Reimagining the smart allocation of road space in Amsterdam for fairness

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Executive Summary

Roads are currently governed by relatively static rules communicated via road signs, road surface markings and navigation apps. However they could also be dynamic, allowing road space to be allocated for a multitude of activities over time. The *Code the Streets* project envisions a digital system for managing urban mobility in Amsterdam that would allow for this dynamic allocation of road space. Road rules are intended to be used to foster specific civic values such as livability or sustainability within the city. But how do we ensure fairness within such a system? This project explores how we can reimagine the smart allocation of road space in Amsterdam for fairness. Fairness is framed within this project as an ideal that cannot be reached but can be approximated through continuous adaptation. Inspired by literature on contestable AI, the continuous adaptation of the system is approached through stakeholder participation. The project relied on research in the form of literature review, expert interviews, and hands-on experimentation as well as the review of related design work. This research inspired design goals and criteria for the project's design outcome: a system map and a speculative prototype. The map presents a system in which stakeholders have substantial influence over the values that the system and its design process foster. The speculative prototype, a low-tech user experience installation, makes parts of this system tangible and presents a provocative proposal for an alternative perspective on the current practice of road space allocation. The project ultimately produced several insights contributing to existing literature in the fields of public AI and design methodology research as well as delivering recommendations for *Code the Streets*.

Table of Content

Chapter 1

Introduction

This chapter provides an overview of the project's context and induces its scope. The first section, the *Project background*, introduces the context of roads in the city of Amsterdam (The Netherlands). The section further introduces recent trends of alternative road use sparked by the Covid 19 pandemic as well as the topic of smart urban technologies and their relationship with societal values. Lastly, the *Code the Streets* project is introduced. The second section, the *Project brief*, builds on this background information to establish the project scope. The general project orientation and problem definition are defined before introducing the research question and the foreseen outcomes. Lastly, the overall process for this project is presented.

1.1. Project background

Roads and road use in the context of Amsterdam

The road network of Amsterdam consists of a variety of roads of all shapes and sizes, from the highway that surrounds the larger city area, over the arterial roads, to a web of neighbourhood roads and historic bridges (see figure 1). Many of the roads in Amsterdam are considerably shaped by the city's historic evolution and have their own unique layout and character. Especially inner city roads, which have their roots in a time before motorised traffic, are often tight and therefore favour walking and cycling over large streams of cars (Grooten & Kuik, 2010). Figure 2 gives an impression of different types of roads in Amsterdam today. The road scene was characterised by people and non motorised means of transportation up until the early 20th century (see figure 3). The car centric vision adopted in Amsterdam in the 1950s and 60s (see figure 4) clashed with the existing infrastructure of the city (TEDx Talks, 2016). Faced with plans to radically change the historic layout of the city as well as increasing negative effects of car traffic, Amsterdammers protested (see figure 5). Other forms of transportation were rediscovered during the car free Sundays (see figure 6) held during the Oil crisis in the 1970s (Bicycle Dutch, 2013). Today, Amsterdam is commonly considered one of the leading cities when it comes to stepping away from car based transportation in favour of other means of transportation such as cycling. In 2017, 78% of citizens relied on bicycles (35%), walking (24%) and public transport (19%) to move through the city on workdays (Gemeente Amsterdam, 2019). While visitors of the city still frequently rely on cars to move to, from or within the city, the overall statistics show that car use is declining while cycling and public transport are becoming more popular.
Roads are of high economic value for the city, creating commerce for businesses, as well as contributing to the liveability and accessibility of neighbourhoods (see figure 7). They are key factors for the attractiveness of city areas for people and companies alike (Gemeente Amsterdam, 2013). Overall, traffic appears to remain an important challenge for Amsterdam in the years to come. Despite an upsurge in flex working and home offices driven by the Covid 19 pandemic (Voermans, 2020), traffic is expected to continue to grow in the foreseeable future (Gemeente Amsterdam, 2021b). The municipality of Amsterdam has made plans towards a transition to sustainable and healthy mobility and improve the liveability of streets as the density of the neighbourhoods increases (Gemeente Amsterdam, 2021b). These plans include the use of smart traffic management technology and envision the city as a testing ground for mobility and traffic management innovation (Kruisweg et al., 2020).

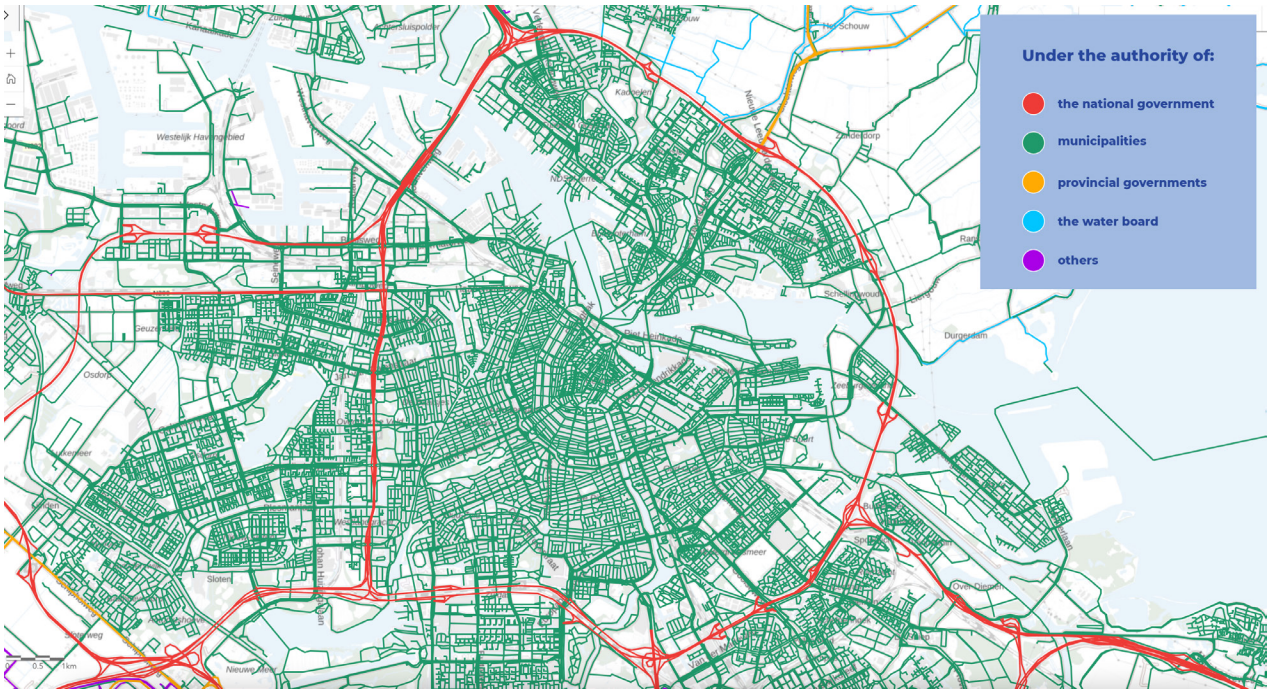


Figure 1: Overview of the road network of Amsterdam. Tinted in red are the highways encircling Amsterdam and connecting the city to the rest of the country. Green lines are city roads, from larger arterial roads to small neighbourhood alleyways. The green streets are under the authority of the municipality (Rijkswaterstaat).

Figure 2: Impressions of different types of roads in Amsterdam. (Google Street View).

Figure 3: Streets of Amsterdam before widespread advent of car-based traffic (Nationaal Archief).

Figure 4: Roads of Amsterdam dominated by cars in the mid 20th century (Nationaal Archief).

Figure 5: Amsterdammers protest the car-related spike in traffic incidents in the 60s and 70s (Nationaal Archief).

Figure 6: Amsterdammers rediscovering alternative road uses during the car-free Sundays established during the 1973 oil crisis (Nationaal Archief).

Figure 7: Businesses use the side of the road to cater to customers who enjoy a sunny day in Amsterdam (left, Gemeente Amsterdam). Comparison between different modes of transportation and the related expenditure (right, Gemeente Amsterdam).

Covid as a catalyst for the alternative use of road space

The spread of the Covid 19 pandemic has changed people's travel habits in Amsterdam and across the world profoundly. Working from home and travel restrictions meant that mobility almost came to a halt. Instead of the usual bustling traffic, roads were suddenly empty (see figure 8), from the inner-city roads of Amsterdam (Amsterdam Magazine, 2020) over the famously crowded Ginza crossing in Tokyo (Japan) and to the notoriously congested Los Angeles (USA) highways (Morton, 2020). The sudden halt caused citizens and cities across the world to reconsider mobility (EIT Urban Mobility, 2021) and to reframe their mindset towards how we use public space (Stevenson et al., 2018). Amsterdam and many other cities such as Berkeley (USA) and Wuhan (China) have allowed restaurants and bars struggling with financial losses during the pandemic to expand into squares, parking spots and traffic lanes, transforming them into outdoor gastronomy spaces. Cities also turned roadside parking spots or entire roads into recreational areas. Amsterdam made it easier for its citizens to demand road closures in their neighbourhoods and to turn their street into a so-called *Holiday street* (Gemeente Amsterdam, n.d.a). In Oakland (USA), the *Slow Streets* initiative closed off several streets for car traffic and made them available as public outdoor space (Martin, 2020). In New York City (USA), yoga classes and dance shows were held on what used to be busy roads only a few months prior (Pistarino, 2021). Similar road closings have been put into practice in Barcelona (Spain), Paris (France), Auckland (New Zealand), Seattle (USA) and many other cities (Colarossi, 2020). Figure 9 shows alternative, temporary road uses introduced during the Covid 19 pandemic. Suddenly, road use was not pre-

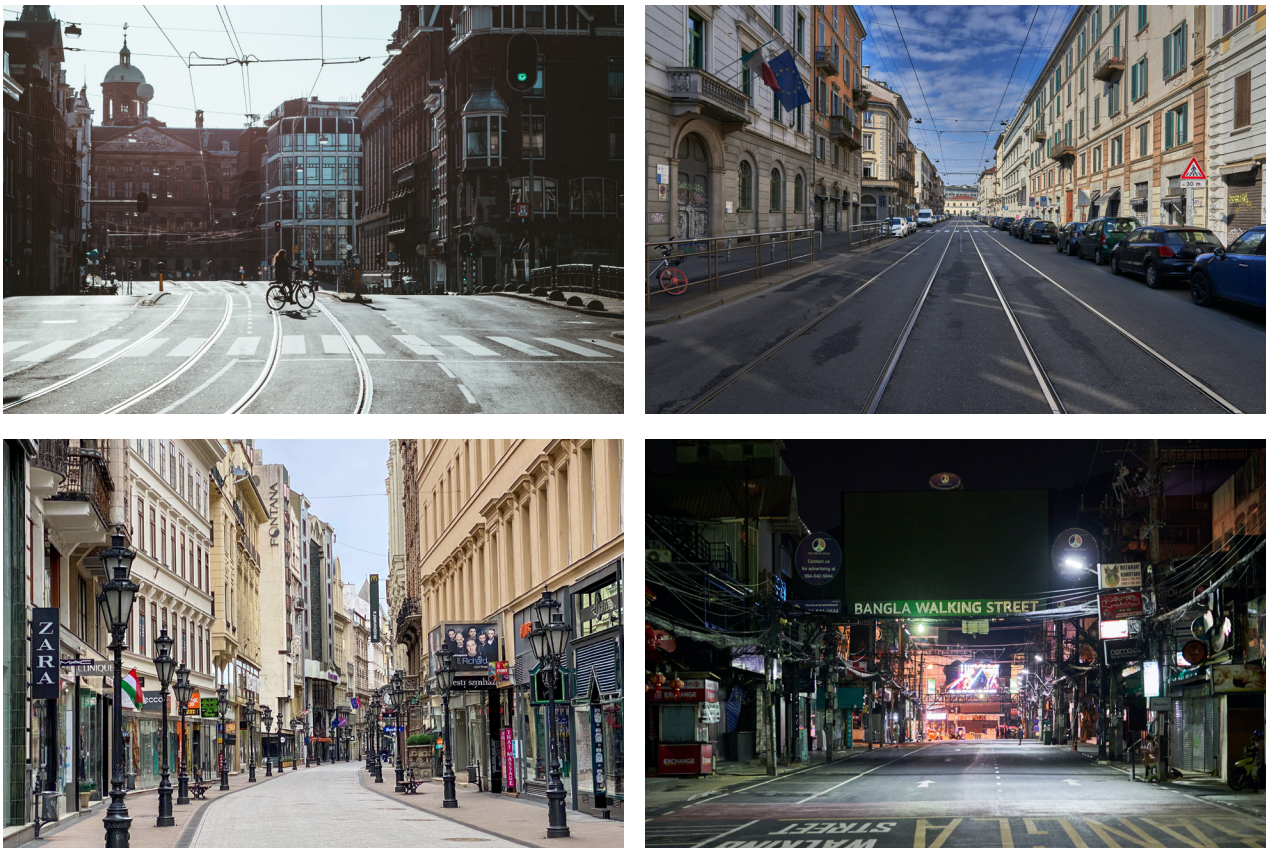


Figure 8: Empty streets during the pandemic in Amsterdam (top left, van den Oetelaar, Unsplash), Milan, Italy (top right, de Paola, Unsplash), Budapest, Hungary (bottom left, Gerbec, Unsplash) and Phuket, Thailand (top right, Braun, Unsplash).

scribed by the usual ideals of efficiency and optimization. Roads were turned into public spaces for citizens to enjoy. Thereby fostering an entirely different set of values than previously, favouring above all physical and mental wellbeing. These transitions that have gained traction during the pandemic (Ratti, 2020; Civic Square, 2020) are bound to shape our cities and lives for years to come. The city of Milan (Italy) has made plans to relocate 35km of street space to cyclists and pedestrians (Laker, 2020). Citizens of Barcelona (Spain) are currently invited to sign the *Manifesto for the Reorganisation of the City after COVID-19* which entails among other things, a call for the reorganisation of mobility and naturalisation of the city (Paolini, 2020). In Amsterdam, the project *The Meantime* (in Dutch *De tussentijd*) was started by the municipality to investigate how citizens rediscovered and reinvented the public space during the Covid crisis and what can be learned from this for future urban planning (Redactie openresearch.amsterdam, 2021).

Figure 9: A *Holiday street* in Amsterdam (left, Willem D A Laros). Chairs and plants occupying a traffic lane during the pandemic in Berlin, Germany (right, Davide Casale).

Cities, Smart technologies & values

Cities play a key role in dealing with today's political, social, economic, and environmental challenges. Many of the wicked problems society is facing agglomerate in cities (Concilio & Tosoni, 2019). In light of these challenges, cities increasingly invest in smart technologies and aim to become so-called smart cities. Smart city initiatives see cities collaborate with the private sector to deploy smart technology aiming to improve governance and urban life through efficiency and optimization (Ranchordás, 2020). The focus on efficiency, corporatization and technocratic governance of the smart city paradigm has received substantial criticism (Ranchordás, 2020). According to Martinussen (2018), the smart city comes from a technology optimistic and individualistic mindset that can be in stark contrast with cultural values present in a specific geographical area. Martinussen states that "...a first step should be to address the digitalisation of cities and societies as a debate about societal values, culture and democracy" (Martinussen, 2018). Similarly, Hill (TEDx Talks, 2020) argues that cities are made to come together and to create community, culture and commerce. Technologies and infrastructure should be the enablers, not the end goal (TEDx Talks, 2020).
How smart mobility solutions may favour the needs of individuals whilst creating externalities that undermine societal values can be seen from the example of navigation apps. While naviga-

tion apps can be handy for finding our ways across a city, they also allow individuals to behave according to their own personal desires which can work against the common good. Using real time traffic data, these apps suggest the quickest route to get to the destination. This allows people to outsmart others by taking shortcuts, but also creates traffic on neighbourhood roads that used to be calm (Bliss, 2019) and that were never designed to handle through traffic (Madrigal, 2018). As the popularity of navigation apps increased, so did the traffic on these roads and the associated negative impacts: from physical and mental wellbeing of the residents to the values of properties (Bliss, 2019). Similar to Hill's (2018) point about certain mobility as a service solutions (Mobike's and Ofo's floating bike sharing offerings and Lime's and Bird's e-scooter), this example illustrates that most navigation apps work for the individual but not for the city.

The Code the Streets project

Code the Streets brings together cities, mobility providers and academic institutions to create new mobility management tools (Van Sprakelaar, 2021). The core idea behind *Code the Streets* is to enable cities to set rules about the desired use of road space based on the cities values and to communicate these rules to service providers and people in the street (L. Leermakers, personal communication, November 26, 2021). *Code the Streets* is an *EIT Urban Mobility* project. Partners are among others: the Municipality of Amsterdam, the Amsterdam Institute for Advanced Metropolitan solutions (AMS Institute) and Delft University of Technology (TU Delft) (see figure 10). In Amsterdam, the current focus of the project lies on developing and piloting the *Social route* concept which aims to stimulate car users to choose alternative routes designed to foster the collective good (Amsterdam Institute for Advanced Metropolitan Solutions, n.d.a).
For the long-term future, *Code the Streets* and the city of Amsterdam envision a digital system for managing urban mobility that would allow traffic rules to be dynamic, changing throughout the day, month or year. The system is proposed to be *grey* or value neutral. Values prevalent at a given moment in time are intended to be *plugged into the system* and used to determine the road rules. *Code the Streets* thereby intends road rules to be set according to the prevalent societal values at a given point in time (L. Leermakers, personal communication, November 29, 2021). The system is envisioned as a digital public infrastructure and its overall structure can be described in four layers (G. Kortuem, personal communication, September 17, 2021):

- A city wide digital infrastructure, which allows the enforcement of dynamic rules that govern the use of public roads.
- A set of dynamic rules that are intended as digital manifestations of values.
- Touch points and interfaces through which citizens experience the rules.
- The mobility behaviour exhibited by road and transport users as a result of their perception and understanding of the rules.

One potential application for this system is to enable roads to be used for a variety of temporary activities by setting dynamic road rules. This could allow the municipality to steer the use of public space in a way that contributes to societal values (L. Leermakers, personal communication, November 29, 2021).

Figure 10: The partners of *Code the Streets* (AMS Institute).

1.2. Project brief

Project orientation

Initially, the project was loosely framed around the alternative use of road space. The *6R framework* by Kim et al. (2022) illustrated by figure 11 was used to make sense of the current context of alternative road use and to find a meaningful orientation for the project. The *6R framework* was chosen for this orientation process as it can guide explorations of approaches to systems-level change in highly uncertain situations such as the previously introduced effects of the Covid 19 pandemic on road use (Kim et al., 2022). Analysing the context through the lens of the six approaches proposed by the *6R framework*, it appears that the Covid pandemic has driven cities and people across the world to *reframe* their mental model about what streets are for and *repurpose* road space to serve their needs. Examples such as the *Slow street* or *Holiday Street* initiative show that a plethora of projects dedicated to an alternative use of road infrastructure already exist. These initiatives appear to be part of a broader trend towards a dynamic use of road infrastructure. On the horizon of this trend are projects such as *Code the Street*'s long-term vision which *reimagines* a whole new conception of roads and traffic governance. Based on this analysis, the project is proposed as a case study within *Code the Streets* long term vision of a digital public infrastructure focused on the dynamic allocation of road space in the city of Amsterdam. The research and design activities are carried out in scope of the approach *reimagine* of the *6R framework* (see figure 12). *Reimagine* entails to imagine something anew, considering alternative futures that include radical system change (Kim et al., 2022).

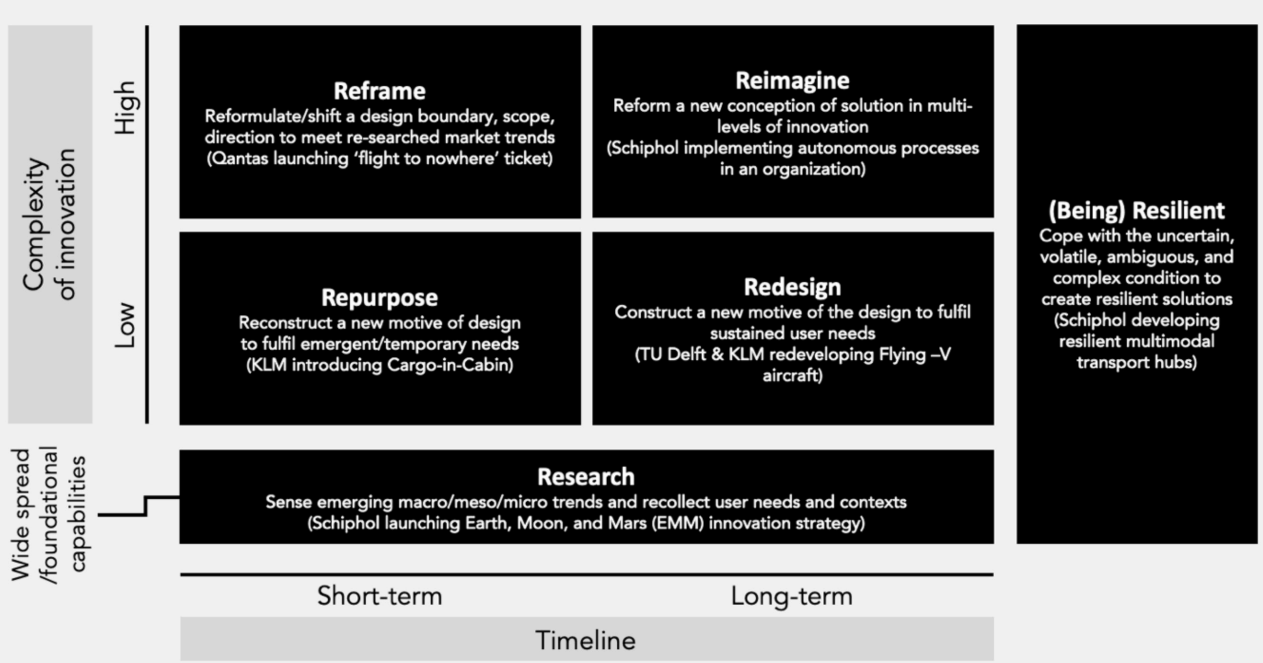


Figure 11: The *6R framework* (Kim et al., 2022).

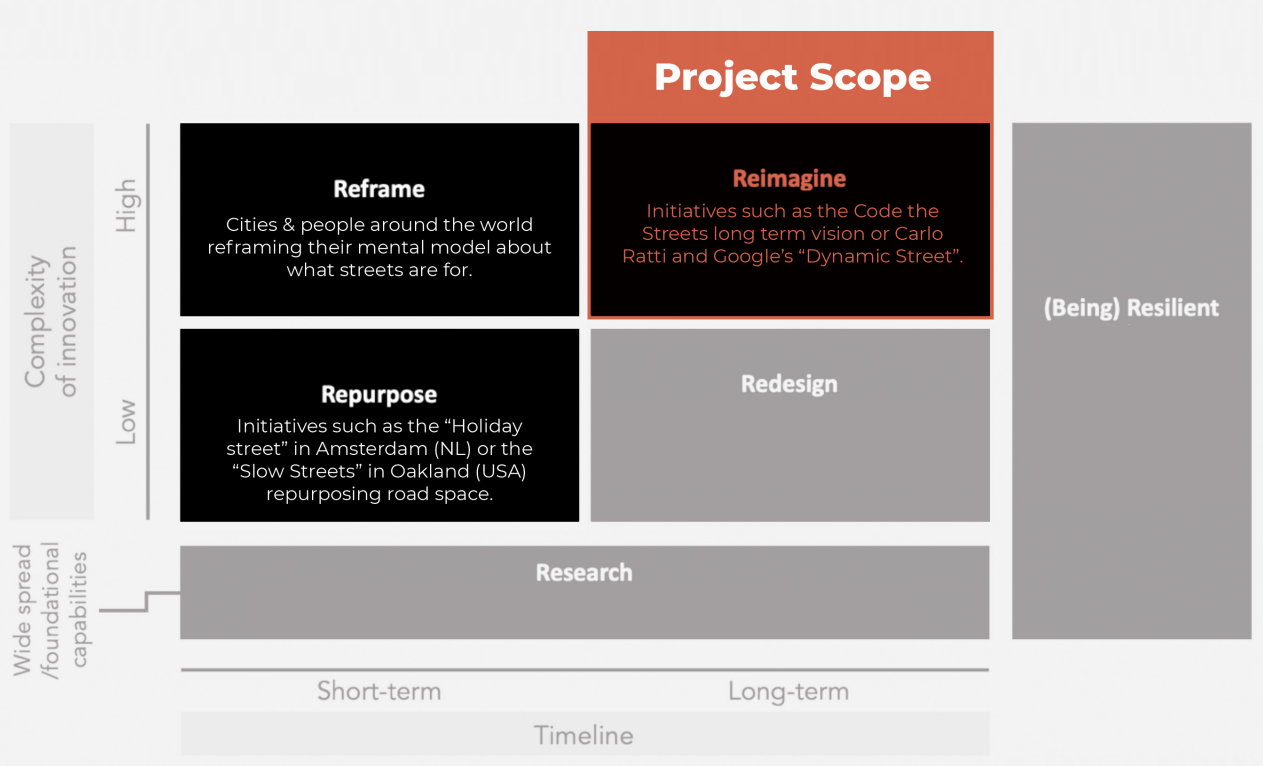


Figure 12: Defining the project scope using the *6R framework* (own visualisation based on Kim et al., 2022).

Problem definition

Imagine that there is a system that dynamically allocates road space. In the morning, it could allocate space for delivery vans unloading their goods. And in the evening it might allow the people living in the street to organise a barbecue. *Code the Streets* envisions that rules governing the allocation of road space are manifestations of values. But what values should govern the allocation of road space? And based on what considerations should the system itself be created? The *Sidewalk Labs* by *Google* has been working together with *Carlo Ratti Associati* to develop *The Dynamic Street*, a system that can communicate changing rules and allow for the dynamic use of road space. Willa Ng, director of mobility at the Sidewalk Labs declared in an interview that we need to "allocate that space fairly, and not just to whoever has the loudest voice" (Quirk & Jafe, 2020). Yet what is meant by fair allocation of space and how we can design a fair system governing the allocation of space remains undefined. According to Bowles (2020), striving for fairness might be a dead end as "any definition of fairness will be unfair from a different perspective. We must choose intelligently and consider the potential consequences and externalities of your choices." This shows that there is a need to carefully consider the mechanisms and their fairness behind the system responsible to continuously re-allocate road space. And ultimately, this represents an opportunity for valuable research and design work.

General research question

How can we reimagine an urban traffic management system governing the dynamic allocation of road space around civic values in the context of Amsterdam?

Foreseen outcome

- A system map describing the assemblage of mechanisms that are necessary to govern the allocation of road space according to values.
- A speculative prototype in form of a low-tech user experience installation illustrating the reality that the mapped out system implies.
- Design recommendations for Code the Streets.
- Design knowledge.

Process outline

The project initially started off with desk research focused on the context of roads in Amsterdam and the stakeholders affected by changes in the allocation of road space (see figure 13). This was accompanied by a pressure cooker in which the methods and approaches used in the project were explored hands-on. The results from these research activities are shown in chapter 3 *Initial research*. Related literature and design work was reviewed throughout most of the project, informing further research activities as well as inspiring design work. The related literature and design work, including the design approaches Value Sensitive Design (which informed several of the research activities such as the aforementioned exploration of stakeholders) and specu-

lative design, are presented in chapter 2 *Related work*. Further research activities include desk research focused on studying the current participatory practices in the context of Amsterdam shown in chapter 4 *Stakeholder participation in Amsterdam* as well as interviews presented in chapter 5 *Expert interviews*. These research activities contributed to early concept iterations and informed the design goals established in chapter 6 *Synthesis* based on which the final designs were created.

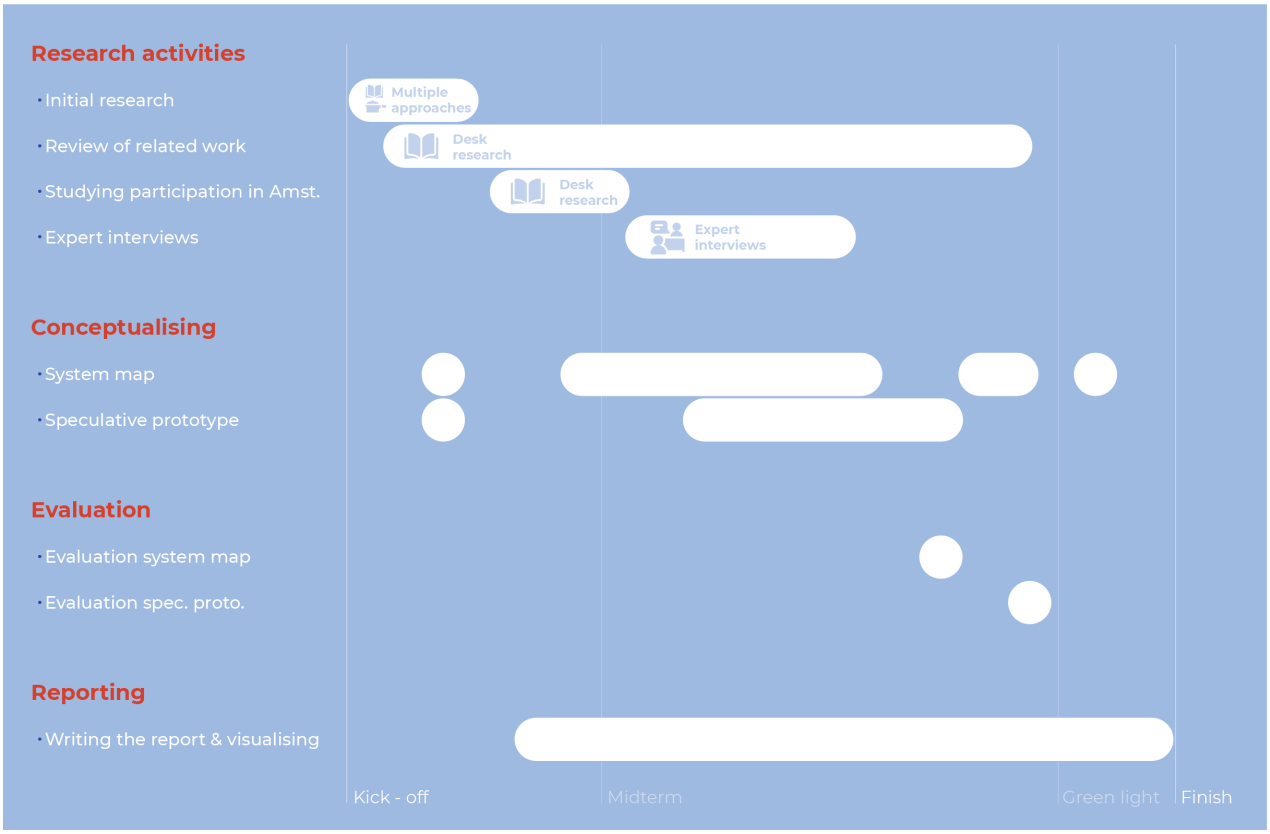


Figure 13: Overview of the project from kick-off to finish (icons from Freepik on Flaticon).

