cityzona showed resemblance with the variables used by the participants: 'The things that you now show in your visual (cityzona) are all aspects that we use as well to match our mobility strategy to. So, we also know very well what the modal split is and which modal split we would like for the future'. An aspect to the cityzona that can be considered relatively new is the inclusion of socio-demographic factors. Participants elaborated that currently they look at travel behavior in the sense of how people move and to which places. To an extent neglecting the underlying reasons for their travel behavior, like for example the socio-demographic characteristics. Furthermore, feedback was provided on the level of abstraction of the cityzona.

figure 8 result of the analysis of the process of designing a mobility strategy, the execution and roadblocks

The design of the visual layout

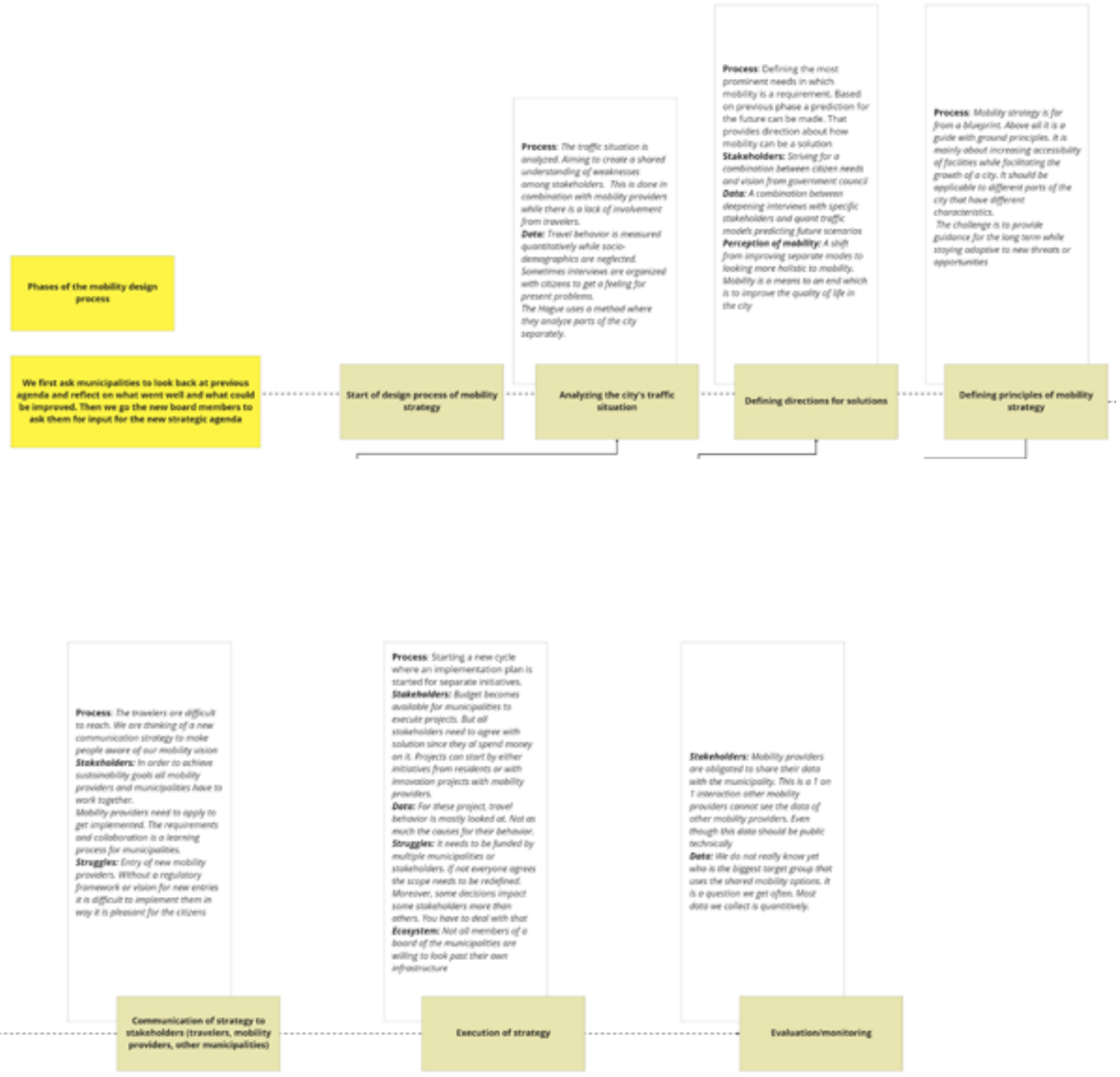

figure 9 General findings from interviews with urban planners and local government categorized by topic and design phase

The design of the visual layout

Service provider

What became evident is that the implementation process is mainly driven by the potential market. Participant 4 elaborated: 'It is actually that they first look at what is technologically feasible and what is a little desirable, but they do not look at what the values or regulations of a specific city is.' Furthermore, it was discussed that they often make initial assumptions about the city on which the service provider bases pilots on. When looking at the cityzona the most value is placed by the participant on being able to clearly see differences between cityzonas. It can function as a tool that helps service providers not to look at only one market to see if it fits, but instead help them to see how their service could potentially fit in different types of cities: 'I think there is even more power in it for an organization that wants to see how their product or service fits within a different kind of market'. For the same reason there was also a greater interest in variables like the perceived danger of biking. These more 'qualitative' variables provided newer insights for the service provider. About this topic participant 4 said. Finally, the option to see what the city's goals are and where this city is going in the future was discussed as an interesting feature for service providers.

Value in comparison

think there is even more power in it for an organization that wants to see how their product or service fits within a different kind of market."

Starting with a mismatch

I think they make a lot of assumptions. They make these assumptions and based on that they start a pilot project."

Perception and culture might be of more value

"I think there is more value in it if you have depth with this cityzona. For example, the fifty one percent of people perceiving biking as dangerous. That is interesting to me'.

The design of the visual layout

Mobility and design experts

In comparison with the other interviews, these interviews focused above all on the inspiration aspect of the cityzona (see figure 11). Often a comparison was made between personas and the current cityzona. This resulted in the feedback that the current cityzona leans towards a mapping of the situation with a lack of knowing why it happens. Furthermore, a discussion about the focus of the cityzona was held. Currently, there is a focus on the modes of transport but this could be shifted towards the travelers. Meaning that more qualitative data should be included. Participant 5 elaborated on this: 'You now look from the perspective of the transport modes, which is good, but you could also translate it to the user of those modes. So, who are those people and who are the people that decide that (which modes are used)? Besides focusing the data on the traveler, the way, the cityzona is being visualized can also have more emphasis on the traveler or city. Suggestions were made to see the city as a user. Even having a quote from the city included in the cityzona.

Show there the city comes from

'How would you come from one situation to a future situation where a city can be called a biking city?'

Qualitative over quantitive

'you could also translate it to the user of those modes. So, who are those people and who are the people that decide that (which modes are used).'

Visualize the city as a user

'What are the needs of the city and tensions come with them. On one hand more green but on the other... I don't know but it could help to categorize the cities in this way'

The design of the visual layout

Towards a refined cityzona

Functionalities

The results of the interview provided two main functionalities (see figure 11). From the government perspective the cityzona can be a communication tool with either other municipalities, or travelers. The purpose of the cityzona would then be in the early phase of the design process of a mobility strategy to communicate the current state of the city infrastructure to start a discussion with travelers or other municipalities about possible solution directions for the future. Understanding each other's perspective and coming to a shared understanding of a vision for the city infrastructure can provide a smoother execution of the mobility strategy later on. Next to that, the cityzona could work as a connection tool between mobility provider and local government. Being able to communicate the needs and desires of the city to a mobility provider makes the mobility provider more aware of where they could make a positive impact in the city. Making the implementation of these providers in the city smoother. Something that, according to the interviews, was something that local governments have struggled with in the past. This could also be done from the perspective of the mobility or service provider. Meaning that the second functionality would be focused on the service provider. In this case the cityzona's value is expressed in emphasizing on the differences between types of cityzonas. The purpose of the cityzona then has an explorative nature. It could benefit service providers in their exploration or brainstorm phase. Making the designers at the service provider imagine how their service should be redesigned if they were to implement their service in different cityzonas. Besides being an exploration tool, it will also help in including the city's needs and desires early on the development process. Since, according to the interviews, the feasibility and desirability of individual users are often analyzed while larger context in which the service functions might be neglected.

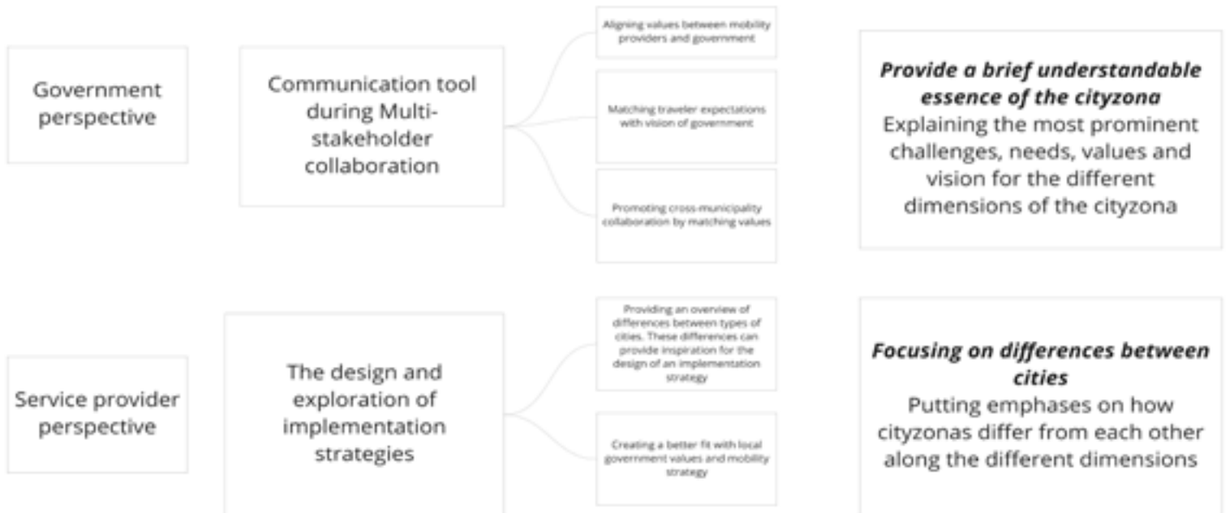

figure 11 Identified functionalities for the cityzona. One from the government perspective and the other from a service provider perspective

The design of the visual layout

A need for qualitative data

Feedback about the cityzona was mainly directed towards the variable presentation and its quantitative nature. More depth and also potential for inspiration could be gained when qualitative data is visible. Also, when considering the potential functions for the cityzona, one might argue for the need of qualitative data. Being able to convey how the city got in the position they are now and what their goal is for the future will be more valuable for both service providers and mobility strategy designers than only showing the quantitative data of the current situation. Therefore, it is a matter of creating more depth. Understanding why the provided data shows these numbers and how the city wants to see these numbers in the future. This provides insight for especially service providers, whether it is and how it could be a sustainable choice to implement in this type of city. Furthermore, it can help designers or an urban planner to identify the underlying problems of this type of city. Creating solutions or strategies that have more value for the city context. Like mentioned in the interviews, this could mean that the city should be seen as an entity with their own goals and needs. However, travel behavior plays a big role in this as well. Like visible in the study of Sujin et al. (34), the demographics of a city plays a heavy role on the most prominent travel behavior in the city. Therefore, it can be said that the travel behavior plays a role in the city's desires and needs. For this reason, we should not only look at the qualitative aspect of the city but also the desires and needs of the major traveler groups of the city.