Chapter 2

Related work

The review of related work presented in this section is rooted in the research questions presented in the introduction. The initial literature review carried out was focused on operationalizing values for design, design for value change, adaptability and fairness. Based on the obtained insights as well as recommendations by experts given at later stages of the project, additional literature review was carried out focusing more specifically on fairness in relation to smart systems and stakeholder participation. The findings from these research activities are followed by a review of related design work. The chapter ends with a reflection on the key insights derived from the review of related work.

2.1. Design approaches

This project builds on two design approaches: Speculative design and Value Sensitive Design. This section explains the core concepts behind both approaches and provides reasoning about why these approaches are used.

Speculative Design

Speculative design is rooted in critical thinking and uses design as a medium to create discourse about potential futures (see figure 14) or alternative presents (Dunne & Raby, 2013). This approach is about breaking free from the constraints of the present or industry and to provoke a sense of imagination in both designer and viewer (Boeijen et al., 2020). This indicates one of the main differences to many other design approaches; in speculative design, the user is replaced by the concept of the viewer. Viewers are invited to suspend their disbelief and become active imagineers of the speculative worlds. Another difference with other design approaches relates to the design outcome itself. Speculative design makes use of so-called props which are not *used* in the traditional sense but intended to trigger imaginative responses. Design props facilitate the imagination and trigger discussion (Dunne & Raby, 2013). Speculative design can thereby ultimately become a tool for collective imagination - by inviting different stakeholders or the public to come together in a dialogue about new technologies and social relations (Dunne & Raby, 2013).
Speculative design theory does not provide a commonly adopted, clear-cut methodology. Instead, literature suggests that designers use any tool, method or technique that is considered useful to achieve the end goal. There are however some key concepts that are commonly found in speculative design: physical props and speculative scenarios which are combined in some form of storytelling. Within this project, speculative design becomes a means to operationalize the previously established *reimagine* approach.

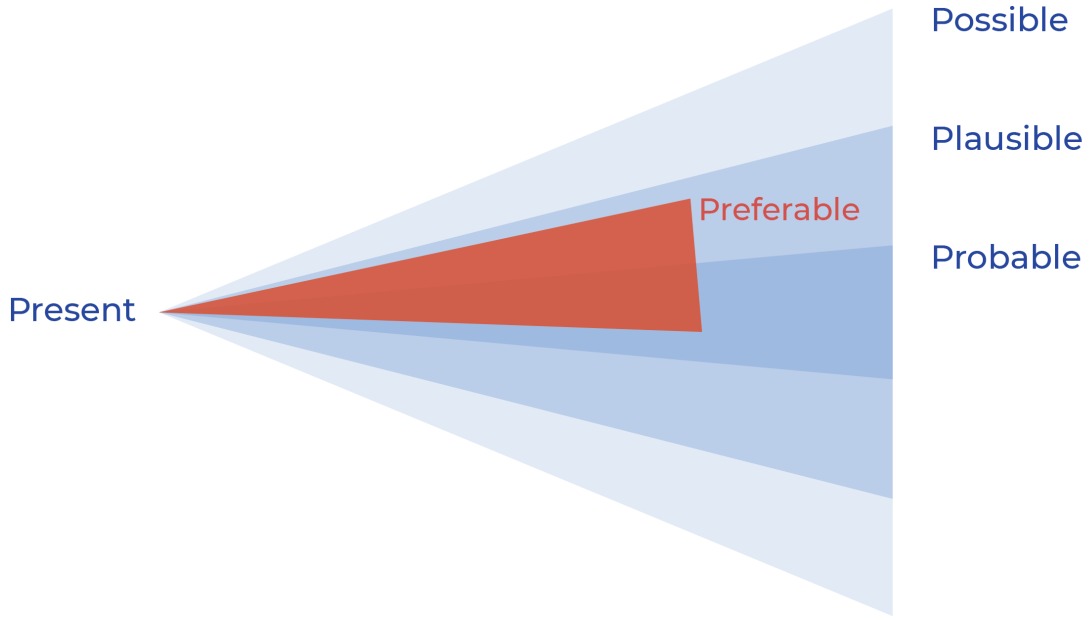


Figure 14: The future cone, illustrating that the future is not set in stone. Speculative design commonly plays with ideas relating to possible, plausible, and probable futures (own visualisation based on Dunne & Raby, 2013).

Value Sensitive Design

Value sensitive design (VSD) is conceived as a framework to engage with the value dimension of technology design through the design process (Alfrink, 2018; Friedman et al., 2006). VSD acknowledges that values are embedded into technology through design. According to Friedman et al. (2006), "certain technologies more readily support certain values while rendering other activities and values more difficult to realise". Technology is therefore never value neutral. Value sensitive design adopts the concept of stakeholder which plays a central role in the approach. Two different types of stakeholders are commonly considered within VSD projects:

- Direct stakeholders "are those individuals who interact directly with the technology or with the technology's output" (Friedman et al., 2006).
- Indirect stakeholders, "are those individuals who are also impacted by the system, though they never interact directly with it" (Friedman et al., 2006).

The project at hand does not strictly follow a Value Sensitive Design approach. However, crucial concepts and activities commonly found in VSD such as stakeholders and stakeholder mapping are adopted within this project. More concepts and activities derived from VSD such as conceptualising values and value change are explained in more detail in the following section.

2.2. Values & value change

What are values?

Within Value Sensitive design, values are defined as "what a person or group of people consider important in life" (Friedman et al., 2006). The philosophy of technology expert Ibo van de Poel provides a more comprehensive definition, describing values as: "lasting convictions or matters that people feel should be strived for in general and not just for themselves to be able to have a good life or realise a good society" (Delft Design for Values Institute, 2019). This definition embodies a perspective on values commonly adopted in literature, which is to view values as guiding principles or ideals (Bos-de Vos, 2020). Furthermore, defining values around a *good life* or a *good society* hints at a diversity of ideals, driven by individual and cultural world views. This perspective is shared by Friedman et al. (2006) who describe values as substantially dependent "on the interests and desires of human beings within a cultural milieu". Values can be differentiated into instrumental and intrinsic values. Intrinsic values are valuable for their own sake while instrumental values are valuable because they contribute to something else. These are however not absolutes - values are more or less intrinsic or instrumental. The value privacy may, for example, be seen as less intrinsic than the value autonomy as privacy can contribute to autonomy, but autonomy does not necessarily contribute to privacy (Delft Design for Values Institute, 2019).

Value change

According to van de Poel (2018) value change primarily occurs due to social development or is induced by technology. Van de Poel (2018) further identifies five types of value change illustrated in figure 15. While these five types of value change appear to be focused on value change over time (see van de Poel, 2018), designing at city level may also require considering value change over space. The research presented in the previous section shows that values are context dependent. Cities such as Amsterdam are generally made up of distinct areas inhabited and visited by different people holding diverse values. It therefore seems reasonable to assume that value change also happens over space, possibly on all five types as suggested by van de Poel (2018). For example, the relative importance of values may be different in a neighbourhood inhabited by families compared to an industrial area within the same city at the same moment in time. The concept of value change over time and space is further illustrated in figure 16 and figure 17.

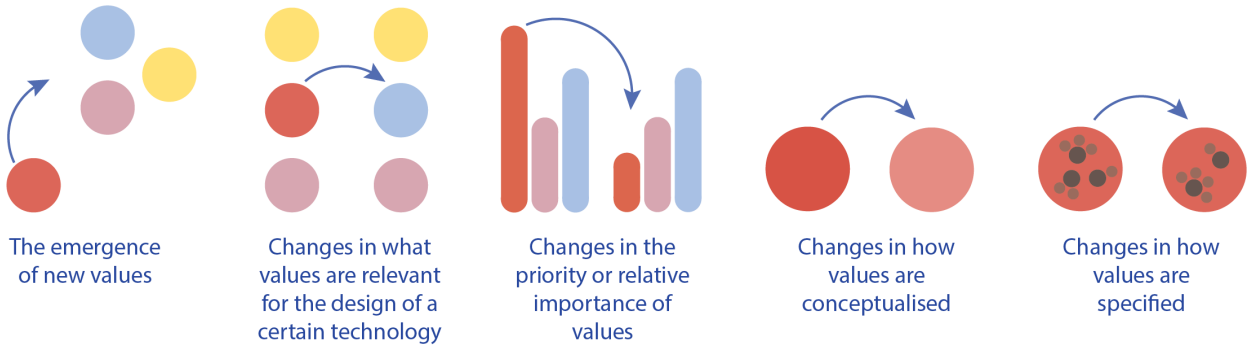


Figure 15: Illustration of the different types of value change (own visualisation based on van de Poel, 2018).

Figure 16: Pictures of Amsterdam *Rokin* in 1948 (top left, Nationaal Archief), 1978 (Top right, Nationaal Archief), 1980 (bottom left, Nationaal Archief) and 2020 (bottom right, Krishnan, Unsplash). The difference in road use was likely shaped by the values present in society at the specific moments in time.

Figure 17: Pictures of roads in three different areas in Amsterdam: *De Pijp* (left, Wikimedia Commons), *North* (middle, Wikimedia Commons) and the *Zuidas* business district (right, Flerman on Unsplash). What values are relevant and what they mean likely differs between the three areas.

A practical example of how value change over time can be reflected in policy is presented by Dan Hill who proposes the example that smoking in an aeroplane was common practice once but is now considered almost unthinkable, relating value change to the so-called *Overton window* (see figure 18) (Civic Square, 2020). The Overton window is an approach to identify a spectrum of acceptable governmental policies (Mackinac Center, 2020). It illustrates that ideas that were unthinkable or radical at one point can become popular and even policy or the other way around.

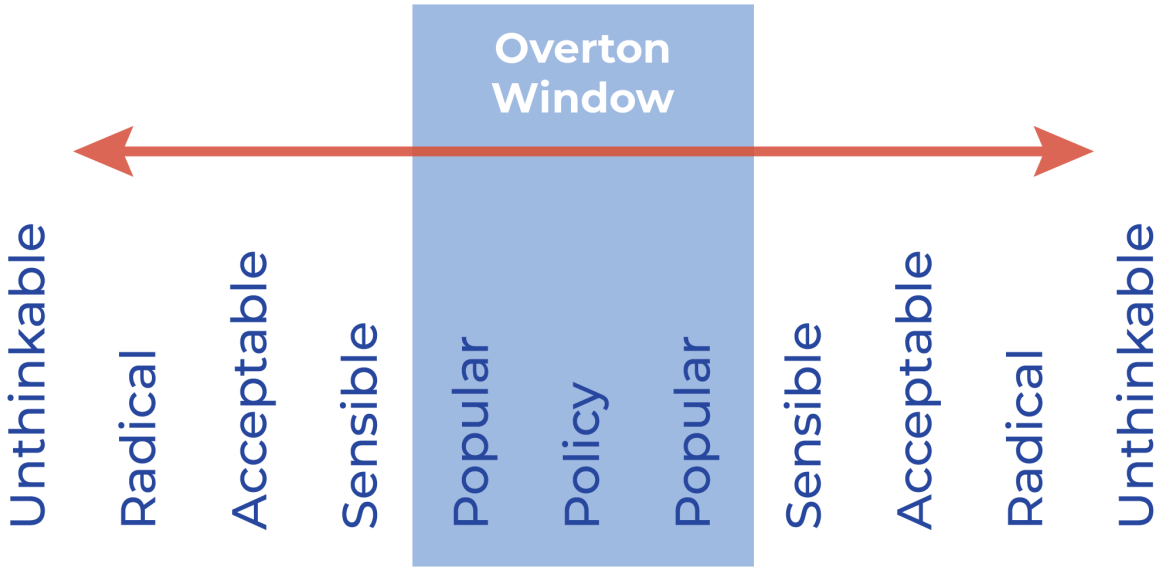


Figure 18: The Overton window (own visualisation based on Wikimedia Commons).

Operationalizing values for design

VSD takes the position that values are not inherent to a technology but embedded into technology through design features and properties that support certain values and hinder others. Values ultimately emerge through the interaction of the user or other stakeholders with technology (Friedman et al., 2006). According to van de Poel (2013) operationalising values for design mainly consists of two interdependent activities: the conceptualisation and specification of values.

Conceptualising values entails making the meaning of a value explicit (van de Poel, 2013). How a value is conceptualised influences how it will be translated into design requirements and ultimately the design itself. A conceptualization should be coherent, illustrate why the value is important and relate to the context for which it is conceptualised (Delft Design for Values Institute, 2019).

Specifying values is about making a value "more specific so that it can guide actions and decisions in a specific context" (Delft Design for Values Institute, 2019). Values can be translated into a variety of requirements not only influencing the design of a product or system but also the design process itself. Translating values into design requirements is a non-deductive activity; more than one specification for a given value is possible. Design requirements are chosen in an act of value judgement, making the process of specification value laden (van de Poel, 2013). Technology design therefore requires careful consideration of choices and their implications and is never value neutral or value free (Delft Design for Values Institute, 2019; Dobbe et al., 2021). The so-called *value hierarchy* is a tool which aims to render the process of translating values into design requirements more systematic as well as making the value judgements and related design choices explicit, debatable, and transparent. *Value hierarchies* consist of a hierarchical structure with values at the top, followed by norms and ultimately design requirements (see figure 19). Within this hierarchy, lower-level elements are defined *for the sake of* higher-level elements. A norm is a subordinate goal or end, the achievement of which contributes to the fulfilment of the value. The same relationship holds true for norms and the subordinate design requirements (van de Poel, 2013). Constructing the *value hierarchy* can be done top-down and bottom-up. Both approaches are typically combined in practice into an iterative process (Delft Design for Values Institute, 2019).

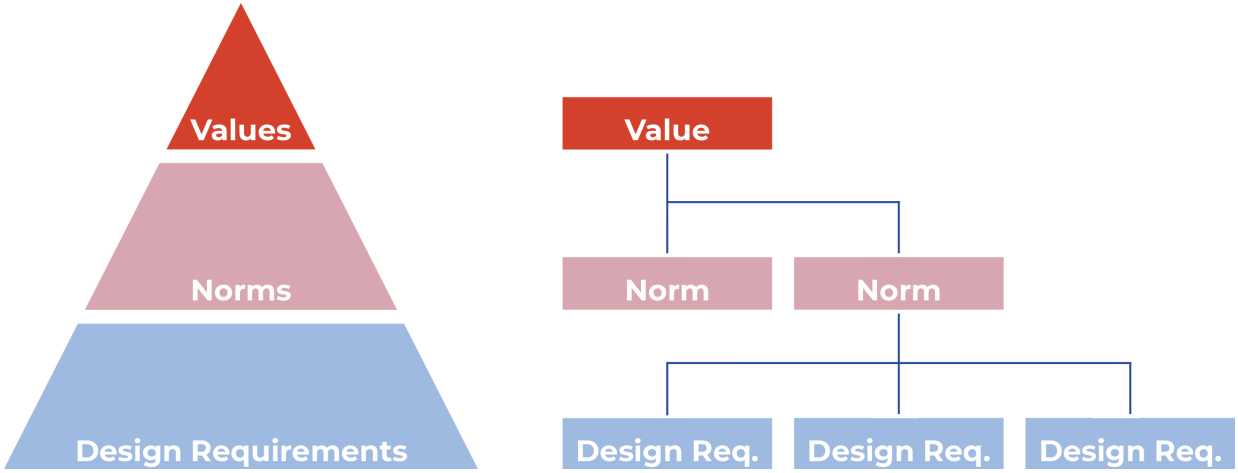


Figure 19: The *value hierarchy* and a schematic drawing showing how design requirements are derived from values through norms (own visualisation based on van de Poel, 2013).

Implications for the project

The theory presented in this section states that design of technology is never neutral. Instead of aiming for a value neutral system, it seems to be reasonable to strive for an adaptive system: a system that is determined by and adapted to the prevalent value in society at any given moment in time. How to approach the design of an adaptive system is further explored in the next section. Another takeaway from this section is that values can be translated into requirements for diverse aspects of a socio-technical system and not necessarily just the road rules.

2.3. Designing an adaptive system

Approaching adaptability through continuous cultivation

According to Giaccardi (2020) the intrinsic malleability of AI (artificial intelligence) and data technology dissolves the clear distinction between design time and use time. This fundamentally changes the object of design. Designing becomes an act of seeding and cultivating conditions, a "sort of constant prototyping", for certain interactions, experiences, or value propositions to come into being (Giaccardi, 2020). Brian Eno takes a similar position regarding the design of streets. With the design principles *Think like a gardener not an architect: design beginnings not endings* and *Unfinished = Fertile* Eno argues that a street is never finished. Instead, designing streets requires ongoing engagement, nurturing and cultivation, just like a garden (Hill, 2021).

Operationalizing adaptability

More concrete ideas about how a system needs to be designed to be able to deal with value change are presented in design for value change literature. Van de Poel (2018) suggests three features of products and systems that allow to better address value change:

- Adaptability (to value change): "...the possibility to change composition or configuration of an artefact or system to better perform the original function or to perform a new function" (van de Poel, 2018).
- (value) Flexibility: described as "different possibilities for using the design" while the design itself remains unchanged (van de Poel, 2018).
- (value) Robustness: "... the ability of a design to perform its function while respecting a range of values despite variety in, among others, circumstances in which the design has to function and variety in how the relevant values are exactly specified, conceptualised or prioritised" (van de Poel, 2018).

Designing the architecture of a system dynamically allocating road space with these features becomes more tangible by relating them to the theory of *Shearing layers* (see figure 20). This theory has its roots in the field of architecture and states that a building is not a single object

but instead consists of several components with different longevity. For example, the *Stuff* such as furniture and other equipment has a relatively short life span and is regularly adapted. Other components such as the *Structure* of the building is likely to remain in use for much longer with relatively little change, even as the way it is used changes or simply remains valuable under new circumstances (Brand, 1994). Adopting this perspective, one can begin to think about what components a smart system, dynamically allocating road space, might be made of and how they relate to the three features of: adaptability, flexibility, and robustness. Similar to a building, some components will likely be more permanent because of pragmatic considerations such as cost. Other components need to be more short-lived so that the system can be meaningfully adapted to value change.

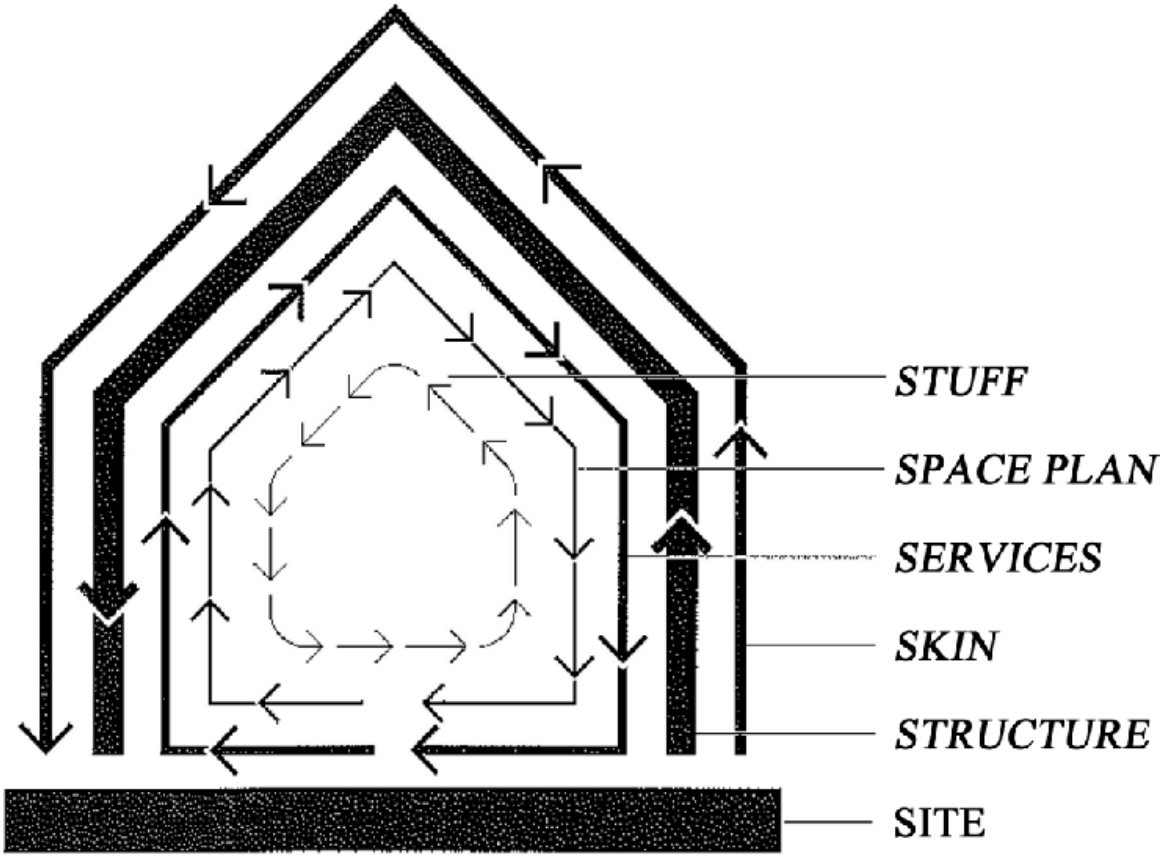


Figure 20: The concept of *shearing layers* illustrated in a schematic drawing of a house. Each of the seven components has different lifespans (Brand 1994).

Implications for the project

The ideas presented in this section suggest that designing an adaptive, smart system governing the allocation of road space means designing conditions for something that is never fully completed but that can be nurtured and cultivated into a desirable assemblage. Furthermore, it is noted that the ability of a system to be adapted to value change in the first place hinges on the design of the system's components features and their lifespans.

2.4. Fairness and the need for stakeholder participation

Making sense of fairness

Fairness is a moral value that is deeply linked with ethics (Velasquez et al., 2018; Schroeder et al., 2019). At its core, fairness commonly used interchangeably with justice, is about being treated as one deserves (Velasquez et al., 2018). As a moral value, fairness can be assumed to be susceptible to value change. Literature on fairness generally differentiates between four different types of fairness / justice:

- Distributive justice: concerned with how outcomes should be distributed.
- Procedural justice: concerned with the procedures for making distribution decisions.
- Interpersonal justice: concerned with how people are treated interpersonally.
- Informational justice: concerned with the information provided during the process. (Peiró et al., 2014)

A widely accepted principle of fairness was proposed more than two thousand years ago by Aristotle: “individuals should be treated the same, unless they differ in ways that are relevant to the situation in which they are involved.” This principle suggests that people should generally be treated equally. Yet it also indicates that deciding if something is fair involves some form of evaluation and the consideration of criteria that justify equal or unequal treatment (Velasquez et al., 2018). As a moral value, fairness is perceived by an individual or group within a cultural milieu (Velasquez et al., 2018; Peiró et al., 2014). The criteria for equal or unequal treatment, and therefore the evaluation of an event as fair or unfair, are affected by individual and social norms. This is summarised in Bowles’ (2020) practical statement presented in the introduction of this report: “Any definition of fairness will be unfair from a different perspective. We must choose intelligently and consider the potential consequences and externalities of your choices.”

Moral acceptability and Stakeholder participation

As fairness is associated with being treated as one deserves, it is also deeply linked with the distribution of benefits and burdens. With limited resources, be it goods, services or infrastructure, decisions about prioritisation have to be made - who is entitled to reap the benefits and who bears the burdens? Stakeholder participation has been commonly adopted in an effort to fairly allocate benefits and burdens in high-stake projects of public interest such as nuclear power plants (Taebi, 2016) or water governance (Pigmans et al., 2017; Irwin, 2018). Current efforts in stakeholder participation however are mainly concerned with social acceptance, which refers to a technology being accepted or tolerated by a community and is commonly implemented through voting. Ethical acceptability on the other hand is concerned with the distinction between right and wrong and the reflection on moral values such as fairness that emerge from the introduction of an intervention. According to Taebi (2016) and Verdiesen et al. (2018) ethical acceptability is generally not part of the scope of participation in public projects resulting in failure of participatory efforts to address ethical questions. Taebi (2016) and Verdiesen et al. (2018)

call for stakeholder participation beyond social acceptance and the inclusion of moral deliberation: “Good governance of technology requires the two concepts of social acceptance and ethical acceptability to be addressed in conjunction”(Taebi, 2016).

The need for stakeholder participation in AI in the public realm (public AI)

According to Dobbe et al. (2021), fairness and other values are emergent system properties that arise from the interaction among components within AI based socio-technical systems. A socio-technical system encompasses a variety of elements, from technical such as intelligent agents over processes and infrastructure to human agents. Emerging properties such as fairness and other values are controlled by designed constraints on the interactions among system components and their behaviours (Leveson & Moses, 2012; Dobbe, 2022). The influence of the design and development process in determining the emergence of values indicates a need to carefully consider aspects of procedural justice or process fairness.
According to König and Wenzelburger (2021), the tunability of an automated decision making during the development process to favour specific outcomes is a core change over human decision making. They argue that this challenges the legitimacy in decision making, creating the so-called *legitimacy gap*. Human decision makers rely on socially accepted goals, procedures and abstract values to legitimise the decision and are generally not able to consciously change specific parameters to adapt the outcome distribution of the decisions they make. Whereas automated decision making systems rely on system parameters such as quality measures that can be purposefully manipulated and linked to specific outcomes and error distributions during the development process (König & Wenzelburger, 2021). König and Wenzelburger (2021) argue that the legitimacy gap can be closed through participatory processes as stakeholder participation ensures input-legitimacy. Henin and Le Métayer (2021) further elaborate on the topic of legitimacy stating that justifiability and contestability are necessary for the legitimacy of automated decision making systems. They argue for different types of justification and contestation are needed to allow for stakeholders with different levels of expertise to participate (Henin & Le Métayer, 2021). Where justification means providing arguments for the decision made by the algorithm based on norms that are outside the automated system and contestation means the possibility for decision subjects to contest decisions made by the algorithm. Almada (2019) differentiates between two forms of contestability: use time contestability and design time contestability. Use time contestability refers to data subjects (A living human being about whom a controller holds personal data and who can be identified by reference to that data (Thomson Reuters, 2022)) being able to contest automated decisions made by machine learning systems after the decision has been taken. For a decision subject to be able to contest such a decision, the automated decision making system needs to have a minimum level of transparency, providing data subjects with access to relevant information about the system and adequate channels to voice their concern (Almada, 2019). Design time contestability can be seen as a preventative intervention approach which allows data subjects to contest decisions made around the machine learning system during its development and deployment (Almada, 2019).

Implications for the project

A complex environment such as the city of Amsterdam is likely full of different opinions and ideas regarding what is a fair allocation of road space, making a fully fair system seem utopian. Fairness is therefore framed as an ideal that can not be reached but that can be continuously approximated through adaptation. This section further points out that the emergence of fairness and the legitimacy of the decisions made by the system are rooted in the systems development processes. This indicated a need to focus on process fairness and the involvement of stakeholders. Stakeholder participation thereby becomes a means for the adaptation of the system, enabling a continuous approximation of fairness as the system evolves. Moreover, explanations and justifications for an automated decision such as the envisioned dynamic road rules are needed for data subjects to judge whether there are grounds for intervention. What role citizens can play by participating in the smart system and what role they have in current smart city initiatives is explored in the following section.

2.5. Stakeholder participation in the smart city

Current participatory efforts in the smart city

The smart city has been under critique for being technocratic and top-down oriented. Algorithmic decision making is used to steer citizens who play mostly instrumental roles and serving the interests of corporations rather than those of citizens. In response to this criticism, cities, policy makers and developers of smart technology are increasingly aiming to adjust the smart city narrative to become more citizen centred or community focused (de Waal & Dignum, 2017; Cardullo & Kitchin, 2019). However, efforts to reposition the smart city around these ideals remain vague (de Waal & Dignum, 2017). Aiming to unpack the diverse ways in which citizens can be framed in the smart city and examine the degree to which smart city initiatives are citizen centric, Cardullo and Kitchin (2019) developed the so-called *Participation scaffold* (see figure 21). They conclude that while the *Participation scaffold* shows potential for diverse citizen participation in the smart city, current efforts of citizen centric smart city programmes prescribe highly instrumental roles for citizens. Citizens become testers and consumers that are controlled or nudged as participatory initiatives are mostly framed by city authorities and corporations around predefined constraints and a market focused perspective. Even within participatory initiatives that are framed around citizen power, citizens are bound to perform within expected and acceptable behaviour (Cardullo & Kitchin, 2019).
According to Chatterton (2000) taking citizen agency and creativity seriously "entails living with and embracing ethical contradictions and conflicts" that stem from a diversity in values present among citizens, civic leaders and other entities. Bottom-up citizen initiatives, such as the *Reclaim the Streets* movement in the UK (see figure 22), have historically been in the grey zone between progressive citizen behaviour and undemocratic nuisances (Chatterton, 2000). Cardullo and Kitchin (2019) state that creating citizen centric smart cities requires us to "reimagine the role citizens are to play in their conception, development and governance."