Refining the cityzona

Clustering

In order to include more qualitative data, an analysis of the studied cities' mobility vision and indices are conducted. These were collected from the government websites and deloitte's mobility index page. The mobility strategies were clustered based on the nature of the city (bike, public transit, car). In this way within the three clusters overlap could be found in their goals for the future. Same applies for the mobility indices. These were collected and put together based on the three clusters. Comparing the strengths and challenges of the indices in one cluster showed that there are similarities between some of the indices. The ones that showed similarities on either the strengths or challenges were connected. These connections were given a name (see figure 12). Doing this for every cluster group left us with 7 different cityzona types based on their strengths and challenges. Two for the bike cluster, two for the private vehicle cluser and three for the public transit cluster. These types were than combined with the overlapping mobility visions from the mobility strategy analysis. This resulted in the following outcomes:

figure 12 Found topics by clustering and comparing mobility indices. From top to bottom: Private vehicle cluster, bike cluster and public transit cluster

The design of the visual layout

Crowded city (public transit)

This type of city with a high use of public transit has problems dealing with the increasing population. The high density of the city created a culture where walking and cycling is normal. The government accommodated this by having built a city-wide bike lane network. Using public transit is a popular way of traveling as well. The transit fares are quite affordable, but the current infrastructure cannot handle the amount of people during peak hours. On top of that the railway and road network deteriorate fairly quickly because of the extreme weather conditions that occur every year. Because of the lack of capacity travelers are increasingly buying cars. Therefore, the government is focusing on improving the metro and train network to be able to handle the peak hours. Next to that, they are heavily investing in new kinds of travel modes to relief the pressure on the existing modes.

Mind over Matter city

This type of city already has a high use of public transit. The infrastructure is well-covered across the city with multiple modes of transport. Also, the ticketing system is integrated well. Making multi-modal travelling possible. Nevertheless, there is a high use of private cars. The biggest cause for this is that this city deals with a lot of urban sprawls. This resulted in a lot of long distance traveling between this city and its satellite cities. Even though there are trains going to the city and some ride-sharing models are present, people are very skeptical about it. Breaking this stigma and shifting the mindset of these travelers is the biggest challenge of this city. Therefore, the city is investing a lot in private-public collaborations. Trying to make these kinds of ridesharing models more attractive and to increase the awareness of the benefits. Next to that they are busy expanding the public transit infrastructure. Closing the gap to the satellite cities. Finally, a big point in their vision is to make the city center more pedestrian and cycling friendly. As if currently, there is little to no room on the streets for these kinds of travelers.

Innovation through emergency cities (public transit)

Unlike the other public transit cities, this city had to figuratively fight private car use. The high level of car use caused a lot of congestion and air pollution within the city. Therefore, the city decided to invest a lot to greatly improve the public transit infrastructure. This led to an integrated ticketing system equipped for multi-modal travelling. Also, the connection between modes of transport is connected well. The government is constantly investing to increase the reliability of the transport modes as well. Besides this, they are constantly looking to make travelling with a bike or on foot more interesting. They are even reducing the amount of parking spots in the city center. Despite all their efforts there is still a lot of congestion. Meaning they are constantly looking for innovations that could improve the attractiveness of using other modes than the private car.

The design of the visual layout

EV enthusiast city (car city)

This city has a high use of cars and does not necessarily want to reduce this. The lack of investing into public transit pushes people to the use of cars. There is no clear road division for other modes of transport either. This results in high congestion rates. Nevertheless, this city aims to improve the situation by making electronic vehicles popular. There is a lot of development and regulation around electronic, even autonomous buses. This seems to work as there is a high adoption of electronic vehicles. Furthermore, the city is aiming to accommodate private car use in the surroundings of the city with a good connection between bus routes, walking and cycling options in the center. The introduction of sharable modes like bikes and e-scooters contribute to this as well

PT potential city (car city)

This city has a lot of potential to become a public transit city, since there is a high demand. However, the supply cannot really keep up with it. Reducing the reliability of public transit during peak hours. Next to that, there is also a lack of connection and integration between different modes. This would be especially important as there is a lack of housing near the city center. Meaning that people have to travel long distances to get to their work. The city tries to tackle this by accommodating micro-transit within the sub-urbs of the city, which is quite popular with the citizens. There is also a high adoption of ride-sharing models. For the future this city aims to create a better connection between the sub-urbs and the city center by investing in the public transit network. Furthermore, they are testing with bicycle fleets and pedestrian infrastructure to promote healthy transport.

The innovators and push city (bike)

These cities are taken together, since they are quite similar. Both cities have a high share of bike use. The main challenge for this city is that public transit is not very well distributed across the entire city. This means that some parts of the city are less accessible than others. Both cities are quite involved with smart mobility companies. Analyzing traffic data to get a better understanding of what is going on in the city. As this city as many bikers a lot of bike share providers are willing to enter their market. This might face challenges as these cities struggle with having an oversight and creating regulation for these kinds of companies. The difference between these cities is that the innovator's city's bike use is related to smart mobility companies that are present in this city. The bike use of the push city on the other hand, is created by heavy promotion and investments by the local government.

The design of the visual layout

Cityception

Next to the lack of qualitative data, feedback was about the idea of presenting the whole city infrastructure as one type of city. Interviewees made the point that a city includes many different zones with different kinds of people, available modes of transport etc. Therefore, making an overview of the mobility landscape of the entire city can result in a too abstract image of the city. Making it difficult to go into depth when discussing the cityzona. So, recognizing different zones within the cityzona could help in creating more depth. For this reason, the decision is made to include smaller 'city zones' within one cityzona. City zones represent specific parts of a city like for example the sub-urbs or the historic city center. Since one can distinguish many city zones within one city a selection must be made about which city zonas should be included. These city zones can be selected based on which zones are the most relevant when designing a mobility strategy or implementation strategy for the city.