<table>
<tr><th colspan="2">Form and Level of Participation</th><th>Role</th><th>Citizen Involvement</th><th>Political discourse/ framing</th><th>Modality</th><th>Dublin Examples</th></tr>
<tr><td rowspan="3">Citizen Power</td><td>Citizen Control</td><td>Leader, Member</td><td rowspan="2">Ideas, Vision, Leadership, Ownership, Create</td><td rowspan="2">Rights, Social/Political Citizenship, Commons</td><td rowspan="3">Inclusive, Bottom-up, Collective, Autonomy, Experimental</td><td>Code for Ireland, Tog</td></tr>
<tr><td>Delegated Power</td><td>Decision-maker, Maker</td><td rowspan="2">Civic Hacking, Hackathons, Living Labs, Dublin Beta</td></tr>
<tr><td>Partnership</td><td>Co-creator</td><td>Negotiate, Produce</td><td rowspan="2">Participation, Co-creation</td></tr>
<tr><td rowspan="3">Tokenism</td><td>Placation</td><td>Proposer</td><td>Suggest</td><td rowspan="8">Top-down, Civic Paternalism, Stewardship, Bound-to-succeed</td><td>Fix-Your-Street, Smart Dublin Advisory Network</td></tr>
<tr><td>Consultation</td><td>Participant, Tester, Player</td><td>Feedback</td><td rowspan="2">Civic Engagement</td><td>CIVIQ, Smart Stadium</td></tr>
<tr><td>Information</td><td>Recipient</td><td rowspan="3">Browse, Consume, Act</td><td>Dublinked, Dublin Dashboard, RTPI</td></tr>
<tr><td>Consumerism</td><td>Choice</td><td>Resident, Consumer</td><td>Capitalism, Market</td><td>Smart building/ Smart district</td></tr>
<tr><td rowspan="2">Non-Participation</td><td>Therapy</td><td rowspan="2">Patient, Learner, User, Product, Data-point</td><td rowspan="2">Steered, Nudged, Controlled</td><td rowspan="2">Stewardship, Technocracy, Paternalism</td><td>Smart meters, Mobile/locative media</td></tr>
<tr><td>Manipulation</td><td>Dublin Bikes, Smart Dublin</td><td>Traffic control</td></tr>
</table>

Figure 21: The *Participation scaffold* showing the roles citizens may play in the smart city (Cardullo & Kitchin, 2019).

Figure 22: Members of the *Reclaim the Streets* movement occupy a street (Wikimedia Commons).

Biases in participation

On a more practical note, one way in which smart cities, policy makers and technology vendors aim to create more citizen-centred smart cities, is by increasingly relying on citizen reported data (Kontokosta & Hong, 2021). Self reported data however may be subjected to significant biases. Analysing self-reported complaints about road conditions, Kontokosta and Hong (2021) found that “low income and minority neighbourhoods are less likely to report street conditions“ and prioritise more serious problems in neighbourhoods. Higher income neighbourhoods on the other hand, although showing high levels of satisfaction with street infrastructure, were more likely to complain about street conditions. Citizens’ expectations about public services appear to be influenced by socio-cultural characteristics of neighbourhoods. If no counter measures are taken, this can result in important biases in participation based on self reported data and lead to an inequitable distribution of services.

Implications for the project

This section shows the diverse roles citizens can play by participating in the development of a smart system governing the allocation of road space. Furthermore, developing a process which foresees citizen involvement beyond instrumental forms of participation the aforementioned system may contribute to the re-imagination of the role citizens can play in the smart city. The potential biases that participation may hold require further investigation.

2.6. Related design work

Having explored some of the key concepts of this project in literature, this section presents five example projects and ideas in the field of design and participation relating to the project at hand. The projects have been grouped into three themes. The first theme shows two designs from the same project addressing concepts of fairness and transparency in automated decision making presented in the previous section. The second theme presents projects illustrating the complexity of the road ecosystem and the third theme is focused on citizen participation in urban design and policy making.

Fairness and transparency in automated decision making

The transparent charging station

by *The Incredible Machine* and the *AMS Institute*

The *transparent charging station* investigates energy distribution for vehicle charging in a future in which the energy grid is not able to support simultaneous charging of the vast amount of electric vehicles present on the roads (Bowles, 2020). The first prototype (see figure 23) was a speculative design aiming to stimulate moral imagination. In the scenario envisioned by this design, users of the charging station scan their ID card which represents an assigned position in

society. Based on this card the algorithm managing the distribution of energy prioritises certain users for example by letting a medical doctor jump the queue and charge faster. Charging requests from others, such as recently released offenders, get low priority (Bowles, 2020). The second prototype (see figure 24) is less provocative and focuses more on algorithmic transparency. In this prototype, users are shown the four rules which govern the distribution of energy by the algorithm (Amsterdam Institute for Advanced Metropolitan Solutions, 2021).
The *transparent charging station* relates to the project at hand in at least two ways. The first prototype plays with the basic notion of fairness introduced previously and the need for stakeholder participation; people in the same situation should be treated the same way. The speculative design confronts viewers with the dilemma of prioritisation within an automated decision making process and can thereby stimulate moral imagination with regards to potential futures as described by Bowles (2020). The first, but even more so the second prototype, shows that transparency into the decision process supports users to judge the fairness of the process and outcome. This relates to the need for explanation and justification in public AI introduced previously.

Figure 23: The first prototype of the *transparent charging station* and the ID cards based on which the system determines the charging priority (The Incredible Machine).

Figure 24: The second prototype of the *transparent charging station* makes the rules, which the smart system uses to determine the distribution of energy, visible to the user (AMS Institute).

The complex road ecosystem

The united micro-kingdoms
by *Anthony Dunne* and *Fiona Raby*

The *united micro-kingdoms* is a speculative design which explores what post fossil fuel-dependent societies might look like through the lens of mobility. The project speculates that in an effort to find the best social, political and economic structure in this post-crash world, England was split up into four supershires. Each of these shires is inhabited by people with different political ideologies and corresponding values who have adopted vastly contrasting technologies around which their mobility systems are based (Dunne & Raby, 2013). The result are four distinctive societies described below and visualised in figure 25.

- The *Digitarians* are governed by algorithms. Citizens are cast in the role of consumers who are under constant surveillance. Their *Digiland* is optimised to be used by machines with never ending planes of tarmac.
- The *Bioliberals* pursue biotechnology to enhance nature. But instead of aiming for rapid pace, they adjust their own needs to live within the boundaries of nature. They travel slowly in efficient organically grown vehicles.
- The *Anarcho-evolutionists* are genetically optimised to fulfil specific functions within the self-organised communities they live in. They travel together in large vehicles and each person contributes to the journey according to their abilities.
- The *Communo-nuclearists* live in a fully centralised society within an enormous nuclear powered train that travels across the country. The surrounding landscape has been turned into a nature reserve. (Dunne & Raby, 2013).

Each of these fictional societies offer a peak at different trade-offs that different ideologies and technologies hold (Dunne & Raby, 2013). Together, they provide a sense for how values may shape people's preferences to move about and the mobility ecosystems and lifestyles that come with it. Thereby, this project touches on the complex relationships within the road ecosystem. The physical properties of the road space, the vehicles, the traffic management tools such as road rules as well as people's lifestyles are deeply entangled.

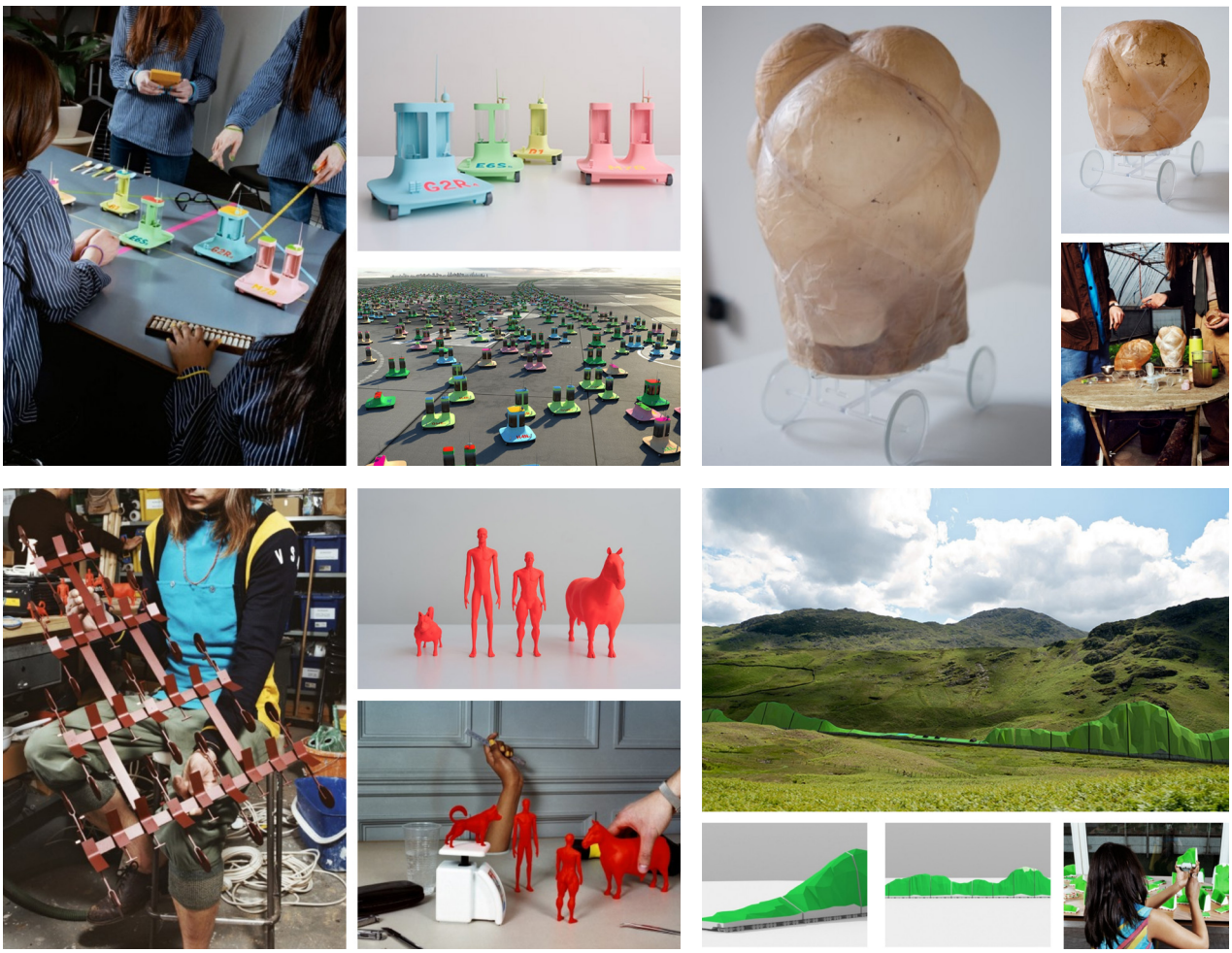


Figure 25: The *united micro-kingdoms*. The *Digitarians* (top left), the *Bioliberals* (top right), The *Anarcho-evolutionists* (bottom left) and the *Communo-nuchlearists* (bottom right) (all images by Jason Evans).

Mobjects
by *Grandstudio*

The complexity of the road ecosystem indicated in the previous design is also reflected in the presentation of Granstudio's Lowie Vermeersch (BKTUDelft, 2021) who notes on a more practical level that traditional mobility infrastructure is extremely static. Vermersch (BKTUDelft, 2021) envisions a new breed of vehicles that are light on infrastructure. An example of this are the *Mobjects* shown in figure 26. *Mobjects* are moving objects that are intended to coexist on a more levelled plain alongside pedestrians (BKTUDelft, 2021) and embody different values compared to current motorised vehicles. This shows that road rules are merely one aspect of the mobility ecosystem. This ecosystem holds many actors and designed objects that have complex relationships and may foster a variety of values.

Figure 26: The *Mobjects* by *Grandstudio* designed to be less imposing on public spaces compared to current mobility solutions (Granstudio).

Citizen participation in urban design and policy making

The One-Minute City

By *Dan Hill* for *Vinnova*

Similar to various tactical urbanism initiatives, Dan Hill (Civic Square, 2020) calls for a redesign of road spaces around materials such as paint and wood to create road environments that are inviting and at the same time relatively flexible. Hill (2021) advocates for the idea that *the street designs the stree*t and has involved a variety of stakeholders such as school children and politicians to design road furniture tailored to the context of specific streets (see figure 27). According to Hill (2021), this process has contributed to feeling empowerment and ownership among participants, highlighting the educational potential of stakeholder participation.

Figure 27: A redesigned road space in Sweden (top Left, Stockholm City; top Right, Elsa Soläng of ArkDes). Pictures of the participatory road design process deployed by *Vinnova* which allows politicians such as Sweden's prime minister (bottom Left, Vinnova) as well as school children (bottom Right, Civic Square) to express their ideas.

Participatory Value Evaluation
By *TU Delft*, *VU Amsterdam*, *ITS Leeds* and *Natural Born Coders*

Participatory Value Evaluation (PWE) (in Dutch *Participatieve Waarde Evaluatie*) is a participatory, value focused method to evaluate policy options with large groups of citizens (TU Delft, n.d.a). The method hinges around citizens being put into the position of a policy maker who is faced with different options using a virtual environment. In this environment, citizens are presented with a policy decision and the advantages, disadvantages and limitations associated with the available options. Citizens are then asked what policy action should be taken and explain their choices (TU Delft, n.d.a). The method thereby aims to deliver rich, quantitative data while increasing the public's understanding of policy choices and requiring little resources compared to traditional forms of participation. The PWE method has been applied on large scale policy challenges by the Dutch government. As Covid 19 restrictions were eased, the Dutch government had to decide which options should be prioritised. Using the PWE method, the preferences of 30.000 people were collected (TU Delft, 2021).

Implications for the project

The *transparent charging station* mainly serves as inspiration for the project at hand, showing how speculative design can address the concept of fairness through questions of prioritisation. The projects, The *united micro-kingdoms* and the *Mobjects*, illustrate the complex relationships present in the road ecosystem and thereby hint that stimulating alternative use of road space requires more than just changes to the road rules. The One-Minute City relates to this idea by emphasising flexible road furniture and creating inviting road spaces for people to use. At the same time, it makes the idea of having diverse stakeholders participating in shaping the roads of a city seem achievable and highlights the educational potential of stakeholder participation. The *Participatory Value Evaluation* approach shows how citizens may participate in policy making decisions by putting them in the shoes of the policy maker and thereby serves as inspiration for the upcoming design work.

2.7. Conclusion

The scientific literature and design work presented in this chapter delivered some important insights with regards to fairness, smart systems, values and adaptability. The key conclusions listed below summarise the most relevant outcomes and the decisions that have been made with regards to the rest of the project. As shown in this chapter, stakeholder participation is a pivotal aspect for the emergence of fairness in smart systems and its continuous adaptation. Stakeholder participation is therefore regarded as a core theme for the research activities presented in the chapters 4 *Stakeholder participation in Amsterdam* and 5 *Expert interviews*. Before diving deeper into the topic of stakeholder participation, the next chapter is focused on identifying the stakeholders, direct and indirect, of a smart system governing the allocation of road space in Amsterdam. Furthermore, the chapter explores the values present in the context of roads in Amsterdam, as well as some of the core design methods and tools of the project.

Key conclusions related work

The exploration of related work delivered relevant insights which will be picked up in chapter 6 *Synthesis*. The most important conclusions of this chapter are presented below.

Operationalizing fairness

- **Framing fairness as an ideal that can be approximated but not reached**
  As a moral value, fairness can be assumed to be susceptible to value change. Fairness is also perceived within a cultural milieu, meaning that contrasting opinions are likely present in a diverse context such as the city of Amsterdam. Within this project, fairness is therefore framed as an ideal that can not be reached but can be continuously approximated.

- **Designing a fair process for an adaptive system**
  Design decisions are value judgements as they define the system components and thereby prescribe which values can emerge. The emergence of fairness and the legitimacy of automated decision making are rooted in the system's development processes. It is therefore specified that this project aims to develop a process through which fairness can be approximated by continuously adapting the system.

- **Approaching process fairness and adaptability through stakeholder participation**
  Designing an adaptable system means designing conditions for a system that can be cultivated and adapted into a desirable assemblage. Stakeholder participation is seen as a means for this continuous adaptation of the system as it can offer opportunities for contestation and ensure legitimacy.

System development and participation

- **Stakeholders participating in shaping the system's values**
  Values can inform requirements for the entire socio-technical system governing the allocation of road space, including its design process. By approaching adaptive system design through stakeholder participation, stakeholders can continuously contribute in shaping the system's values such as fairness.

- **Transparency is needed to determine possible grounds for intervention**
  Transparency supports the decision subject's reasoning whether there is grounds for intervention. Transparency can be realised through justifications and explanations of an automated decision.

Other key findings

- **Speculative design can illustrate value tensions related to fairness**
  Confronting viewers with the dilemma of prioritisation can elicit tensions relating to fairness as it challenges the notion of equal treatment.

- **Rules are part of a larger road ecosystem**
  Rules governing the road space are deeply entangled with the larger road space eco-

system. Simply changing the allocation of road space via rules may not be sufficient to change how roads are used.

Chapter 3

Preliminary research

This chapter presents the preliminary research activities carried out at the start of the project. The aim of these activities was to familiarise myself with the context of roads in Amsterdam and the concept's stakeholders and values. Furthermore, the initial research was intended as a learning activity, aiming to gain a better understanding of some of the key concepts of the project. Note that these activities were carried out before thoroughly familiarising myself with the theory and examples presented in the previous chapter 2 *Related work*. This chapter is split into two main sections. The first section presents an investigation into the stakeholders affected by changes in the allocation of road space in Amsterdam and an exploration of the values currently present in the context of roads in Amsterdam. The second section shows the process and results of a pressure cooker based on which adjustments to the design and research process of the project were made.

3.1. Stakeholders & values at stake

Aim of the exploration

The aim of this exploration is twofold. Firstly, it is carried out to familiarise myself with the concepts of stakeholders and values. Secondly, it aims to create a stakeholder map showing the direct and indirect stakeholders affected by the allocation of road space, and an overview of the values present in the context of roads in Amsterdam. These outcomes are intended to be used at later stages in the process. Note that this investigation does not claim to be a comprehensive study of values at stake in the context of Amsterdam or deliver a complete overview of stakeholders. It is intended as an exploration. This will be further elaborated in the section Limitations.

Research questions:

- *Who are the direct and indirect stakeholders affected by changes in the allocation of road space in Amsterdam?*
- *What values are currently regarded as important in the context of roads in Amsterdam?*

Approach

The exploration is based in the grounded theory research methodology and was carried out by means of content analysis. A total of 18 publications by the municipality of Amsterdam, the AMS institute, news articles and publications by mobility partners of the municipality were used as sources for the content analysis. A table showing an overview of the publications used can be found in *appendix 2*. The publications were studied for expressions relating to values and/or stakeholders which were extracted and scrutinised using the structure shown in figure 28. This resulted in a collection of values and stakeholder groups. The exploration ultimately generated a stakeholder map, showing the direct and indirect stakeholders that are likely to be affected by a system allocating road space in Amsterdam, and an overview of the values at stake in the context of roads in Amsterdam. The value map was created without relying on a list of values defined in literature as predefined lists may be incomplete (Umbrello & van de Poel, 2021; Friedman et al., 2006). This can result in values that are important to the specific context to be overlooked (Umbrello & van de Poel, 2021). To create the stakeholder map, the *Stakeholder token* approach was used (see figure 29). Itis an approach designed to support stakeholder analysis in VSD by making the process more hands-on and emphasising stakeholder relationships and dynamics (Yoo, 2018).

Quote & Source	"Through an extensive system of sensors and ICT infrastructure and various methods of data collection, it observes mobility and travel behaviour for research on mobility and transport in urbanised regions. By using and combining this data, better decisions can be made to create safe and efficient experiences for both citizens and visitors." The innovative quest for mobility solutions (AMS Institute, 2019)	"Amsterdam's city government is therefore taking steps to eliminate through traffic in the city centre, while still keeping the area accessible for residents, visitors, and suppliers. Measures designed to improve traffic flow, relocate heavy traffic to the outskirts of the city and reduce through traffic will have the added benefit of improving air quality." Policy: Traffic and transport (Gemeente Amsterdam, n.d.)
Who?	The municipality of Amsterdam & the AMS Institute	The municipality of Amsterdam
What & Why?	Use ICT systems... > to create safe and efficient (travel) experiences for citizens and visitors	Reduce through traffic... > to improve air quality > to improve liveability
Associated Stakeholder	Municipality of Amsterdam, ICT Partners, Citizens, Visitors	Municipality of Amsterdam, Logistics, Citizens, Visitors
Associated Value	Safety, Efficiency	Sustainability, Health, Liveability, Accessibility

Figure 28: Table showing the structure of how the quotes extracted from the publications were analysed.

Figure 29: Creating the stakeholder map using the *stakeholder token* approach.

Overview of the values at stake

The overview in figure 30 shows values related to road infrastructure in the context of Amsterdam. The size of the blue dot relates to the number of times a certain value was indicated in the source material. The lines indicate relationships between values. The values are clustered into four sections described below.

Value clusters & description

- Liveability, safety & health
  Amsterdam as a liveable city where people flourish. A city that offers a living environment that promotes physical and mental health and where people feel safe.

- Inclusivity, democracy, participation & more
  Amsterdam as a city that is for everyone and by everyone. Where people are equally able to participate in determining what their city looks like and are trusted to take initiative.

- Accessibility, efficiency, freedom of movement & more
  Amsterdam as a city where everything needed for a good life is accessible to everyone. A city whose accessibility is enabled by an efficient and seamless mobility system and whose citizens are highly mobile and free to move as they please.

- Sustainability
  Amsterdam as a sustainable city that exists within the ecological boundaries of the planet. Where sustainability is regarded as a basic requirement for a healthy, liveable environment - from which human and non-human citizens profit alike.

Besides giving a hint about what values are currently considered important in the context, this overview indicates that values are not isolated. Many values relate to other values outside their cluster, for example the values: accessibility, livability and inclusivity appear to go hand in hand. Expressions related to inclusivity such as “...for everyone” are often mentioned as a specification in remarks related to accessibility or liveability. Similarly, efficiency appears to be seen as a means in a larger aim for sustainability which in itself seems to be mainly thought of as an enabler of human mental and physical health and is ultimately contributing to liveability. This illustrates the idea of intrinsic values described in chapter 2 *Related work*.

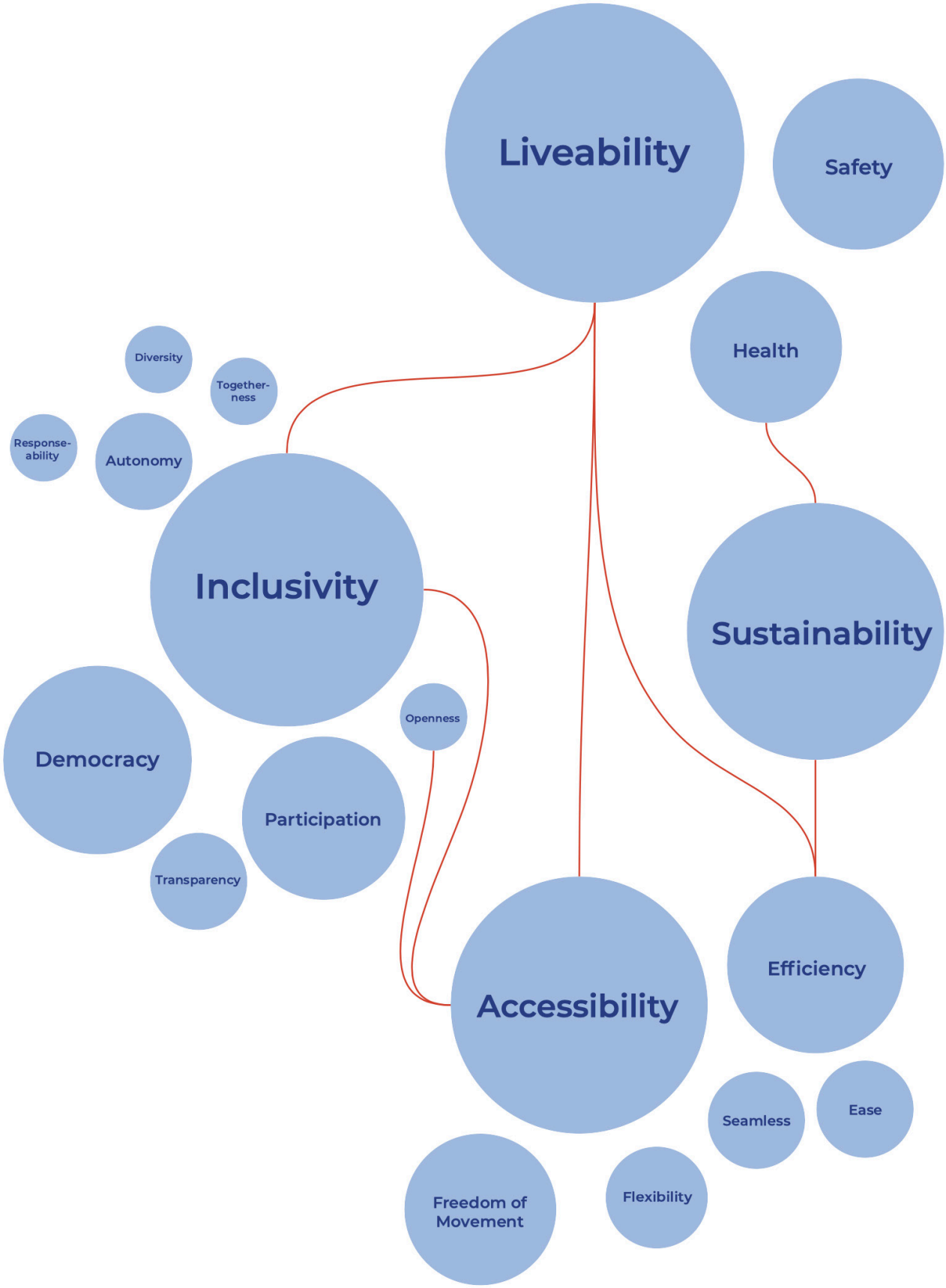


Figure 30: The value map hinting the values currently considered important for the context of roads in Amsterdam.

Results: Stakeholder map

The stakeholder map presented in figure 31 illustrates the different stakeholder groups that are likely to be affected by changes in the allocation road space in Amsterdam. The stakeholder groups are split into: direct stakeholders, who interact directly with the system or its output (inner ring), and indirect stakeholders, who don't interact directly with the system but are impacted by it (outer ring). As explained in the introduction, this differentiation is commonly suggested in VSD literature.
The map illustrates the far-reaching implications of a system allocating road space. There are many stakeholders that are potentially affected by changes in the allocation of road space- from citizens over businesses to providers of basic services such as ambulances and firefighters. Note that the stakeholders indicated in the map represent high-level stakeholder groups which potentially hold diverse sub-groups. The stakeholder group *Citizens of Amsterdam* for example is made up of a variety of demographics. And also institutions and companies may not be as uniform as the map suggests. The municipality of Amsterdam, for example, is made up of different sections and specialised teams such as: policy makers, traffic managers and innovation experts each with their own agendas and wishes.

Implications for the project

The investigation presented in this section provided a better understanding of the context of roads in Amsterdam. The stakeholder map shows the diverse stakeholders that are affected by changes in the allocation of road space. As participatory processes should be tailored to the abilities of stakeholders (see chapter 2 *Related work*), engaging these stakeholders likely requires a multitude of participatory processes. The value map shows the values which are currently considered important in the context. Tradeoffs between these values may create captivating tensions that can be conveyed in the design outcome.

Limitations

As mentioned in the introduction, the investigation presented in this section does not claim to be a comprehensive study of values at stake in the context of road infrastructure in Amsterdam, nor does it deliver a watertight overview of stakeholders. This would require an analysis of more diverse sources as well as a more systematic analysis process. Within the project at hand this was not further pursued as this would likely have taken up a significant amount of time and it was decided to prioritise research into the topic of stakeholder participation. The investigation presented in this section was mainly intended as context exploration delivering practical hints and providing an initial feeling for the concept of values and stakeholders within this project.

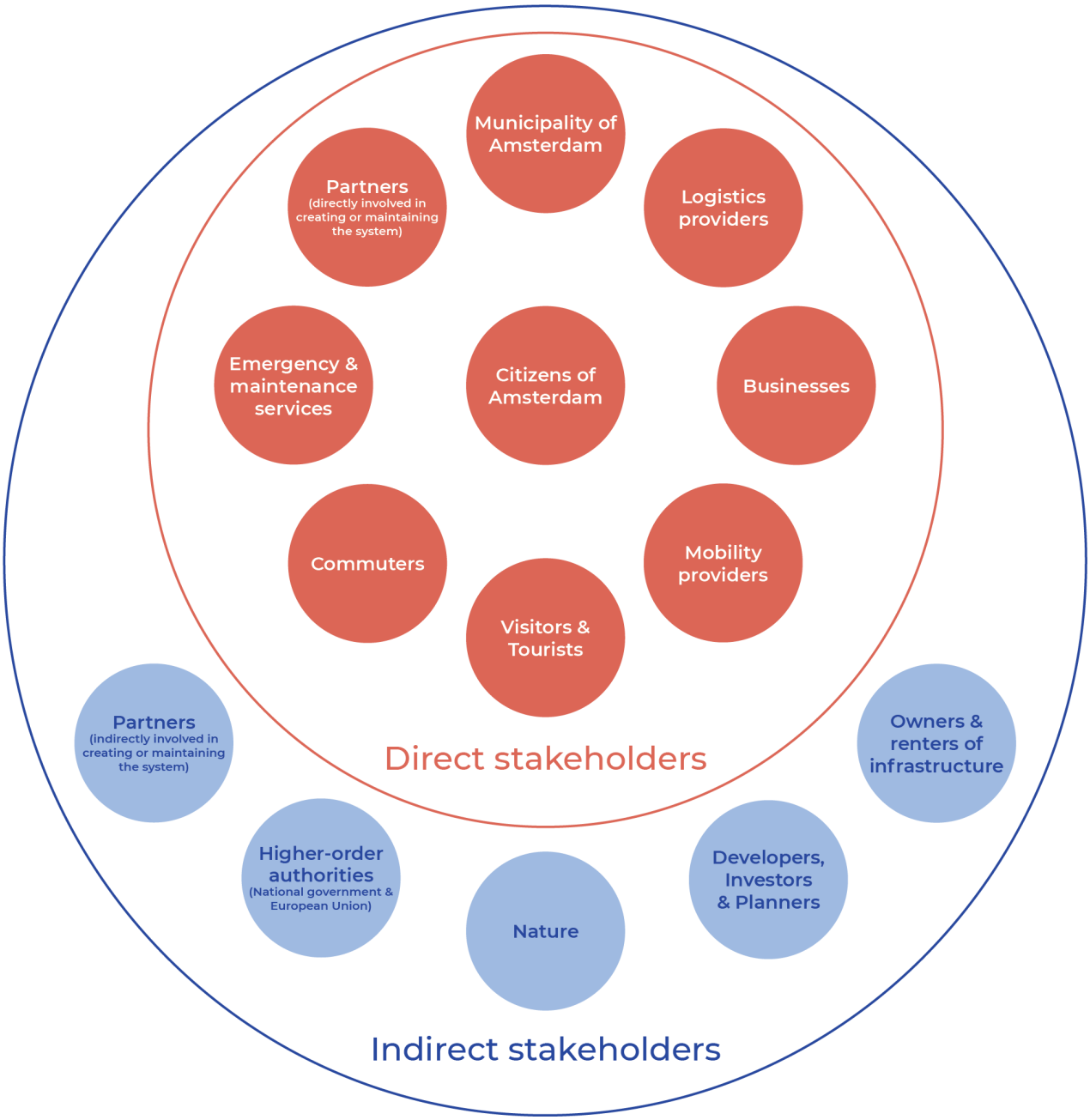


Figure 31: The stakeholder map showing the direct and indirect stakeholders affected by changes to the allocation of road space in Amsterdam.

3.2. Pressure cooker

Aim of the exploration

The goal of the pressure cooker is to get some hands-on experience with some of the key concepts of this project and the related activities I had initially planned to execute. It thereby seeks to create a better understanding of these concepts and activities and deliver insights based on which adjustments to the remaining design and research process can be made. Instead of being guided by research questions, the pressure cooker was focused on studying the following activities:

- Stakeholder interviews (Deriving values from stakeholder interviews)
- Conceptualising values (Defining what values mean in a specific context)
- Specifying values (Translating values into design requirements using *value hierarchies*)
- Designing a system map
- Creating and testing the speculative prototype

Process and results

Stakeholder interviews

The stakeholder interviews were simulated by using a role play approach. The stakeholders were played by two Design for Interaction master students and one design professional. These participants took part in semi-structured interviews carried out individually. Two of the sessions were carried out online, one in person. Several tools and techniques were used to explore how to engage stakeholders in a way that would lead to meaningful data: trigger images, laddering *Why?* questions, future scenarios, underlayers and props. Figure 32 shows some impressions of these sessions.

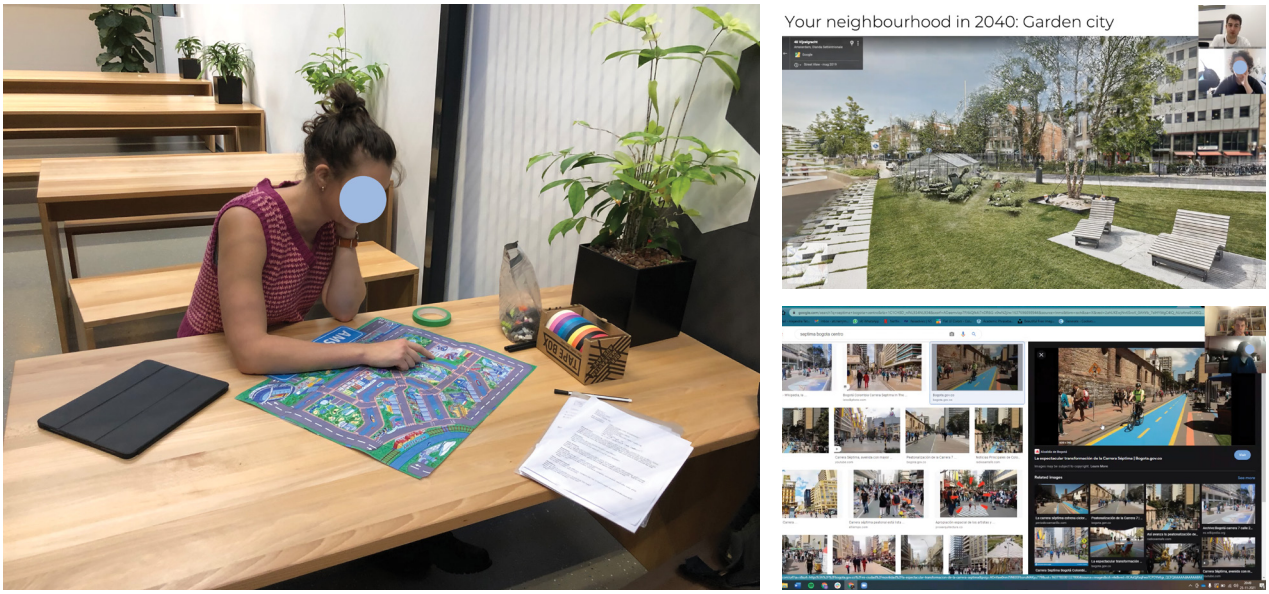


Figure 32: Impressions from the stakeholder interviews.

Extracting values

Audio and video recordings of the interviews were analysed for expressions of benefits and harms mentioned by each participant with regards to the system - an approach commonly suggested in VSD literature. These hints were clustered and translated into values (see figure 33).

Conceptualising values and creating a value hierarchy

The values were sorted, conceptualised, and translated into design requirements in several iterations. The final iteration was carried out with the following two values:

- **Liveability**
  Conceptualised as: *An environment that enables and promotes human wellbeing*.

- **Fairness**
  Conceptualised as: *Judgement and action that is informed by a bias free consideration of different perspectives and potential consequences*.

These values were chosen because they were emphasised by the participants in the stakeholder sessions. The number of values was limited to two to keep the process concise within this pressure cooker. Figure 34 shows the derived *value hierarchy*.

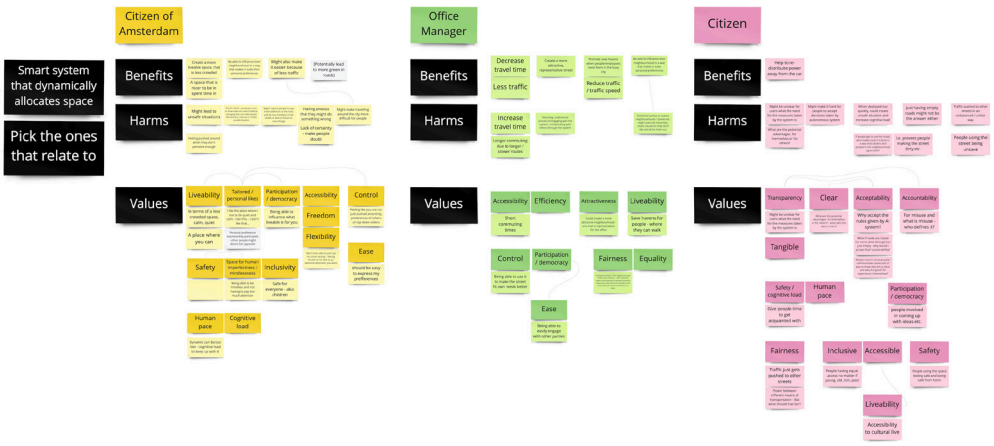


Figure 33: Overviews derived from the interview showing the perceived benefits and harms of a smart system governing the allocation for road space. The benefits and harms were used to define the relevant values for the system.

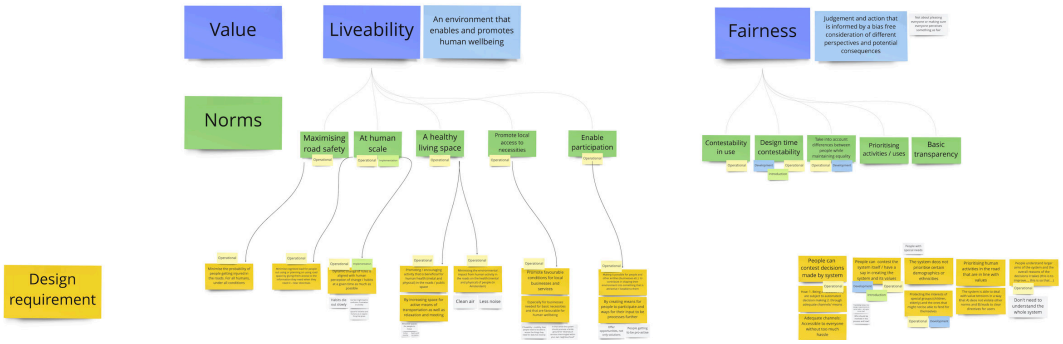


Figure 34: The *value hierarchy* created from the values liveability and fairness.

System map

The system map shown in figure 35 was designed in several iterations based on the design requirements defined in the *value hierarchy*. The content of the system map is not considered relevant for the pressure cooker. Creating the system map was seen as an exercise aimed to get an initial feeling of what a smart system allocating road space might look like and how it can be represented in a map. The content of this early version of the system map is described in *appendix 3*.

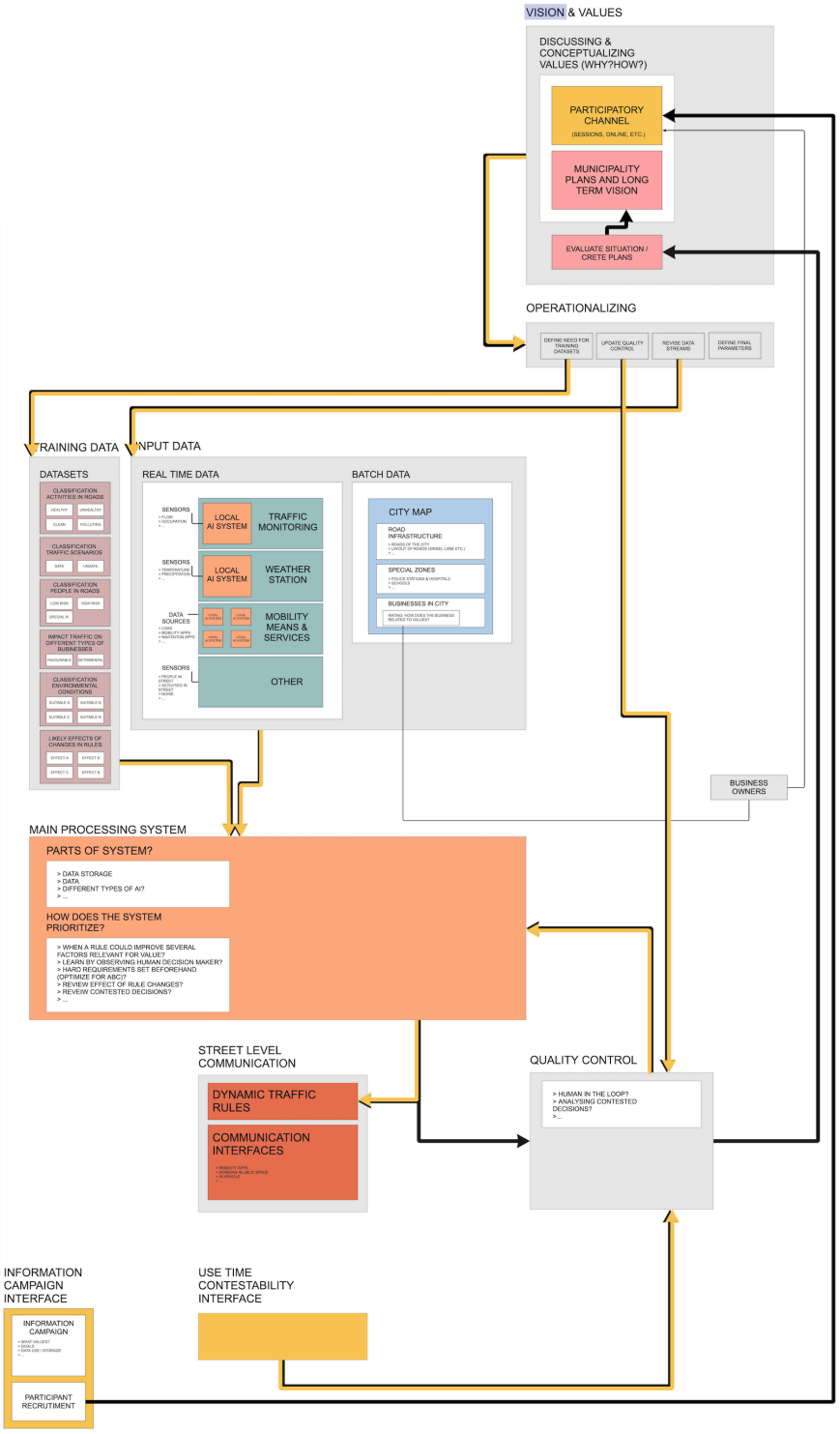


Figure 35: The system map built from the design requirements established in the *value hierarchy*.

Speculative prototype

The speculative prototype was created based on the system map introduced in the previous paragraph. The speculative prototype consists of four scenarios which are visualised with props and an abstract underlayer of a city map of Amsterdam (see figure 36). The scenarios revolved around imagined future realities where people and businesses are prioritised (i.e., granted favourable conditions through the allocation of road space) depending on their contribution to the value of liveability in the city and the world at large. One example scenario is as follows: "In this street there are offices from Amazon and Patagonia, a certified B-corporation. It is a nice and sunny spring day. One of the road lanes has been closed for traffic. The employees of the Patagonia office receive an invitation to use the road space for meetings and breaks. The Amazon office is not granted privileges to use the road space." The rest of the written scenarios can be found in *appendix* 4.

Testing the speculative prototype

The speculative prototype was tested with one participant, a Design for Interaction master student. The scenarios were read to the participant and played out using props on an underlayer showing a simplified map of Amsterdam. Figure 36 shows the test set-up. This was followed by an open discussion. The discussion started off slowly as the participant was initially somewhat overwhelmed but ultimately resulted in a rich dialogue about both benefits and harms and potential improvements to the system. The exact content of the discussion is not further elaborated as it is not relevant for the goals of this pressure cooker.

Implications for the project

The pressure cooker helped to gain experience with the approaches and tools explored in this project. More specifically, stakeholder interviews, translating values into design requirements and system mapping as well as speculative design. Furthermore, it delivered hints at how a smart system governing the allocation of road space may be perceived by stakeholders which are described in the key conclusions of the chapter.

Figure 36: Testing the speculative prototype.

3.3. Conclusion

This chapter presented the outcomes of an initial exploration of the road context of Amsterdam. It provided a better understanding of the values currently at play and the direct and indirect stakeholders that are possibly impacted by changes to the allocation of road space. The pressure cooker further proved to be a valuable initial exploration of the design process. The overall project planning was significantly influenced by the learnings obtained in this pressure cooker. The following chapter looks deeper into stakeholder participation in the context of Amsterdam.

Key conclusion

Value map

- **Showcasing tradeoffs between desirable values may generate interesting discussions**
  The value map hints which values are currently considered important in the context of roads in Amsterdam. Having the speculative prototype showcase tradeoffs between these values may create captivating tensions and lead to interesting discussions.

Stakeholder map

- **Diversity in stakeholders requires a multitude of participatory processes**
  The stakeholder map shows a large number of stakeholders that are affected by changes in the allocation of road space. Engaging such a diverse set of stakeholders likely requires a multitude of participatory processes.

Pressure cooker

- **Adopting a more iterative research and design process**
  Based on the experiences made in this pressure cooker, the original, linear project planning was adapted to create a more iterative research and design process. Furthermore, as the focus shifted towards adaptability, investing resources in creating elaborate *value hierarchies* was deemed unnecessary for the purposes of this project.

- **Early speculative experiments seem promising**
  The props and examples presented during the interviews proved to be highly valuable in showcasing value tensions and triggering participants' imagination.

- **Alternative road use may require changes to the physical road space**
  The interviews indicated that road rules may not be enough to facilitate alternative road use. Participants commented that rules need to be accompanied by changes to the physical road space.

- **A system at human scale**
  Dynamic road use may create substantial cognitive loads for citizens. Interview participants highlighted the importance of a system at human scale - respecting the human habits and the perception of change.

Chapter 4

Stakeholder participation in Amsterdam

Stakeholder participation was identified in chapter 2 *Related work* as a means to foster process fairness in the continuous adaptation of a smart system. This chapter explores the concept of stakeholder participation in more detail, focusing on the current participatory practices of the municipality of Amsterdam. Desk research was carried out analysing several publications of the municipality of Amsterdam addressing the topic of stakeholder participation. The following sections present the aim of the investigation, the results and derived conclusions as well as some limitations of the study.

4.1. Aim of the investigation

Learn about the current participation practices of the municipality of Amsterdam.

Research questions:

- *How does the municipality currently decide who should participate?*
- *What needs to be considered when setting up a participatory process at city level?*
- *How does stakeholder participation relate to other democratic processes such as voting?*

Learn about the plans of the municipality with regards to stakeholder participation for the future.

Research question:

- *What role is stakeholder participation to play in Amsterdam in the future according to the municipality?*

4.2. Data collection and analysis

Data was collected by means of desk research, analysing publicly accessible documents and articles on stakeholder participation published by the municipality of Amsterdam. An overview of the sources that contributed to the results of this investigation are shown in table 1. The publications were analysed and notes were taken of pieces of information relating to the investigation aim introduced previously. The notes were then clustered into themes.

Table 1: Overview of the analysed sources.

Original title of publication	Translated title of publication	Type of publication	Year of publication
Beleidskader participatie	Participation policy framework	PDF document	2021
Leidraad burgerparticipatie	Citizen participation guidelines	PDF document	n.d.
Omgevingsvisie 2050	Regional plan 2050	PDF document	2021
Participatie	Participation	Online article	n.d.

4.3. Results

Setting up a participatory process

Goal setting and defining participation in relation to the project phase

The *Citizen participation guidelines* of the municipality of Amsterdam suggests that planning a participation process starts with defining the goal of participation. The guidelines suggest six potential goals:

- Ownership: Increasing personal responsibility of stakeholders
- Quality of approach and policy: Tapping into stakeholders' experiences and knowledge
- Right to say: Increasing power and influence of citizens.
- Understanding the interests: Gather perspectives and arguments around the task at hand
- Legitimacy: Increasing acceptance of decisions taken or reducing discomfort.
  (Gemeente Amsterdam, 2021a).

Participation can take place in different phases of a project. For example, early on by contributing in setting agendas, or also later, evaluating the outcome through participation. The goal influences during which phase participation should take place within a project. The degree of influence people can have about the outcome is higher in the early phases, and so if for example the goal is to increase citizen control, citizens should participate in early stages of the project (Gemeente Amsterdam, n.d.a).

Defining the level and the participation channel

The level of participation is set based on the goal of participation and the project phase in which participation is intended to take place (Gemeente Amsterdam, n.d.h). The *Citizen participation guidelines* present four possible levels of participation:

- Informing: Amsterdammers are informed about new policies, plans or regulations
- Think along: Amsterdammers advise or contribute ideas
- Co-Create: Amsterdammers co-create a policy or project
- Co-Decide: Amsterdammers co-decide about a policy or in a project
  (Gemeente Amsterdam, 2021a)

The participation channel (e.g. online voting, citizen evenings etc.) is defined based on the chosen goal, the level of participation and the target group. For each combination of goal and level, the *Participation policy framework* presents several potential participation channels. For example, for the combination of *Right to say* (goal) and *Co-Create* (level), the municipality suggests participation through co-creation places (Gemeente Amsterdam, 2021a).

Deciding who should participate

The key factor based on which the municipality currently decides who should participate is impact; stakeholders are actively targeted and involved depending on the impact a project has on them. How impact is defined remains unanswered from the consulted sources (Gemeente Amsterdam, 2021a). Beyond defining a target group based on impact, deciding who should

participate also involves defining who best represents a certain group of stakeholders and what their abilities are. According to the municipality, the participation level, channel and the method of communication should be adapted to meet the participation abilities and needs of those targeted (Gemeente Amsterdam, 2021a).

General consideration participation

Basic requirements for participation

The municipality of Amsterdam points out several key requirements that are the basis for any participation process and influence choices such as the level of participation:

- Commitment and support for the process among those in charge of the project.
- Available resources in terms of time and money
- Legal freedom (does the process fit within existing legislation and regulation?)
- Policy space (does the existing policy space allow for a certain process?)
  (Gemeente Amsterdam, n.d.h)

Communication is the backbone of participation

Communication is the backbone of participation and municipalities in the Netherlands are obligated to publish opportunities for participation (Gemeente Amsterdam, n.d.i). Inclusive communication requires customisation of the channels as well as the language used to fit the abilities and wishes of those involved (Gemeente Amsterdam, 2021a). Communication is furthermore a key factor in managing expectations. According to the municipality of Amsterdam, stakeholders should be informed about the goal of participation, what participants can have influence on as well as receiving feedback on the outcome that a participation process delivered (Gemeente Amsterdam, n.d.h).

Adapting a participation process over time

According to the *Participation policy framework* by the municipality of Amsterdam, long term participatory processes need to be re-assessed throughout their running time as the views, interests and needs of citizens change. The re-assessment should first and foremost consider the goal of participation which ultimately can lead to a reassessment and updates through the entire participation process (Gemeente Amsterdam, 2021a)

Participation in relation to other democratic processes

Participation is not a substitute for representative democracy and existing democratic processes

Especially in decision processes with fundamental conflicts of interests, elected representatives need to take responsibility, make clear decisions and deal with trade-offs using established consensus seeking strategies (Gemeente Amsterdam, 2021a). Furthermore, existing democratic processes for influencing life in the city such as bringing a concern forward to the city council, handing in a complaint and electing representatives are not to be substituted by participation but need to exist alongside it (Gemeente Amsterdam, 2021a).

Adjusting internal processes

Higher level participation requires the municipality to significantly change internal processes: decision processes that were previously fully in the hands of elected officials need to be opened up to make room for stakeholders to influence their outcomes (Gemeente Amsterdam, 2021a).

Outlook for the future

Amsterdam aims to increasingly rely on stakeholder participation

A core idea of the *Regional Plan 2050* is to to give Amsterdammers a more active role in shaping the city, increasing self-organisation and fostering a greater sense of ownership and responsibility towards living environments among citizens. The municipality states that this is intended to introduce more diverse voices to the city-building process and emphasises that this does not mean that the city should be a sum of individual preferences (Gemeente Amsterdam, 2021b).

4.4. Conclusion

The investigation presented in this chapter provides insights into current participatory practices by the municipality of Amsterdam. The results also show general points of attention for stakeholder participation at city scale (e.g. tips for setting up a participatory trajectory and potential challenges) as well as concisely introduce the municipality's plans for participation in the future. The learnings from this investigation influenced early iterations of the system map but also highlighted the need for further research, focusing specifically on stakeholder participation in the context of *Code the Streets*. This and more will be the focus of the investigation presented in the next chapter.

Key conclusions

Handling long term participatory processes

- Long term participatory processes need to be reassessed and adapted
  Changes in participants' views, interests and needs require long term participatory processes to be reassessed and potentially adapted.

Basic considerations for setting up a participatory process at city level

- Composing a participatory process
  Setting up a participatory process requires matching the participation goal and the project phase, carefully defining who will be involved as well as choosing a fitting level, participation channel and adequate communication.

- Participation requires customised communication and processes
  Communication and the participation channel should be tailored to fit the perspective and abilities of the participating stakeholders.

- **Impact and representativeness are used to determine who should participate**
  Impact is a core decision factor used by the municipality to decide who should participate and what their influence should be. Determining who should participate also requires considering who best represents stakeholder groups and who is able to meaningfully participate.

- **Restrictions on participatory processes**
  The available policy and legal freedom as well as resources such as time and money present important restrictions on participation.

Participation within a democratic government

- **Participation in relation to other democratic processes**
  According to the municipality, participation is not a substitute for representative democracy and other democratic processes such as handing in an objection or electing representatives.

Outlook for the future

- **More participation in the future**
  The municipality aims to give Amsterdammers a more active role in shaping the city and foster a greater degree of ownership and responsibility towards their living environments.

4.5. Limitations

The publications analysed to gather insights in this investigation were written in Dutch. As a non-native speaker, I used translation tools to aid in understanding specific terms or short passages, potentially altering the meaning of the original.

Chapter 5

Expert interviews

This chapter presents a qualitative study which uses expert interviews to develop a better understanding of the potential role of stakeholder participation within *Code the Streets*. More specifically, it aims to explore the ideas and opinions relating to stakeholder participation present in the *Code the Streets* team of the municipality of Amsterdam. The following sections elaborates on the goals of the study and introduce the research approach, results and main conclusions as well as limitations of this study.

5.1. Aim of the investigation

The aim of the investigation presented in this chapter is to:

Learn about the perspective of the *Code the Streets* team on the potential role of stakeholder participation within the project.

Research question:
- *What could be the role of stakeholder participation in Code the Streets according to the team? (Why do they think this way?)*
- *What should be the role of stakeholder participation in Code the Streets according to the team? (Why do they think this way?)*

Gather insights about participation at city level from the experiences of experts practising at the municipality of Amsterdam.

Research questions:
- *How may stakeholders be involved in Code the Streets?*
- *What are potential issues in stakeholder participation?*

Verify some of my initial insights and ideas regarding the value of fairness, value change and stakeholder participation. This is further elaborated in the research questions.

Research question:
- *What do the experts think of my conceptualization of fairness as an ideal that can be approximated through adaptability and stakeholder participation?*
- *How may we detect value change through stakeholder participation?*

5.2. Research design

Experts participated in this study through semi structured interviews. This approach was chosen as it allows for a comprehensive exploration of the understandings, experiences and perspectives of those being interviewed (Patton, 2002).

Sampling

The sampling strategy chosen for this investigation was purposeful (Palinkas et atl., 2015). Interviewees were identified and recruited in two ways: through snowballing (Palinkas et atl., 2015), or by searching for and contacting participants via the online staff overview of different faculties of TU Delft. The interviewees were chosen based on their relevance to the goal of the investigation. They needed to be closely associated with *Code the Streets*, have expertise in stakeholder participation in the city of Amsterdam, and/or in the topics fairness, ethics or values.

Data collection and analysis

Data was collected from six interviews with a total of ten interviewees from industry and academia (see table 2). Figure 37 shows the overall sequence of interviews and distribution of participants over the interviews. The interviews were carried out online through video calls and lasted between 1 to 1.5 h. There was no standardised interview set-up. Each interview was tailored to the expertise of the participant and had specific focus points. Data was collected in the form of handwritten notes taken during the interview, except for interview I2 for which the audio was recorded and transcribed using a transcription software. This exception was made to ensure that the interview would be manageable as this was the largest group and most of the participants were not familiar with the project at hand.

Table 2: Overview of the interview participants.

Participant ID	Type of expert	Expertise	Affiliation
P1	Practitioner	· Code the Streets project · Political sciences · Ethics	AMS Institute
P2	Practitioner	· Code the Streets project	Municipality of Amsterdam
P3	Practitioner	· Code the Streets project · Mobility systems · Commons	Municipality of Amsterdam
P4	Practitioner	· Code the Streets project · Citizen participation	Municipality of Amsterdam
P5	Practitioner	· Code the Streets project · Inclusivity · Ethics	Municipality of Amsterdam
P6	Academic	· Contestable AI	TU Delft
P7	Academic	· Values & value change · Fairness	TU Delft
P8	Practitioner	· Code the Streets project · Future mobility systems	Municipality of Amsterdam
P9	Practitioner	· Participation · Diversity & Inclusion · Democracy	Municipality of Amsterdam
P10	Practitioner	· Participation · Commons · Democracy	Municipality of Amsterdam

Interview #1

Participant(s): **P1**

Duration: **1h**

Topic(s) of focus:

- Code the Streets
- Stakeholder participation in a smart system allocating road space

Shared materials:

- Introduction to graduation project (Presentation)

Interview #2

Participant(s): **P2, P3, P4, P5, P6**

Duration: **1.5h**

Topic(s) of focus:

- Stakeholder participation in a smart system allocating road space / in Code the Streets in general
- Previous experiences with stakeholder participation in Amsterdam
- Approaching fairness through participation

Shared materials:

- Introduction to graduation project (Presentation)

Interview #3

Participant(s): **P7**

Duration: **1.5h**

Topic(s) of focus:

- Value change
- Fairness as a philosophical concept
- Approaching fairness through participation

Shared materials:

- Introduction to graduation project (Presentation)
- Preliminary version of the system map

Interview #4

Participant(s): **P8**

Duration: **1h**

Topic(s) of focus:

- Stakeholder participation in a smart system allocating road space / in Code the Streets in general
- Approaching fairness through participation

Shared materials:

- Introduction to graduation project (Presentation)
- Preliminary version of the system map

Interview #5

Participant(s): **P3**

Duration: **1h**

Topic(s) of focus:

- Previous experiences with stakeholder participation in Amsterdam
- Participation in Commons

Shared materials:

- --

Interview #6

Participant(s): **P2, P4, P9, P10**

Duration: **1h**

Topic(s) of focus:

- Stakeholder participation in Code the Streets
- Previous experiences with stakeholder participation in Amsterdam

Shared materials:

- Introduction to graduation project (Presentation)

Figure 37: Overview of the carried-out interviews showing the participants, duration, topic(s) of focus and shared materials for each of the six interviews. The preliminary version of the system map shared with the participants can be found in *appendix 5*.

Thematic analysis was chosen as a method to analyse the gathered data. This method was chosen as it allows researchers to "capture complex, messy, and contradictory relationships that prevail in the real world" (SAGE Publications, 2019). The written data was analysed and labels were created (Ritchie et al, 2013). Snippets of data were extracted and assigned to one or several labels (see figure 38). This was followed by several iterations of clustering the labelled data snippets and defining themes until the final set of themes was chosen.