Figure 13 some example of the city zones. Including socio-demographic, plannign and environmental variables about the zones

The design of the visual layout

The refined cityzona

Like mentioned previously the 7 types of cityzonas are the starting points of the refined cityzonas. In this way the qualitative aspect is central to the cityzona. Therefore, the left half of the cityzona is used for the city or local government's perspective. It shows what the city is currently dealing with, what their strengths are and what they are doing for the future of the city. As this might be the most important aspect in terms of conveying the values and 'feeling' of the city. Additionally, a quote is placed at the bottom left of the cityzona. This quote is written like it is said by the city. The function of this quote is to quickly give the reader an impression of the city's priority.

Furthermore, the left half provides some information regarding environmental factors. This also serves the purpose to provide the user a holistic image of the city. It shows a map that shows the locations, the size and the population density of the most prominent city zones in the cityzona. Besides that, underneath this section the modal split is provided. Including the modal split of the city is essential to inform the user about the travel behavior of the city. However, from a design perspective the modal split of the entire city is too general to inspire designers of the cityzona. Therefore, the modal split is visualized in a small matter.

While the left half of the cityzona provides an image of the entire city, the right half goes more into depth. The right half explains more about the city zones that are included. An image is provided to help users understand how this city zone looks like. After that, the socio-demographic factors of each zone are explained. As these factors have shown to have the most impact on the modal split (34). The same axes for the socio-demographics are used as in the previous cityzona iteration. This is because interviews proved that this element of comparison that the axes bring is quite valuable. These factors are complemented with key insights about the travelers in that zone. Adding qualitative data to the quantitative socio-demographic factors adds more richness to data. It can say more about how these variables impact the travel behavior. Finally, for each zone the planning factors are provided. These consist only of the accessibility, capacity and resilience of the three modes of the transport. The push/pull factors are left out as these are already to some extent reflected by the city's strength, weaknesses and vision. These planning factors are used to get insight in the current situation of each transport mode within that zone. The variables are visualized in a three-point system. Where three points mean that for example the accessibility is very good while one point means it is bad. The reason for using this point system is that the variables are meant to provide an indication of how well this specific aspect is doing. Preventing users from going too deep into analyzing the numerical data. Figure 14 provides an example of the cityzona called the EV enthousiast.

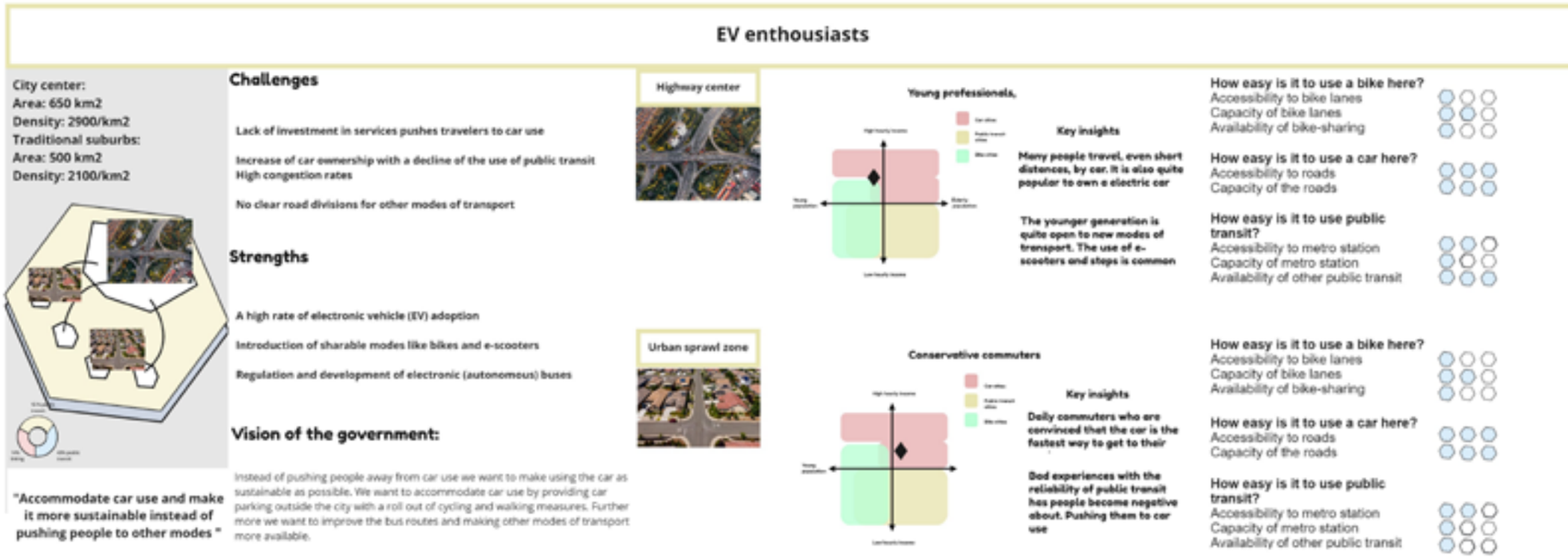

Figure 14 an example of the refined cityzona. The electric vehicle enthousiast

Testing functions

Testing functions

Process

After determining the visual layout and identifying two possible functions, the cityzona needs to be tested to see if the visual layout fits with the two possible functions that were found. In order to find out co-creation sessions will be organized with designers. In these sessions the designers will play around with the factors that are present in the cityzona to create their own layouts for the cityzona. The participants are given tasks related to the two identified functions to see if they would create similar layouts as the cityzona designed by us. Next, to that these co-creation sessions will tell us which of the functions are easier to fulfill with the cityzona. Finally, the sessions will provide us with possible new factors that could contribute in further specializing the cityzona to one of the functions. The sessions will be analyzed by looking at the results of the assignments and from notes made during discussions with the participant about the assignments. The results of this analysis will be used to validate the layout of the current cityzona and to determine the function with the most potential for the cityzona.

Co-creation method

The goal the co-creations sessions are to understand how the layout of the cityzona could change based on which functionality it serves. During these sessions participants had to do 5 different assignments that made the participants design cityzona layouts from different perspectives. One session lasted around one and a half hour. In total two sessions were organized. After each assignment participants were asked to explain their layout and a discussion was held about how easy or difficult each of the assignment was

The first assignment involved a basic brainstorm session in which three topics were given: personas, different modes of mobility and what influences travel behavior. The assignment was that every 3 minutes a participant needs to choose one topic and try to write as much as they know about this topic. This assignment functioned as an ice breaker and provided insight into the knowledge level of the participants. After this assignment the participants got three tasks. First the participants were asked to think of a city of which they are familiar with the mobility landscape. After this the participants were given an empty white box with the factors presented in colored boxes that are present in the current version of the cityzona. Each dimension (environment, perception, planning, socio-demographics) had a different color. This in order to able to analyze which kind of dimension would be used most. The assignment was to think about which factors would best describe their own perception of the mobility landscape. They could choose a maximum of 8, so that they had to prioritize factors, and had the possibility to create own factors as well. As long as they categorized them in one of the existing dimensions. Furthermore, they could enlarge or shrink the boxes dependent on how important the participant ought the factor to be.
For the second assignment they were introduced to an electric scooter sharing company called Yego. An explanation was given about where these scooters are already implemented, how large their fleet is and how the process of renting a scooter works. After this, participants were asked to brainstorm about what Yego would want to know about their chosen mobility landscape if they would want to redesign their service and implementation strategy. This provided the participants with insights about the considerations a mobility provider would make and prepared them for the next assignment.
For the third task, the participants had to go back to their visual from assignment 1. They received the question what they would change if they were designers for Yego and they needed to redesign

Testing functions

their service. In this way they took another look at their cityzona with a different perspective.
Finally, the participants were asked to imagine that they were working on a regional mobility strategy design and their chosen mobility landscape is a part of this region. So, for this assignment they needed to figure out which factors would be useful to communicate the mobility situation of their city to other municipalities. In other words what factors would be important when the cityzona is used as a communication tool.
After the workshop, the last version of this research's cityzona was presented to discuss how it should look like.

Participants

Both sessions included a group of three novice designers. One difference between these groups is present. One group is namely working on mobility related projects while the others do not have any significant knowledge about mobility. In this way we will receive insights in whether designers outside the mobility sector would have a different take on cityzonas. The choice to include only designers is based on the assumption that understanding the concept of a cityzona is easier for these participants. Since, they are already quite familiar with the topic personas. Hence, making an easier connection with cityzonas. This knowledge will also be tested in the first assignment

Results

The results were analyzed by looking at the size of the surface of each dimension (see figure 16, 17, 18). By comparing the size of each dimension an idea of the distribution of factors can be made for the cityzonas. Next to that, the type of factors that were used are analyzed. Factors that were used more than twice are noted above the corresponding surface. In this way, we know which dimension is most prominent in each cityzona as well as which factors of that dimension is used the most. The cityzonas from the regular novice designers are separately analyzed from the cityzonas of the designers that are working on a mobility related project. This in order to make the previously mentioned comparison.

Testing functions

Surface analysis

The first assignment showed that between groups there is a shared agreement on the importance of the planning factors. However, the group involved in mobility projects has a higher perceived value towards the traveler's perception on the available mobility.

For the second assignment there is less of an agreement about which dimensions are important to include. The mobility group weighs the perception dimension and environmental factors much heavier than the other dimensions while the other group remains to see the planning factor as the most impactful. Nevertheless, both groups seem to have a preference for the perception dimension in this second assignment.

The third assignment gave very different results. Here the mobility group rearranges the factors to have the environmental and planning factors to be the most important while the perception became the last one. The other group did the opposite and made the perception dimension the most important. Across all assignments the socio-demographic factors were used the least by both groups. The planning factors and to some extent the perception dimension was perceived the most important across both groups.

Content analysis

Looking at the specifically used factors, in the first assignment the capacity and accessibility of the road network is frequently mentioned as an in the second assignment (cityzona for the redesign of the scooter service) this factor turned into the target area per specified area in the city. Moreover, the needs and desires of the traveler became more important in both groups. A noticeable difference is that the mobility group was more focused on the needs and desires of the traveler, while the other group included more factors concerning the accessibility and capacity of the bike lanes and road network.

Also, the city's mobility vision was added as quite an important factor in this group while the mobility group did not mention this at all. For the final assignment, where the cityzona is used as communication tool, both groups went different directions. The mobility group chose overall quite general factors like the modal split, the city size and the indication of different areas. The other group on the other hand, focused a lot more on the qualitative aspects. Choosing the city's mobility vision, the strengths and challenges of the city and the needs and desires of the travelers.
When discussing the assignments participants explained that the second assignment was considered to be the easiest. Possibly indicating that this function is a better fit for the cityzona. Furthermore, participants explained that the design of such a cityzona is difficult. Explaining that all factors are to some extent connected with each other. This made it difficult for participants to prioritize factors. Nevertheless, the participants realized the usefulness of the cityzona. Especially the ability to compare cityzonas between each other was deemed valuable. One participant mentioned the importance of including the city's mobility vision for the scooter provider: 'For the scooter company it is convenient to know where this city wants to go in the future. It provides insight into how implementing in this city can be sustainable'. Furthermore, a discussion was held about the factors being dependent on the stakeholder that uses it. Meaning that scooter providers would need slightly different factors than for example bike providers.