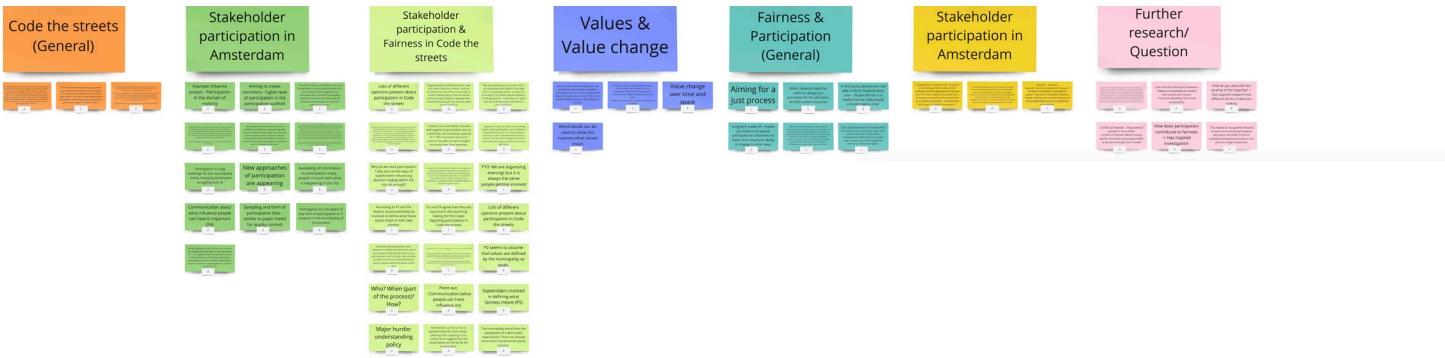


Figure 38: The initial labels used for the data snippets. These snippets were subsequently used to define the four themes.

5.3. Results

The investigation resulted in four themes. The first theme sheds light on the potential role of stakeholder participation in *Code the Streets* based on the perspective of the municipalities' *Code the Streets* team and a close collaborator. The second theme presents key considerations that according to the interview participants are at the core of designing a participatory process. The third theme highlights challenges in citizen participation experienced by the participants. Feedback on the approach to fairness adopted in this project is presented in the fourth theme.

Diverse ideas about stakeholder participation in Code the Streets

The interviews sparked some initial thoughts and discussion among the participants about the role of stakeholder participation in *Code the Streets*. The team seems positive about the general idea of participation. They are taking their first steps in defining a strategy for stakeholders which is illustrated by team members' diverse ideas put forward during the interviews.
Code the Streets is rooted in the assumption that the municipality should define the values governing the rules at street level (including the allocation of road space). According to presentation material of the *Code the Streets* team shared during the interviews, the system would allow the municipality to: "steer the use of public space based on values that we as a city consider important at that time." P2 and P8 explain that this perspective is based on the belief that it is the role of the municipality to safeguard societal values and to balance out more individualistic needs of the individual as well as the efficiency and profit focus of technology organisations. Participation expert P9 criticises this current framing of the project and mentions that it "misses the perspective of the citizen".
While it appears that *Code the Streets* is not founded on the idea of stakeholder participation, stakeholder participation appears to have been recognised as an important topic within *Code the Streets* prior to the interviews. According to P2 and P4, stakeholders could be involved to define what values determined by the municipality mean within the context. P2 commented: "I think we should constantly be in conversation with people in the organisation but also outside the organisation like citizens..., what is a liveable city? Does that mean you have a safe place for people to work there and bike there? Does that mean you have enough green?". P4 similarly stated that "...you can use participation as a vehicle, so to say, to operationalise those city values because they're quite big words, and in each part of the city, it can mean different things for the people who live there." On a different note, P5 mentioned that citizens could participate in defining which values are prioritised. P5 further elaborated that citizens might also need to participate in defining the moral values around which the system governing the allocation of road space itself is designed. P5 expressed the need to "get more insight into what people would consider fair" and that participation could be used "...to find out what fairness means...". This point was picked up in the interview with P8. In the interview with P8, the idea that stakeholders should participate in continuously defining the meaning of fairness in the *Code the Streets* system was presented. P8 agreed with this thought stating that it would make sense as the reality of people who will live in over 20 years time would be unfair from our current perspective. P8 also provided feedback on my ideas embodied in the system map. P8 seemed intrigued by the idea of operationalizing stakeholder participation in *Code the Streets* through multiple, simultaneous participation processes targeted at different stakeholders and with different objectives. P8 agreed that stakeholders should be involved in a broad spectrum of activities and decision making processes around the system, from "defining what is a good life" and values to participatory data labelling in the machine learning system.

Key considerations in designing a participatory process

During the interviews, participants shared some important questions that according to them, are at the very core of designing a participatory process. According to P5, P2 and P4, setting up a participatory process requires defining who should participate, what citizens have influence on, how citizens participate and when in the process of policy making are citizens involved. P4 elaborated on this last point stating that: "if you are in the front of the design, they [citizens] can contribute a lot. But it's also very likely that the outcomes at the end of the process are completely different." P5 and P1 further highlighted the issue of dealing with conflicting interests and the comparability and prioritisation of stakeholder input. P5 elaborated on this by bringing up the notion of *tyranny of the majority* and inquiring about my ideas around fairness by asking: "a lot of people can vote in favour of using the streets as a big terrace after eight o'clock. But maybe some people have very strong reasons why they don't agree with that. How do you take those reasons into account? The majority vote says we should do it."

Meaningful participation is a challenge for the municipality

Meaningful engagement with citizens is a challenge for the municipality and its employees. Several participants shared their experiences during the interviews. P3 mentioned that current efforts to engage citizens often remain one way monologues and fail to create a sense of ownership over the public space among the citizens. Both P3 and P4 explained that engaging with citizens about their needs and wants for the public space can be difficult for policy makers and city officials. Citizen engagement therefore often remains superficial. Participatory experts P9 commented that bureaucratic approaches and the general image of the municipality can be experienced as off putting for citizens and represents a hurdle for participation. P9 further expresses that there is a general lack of understanding of the citizens' perspective by the municipality. Similarly, P4 mentioned that a major hurdle for citizen participation is to "understand all the policy and rules the municipality has, and all the different kinds of places you can interact with the municipality to get something done". P4 expressed the need for clear communication about how citizens can participate, mentioning that it is important to communicate to stakeholders what they can have influence on and to manage expectations about how their input will be used and will be reflected in the outcome. P3 highlighted the importance of the availability of information about what is happening in the city for citizen driven, bottom up participation. But even if a satisfactory dialog between the municipality and the citizens is established, there are still important challenges. According to P3 and P4, the participation channel influences who will take part in the participation process and can thereby create a biased outcome. P4 explained that "we use surveys, we organise evenings for people who live in neighbourhoods, but you likely see the usual suspects". Both P3 and P10 agreed that this is an important challenge for the municipality. P3 mentioned that one way the municipality tries to deal with it is by making use of new forms of participation such as installations in the public space, aiming to make participation more accessible and gathering input from a diverse participant sample. P4 takes a more accepting perspective stating that there is no reliable solution to this bias and that it is important to take it into consideration when designing a participation process as well as when analysing the outcome.

The approach to fairness adopted in this project is met with approval

P7, an expert on philosophy of technology provided feedback on the approach to fairness established in chapter 2 *Related work*. P7 approved of my framing of fairness as a guiding principle,

an ideal that can be approximated but not fully reached. P7 commented that it was reasonable to approach fairness as a “beacon” with a “navigation function” and that this is in line with prominent ideas in the domain of philosophy presented by John Rawls. Detecting changes in values such as fairness in society however remains a difficult endeavour. According to P7, there is no single, perfect method that guarantees success. P7 suggested focusing on procedural justice (introduced in chapter 2 *Related work*), mentioning that it would be “beautiful” if stakeholders would feel that the outcome was reached in a correct way and that they get the chance to influence it again. After reviewing the early idea of the system map presented in the interview, P7 added that ultimately, the mapped out system could result in an approach that may be used for the allocation of diverse public resources. A just process through which people could have a continuous say in the allocation of a public resource such as shared environments, infrastructure and other public resources.

5.4. Conclusion

The interviews conducted were successful in delivering satisfactory insights relating to the research questions stated at the beginning of this chapter. Certain insights were in line with and elaborated on findings from previous investigations such as the importance of communication in participation processes. Other insights were new and more specific to the scope of the project at hand. The key conclusions from this investigation will be combined with the outcomes from research activities presented in previous chapters to frame the design goal and define criteria for the speculative prototype and system map.

Key conclusions

Stakeholder participation in Code the Streets

- **Taking the first steps in developing a strategy for participation**
  The discussion about the potential role of stakeholder participation within *Code the Streets* appears to still be in its early stages. The team members seem positive about the general idea of participation and are taking first steps in defining a strategy for stakeholder participation within the project. This project may contribute to their strategy.

- **Ideas and opinions within the team are diverse**
  Initial ideas and options shared what the role of stakeholder participation could and should be are diverse: from stakeholders participating by operationalizing values set by the municipality, to stakeholders defining and prioritising values (such as fairness) which guide the system development.

Insights on participation from practice

- **Designing a participatory process requires prioritising**
  Designing a participatory process requires carefully specifying who, what, how, and when. These are ultimately questions of prioritisation relating to the perception of fairness.

- **The challenge of comparing and prioritising stakeholder input**
  Managing a participatory process likely requires comparing and prioritising the input of different stakeholders. Decision making processes such as majority vote may be used and appear to hold important implications for the perception of fairness.

- **Citizens participating in policy making can be challenging**
  Meaningful citizen engagement in participatory processes is a challenge for the municipality and its employees. Especially creating an attractive and understandable way for a diverse group of citizens to participate in policy making remains difficult.

Feedback on my approach to fairness

- **Approach to fairness is met with approval**
  According to the consulted philosophy of technology expert, conceptualising fairness as an ideal that can not be reached but approximated as well as a focus on procedural justice is reasonable.

- **A process for the fair allocation of public resources**
  This process presented in the system map may contribute to establishing just processes through which stakeholders have a continuous say in the allocation of diverse public resources.

5.5. Limitations

Participants seemed to struggle to stick to the scope when discussing stakeholder participation in a smart system governing the dynamic allocation of road space. Their comments generally revolved around stakeholder participation within *Code the Streets* at large. Another limitation of this investigation is that the discussions around stakeholder participation in relation to *Code the Streets*, value change and the city of Amsterdam frequently had a focus on citizen participation. When referring to participation, interviewees commonly mentioned citizens or used the terms stakeholders and citizens interchangeably. This created a lack of discussion about participation of other stakeholders and presented a challenge when analysing the data.

Chapter 6

Synthesis

This chapter marks the transition from research to design activities. The first section brings draws conclusions from the most important findings from the research activities carried out in this project and presented in the chapters 2 *Related work*, 3 *Initial research*, 4 *Stakeholder participation in Amsterdam* and 5 *Expert interviews*. The goals for the design outcomes, a system map and a speculative prototype, are set based on these conclusions. Finally, a set of criteria are defined for each design outcome intended to guide the design process and function as measures for success in the evaluation.

6.1. Synthesis research findings

Approach: defining the overall research conclusions

The findings from the research activities presented in the previous chapters were clustered and arranged in a table (see *appendix* 6). The findings were then compared and the overall research conclusions were derived. Figure 39 shows an example of the clustered research conclusions in the table and the derived overall conclusions.

Figure 39: Example of how the findings from different research activities were grouped to define the overall research conclusions.

Research conclusions

The conclusions are presented in three sections. The first section contains a recap of how fairness is conceptualised and operationalized within this project. The second section focuses on conclusions that are of core interest for the design activity. The third section contains conclusions that are beyond the scope of the design project at hand but are still relevant for *Code the Streets* or the meaning of the project at hand within design research and will be picked up again in chapter 9 *Discussion & conclusion*.

Conceptualising and operationalizing fairness within the project at hand

Conceptualising fairness as an ideal that can be approximated but not reached

Research presented in chapter 2 *Related work* suggests that the perception of fairness is influenced by individual and cultural norms. With a context as diverse as the city of Amsterdam and the large number of stakeholders shown in the stakeholder map it can be assumed that there are many different opinions and ideas regarding what is a fair allocation of road space. Fairness is therefore approached within this project as an ideal that can not be reached but can be continuously approximated. This conceptualisation of fairness was approved by the philosophy of technology expert in the interviews presented in chapter 5 *Expert interviews*.

Operationalizing fairness through adaptability and stakeholder participation

Literature presented in chapter 2 *Related work* indicated that the emergence of fairness and the legitimacy of the decisions made by the system are rooted in the systems' development processes. This project is therefore focused on process fairness which is approached through continuous adaptation of the system with regards to value change and stakeholder participation. Stakeholder participation is seen as a means for this continuous adaptation as it can offer opportunities for contestation and ensure legitimacy.

Input for design

Long term adaptability requires contestability at three levels

Literature highlights the need for a system to be contestable by stakeholders at two levels: at use time and at design time. The system conceptualised in the project at hand is intended to have a long life span and to be continuously adaptable to value change in society through stakeholder participation. The investigation presented in chapter 4 *Stakeholder participation in Amsterdam* shows that long term participatory processes need to be re-evaluated and re-designed over time. Furthermore, the same chapter and chapter 5 *Expert interviews* suggest that designing a participatory process requires defining aspects such as who should participate, what they should have influence on and how they should participate. These are decisions of prioritisation and relate to the value of fairness. To ensure that the redesigned participatory process fosters fairness (whatever fairness means at any given moment in time), stakeholders need to be able to contest the participatory design process through which the adaptive system is developed.

Communication is the foundation for participation

Communication and, more generally speaking, the availability of information are the foundation for participation in a socio-technical system. The research presented in chapter 2 *Related work* suggests that a minimum level of transparency is needed for stakeholders to decide whether there are grounds for intervention. This transparency may be provided in form of explanations and justifications for the road rules defined by the traffic management system. The results presented in chapter 5 *Expert interviews* further indicate that Stakeholders need to be aware of what they can have influence on and how they can participate. These insights will have to be taken into consideration in the design of the smart system allocating road space as they appear to form the foundation for stakeholder participation.

The need for multiple participatory processes

The stakeholder map introduced in chapter 3 *Initial research* indicates that there is a diverse mix of direct and indirect stakeholders who are potentially affected by changes in the allocation of road space. The research presented in chapter 4 *Stakeholder participation in Amsterdam* and chapter 5 *Expert interviews* further show that participatory processes need to be carefully tailored to the abilities of the targeted stakeholders. It is therefore concluded that meaningful stakeholder participation within the context of a smart system allocating road space requires a multitude of participatory processes specifically designed to engage different stakeholders.

Monitoring participation for biases

The notion that participation may hold important biases was initially proposed in chapter 2

Related work. The experts consulted in chapter 5 *Expert interviews* further explained that engaging diverse groups of citizens through participation and the resulting sampling bias is an important challenge in the current participatory efforts of the municipality. The participatory processes through which the smart system governing the allocation of road space is adapted should therefore be monitored for biases. This may promote the identification of biases and allow for adequate measures to be taken.

Factors limiting stakeholder influence

Extensive participation processes can require significant resources in terms of time and finances. Participatory processes and efforts to adapt the socio-technical system have to match the available resources. Stakeholder participation can be limited by the policy and legal freedom which the municipality holds. As certain aspects of the system are prescribed by higher level authorities (for example the GDPR guidelines defined by the European Union) it may simply not be possible for stakeholders to exert influence over certain aspects of the system.

Supporting the Code the Streets team in defining their strategy for stakeholder participation

The expert interviews presented in chapter 5 *Expert interviews* showed that the discussion of what role stakeholder participation could and should play in *Code the Streets* is still in its early stages. According to the project manager of *Code the Streets* at the municipality, stakeholder participation is poised to become a key research topic within *Code the Streets*. This presents an opportunity for the project to contribute to defining a strategy for stakeholder participation within *Code the Streets*.

Speculative design can illustrate value tensions relating to fairness

The design examples presented in chapter 2 *Related work* as well as the speculative prototype created during the initial pressure cooker indicate that speculative design can make value tradeoffs tangible and discussable. Tensions relating to fairness can be brought to life within the speculative prototype by confronting viewers with the dilemma of stakeholder prioritisation.

Input for further discussion

A smart system allocating road space is never value neutral

Literature presented in chapter 2 *Related work* suggests that technology is never value free. Instead, values are embedded into technology through design. Even or especially the most fundamental design choices can influence which values a system ultimately fosters and which are hindered. For example, choosing to attempt to close the legitimacy gap through stakeholder participation as done within this project is a design choice in itself which introduces democratic values. Components may be designed to be adaptable, flexible or robust with regards to value change but they still are not value free. Values promoted and hindered by the system at any given moment in time need to be carefully considered.

Road rules are one piece in the puzzle of alternative road use

The design examples presented in chapter 2 *Related work* illustrate that road rules are not isolated but exist within a complex ecosystem. The pressure cooker of chapter 3 *Initial research* further indicates that changing the allocation of road space via rules may not be sufficient to meaningfully change how roads are used. Participants commented that rules need to be ac-

companied by changes to the physical road space. So while rules seem to be necessary for the alternative use of road space, meaningful change in how roads are used may require change across larger parts of the ecosystem. The complex relationships in this ecosystem are out of scope for the project at hand, yet it seems relevant to consider the position of *Code the Streets* within it. Especially as these entanglements bring up important questions for the scope of and relationships between participatory processes, for example: Should participatory processes designed to inform rules at road level also inform physical changes to the road space? Or should both of them be informed by other, higher level participation processes? How may we exchange input between different participatory processes?

The cognitive load of dynamic rule changes

Interview participants in the pressure cooker presented in chapter 3 *Initial research* highlighted the importance of considering the human perception of change when creating a system dynamically changing road rules. Rapid and contrasting rule changes may be experienced as overwhelming, possibly resulting in significant cognitive load and even unsafe situations as human habits take time to adapt. The importance of designing a system at human scale was further pointed out by a TU Delft expert in safety of AI systems in policy contexts during an informal interview. The experience of dynamic rule changes, and how rules are communicated goes beyond the scope of this project but should be considered in further research efforts.

Reimagining citizenship in the smart city

The approach developed in this project could potentially inspire just processes through which stakeholders have a continuous say in the smart allocation of diverse public resources. This was suggested by the philosophy of technology expert in chapter 5 *Expert interviews*. This indicates that the project at hand may contribute to the research efforts focused in reimagining citizenship in smart cities which will be further elaborated upon in chapter 9 *Discussion & conclusion*.

6.2. Design goals and criteria

Design goal and criteria system map

The system map was originally intended to describe the assemblage of mechanisms that are necessary to govern the allocation of road space according to the defined values (see chapter 1 *Introduction*). This perspective has changed throughout the project. While the system map is intended to show the larger socio-technical system it would not be able to show all mechanisms and assemblages necessary to govern the dynamic allocation of road space. Instead, the system map is focused on the value fairness. As explained previously, I take the position that a fair system can not be reached but can be continuously approximated through adaptation enabled through stakeholder participation. The investigations showed that the municipalities' *Code the Streets* team seem positive about the general idea of participation and are taking first steps in defining a strategy for stakeholder participation. It is therefore decided that the aim of the system map is to illustrate to the team of the municipality of Amsterdam how stakeholders should participate in the socio-technical system to enable the continuous emergence of fairness. The system map thereby intends to enable further discussions focused at forming a better

understanding of the value fairness and the role stakeholder participation could and should play within the *Code the Streets*.

Criteria:

The system map is concerned with a smart traffic management system governing the dynamic allocation of road space determined by (ever changing) values. The system map is designed to:

1. illustrate how, i.e. through which mechanisms and processes, we can enable the continuous approximation of fairness.
2. be understandable to the members of the *Code the Streets* team of the municipality of Amsterdam.
3. be perceived as potentially useful for discussions focused at forming a better understanding of the value fairness and the role stakeholder participation could and should play within the *Code the Streets* project by members of the *Code the Streets* team of the municipality of Amsterdam.

Design goal and criteria speculative prototype

The speculative prototype was conceived in the introduction of this report as a low tech experience installation. It was originally intended to allow stakeholders to join the discussion that would struggle to give meaningful criticism based on a system map. Creating a speculative prototype that lets stakeholders experience the entire system shown in the system map does not seem to be feasible within this project. Instead, a variety of speculative prototypes could be made relating to distinct parts of the map. Different opportunities were considered (see brainstorm figure 40) and in combination with the conclusions explained in the previous section, some key design goals were defined.
The speculative prototype should address the notion of fairness as this is the driving concept behind the project at hand. Fairness is approached within this project as a property emerging from the interaction of system components which can be approximated through adaptability and stakeholder participation. It is therefore deemed desirable that the speculative prototype illustrates the relationships between stakeholder participation, decision making processes, smart technology and the rules at road level. Next, the speculative prototype should illustrate the effects of value change in relation to the road rules which govern the allocation of road space. Showcasing the effects of value change on the other levels, the design process and the qualities of the system, is not pursued to reduce complexity. And finally, as a speculative design, the exhibition should allow visitors to suspend their disbelief and become active imagineers of the reality brought to life by the designed props. This entails that the exhibition needs to be evocative but also picture a believable reality.

Criteria

The criteria for the speculative prototype represent a more concrete version of the design goal established above and explain what the speculative prototype should do. These are used to guide the design process and will also function as measures for success in the evaluation of the speculative prototype.

The speculative prototype...

1. addresses the notion of fairness with regard to a fictional smart urban traffic management system governing the dynamic allocation of road space around civic values.
2. illustrates the effect of value change on the rules governing the allocation of road space and how roads are used.
3. illustrates the roles of and relationship between stakeholder participation, official decision making processes, smart technology and the rules at road level within the aforementioned smart urban traffic management system.
4. is a provocative proposal for an alternative perspective on the current practice of road space allocation (Bardzell et al., 2014).
5. is sufficiently believable for viewers to imagine themselves living in a world where the illustrated circumstances are reality. The scenario cannot be easily dismissed as science-fiction (Bardzell et al., 2014).

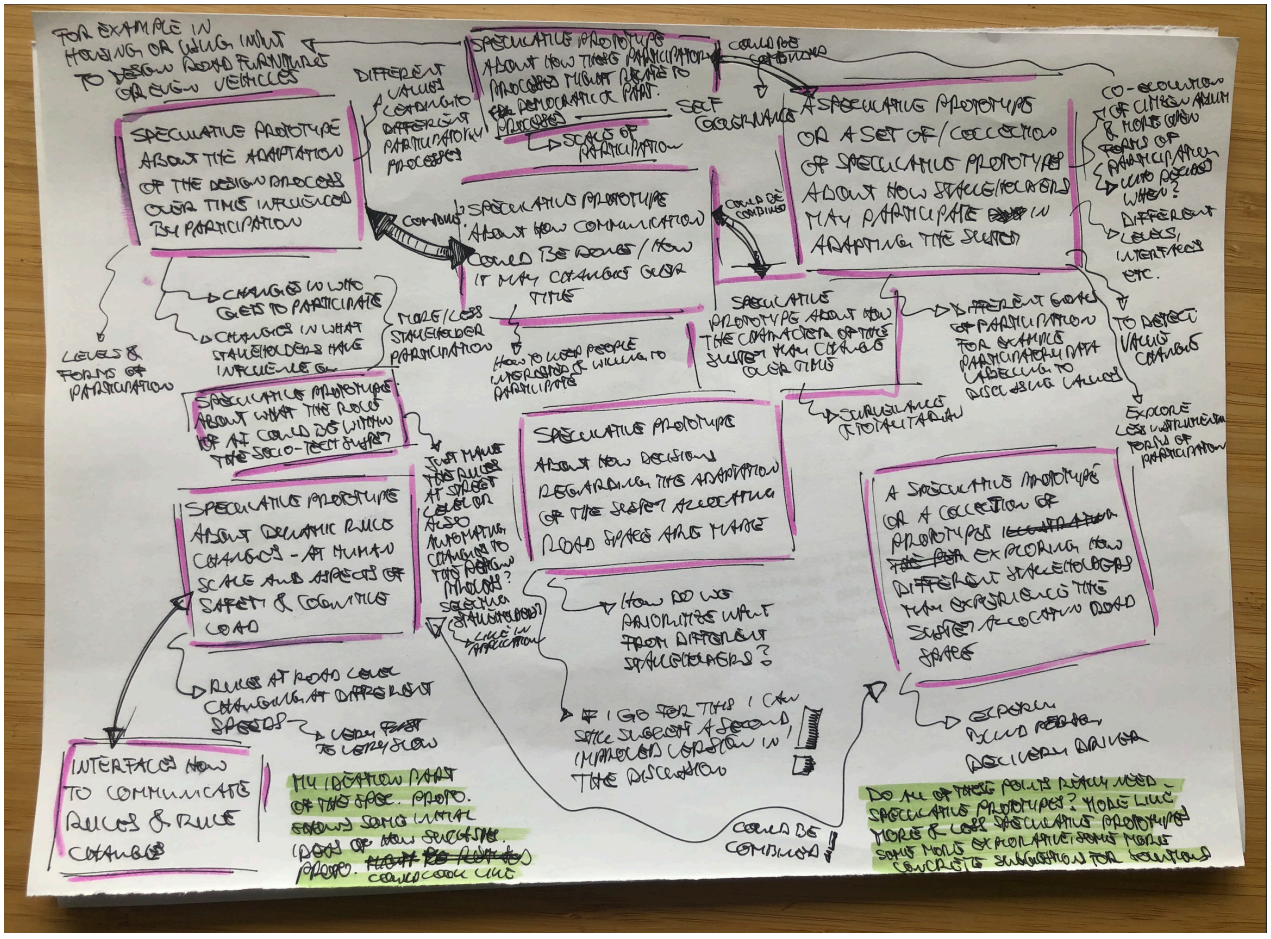


Figure 40: Outcome of a brainstorm about the different parts of the system map for which speculative prototypes could be created.

6.3. Conclusion

This chapter presented the main conclusions derived from the research activities carried out in this project. The research conclusions were used to define design goals and criteria for the system map and speculative prototype. The criteria established in this chapter will be used to guide the design process presented in the following chapter and will also function as measures for success in the evaluation of the speculative prototype shown in chapter 8 *Evaluation*.

Chapter 7

Conceptualization

This chapter presents the conceptualization process as well as the system map and the speculative prototype designed around the criteria set in the previous chapter and used in the evaluation. The design processes for both outcomes were significantly intertwined as speculative prototype iterations were inspired by the previously created system map iterations created around research insights. For ease of understanding, the conceptualization processes of the system map and the speculative prototype will be described in this chapter in two separate sections. Each section ends with the presentation of the respective design outcome.

7.1. Conceptualization system map

This section presents the design process of the system map through several iterations. The section begins with a summary of the conceptualization process. Next, the main iterations of the system map are shown. The section ends with an in-depth explanation of the system map used in the evaluation. The final system map iteration created in this project can be found in chapter 9 *Discussion & conclusion*.

Conceptualization process

The system map was developed alongside the research activities. Results from each research activity informed a new iteration of the system map. A timeline of this process showing the different research activities and system map versions can be seen in figure 41. The iterations of the system map were not created around the criteria defined in chapter 6 *Synthesis* or other criteria. Instead, they are based on the interpretation of relevant research findings which were mapped into early iterations of the system map. Only the system map used for evaluation and the final iteration were created to meet the criteria defined in chapter 6 *Synthesis*.

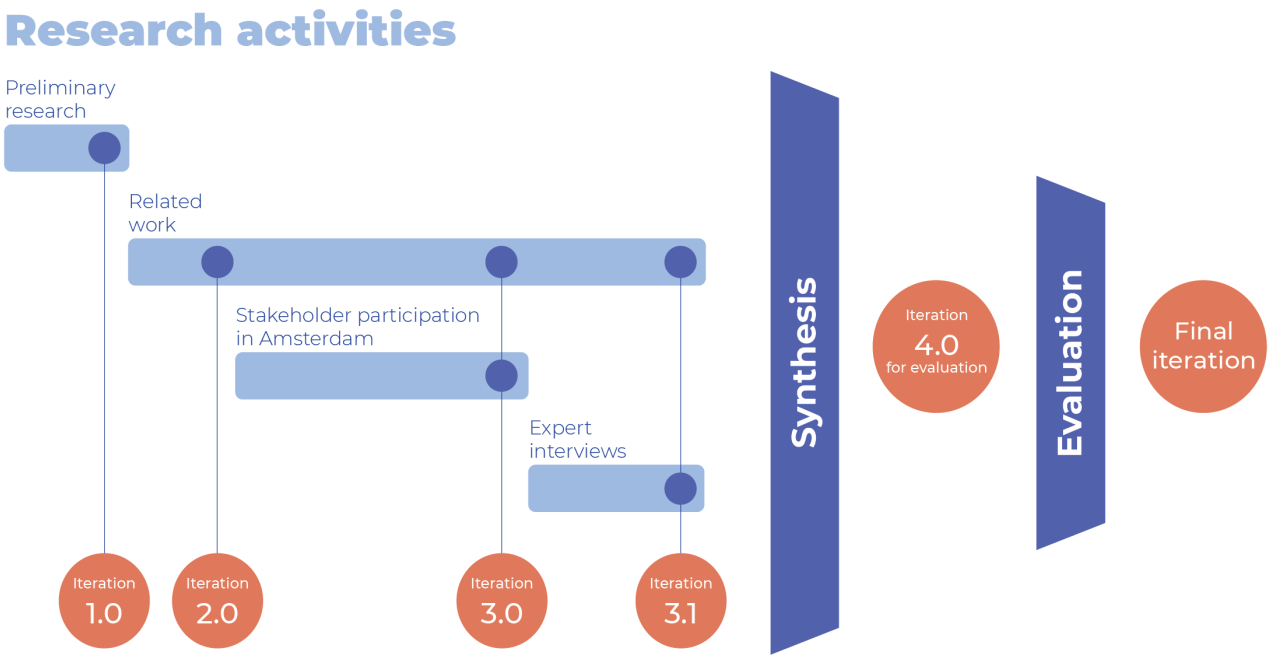


Figure 41: The conceptualization process of the system map showing a timeline of the main research activities and the system map iterations. The illustration shows which system map iteration was informed by which research activities.