figure 16 the results of the co-creation session. Own perception assignment

figure 17 the results of the co-creation session. Mobility provider assignment

Testing functions

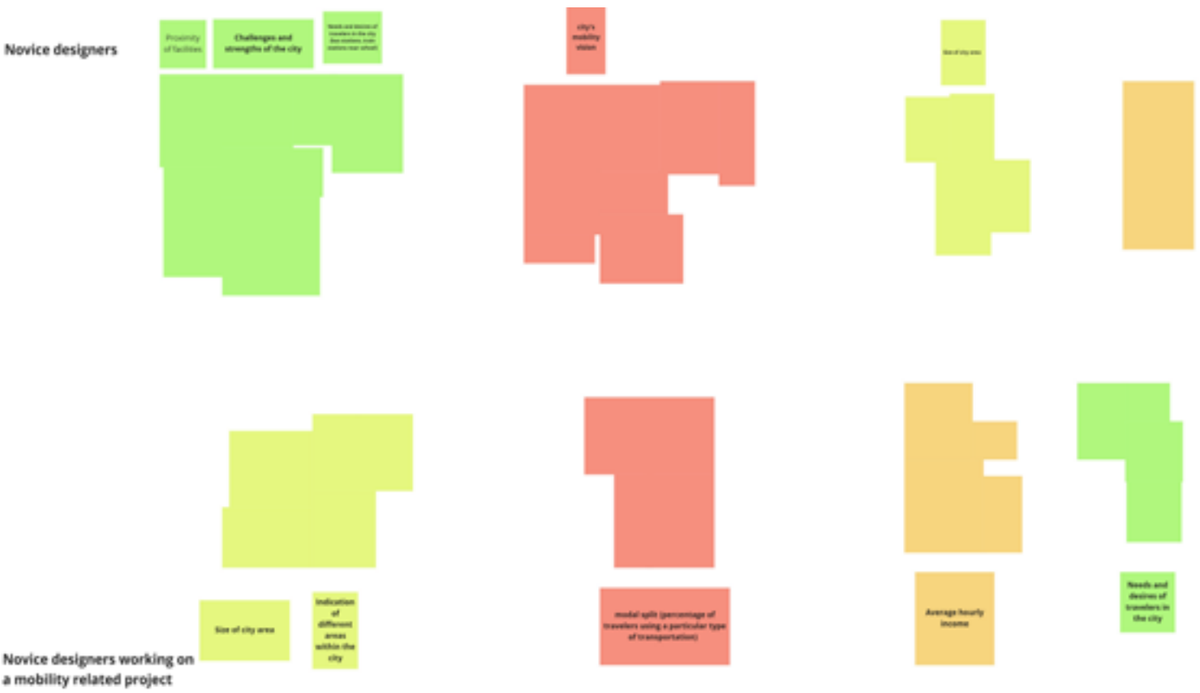

figure 18 the results of the co-creation session. The government assignment

Testing functions

Planning and perception

The co-creation sessions showed that in the majority of the assignments the planning and perception factors are considered most important for the cityzona. The fact that the perception is perceived important validates the feedback from the interviews and the addition of qualitative data to the cityzona. Moreover, this result validates the current layout of the cityzona where the perception and planning factors are the major elements of the cityzona. Also similar to the co-creation sessions, the socio-demographic and environmental factors play a less signifact role on the effectiveness of the cityzona.
Next to that, the factors concerning the capacity and accessibility of the road and bike lane network seemed to be paired with the travelers needs and desires. Suggesting that the combination of these factors can provide a lot of insight for the participants to use when design for their chosen city.

A tool for service providers

While discussing the level of difficulty of each assignment with participants it became apparent that the assignment with the e-scooter was considered the easiest among both groups. Reasons for this were that the objective and goal of the service provider was more clear to them. Next to that, the concept of the scooter provided them more ideas for variables that are relevant to know for a scooter provider. Enabling them to go more into depth about the topic. This applied for both groups. Meaning that potentially there is more prospects for the cityzona to go into the direction of the service provider.

City zones

An interesting outcome of the co-creation sessions were that some participants across groups included additional factors that talked about splitting the variables up into different zones within the cityzona. Meaning that without guidance from the facilitator, designers could come up with this option. In this way the layout of the cityzona was further validated without this even being the specific goal of the co-creation session.

Conclusion

Conclusion

Summary

While most mobility providers likely have a sustainable or environmentally friendly goal at heart, a poor implementation strategy can do more harm than good within a city. The lack of awareness about the city's environmental, socio-demographic or socio-economic characteristics or the absence of a clear vision of the local government about how to deal with new mobility providers plays a crucial role in this [3]. The design of a new tool called 'cityzona' can aid in creating a better connection between local government and mobility provider by making urban planners or designers more aware of the relations between variables influencing the modal split but also by improving the communication about the city between stakeholders. Making the involved parties aware of the contextual environment. In this paper the first steps of designing the cityzona were taken by answering the three following questions: 'Which variables are relevant to include in the cityzona design?', 'How should the visual form of a cityzona look like in order to be inspiring for designers and urban planners?', 'In which use cases could the use of a cityzona potentially make a beneficial impact?'.

Which variables are relevant to include in the cityzona design?

The first question was initially answered by doing a literature review (see table 2). Later, the feedback during interviews resulted in the addition of qualitative factors like the travel behavior, perception and the government challenges. These were added in order to create more depth to the cityzona. Shifting the cityzona from a factsheet to an entity with needs, desires and goals of the future. These perception factors replaced the orientation factors since these factors did not deem very impactful for the interviewees. Besides the qualitative data, another way that created more depth is to include different city zones within the cityzona. Showing planning, environmental and socio-demographic factors for each city zone gives a better indication of the dynamics that play in the city. Providing data per city zone was eventually also validated during co-creation sessions. Where participants did a similar thing without guidance from the facilitator.
The used variables in the cityzona are to an extent validated but more research can be done into different perspectives of the most prominent stakeholders in the city. This means the perspective of the local government and the different kinds of travelers. Next to the previously discussed qualitative, cultural aspects could play a role in this as well [19]. However, more research needs to be done into what cultural factors play a role in the travel mode choice before being able to include this within the cityzona.

How should the visual form of a cityzona look like in order to be inspiring for designers and urban planners?