Concept iterations

System map iteration 1.0

The first iteration of the system map (see figure 42) was developed during the pressure cooker carried out in the first weeks of the project. This version of the system map can be seen as a first exploration of the influence stakeholders might have on different system components (yellow arrows). The map envisions stakeholders' input affecting aspects such as the training data for the smart system governing the rules at road level and the quality control of the traffic rules. Important concepts such as value change and adaptability however had not been thoroughly explored at this point. This iteration of the system map is therefore limited to basic feedback loops. This system map is described in more detail in *appendix* 3.

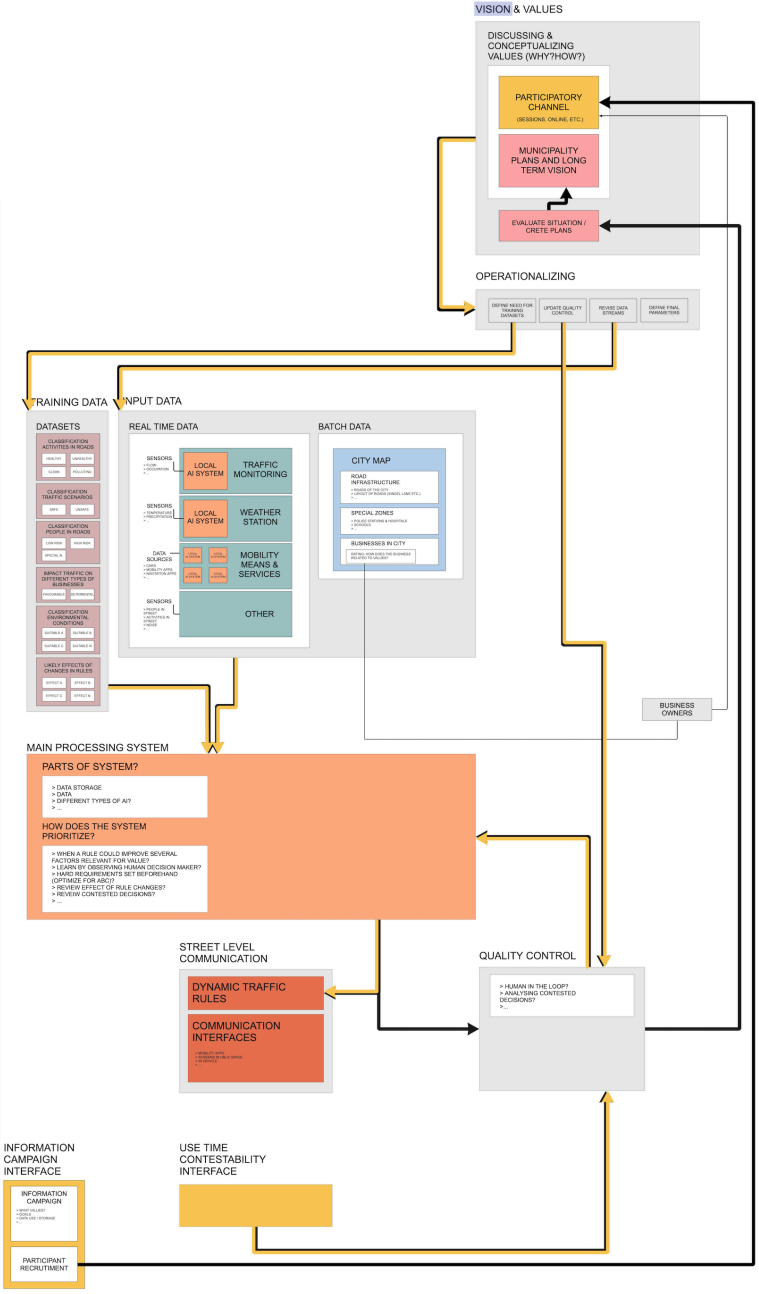


Figure 42: System map iteration 1.0 created during the pressure cooker presented in chapter 3 *Initial research*.

System map iteration 2.0

The second iteration (see figure 43) represents a first attempt in translating learnings about adaptability and value change into a system map. The map is laid out as a loop with four main stages and revolves around a continuous VSD process. In this design process, requirements for the system are defined through stakeholder participation (yellow rectangle). These requirements are then adopted by experts to carry out technical changes to the system (pink rectangle) which defines the rules experienced at road level (green rectangle). An information campaign (blue rectangle) is used to create awareness among stakeholders for the opportunity to participate and thereby feed stakeholder participants into the continuous VSD process.

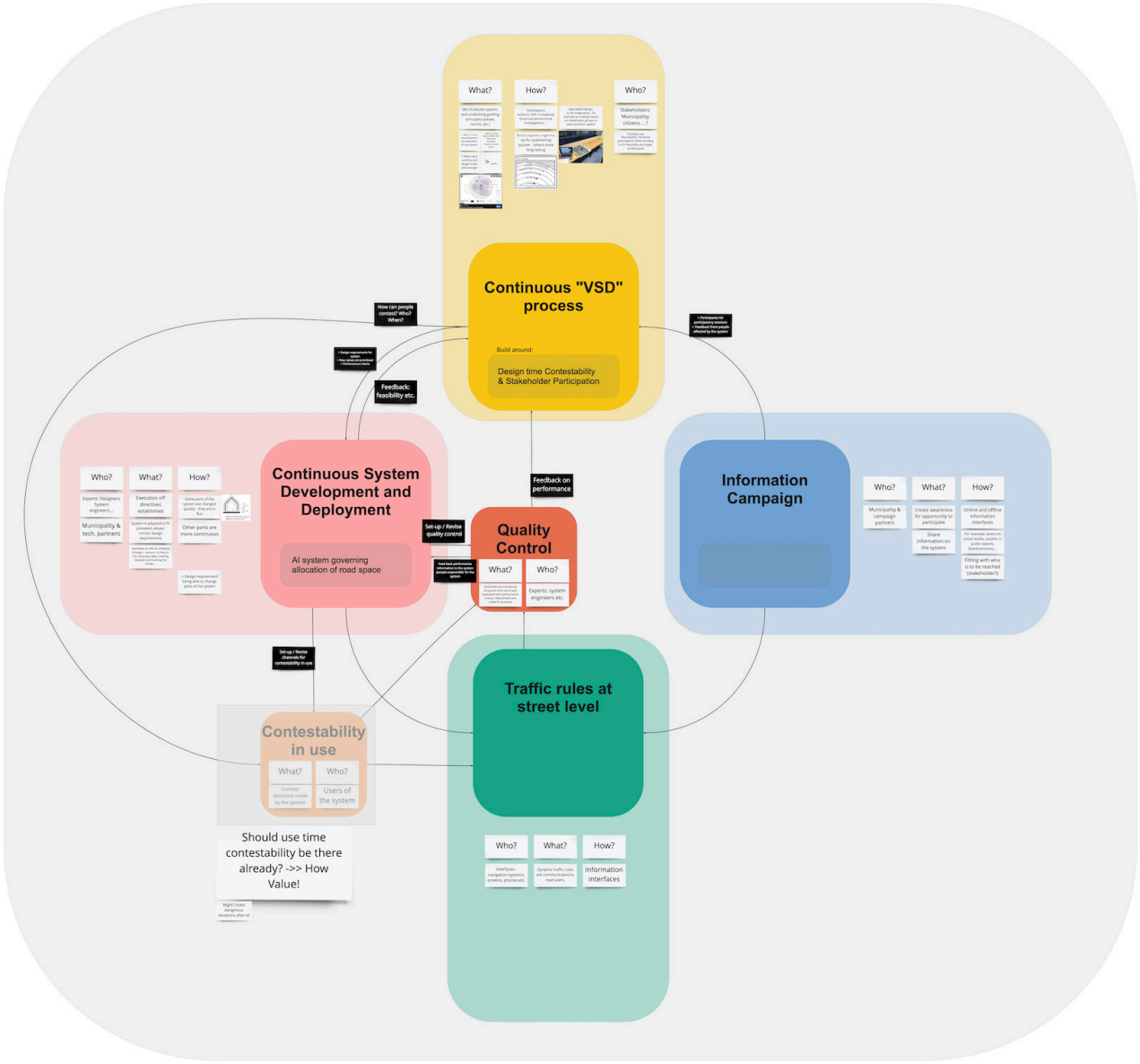


Figure 43: System map iteration 2.0.

System map iteration 3.0

The third iteration (see figure 44) of the system map goes beyond the idea that values can be translated into design requirements for how road space is allocated and for the system that governs this allocation. Values may also be translated into requirements for the design process through which the system governing the allocation of road space is created and adapted. Values might therefore inform the participatory design process including basic considerations such as who should participate, how participation should be done and what stakeholders should have influence on. And as values change, so should the design process. In the system map, this idea takes shape in the *self-reflexive loop* indicating a process of continuous participatory re-evaluation and redesign to adapt the continuous design process itself.

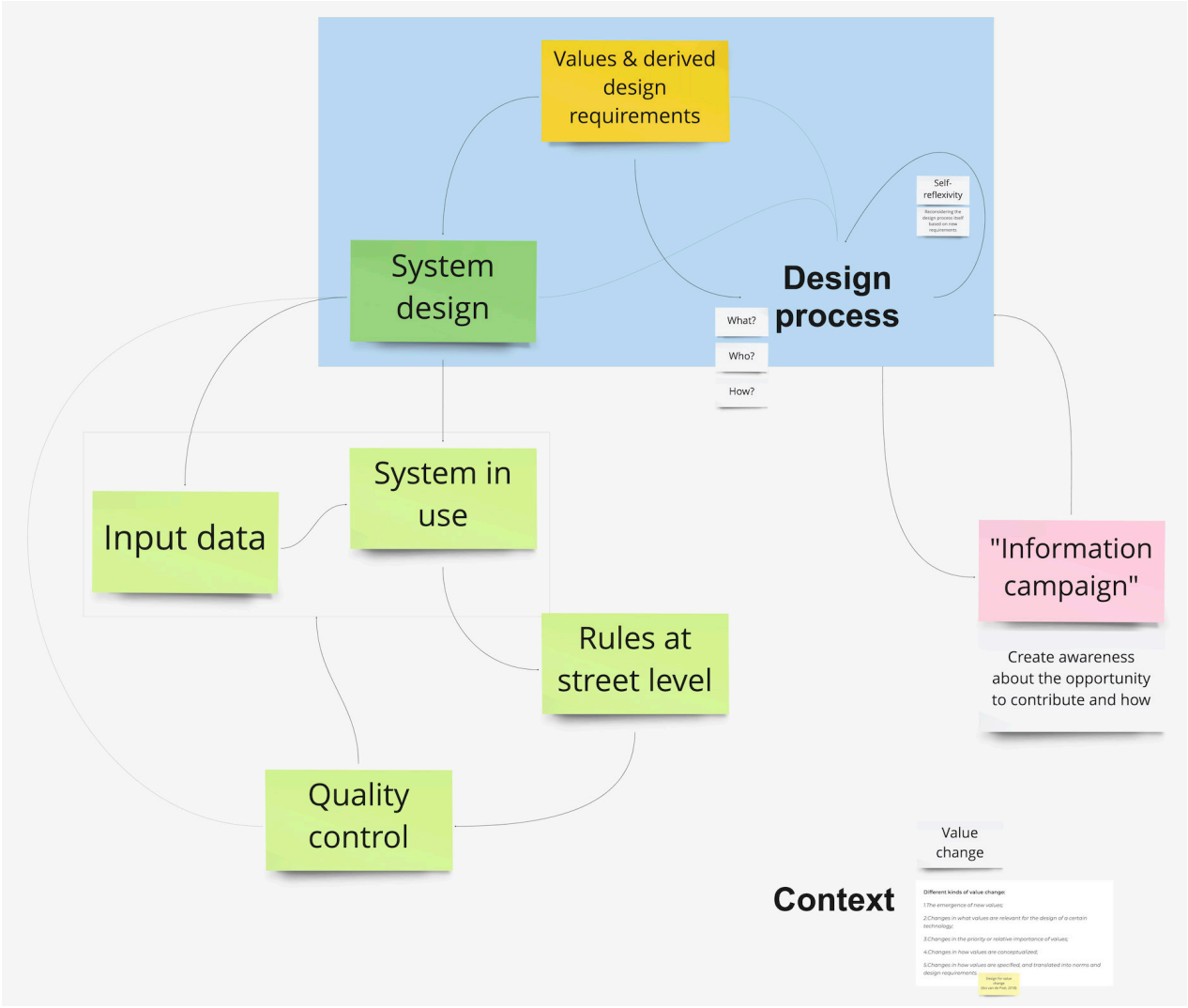


Figure 44: System map iteration 3.0.

System map iteration 3.1

This iteration of the system map (see figure 45) is an extension of the third iteration. It brings together the most important findings from the research activities. A simplified version of this map (see *appendix* 5) was used during the expert interviews presented in chapter 5 *Expert interviews*. Furthermore, this system map iteration significantly informed early criteria and concepts of the speculative prototype. In essence, this iteration holds almost all the information present in the system map used for evaluation and was merely rearranged and fine-tuned around the system map criteria set in chapter 6 *Synthesis*. Because of this overlap it is not described in detail in this section and instead it is suggested to read up on the next iteration in the following section.

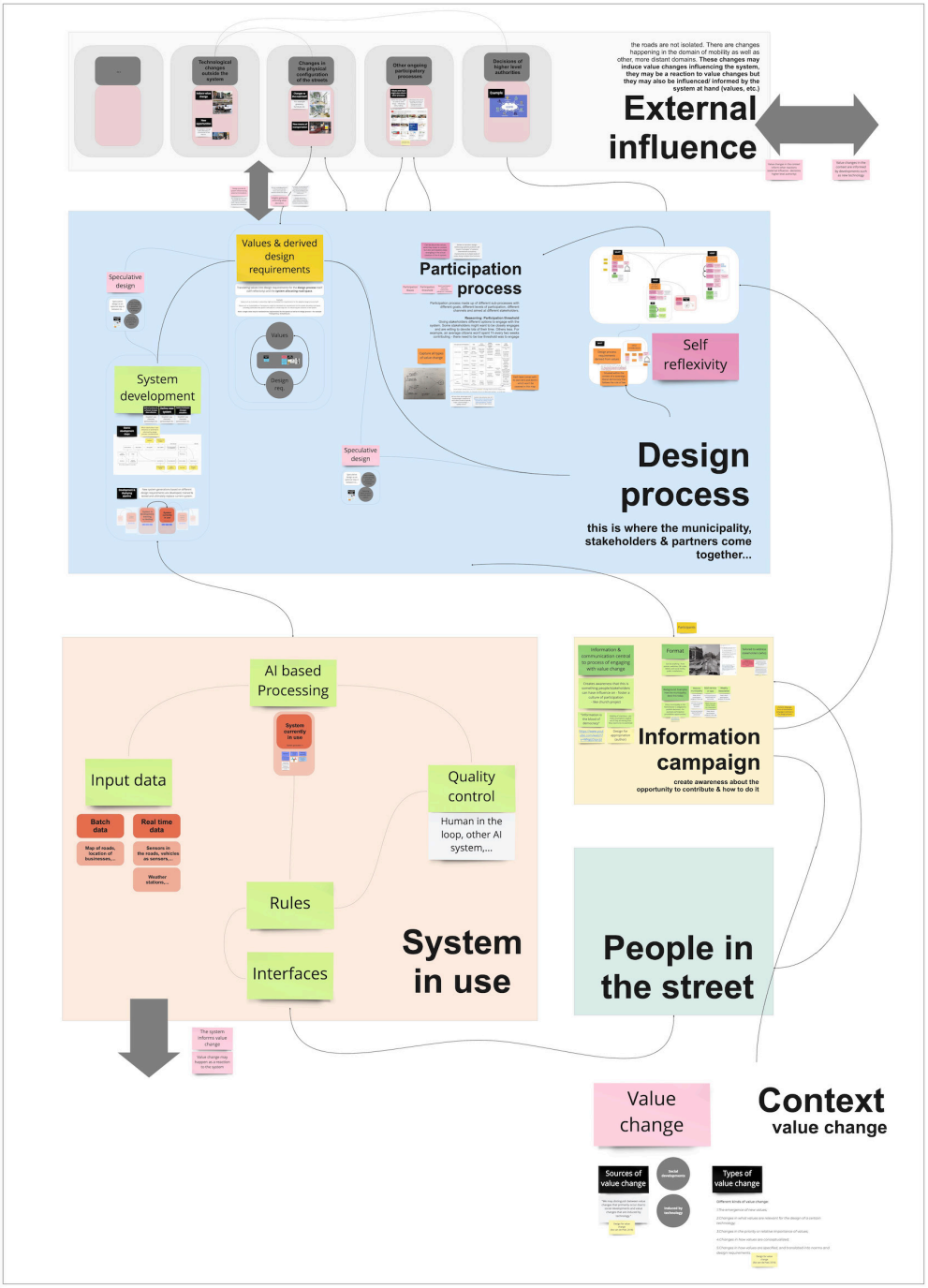


Figure 45: System map iteration 3.1.

System map iteration 4.0 (used for evaluation)

The system map used for evaluation was designed to meet the criteria defined in chapter 6 *Synthesis*. Similar to previous iterations, this version of the system map intends to illustrate how we can enable the continuous approximation of fairness. In addition, it also aims to be understandable and perceived as useful by members of the *Code the Streets* team of the municipality. While at first sight it looks different from iteration 3.1, its content has been refined but not drastically changed. Changes mainly aimed to improve understandability and reduce complexity. The system map used for evaluation was realised on an *A0* poster (see figure 46). The poster presents the system map and additional information intended to explain the map (see figure 47). The poster introduction describes what the system map illustrates: the processes which enable the emergence of fairness in a system governing the dynamic allocation of road space. The explanations of the main parts describe what happens at each of the four main levels of the system map and how they relate to each other. The text further provides additional information that was not visualised in the system map itself. For example, the conclusion that meaningful stakeholder participation within the mapped out system requires multiple participatory trajectories tailored at different stakeholders established in chapter 6 *Synthesis* was not visualised in the map but only mentioned in the explanation. This was done in an effort to keep the map concise and understandable.

Components system map

The system map used for evaluation is made up of four main levels. The title of each level is accompanied by an icon indicating at which levels stakeholders participate and where the AI sits. Within the system map, stakeholders refers to potentially all stakeholder groups identified in the stakeholder map presented in chapter 3 *Initial research*. Note however that this was not explained in the system map. Who exactly the stakeholders are that participate at any given moment in time is defined in level 1 *Participatory process design*. Each level contains sections referred to as *Steps* (circles within the main levels). The steps explain what happens within the main level. They describe the actions and activities that are carried out at each level and thereby aim to aid understandability. The main levels and steps are interconnected by arrows. The arrows are intended to show and explain the relationship between different levels and steps. They can be seen as inputs and outputs of the levels and steps. The four levels, their steps and the connecting arrows are described in the following paragraphs.

Level 1: Participatory process design

At this level stakeholders shape the design of the participatory process through which the traffic management system is developed at level 2. Stakeholders update or redesign the design of the participatory process together, defining who gets to participate and how much weight does their voice carry compared to others, what parts of the system they can influence, when in the process they get to participate and how they will participate. This process of updating or redesigning the design of the participatory process is intended to be value driven. Stakeholders participate in defining which values the participatory process should foster and conceptualising these values (i.e. defining what these values mean in the contest of a smart system allocating road space.). They then translate the values into requirements for the design of the participatory process. Ultimately, these requirements are used to establish an updated or redesigned participatory process which is deployed and put into service in the continuous development of the smart traffic management system.

Level 2: Smart traffic management system development

Here, the smart system governing the dynamic allocation of road space is developed. Stakeholders contest (at design time) the smart traffic management system governing the allocation of road space by participating in its development through the participatory process designed at level 1. Together, stakeholders define and conceptualise which values the smart traffic management system should foster and conceptualise these values. They establish design requirements for the smart system. The design requirements are then used to develop an updated version of the smart traffic management system. This development process is illustrated in the system map using the AI lifecycle by Binns and Gallo (2019). The Updated system is deployed to govern the allocation of road space. The deployed system, including interventions at use time (see level 4) is monitored to ensure that it respects the requirements it was designed for. This was taken over from the model for contestable AI by design by Alfrink et al. (2021).

Level 3: System in use

At this level, the smart traffic management system defines the rules at road level. Sensors collect data necessary for the decision making such as weather data. The data is used by the AI component to define road rules. The rules are then sent to the interface at street level along with explanations and justification for the rules (see level 4). Use time interventions at road level (see level 4) are registered and may override a rule set by the AI system.

Level 4: Street level

At street level, the road rules are communicated to road users via interfaces. In addition, road users are provided with explanations and justifications for the rules as well as information about their opportunities for intervention. If road users do not agree with the road rules, they may decide to contest the road rule by intervening at use time by using the interactive control element. The interactive control element is inspired by Alfrink et al. (2021) and intended to give road users limited options to override the rules set by the smart system. This could for example be a temporary rule change in a specific street, requested by a craftsperson demanding access to the street with their vehicle. What this interactive control would look like and which options it should give is not further specified. As a means for stakeholder participation in the decision making process it is instead intended to be defined through the participatory process design explained in level 1. Besides intervening at use time, road users are presented with their opportunities to intervene at design time. They may enlist and take part in the continuous development process of the smart traffic management system which is shown by the arrow from level 4 back to level 2.

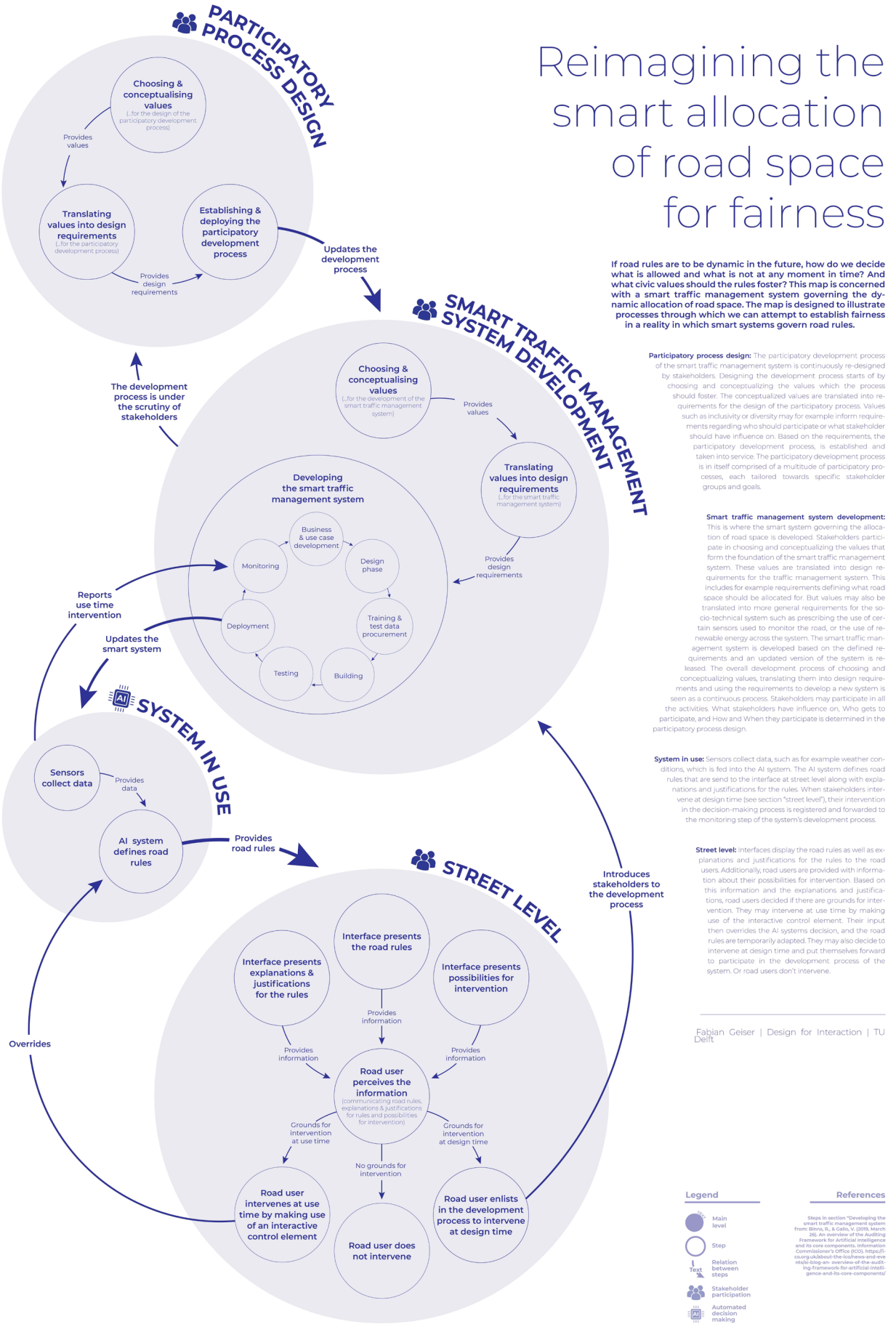
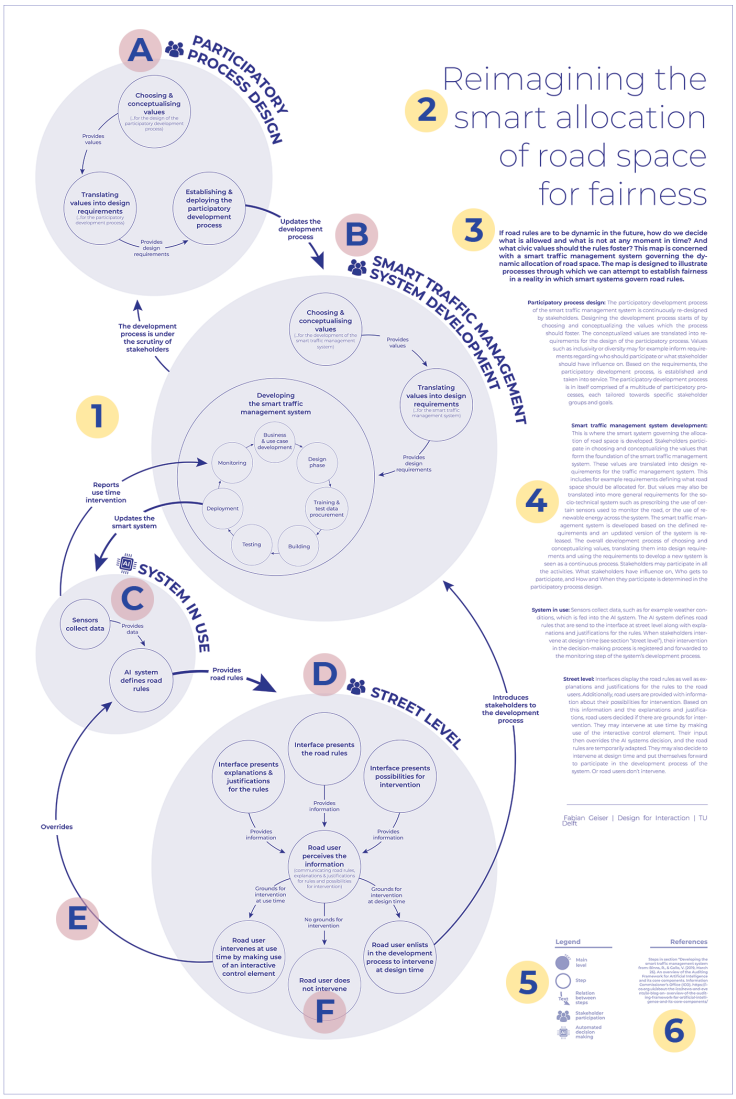


Figure 46: The system map poster used in the evaluation.



System map poster

1. The system map
2. Poster title
3. Introduction of the system map
4. Explanation of the main parts of the system map
5. Legend
6. References

System map

- **A.** Level 1: Participatory process design
- **B.** Level 2: Smart traffic management system development
- **C.** Level 3: System in use
- **D.** Level 4: Street level
- **E.** Connecting arrows showing the relationships between levels and / or steps
- **F.** Example step

Figure 47: The system map poster used in the evaluation with annotations.

7.2. Conceptualization speculative prototype

This section presents the speculative prototype and the related ideation and conceptualization process. As mentioned in the introduction to this chapter, the early stages of ideation and conceptualization were based on different criteria than the ones presented in the chapter 6 *Synthesis*. To be specific, they were based on the conviction that the speculative prototype should illustrate as much as possible of the mapped out system. This meant that early iterations of the speculative prototype turned out to be complex. The initial criteria were adapted during the conceptualization phase, ultimately resulting in the criteria presented in chapter 6 *Synthesis*.

Concept ideation

Initial ideation

The conceptualization phase started with a broad exploration in the form of a brainstorm about the effect of value change on the rules at road level, the socio-technical system defining the rules, and the design process through which the socio-technical system is created. This brainstorm aimed to generate a more tangible conception of the reality implied by the system map. Besides exploring the effect of value change on these three levels, this brainstorm also brought up a number of initial ideas of how the effects of value change could be illustrated in an interactive exhibition. The outcome of this divergent investigation together with an exploration of how exhibition visitors may engage in shaping the system allocating road space is presented in figure 48.

A card deck (see figure 49) of more than 90 cards was created based on initial ideas of how the effects of value change could be illustrated in an interactive exhibition collected in the brainstorm. The cards contained a diversity of ideas: from high-level concepts, to potential exhibition components and their details. The deck was intended as a supporting tool aiming to generate more control over the design process: helping on one hand to manage a diversity of ideas and on the other hand allowing to create quick concept iterations. The deck was ultimately used throughout the conceptualization process and ideas presented on its cards informed concept iterations as well as the final speculative prototype.

Figure 48: Ideation brainstorms of the effects of value change on the rules at road level (top left), the socio-technical system defining the rules (top right) and the design process through which the socio-technical system is created (bottom left). The collection of ideation sketches (bottom right) explore early ideas for interfaces for the exhibition.

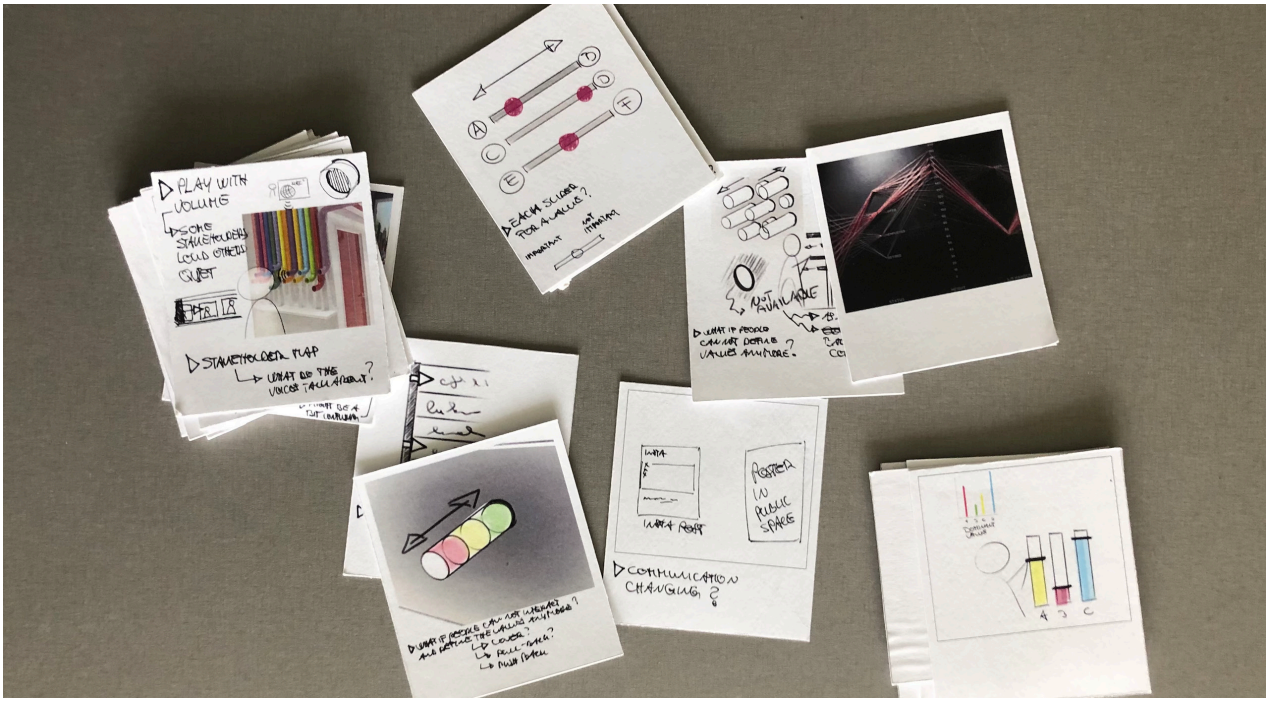


Figure 49: The card deck containing the ideas gathered in the brainstorms.

Concept iterations

Speculative prototype iteration 1

The first concept iteration was worked out in the form of a basic schematic overview and was set up around a linear, clearly laid out path for the visitors to follow (see figure 50). The aim of this concept was to have visitors of the exhibition experience the reality implied in the system map. The concept intended visitors to be recruited and sensitised by means of a sensitising booklet before the exhibition. During the actual exhibition, visitors would experience the socio-technical system from the system map created around two distinct sets of values illustrated through the rules at street level, the design process and the character of the system. Hands-on experiments were carried out to see what parts of the exhibition could look like (see figure 51). The overall concept still lacked an interactive aspect and its linear nature was deemed unsuitable in consultation with the coaches. Later exhibition iterations pursue a more open ended format, aiming to be as self explanatory as possible, allowing viewers to engage on their own terms.

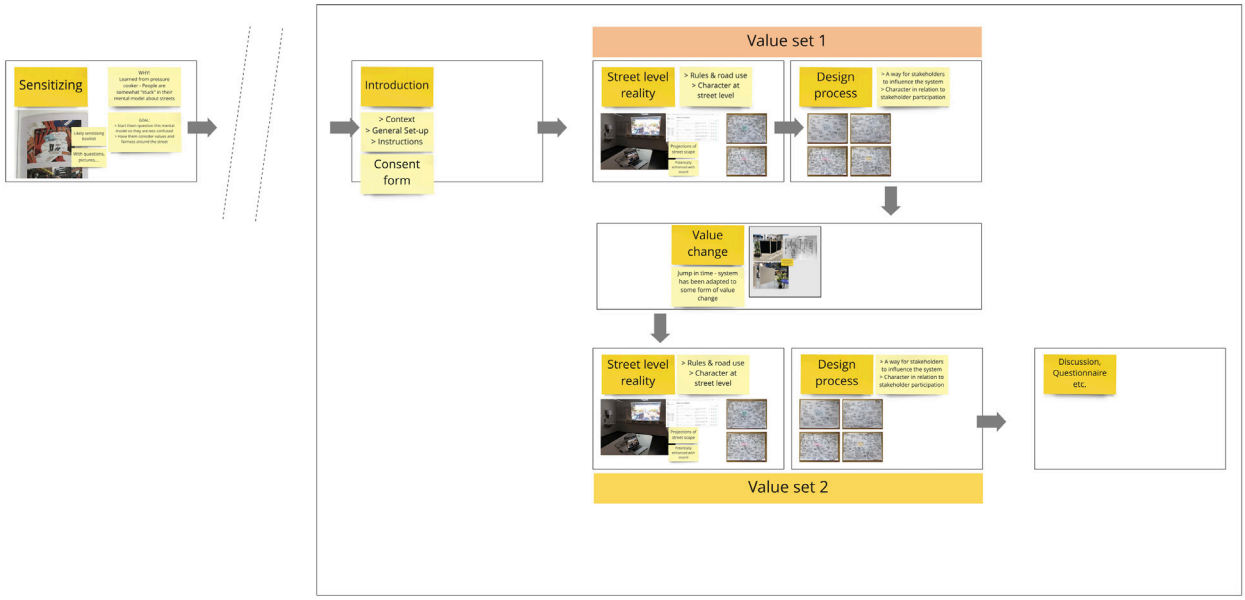


Figure 50: Schematic drawing of the first speculative prototype concept.

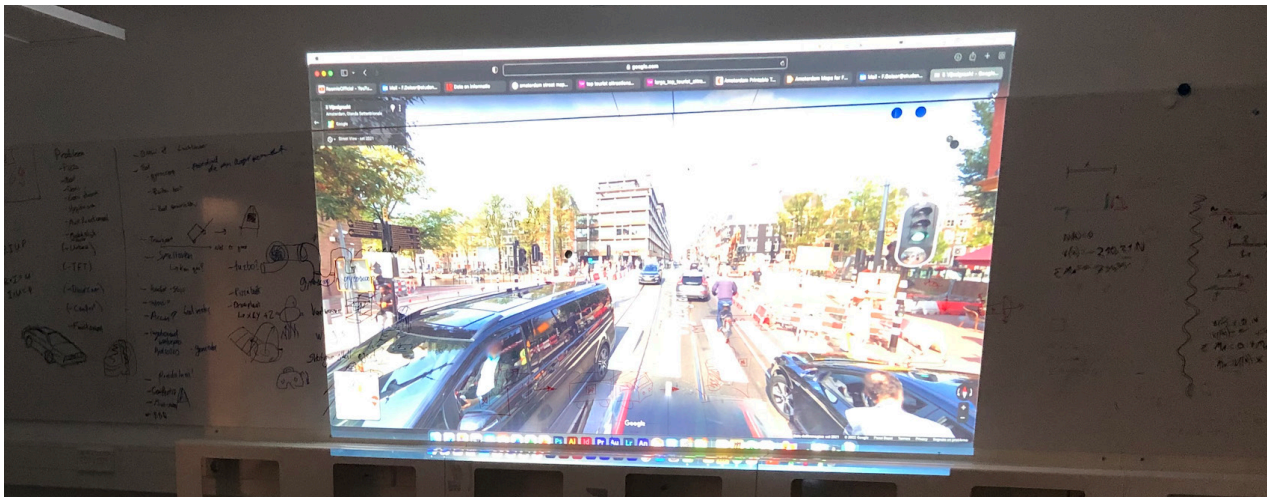


Figure 51: Initial exploration of how road level scenarios could be illustrated.

Speculative prototype iteration 2

The second iteration of the speculative prototype (see figure 52) differs fundamentally from the first iteration due to its more open ended exhibition format that does not prescribe a specific path for the visitor. Instead, visitors would be free to move within the exhibition space which is cast between two boards. On one board visitors would see a street scene of Amsterdam showcasing fictional road uses. On the other board, which was intended to represent a street level screen interface, viewers would be able to interact with the system governing the allocation of road space through a variety of levers and dials inspired by the ideas in the card deck. Through these dials, visitors could attempt to adapt the socio-technical system by changing the values around which the system is created. However, as visitors of the speculative exhibition would take on the role of one of many stakeholders, their input would not automatically result in system change. Instead the system changes based on an accumulation of input from a variety of actors. Their input may not be in line with the opinion of the visitor. This was intended to create awareness among the visitors that this system is co-created around not just their input, but also the input of other stakeholders.

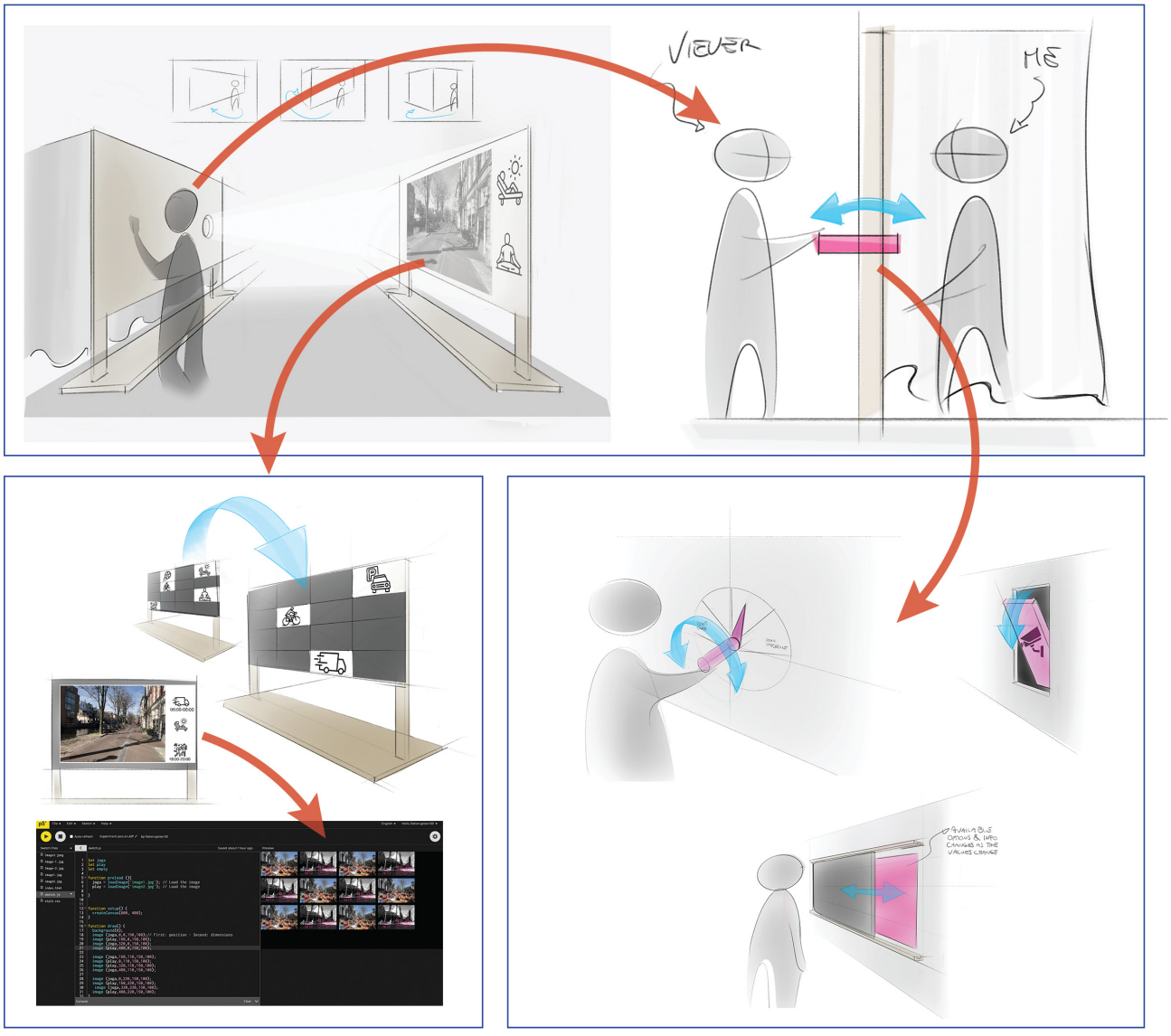


Figure 52: Concept sketch of the speculative prototype iteration 2.

Speculative prototype iteration 3

The third iteration of the speculative prototype (see figure 53) was created based on feedback received on the previous iteration from two Design for Interaction students during two separate ideation sessions (see figure 54). It differs from the second iteration mainly by an initial exhibition section, which was intended to allow visitors to familiarise themselves with the correlation between values and the socio-technical system by showing fictional system iterations created around different values. The overall exhibition was still intended to show the entire system illustrated in the early iterations of the system map. This however, seemed increasingly unnecessary and overly complex which is why after this iteration, the design criteria for the speculative prototype were adapted to the ones shown in chapter 6 *Synthesis*.

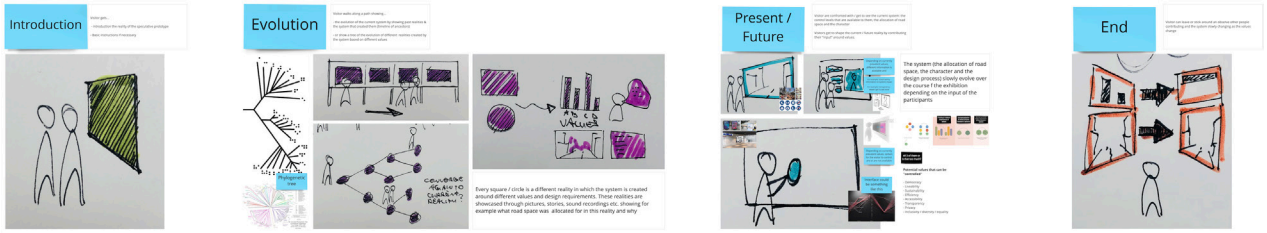


Figure 53: Basic experience journey for the third iteration of the speculative prototype.

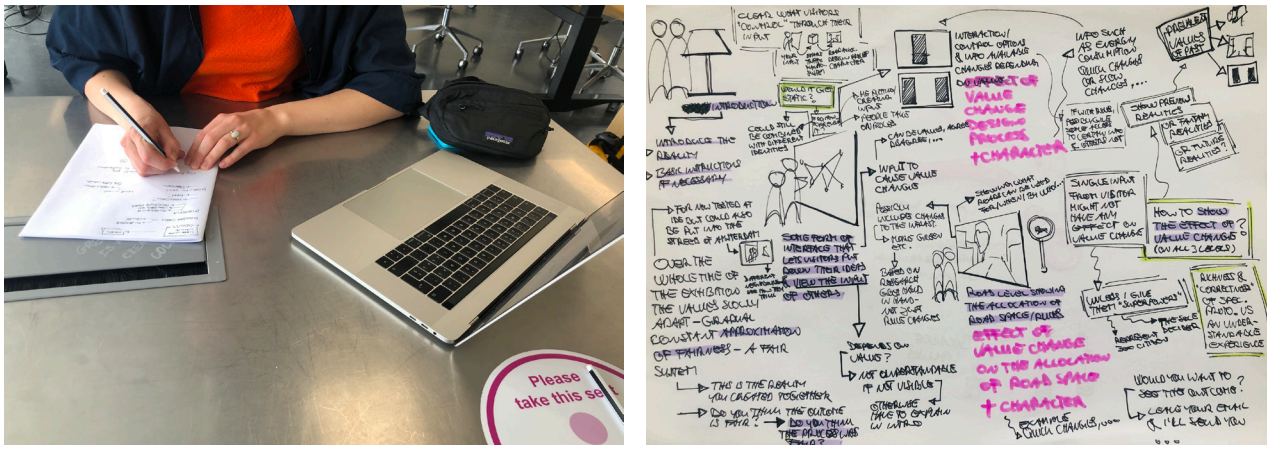


Figure 54: Ideation session with Design for Interaction student (left), quick concept sketch for the speculative prototype iteration 3 (right).

Final speculative prototype

The final speculative exhibition prototype was created based on the criteria shown in chapter 6 *Synthesis*. The final concept, while looking somewhat similar to previous concepts at first sight, shows some fundamental differences to the previous iterations. This section presents the final prototype, covering the overall concept, its components and design details and the final exhibition set-up.

The overall concept

The final speculative exhibition is inspired by the *Participatory Value Evaluation* approach presented in chapter 2 *Related work*. Visitors take on the role of a civil servant and are faced with contrasting and contradicting input from diverse stakeholders. It is the visitor's task to make sense of this input and to rank a set of optimization goals associated with different values (e.g. Optimization goal: *Economic opportunity*, Associated value: *Efficiency*). They are thereby asked to make a prioritisation decision as their choice will inevitably favour the wishes of certain stakeholders while disregarding the interests of others. This focus was chosen as it relates to the idea of equal treatment which is a fundamental aspect of commonly adopted conceptions of fairness (presented in chapter 2 *Related work*). It was further decided that the civil servant played by the exhibition visitor is in charge of the optimization goals for a specific neighbourhood. The neighbourhood scale was chosen as it represents a midpoint between road rules being set at city level and rules being set at the level of an individual street or even smaller. The former presents a generalisation of road rules and the latter an individualization. Both levels are assumed to hold potential issues in the fair allocation of road space. The neighbourhood level is chosen as it is believed to embody issues from the generalisation and at the same time individualization of road rules. For the final exhibition, the street *Lijnbaansgracht* in the neighbourhood *De Weteringschans* was chosen as I had collected images of this street during a prior excursion to Amsterdam. These images were used in the prototype. The overall concept is explained in more detail in the experience journey.

Experience journey

The experience journey presented in figure 55 shows how visitors may move through the exhibition. The exhibition does not prescribe a specific path or sequence of actions to the visitor. Instead visitors are free to move between the different exhibition elements as they please. However, due to its basic set-up, the exhibition still steers visitors to some extent. The experience journey illustrates a likely journey of a duo of visitors moving through the exhibition space.

1 Introduction

Visitors read up on the exhibition and the reality which the exhibition aims to bring to life: a reality in which the city of Amsterdam has introduced a smart system governing the dynamic allocation of road space which is continuously adapted through stakeholder participation.

2 Rules at road level and road use

Visitors enter into the fictional reality described in the introduction at road level. They see a fictional traffic sign and a road use scenario illustrating how roads are currently being used. Visitors take their time to familiarise themselves with the environment.

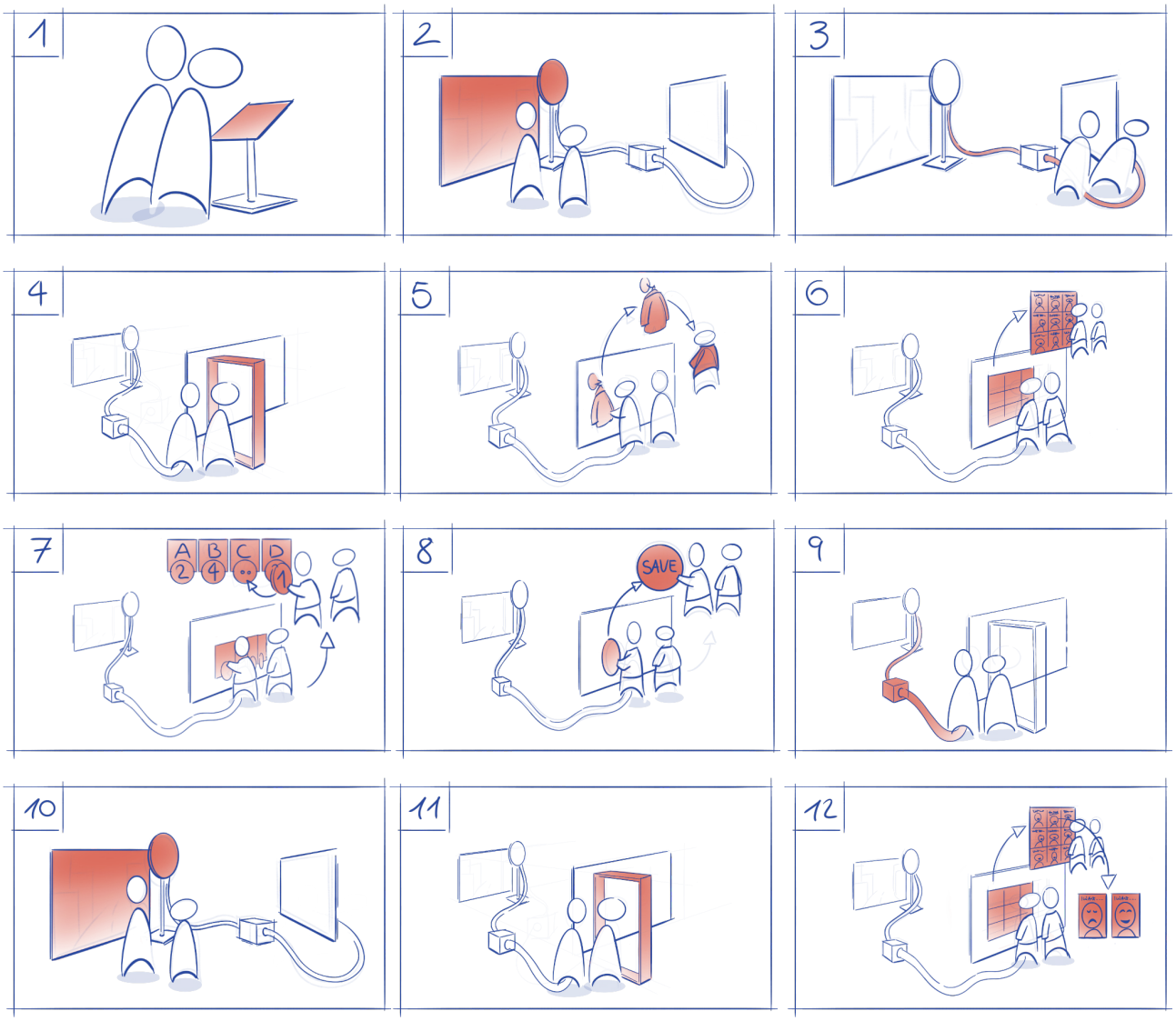


Figure 55: Experience journey speculative prototype.

3 Discover the control room

Visitors notice the cable connected to the road sign. Intrigued by its whimsical looks, visitors follow the cable leading past a box and into the control room.

4 Entering the control room

Visitors enter the control room of the system governing the rules regarding the allocation of road space.

5 Becoming a civil servant

Upon entering the control room, visitors take on the role of the civil servant. They put on the blazers which they find hanging in the control room and read the control room instructions. The instructions address visitors as civil servants and explains their task.

6 Perceive stakeholder input

Visitors perceive the input from different stakeholders, asking for changes to be made to the system and expressing their interests and wishes. Visitors can take the time they need to study the different profiles and their input.

7 Adapt the parameters of the system

After having studied the wishes and desires from different stakeholders, visitors adapt the goals to define what the smart system should optimise the road rules for.

8 Hit *save*

Visitors hit the *save update button* to save their changes made to the goals in the previous step.

9 Follow signal in cable

Upon pressing the *save update button*, visitors see a light pulse running through the cable. They follow the light chain which brings them to the black box (intended to symbolise the AI component of the system). The visitors see the box light up before the signal continues in the cable to the fictional traffic sign.

10 Perceived changes at road level

As the light in the cable vanishes, visitors see that the fictional rules depicted on the traffic sign as well as the road level scene shown by the projection have changed; there are now new rules and the road is used differently.

11 Return to control room

Visitors return back to the control room.

12 Perceive changes in stakeholder input / expression

Back at the control room, visitors see that the expressions of stakeholders have changed. Stakeholders that were happy before now seem neutral or angry or the other way around. Visitors can begin anew and adjust the goal around which the system is optimised and move back and forth between the road level and the control room as much as they like.

Please note: this is a speculative exhibition, it is not intended to fully illustrate how the system governing the dynamic allocation road space should look like. The whimsical cable that lights up, the oversized *save update button* and other parts are somewhat theatrical design props intended to aid the exhibition flow and create a more immersive experience. They do not illustrate my view on what the system would look like in reality.

Annotated prototype

The experience journey introduced some of the core components of the exhibition. This section presents an annotated prototype (see figure 56, 57 and 58) showing how the ideas of the experience journey were translated into the final design props making up the speculative prototype.

1. Entrance to the exhibition
2. Road level
3. Black box and cable
4. Control room

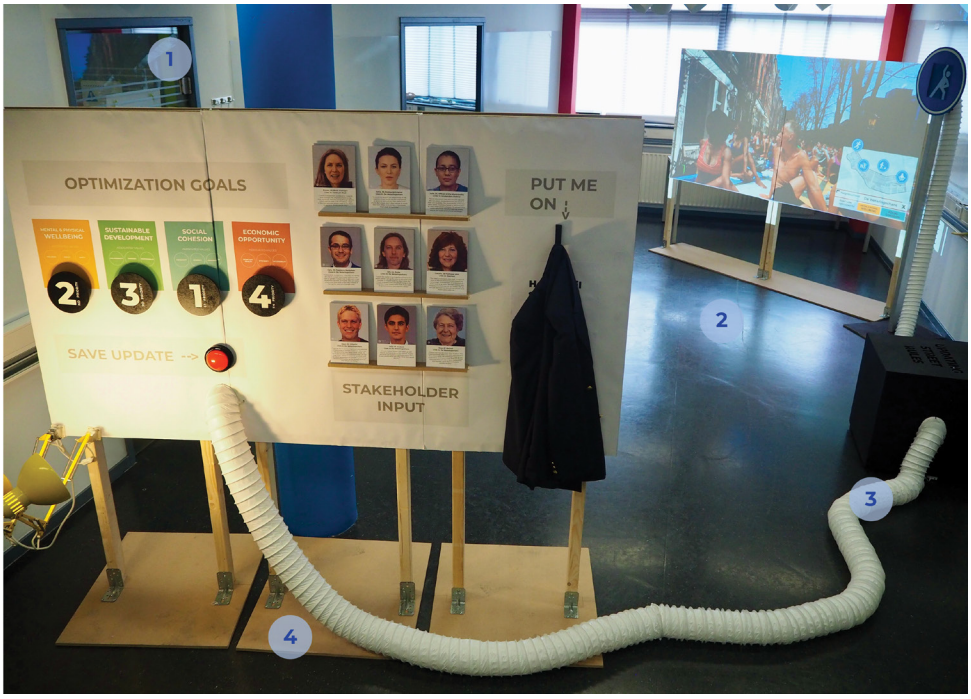


Figure 56: Overview of the exhibition showing the main areas and overall set-up of the exhibition.

5. Road sign prop
6. Road use scenario
7. Neighbourhood map and additional road rules
8. Name of the neighbourhood
9. Optimization goals which informed current road rules

Figure 57: Road use scenario and road sign design prop.

10. Civil servant costume
11. Control interface instructions
12. Stakeholder cards
13. Optimization goals and assosciated values
14. Detachable disk used to define the priority of the optimization goals
15. *Save update* button

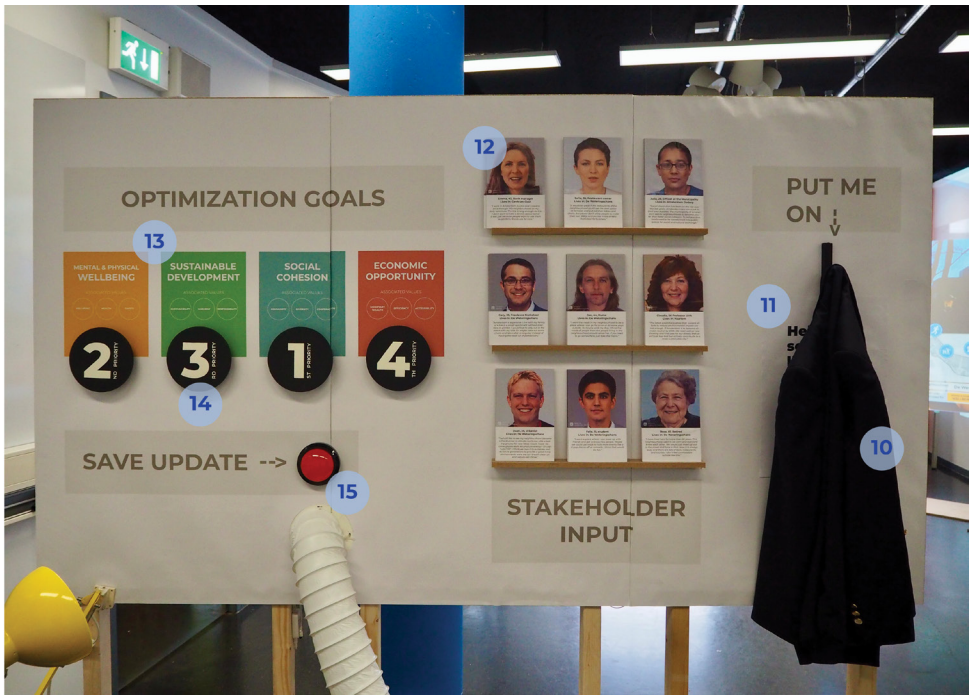


Figure 58: Control interface.