Interviews have shown that understanding the differences between cityzonas can be a source of inspiration. Meaning that the individual cityzona needs to emphasize its characteristics in an almost archetypical way. This enables designers to explore directions that their service can go into if they would want to implement this service in different types of cityzonas. Adding the qualitative data to the cityzona also helped in creating more inspiration for the cityzona. Depicting the cityzona as an entity with a goal and challenges makes it possible to differentiate it from other cityzonas. Making it

Conclusion

easier for service providers or other local governments to see if this type of city would fit with their own values. Finally, the layout has been validated through the co-creation sessions. As the majority of participants selected the planning factors and perception factors as most important in a cityzona. Furthermore, the city's mobility vision was selected as a returning important factor. Similar to the cityzona of this research.

In which use cases could the use of a cityzona potentially make a beneficial impact?

The third question is answered by the identification of two functions for the cityzona. On the one hand, the cityzona could be used as a tool by governments in the early phase of the mobility strategy design process. It can be used to start a discussion with stakeholders (travelers and other municipalities) about their perception of the current infrastructure of the city. Aligning expectations and creating a shared vision for solutions. On the other hand, the cityzona showed promise in the exploration phase of service providers. Being able to recognize different types of cities and understanding how their service needs to be changed in order to be successfully implemented. The co-creation sessions showed most potential in the latter. Designing a cityzona for this function deemed easier than with other functionalities. Furthermore, the use of qualitative aspects is to some extent validated as well. Since, they were chosen frequently across both groups in the co-creation sessions. Also, the division of different areas within a cityzona has found itself to be useful during the sessions.
Overall, the cityzona shows potential. Howver, the concept needs to be tested further in practice to get a better idea of the impact this concept can make.

Discussion

The participants

The 6 interviews have indicated that the cityzona has potential for two different functions (see figure 5) that are focused on different users. However, more interviews are needed with both urban planners as service providers to assure the cityzona's potential in these functions. Especially, since currently there has only been input from one service provider. So, being able to discuss the cityzona with more service providers will greatly improve the validation of the cityzona.
Despite this, co-creation sessions gave insight into how the cityzona could serve these functions. Next to that, considering that the participants are novice designers, the outcome of the sessions cannot be fully validated. Further testing and development should therefore be done with expert designers. Nevertheless, these sessions provided insights into how the cityzonas could be altered to better suit one of the functionalities

More research in the qualitative data

Besides the functionality both the interviews as well as the co-creations have shown that there is a relevance to the selected variables and the division of multiple areas within the cityzona. The addition of qualitative data provided more depth to the cityzona. Potentially increasing the amount of inspiration, it can trigger for the designer or urban planner that uses it [31]. Nevertheless, more research can be done about the qualitative aspects (e.g., culture and perception) that influence the modal split of cities. Being able to identify which of these variables make an impact will contribute to improving the qualitative layer of the cityzona.

Future research

Finally, the visual aspect has been a returning topic in the design of the cityzona.
to spark inspiration while remaining holistic enough to be representative for multiple cities. This balance also lies with the chosen factors for the cityzona. As discussed during the co-creation session, some chosen factors can be highly dependent on the type of stakeholder that uses it. Altering these factors can open up the use of cityzonas beyond the scope of mobility. Assisting designers with for example smart city services. These directions remain open and could be implications for future research.

Reflection

Comparing this project to the last large project I did individually, which was my final bachelor project at the University in Eindhoven, I have to say that I was able to execute this project with a lot more structure. Creating order from chaos was the topic of the first weeks. The direction of the project was quite vague at the beginning. Making me try and explore many directions that this project could go into. The discussions with my chair and mentor helped to get an eventual plan for this project. After that the plan was quite clear with only minor changes down the road. The collaboration with my chair and mentor was pretty good. The bi-weekly meetings made sure that there was enough to discuss. Because these meetings were not that frequent, I was able to compensate that by having weekly meetings with the seamless personal mobility lab in which I could talk about the decisions I was facing. Besides this I also had bi-weekly meetings with other graduation students. These also helped in providing the necessary feedback on my project. I noticed that the help from other students and seeing their work as well, has been very valuable. Especially in times where you work from home without seeing anyone else working on their graduation project. It does not only help you to improve your project, for me it also functioned as a way to keep me motivated. These meetings were moments in the week that almost functioned as deadlines in my head. Enabling me to work towards these meetings. I also learned that changing the place where you work also helped in maintaining your motivation. Working from home can be a quite distracting. Therefore, I regularly decided to go to local libraries. Such a new setting helped in getting into that work mode which is sometimes difficult to turn on when I am working at home.
Looking at the goals I had at the beginning of this project, I am quite proud of myself. Especially, that I was able to reach the goal of submitting a paper for a conference during my green light meeting. I can also say that I have gotten quite comfortable working in mobility projects. Not only because my project was about city-level mobility. But also, by being involved and seeing the projects of others at the seamless personal mobility lab I got insight in how these projects and stakeholders think about mobility solutions. What I noticed that I could improve when working individually on a project is the fact that I keep adjusting and altering aspects of the design or the thesis. Making it more time and energy consuming than it would have been. Being critical and iterative is a good thing and improves the quality of my work. But I believe a better balance can be generated. What could help in this is asking feedback more frequently. Letting other people judge the quality of what I have can help me in getting more quickly satisfied with what I already have made.

References

References

[1]Een Europese Green Deal. (2019, 12 oktober). Europese Commissie - European Commission. https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal_nl
[2]Shared mobility and MaaS - Regulatory challenges of urban mobility. (2020, 4 december). CERRE. https://cerre.eu/publications/shared-mobility-and-maas-regulatory-challenges-urban-mobility/
[3]Ngo, H. (2021, 13 januari). Why some bike shares work and others don't. BBC Future. https://www.bbc.com/future/article/20210112-the-vast-bicycle-graveyards-of-china
[4]T., Kenworthy, J. R., & Lanzendorf, M. (2013). Dimensions of urban mobility cultures–a comparison of German cities. Journal of Transport Geography, 31, 18-29.
[5]Deloitte City Mobility Index. (2020, 2 oktober). Deloitte Netherlands. https://www2.deloitte.com/nl/nl/pages/publieke-sector/articles/deloitte-city-mobility-index.html
[6]Ko, J., Lee, S., & Byun, M. (2019). Exploring factors associated with commute mode choice: An application of city-level general social survey data. Transport policy, 75, 36-46.
[7]Soltani, A., Pojani, D., Askari, S., & Masoumi, H. E. (2018). Socio-demographic and built environment determinants of car use among older adults in Iran. Journal of transport geography, 68, 109-117.
[8]Storme, T., De Vos, J., De Paepe, L., & Witlox, F. (2020). Limitations to the car-substitution effect of MaaS. Findings from a Belgian pilot study. Transportation Research Part A: Policy and Practice, 131, 196-205
[9]Ahanchian, M., Gregg, J. S., Tattini, J., & Karlsson, K. B. (2019). Analyzing effects of transport policies on travelers' rational behaviour for modal shift in Denmark. Case studies on transport policy, 7(4), 849-861.
[10]Cao, X., Mokhtarian, P. L., & Handy, S. L. (2007). Residential and travel choices of elderly residents of Northern California (No. 1428-2016-118583).
[11]Hjorthol, R. J., Levin, L., & Sirén, A. (2010). Mobility in different generations of older persons: The development of daily travel in different cohorts in Denmark, Norway and Sweden. Journal of Transport Geography, 18(5), 624-633.
[12]Haustein, S. (2012). Mobility behavior of the elderly: an attitude-based segmentation approach for a heterogeneous target group. TranInturri, G.,
[13]Santos, G., Maoh, H., Potoglou, D., & von Brunn, T. (2013). Factors influencing modal split of commuting jorneys in medium-size European cities. Journal of Transport Geography, 30, 127-137.
[14]Ashalatha, R., Manju, V. S., & Zacharia, A. B. (2013). Mode choice behavior of commuters in Thiruvananthapuram city. Journal of Transportation Engineering, 139(5), 494-502.
[15]Ignaccolo, M., Le Pira, M., Caprì, S., & Giuffrida, N. (2017). Influence of accessibility, land use and transport policies on the transport energy dependence of a city. Transportation research procedia, 25, 3273-3285.sportation, 39(6), 1079-1103.
[16]Kenworthy, J. R., & Laube, F. B. (1999). Patterns of automobile dependence in cities: an international overview of key physical and economic dimensions with some implications for urban policy. Tran
[17]Zhang, Y., Zheng, S., Sun, C., & Wang, R. (2017). Does subway proximity discourage automobility? Evidence from Beijing. Transportation Research Part D: Transport and Environment, 52, 506-517.
[18]Santos, G., Behrendt, H., & Teytelboym, A. (2010). Part II: Policy instruments for sustainable road transport. Research in transportation economics, 28(1), 46-91.
[19]Buehler, R. (2011). Determinants of transport mode choice: a comparison of Germany and the USA. Journal of transport geography, 19(4), 644-657.
[20]Naess, P. (2003). Urban structures and travel behaviour. European Journal of Transport and Infrastructure Research, 3(2).
[21]Scheiner, J. (2010). Interrelations between travel mode choice and trip distance: trends in Germany 1976–2002. Journal of Transport Geography, 18(1), 75-84.

References

[22]Cao, X. J., Næss, P., & Wolday, F. (2019). Examining the effects of the built environment on auto ownership in two Norwegian urban regions. Transportation Research Part D: Transport and Environment, 67, 464-474.
[23]Böcker, L., Prillwitz, J., & Dijst, M. (2013). Climate change impacts on mode choices and travelled distances: a comparison of present with 2050 weather conditions for the Randstad Holland. Journal of Transport Geography, 28, 176-185.
[24]Aultman-Hall et al., 2009 L. Aultman-Hall, D. Lane, R. Lambert. Assessing the impact of weather and season on pedestrian traffic volumes
[25]Haustein, S., & Nielsen, T. A. S. (2016). European mobility cultures: A survey-based cluster analysis across 28 European countries. Journal of Transport Geography, 54, 173-180.
[26]Klinger, T., & Lanzendorf, M. (2016). Moving between mobility cultures: what affects the travel behavior of new residents?. Transportation, 43(2), 243-271.
[27]Gutiérrez, M., Hurtubia, R., & de Dios Ortúzar, J. (2020). The role of habit and the built environment in the willingness to commute by bicycle. Travel behaviour and society, 20, 62-73.
[28]Giboin, A. (2011, February). From individual to collective personas modeling realistic groups and communities of users (and not only realistic individual users). In The Fourth International Conference on Advances in Computer-Human Interaction (ACHI 2011) (pp. 132-135).
[29]Miaskiewicz, T., & Kozar, K. A. (2011). Personas and user-centered design: How can personas benefit product design processes?. Design studies, 32(5), 417-430.
[30]Matthews, T., Whittaker, S., Moran, T., & Yang, M. (2010). Collaboration personas: A framework for understanding & designing collaborative workplace tools. In Workshop" Collective Intelligence In Organizations: Toward a Research Agenda." at Computer Supported Cooperative Work (CSCW).
[31]Salminen, J., Guan, K., Nielsen, L., Jung, S. G., & Jansen, B. J. (2020, July). A Template for Data-Driven Personas: Analyzing 31 Quantitatively Oriented Persona Profiles. In International Conference on Human-Computer Interaction (pp. 125-144). Springer, Cham.
[32]Dos Santos, T. F., de Castro, D. G., Masiero, A. A., & Junior, P. T. A. (2014, June). Behavioral persona for human-robot interaction: a study based on pet robot. In International Conference on Human-Computer Interaction (pp. 687-696). Springer, Cham.
[33] Schmidt, C. (2004). The analysis of semi-structured interviews. A companion to qualitative research, 253, 258.
[34] Lee, S., Lee, J., Hiemstra van Mastrigt, S., Kim, E. Y. (2021). What cities have is how people travel: A modal split framework by evaluating the influence of environmental, socio-demographic, and planning factors.