Note that the final speculative prototype lacks the door frame shown in the experience journey. The door frame was intended to make visitors aware of the spatial change when stepping from the road space into the control room of the other way around. The door frame was built but forgotten in the final exhibition set-up. While it is unclear what effect the door frame would have had on the exhibition experience, the results presented in chapter 8 Evaluation show that the door frame might not have been necessary after all.

Components & design details

This section elaborates on the annotated prototype presented in the previous section by explaining and illustrating the details of the main components of the prototype. The components of the speculative prototype were defined in several iterations. The detailing process included two ideation sessions, each one carried out with a Design for Interaction student, as well as several discussions with the coaches and playful explorations with the aforementioned card deck. Figure 59 shows how the details described in the following paragraphs were realised in the speculative prototype.

Introduction

The introduction outlines the reality to which the design props in the exhibition belong. It describes a future scenario where a smart system governing the dynamic allocation of road space was introduced in Amsterdam. Furthermore, it explains the decision to take into consideration the wishes and ideas of stakeholders. This ensures that the rules set by the smart system represent the interest of the people. In the final exhibition set-up, the introduction was placed on the glass door leading to the exhibition space as shown in figure 56. This was done to attract attention to the exhibition. The introduction was accompanied by the exhibition title: *The dynamic road rules of Amsterdam*.

Road use scenario and road rules

The road use scenario consisted of a projected image showing how the road the *Lijnbaansgracht* in the neighbourhood *De Weteringschans* is currently being used. This could for example be people laying in the sun, using the street for a staycation or vehicles driving on the road. The projection is accompanied by a road sign prop which illustrates the current road rule for the specific street. Similar to current road signs, the road sign prop is a simple blue sign with an icon in the centre prescribing a specific road use. The icon could for example be a lounger and a parasol indicating that people could use the road as a vacation or relaxation space. In total, 12 combinations of road use scenario images and road rules were created for the final exhibition (see figure 60). Both, the road use scenario and road rules can be switched out as visitors of the exhibition adapt the priority of the optimization goals. Besides showing how the road is currently being used, the projected image also contains the name of the neighbourhood and a small map showing its streets. The map illustrates road rules for other streets in the neighbourhood. This is intended to show visitors that road rules change at neighbourhood level and not just for an individual street. Furthermore, the projection communicates towards which goals the system was currently optimised for. For example, if the system is optimised for *Mental and physical wellbeing* (first priority) and *Sustainable development* (second priority), the road rule would allow people to hold a staycation in the road space as mentioned before.

Connecting the control interface and road scenario: the white cable and the black box

The cable is intended as a guiding element within the exhibition, connecting the control interface into the black box and from there to the road sign prop. After entering the exhibition and experiencing the road use scenario, the cable should guide participants into the control room where they can adapt the priorities of the optimization goals. Once they hit the *save update button* on the control interface, a colourful light signal runs through the cable and into the black box. The black box is intended to symbolise the AI component of the smart traffic management system which sets the rules at road level according to the defined optimization goals. The black box is placed between the control interface and the road use scenario and lights up displaying the read out *updating street rules* as the signal in the cable passes through. From the box, the signal in the cable continues to the road sign prop where the road rule and road use scenario is changed. The cable is thereby expected to guide visitors from the control room back to the street level scenario where they can see the effect of the changes they made.

Control interface instructions and civil servant costume

The right side of the control interface is intended as the starting point within the control room. Here participants are asked to slip into the role of the civil servant by putting on a costume (a blazer) intended to remind visitors of their role as they interact with the control interface. Behind the blazer, visitors encounter the instructions for the control interface. The instructions address the visitor as a civil servant and explain to them their task: to update the road rules for the neighbourhood *De Weteringschans*. Visitors are asked to examine the stakeholder input and based on this adjust the priority of the optimization goals before hitting the *save update button*.

Representing the stakeholders and their wishes

The stakeholders and their wishes regarding road use for the neighbourhood *De Weteringschans* are presented on stakeholder cards placed on a shelf in the control interface. Each card contains a stakeholder profile consisting of a profile picture, a short profile description,

including the stakeholders name, age, occupation and place of residence, and a made-up quote communicating their wishes. A total of 12 stakeholder profiles were created for the final exhibition. The control interface holds nine stakeholder profiles while the remaining three are intended as reserve. The stakeholder profiles are inspired by the stakeholder map introduced in chapter 3 *Initial research* and show a diverse set of stakeholders: from parents, elderly and children, over business owners and contractors, to tourists and people living outside of the neighbourhood. The diversity in stakeholders is aimed to reflect the diversity of their wishes for road use which relate to different optimization goals and associated values. The composition of the nine stakeholders presented on the control interface is intended to be relatively neutral and not favour any optimization goal. The profile picture of each stakeholder is an AI generated image showing the stakeholder expressing an emotional expression: happy, neutral or angry. Each of the twelve stakeholders is represented with three stakeholder cards, each of them showing one of the three emotions, resulting in a total of 36 stakeholder cards. The emotions are intended to show visitors that people have different opinions of the current state of the system and the changes they have made. The nine stakeholders are presented on the shelf on the control interface with the alternative emotional expressions stacked behind each other. This way, quick changes to the stakeholders' emotional expression can be made as the rules at road level are adapted.

The optimization goals and associated values

The control panel presents the visitors with four different optimization goals: *Mental and physical wellbeing*, *Sustainable development*, *Social cohesion* and *Economic opportunity*. The goals are intended to show diverse ideals towards which the system could be optimised. They are inspired by the clusters of values in the value map introduced in chapter 3 *Initial research* as well as the wishes of the stakeholders. The goals were reviewed and approved by the *Code the Streets* project manager of the municipality of Amsterdam. Each optimization goal is presented with three associated values. The associated values were inspired by the value map presented in chapter 3 *Initial research* and Frankena's list of intrinsic goods, often referred to as intrinsic values (Frankena, 1973). Visitors can change the priority of the goals and their associated values by unplugging and rearranging black disks attached to the control interface indicating priorities one to four. The combination of optimization goals and associated values is intended to aid visitors' understanding as it was speculated that choosing directly between often somewhat abstract values might be confusing. In an effort to keep the exhibition manageable, it was decided that only the optimization goals assigned first and second priority by the visitor would be considered for the road rules and road use scenario. This resulted in the 12 different road rules for the road sign prop and corresponding road use scenarios shown in figure 60.

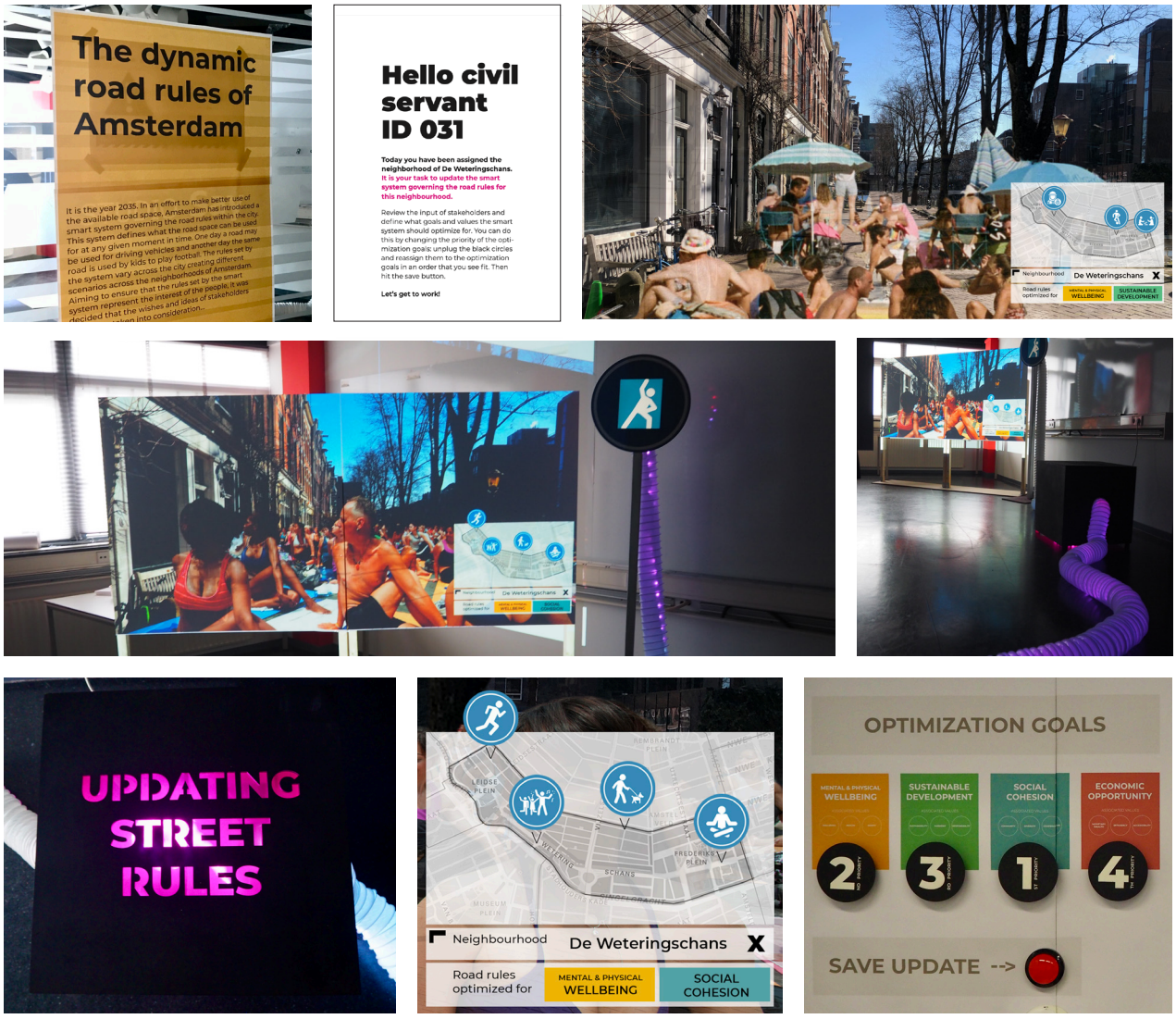


Figure 59: Details of the speculative prototype. Introduction (top left), instructions control room (top centre), road level projection (top right), road level projection with road rule prop (second row, left), white cable with lights and the black box (second row, right), black box with lights and read out (third row, left), map, name of neighbourhood and current optimization goals (third row, centre), optimization goals and *save update button* (third row, right), example of a stakeholder card (images by generated.photos) showing three emotions (fourth row, left: happy; centre: neutral; right: angry).

Figure 60: The 12 road use scenarios and associated road rules displayed on the road sign prop (Icons from Deemakdaksina, Eucalyp, Freepik, Gorbachev, Kosonicon, Smashicons on Flaticon).

Managing the exhibition

The speculative prototype is managed manually (*Wizard of Oz* style). Changes to the road use scenario are done by sending a picture to the device attached to a projector. Similarly, the road rule shown on the road sign prop is updated by sending a different illustration to a screen built into the prop. The stakeholder cards can be changed manually as the visitor leaves the control room. All of this is managed through a control folder which holds a road rule, a road use scenario and instructions for the stakeholder emotions for each relevant combination of the optimization goals (see figure 61). The lights in the cable and black box are managed by a remote control.

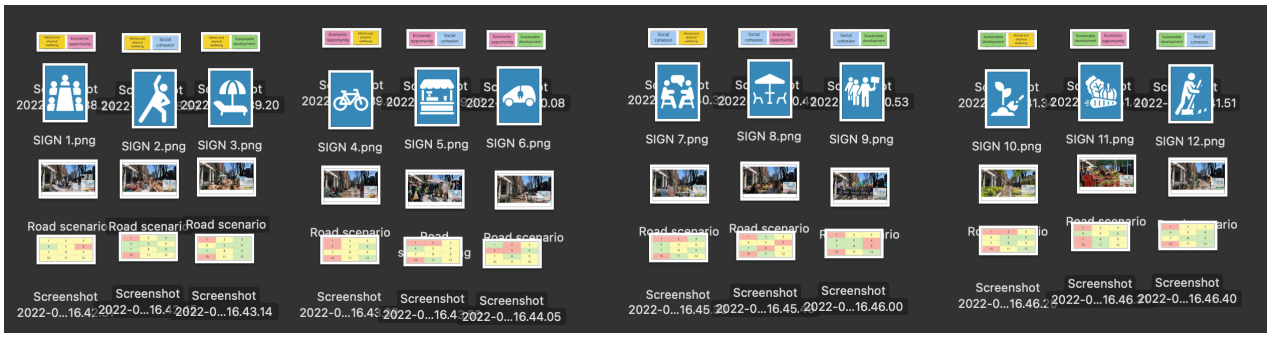


Figure 61: Screenshot of the control panel used to manage the exhibition.

7.3. Conclusion

This chapter illustrated the conceptualization process and the resulting two designs created for the project at hand. Moreover, the chapter presented arguments for design decisions regarding the design outcomes rooted in the criteria defined in chapter 6 *Synthesis*. The system map used for evaluation and final speculative prototype presented in this chapter are picked up again in the next chapter which describes the evaluation process and outcomes for each design.

Chapter 8

Evaluation

This chapter describes the evaluation of the design outcome, the final system map and the speculative prototype, presented in the previous chapter. The design outcomes were evaluated separately from each other and with different audiences. The evaluation for each design is described in this section, starting off with the goal of the evaluation before outlining the approach and presenting the results. This is followed by a conclusion and description of the limitations of the evaluation approach for each design. The chapter closes with a short conclusion.

8.1. Evaluation system map

Goal

The goal of the evaluation of the system map is to investigate how the designed map performs with regards to the system map criteria defined in chapter 6 *Synthesis*. In addition, the evaluation aims to generate insights about how the system map may be improved with regards to the criteria. Note that criteria 1, "illustrate how (...) we can enable the continuous approximation of fairness", relating to the content of the system map is not evaluated. Instead, it is verified whether the *Code the Streets* team agrees with the content of the system map or not. This is because the content of the system map, while influenced by insights gathered during the interviews with the experts present in the evaluation, is mostly based on theory derived from literature. The evaluation of the system maps' content, the mechanisms and processes it shows, would therefore have to be carried with experts of the theory.

Approach

The system map iteration 4.0 presented in chapter 7 *Conceptualization* was used for the evaluation. The map was evaluated with three members of the *Code the Streets* team of the municipality of Amsterdam (see table 3). The evaluation was carried out as an online video call lasting 1.5h. The system map poster as shown in chapter 7 *Conceptualization* was shared with the participants who were asked to study the poster two days prior to the evaluation. During the evaluation, participants received a short introduction, covering the agenda and goal of the evaluation, followed by an additional ten minutes to study the poster. This was followed by a semi-structured interview. A *Miro board* (see figure 62) showing the system map poster was shared with the participants and used during the interview. It was intended to aid orientation during the discussion, allowing everyone in the meeting to point out the parts they were referring to. Making comments using the prepared post-it notes was optional. The *Miro board* furthermore contained a list of questions which were intended to guide the semi-structured

Table 3: Participants of the evaluation of the system map.

Participant ID	Type of expert	Expertise	Affiliation
P1	Practitioner	· Code the streets project	Municipality of Amsterdam
P2	Practitioner	· Code the streets project · Mobility systems · Commons	Municipality of Amsterdam
P3	Practitioner	· Code the streets project · Citizen participation	Municipality of Amsterdam

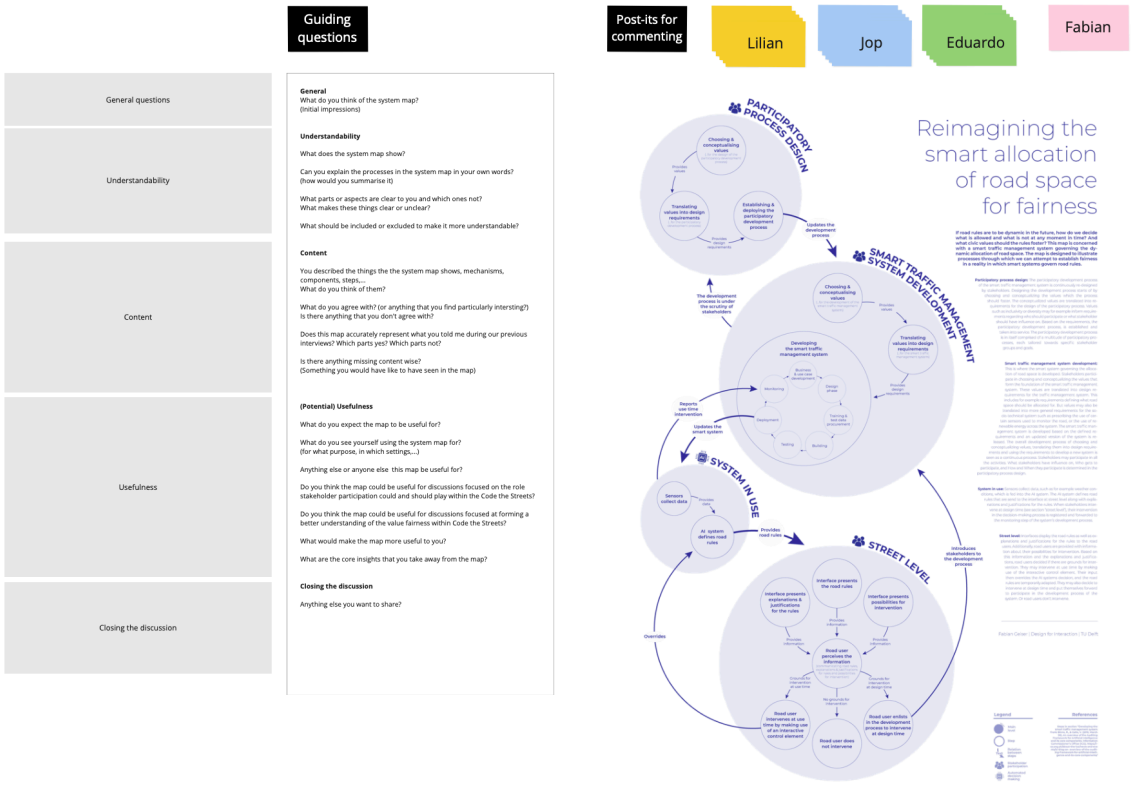


Figure 62: The *Miro board* shared with the participants of the evaluation.

interview. The questions referred to one of the three system map criteria and were clustered into three topics presented in the following order: understandability, agreeableness of the content and perceived usefulness. This list of questions was revealed to the participants during the interviews topic per topic and accompanied by general and closing questions. An overview of the questions presented to the participants can be found in appendix 7.

Participants

The participants of the evaluation had previously participated in the expert interviews presented in chapter 5 *Expert interviews*. Table 3 shows an overview of the participants. Besides being part of the *Code the Streets* team, these participants represent diverse and relevant fields of expertise: from mobility systems to citizen participation. Of the three participants, only participant P1 had seen previous iterations of the system map. Participant P2 had to leave the evaluation early and therefore missed the last part focused on the map's perceived usefulness.

Data collection and analysis

Data was collected from the participants' comments in the semi-structured interview. The audio of the video call was recorded and transcribed using a transcription software. The transcript was analysed for comments relating to the system map criteria and notes were taken. The participants' comments and notes were collected on *Miro* and clustered into themes. The themes are presented in the results section.

Results

This section presents the results of the evaluation of the system map. Overall, the participants appear to be positive about the map's content (relating to criteria 1). The results also indicate that the participants perceive the map to be useful for further discussions exploring the role of stakeholder participation in *Code the Streets* (criteria 3). The system map did not perform well with regards to criteria 2 as the participants struggled to understand the map.

Results agreeableness of content: The content is well received

Once participants appeared to have understood the system map, their comments regarding the map's content were positive. P2 seemed to be enthusiastic about the idea of extensive stakeholder participation as depicted by the system map. P2 commented: "Civic participation is the holy grail, right?... And I think that's a really, really super thing and you have managed to map that out. But yeah, it is definitely speculative design, I think third horizon stuff". The participatory expert P3 appeared to share P2's opinion and pointed out more positive aspects of the system map. P3 appeared enthusiastic about the idea that road users are presented with information about how they can intervene and have influence in the system, shown in the map at level 4 Street level. P3 commented: "I think it's a really, really strong element. I think in a lot of cases... people are not aware about how to influence and if you can make that clear directly on the street ... I think that will be really, really helpful for a lot of people to know". P3 further approved of the ideas presented in level 1 *Participatory process design*, especially that stakeholders could participate in designing the participatory process itself commenting "that's really nice about the design, I think". Only a few critical points regarding the system maps' content were raised during the evaluation. P1 questioned if AI should be used to set the rules at road level as depicted in the system map. As an alternative, P1 suggested that it may be desirable to instead have the AI system define different options for road rules which a civil servant then uses to set the final rules. P1 further wondered what the ideas depicted in the system map were based on asking: "Who says it works this way?".

Results Understandability: Participants struggle to understand the map

Participants struggled to understand the system map. P2 and P3 commented that they found the map to be complex and when asked to explain the system map in their own words, they seemed to be insecure. Only after some additional explanation and examples provided by me during the evaluation participants started to understand the system map with P3 commenting: "...especially discussing it right now I think it's really clear how the relations between the different levels are". Towards the end of the evaluation, participants even started to explain each other sections of the system map. The explanations provided on the system map poster, in which most of the explanations I gave during the evaluation were written out, did not seem to provide enough clarification.

The levels that participants struggled most to understand appeared to be level 1 *Participatory process design*, and level 4 *Street level*. Regarding level 1, participants struggled to understand that at this level, the participatory process through which stakeholders take part in the system development (level 2) is designed. And that this requires defining who gets to participate in the development process. Due to the struggle of the participants to understand level 1, they were confused by the stakeholder icons presented next to the titles of the four levels. Participants wondered who exactly the icons are intended to represent and therefore who gets to

participate in the system development. Regarding level 4, it was mainly the opportunities for intervention at street level and how they relate back to level 3 and level 2 that caused confusion. P1 commented: “What I did not understand is that they can also intervene with the rule and influence the AI system. I wouldn’t know how. And the other part is that it says road users enlist in the development process to intervene at design time”. According to the comments of the participants, the main reason why they struggled to understand these two levels and how they relate to the rest of the system was the abstract, theoretical language used in the map. Participants struggled to relate to expressions such as *grounds for intervention at design time* and *interactive control element*. When explaining these expressions in a more practical language and with examples, participants appeared to understand them without much difficulty. The reason for this seems to be that all participants tried to understand the system from a practical perspective, trying to visualise the system in action. P1 for example commented that they tried to put themselves in the shoes of the road user: “When I read this, I’m visualising … I’m this road user”.

Another factor that seemed to cause difficulties in participants understanding the system map were the initial expectations and perspective of the participants rooted in *Code the Streets*’ current focus. The system map was perceived as a big leap over what the *Code the Streets* team is currently working on. P2 and P3 initially appeared to try to understand the map within the context of the current *Code the Streets* system where the municipality defines relevant values and communicates the desired use of road space. For them, the idea that an AI system would be used to automate dynamic rules at road level appeared to be new (note that this was explained in the instruction of the system map poster but the explanation seems to not have been clear enough). They referred to the illustrated system as “futuristic”, “third horizon”, “speculative” and commented “you are way ahead of us Fabian”. It seems that for the system map to be more understandable by the *Code the streets* team, a clearer baseline needs to be established explaining what the system map is intended to show. When asked how the understandability of the system map could be improved, participants unanimously pointed out the need for practical examples which according to them would help to follow through the map and imagine what happens at each level.

Results perceived usefulness: The map is perceived to be useful for further explorations of stakeholder participation in Code the Streets

The participants perceived the mapped-out system as futuristic. According to the participants, the system map is therefore unlikely to be highly influential in the teams’ current day to day practices. P3 commented: “you are way ahead of the things we are working on right now”. The participants did however point out that the system map may function as a beacon which can provide orientation in the development of the *Code the Streets* system. P1 commented that the map can help to put their current efforts into perspective, illustrating important aspects that they may still want to consider: “I think it gives us an overview of all the elements that should be taken into account when developing the complete system. Yeah, I think it makes us aware of where we are”. When asked how they see themselves applying the system map, the consensus was that the map could potentially be used in discussions about stakeholder participation within the team and with project partners. According to P3, the system map provides a starting point from where the team can start discussion about stakeholder participation and carry out further research and pilot studies. P3 further elaborated, mentioning that the system map could be used in discussions focused on exploring how a participatory system can be designed.

Conclusion

This section presented the evaluation of the system map. The goal of this evaluation was to investigate how the designed map performs with regards to the criteria defined in chapter 6 *Synthesis*. Overall, the system map has performed decently with regards to these criteria. However, the evaluation also showed some issues of the current design that should be addressed in the final iteration.

Key conclusions

The system map's content was well received. As mentioned in the goal section, this evaluation verified whether the Code the Streets team agrees with the content of the system map. While not the whole Code the Streets team was present in the evaluation, the team members that were present predominantly agreed with the map. It appears that the map illustrates, at least to the Code the Streets team, a positive perspective on stakeholder participation and fairness relating to criteria 1.

The results indicate that the system map is perceived as useful by the participants from the Code the Streets team. According to the comments of at least one participant, the team considers using the system map for further discussions, research and pilots aiming to better understand the role of stakeholder participation in Code the Streets. Another participant highlighted the map's usefulness as a beacon, aiding orientation in the Code the Streets project. However, this also shows that the feedback from the participants was rather vague and diverse. Furthermore, data regarding the map's perceived usefulness was collected from only two participants as P2 left the evaluation early. Nonetheless, it seems that the system map performed decently with regards to criteria 3, focused on the maps perceived usefulness.

Participants struggled to understand the system map without additional explanation provided by me during the evaluation. The results indicate that the poor understandability, relating to criteria 2, is caused by the map failing to address the participants practical perspective. Main issues appeared to be the abstract, theoretical wording used in the poster as well as the perceived gap between the team's current practices and the system illustrated in the map. The evaluation also aimed to generate insights how the system map may be improved for a further iteration. These insights are listed below and they are used to design the final system map iteration presented in chapter 9 *Discussion & conclusion*.

Opportunities to improve the design of the speculative prototype in relation to the criteria.

- The map should include examples to address the participants' practical perspective and thereby aid the map's understandability.
- The abstract, theoretical expressions on the map should be substituted with more practical explanations to improve the map's understandability. The wording may be inspired by the informal explanations given during the evaluation.
- An element clearly communicating what the system map illustrates should be included prominently on the map. This may help members of the *Code the Streets* team to manage their expectations and adapt their initial perspective towards the map.
- Providing limited background information on the theory and insights on which the sys-

tem map is based may improve the map's credibility. Alternatively, this report or a separate document containing background information explaining the ideas behind the map could be linked on the poster.

Limitations

- The three participants of the evaluation do not represent the full *Code the Streets* team of the municipality of Amsterdam. Ethics expert P5 from the expert interviews was for example not present for this evaluation. The results might have looked different if P5 or others would have participated in the evaluation. Furthermore, P2 had to leave the meeting early and missed the last part of the evaluation focused on the map's perceived usefulness.
- This study evaluated the perceived usefulness of the system map. Whether the map is actually useful in practice remains unclear and would need to be further evaluated.
- As mentioned in the goal of the evaluation, this evaluation verified only whether the participants agreed to the content of the map. Therefore, no final conclusion can be made about system map criteria 1.
- While the *Miro board* with the system map helped in the discussion, the online set-up was not optimal. It still proved difficult at times to understand what a participant was referring to and participants seemed to stay in the video chat, only opening the *Miro board* when they struggled to explain something without it.
- Participants were asked to study the system map poster before the evaluation. During the evaluation, all of them stated they had done so, however, some also mentioned that they only had a quick look as they had little time. Combined with only ten minutes to review the map given during the evaluation this may have affected their understanding of the map.
- The low performance in terms of understandability of the map may have affected the participants ability to judge the map's content and perceived usefulness. While the participants seemed to understand the map's content after some additional explanation and before being asked to give feedback on the map's content and usefulness, it can not be said for sure that they fully understood the map.

8.2. Evaluation speculative prototype

Goal

The main goal of the evaluation of the speculative prototype is to investigate how the design performs with regards to the speculative prototype criteria defined in chapter 6 *Synthesis*. Next to that, the study also aims to evaluate the usability of the speculative prototype and its components. Ultimately, the evaluation is intended to generate data which can be used to reflect on the design's performance and to define potential points for improvement. Gathering new insights relating to the topics of the project is seen as secondary within this evaluation. That means no concrete efforts will be made to gather such data, however, if new insights surface during the evaluation process, they will be included in the results

Approach

The speculative prototype was evaluated at the Faculty of Industrial Design Engineering (IDE), TU Delft. The exhibition was held in *Studio Say* of *Studiolab* (32B-2-060) and set up as shown in the annotated prototype presented in chapter 7 *Conceptualization* and final designs. The decision to hold the evaluation of the speculative prototype at the IDE faculty was driven by considerations of feasibility with the limited resources available. The exhibition was carried out over two consecutive days. On day one, a pilot for the evaluation was held whereas the formal evaluation took place on day two.

Pilot

The pilot was intended to iron out smaller issues and to give me some practice time in managing the exhibition, aiming to create a smoother experience during the formal evaluation. In this scope, day one of the exhibition was held as an informal event. Visitors could enter the studio, observe and interact with the design props and leave as they pleased. Engaging in a discussion with me or other visitors was optional. A total of four visitors piloted the formal evaluation and their feedback led to minor adjustments to the exhibition set-up. A more detailed description of the pilot can be found in *appendix* 8. The rest of this chapter will be focused on the formal evaluation.

Formal evaluation

Participants were recruited at the faculty and through online chats. They received a formal introduction to the evaluation. Instructions given to the participants were kept at a minimum. Participants were asked to engage with the design props as they pleased and to verbalise their thoughts while doing so (see figure 63). Before entering the exhibition space, they were given the task of updating the rules at road level. Upon completing this task participants took part in a semi-structured interview. The introduction presented to the participants and questions of the semi-structured interview can be found in *appendix* 9.
Note that I was present on both days to manage the exhibition. In both cases, I tried to stay behind the scenes as much as possible while visitors interacted with the exhibition.

Participants formal evaluation

A total of seven participants took part in the formal evaluation of the speculative prototype. All participants were associated with the faculty of Industrial Design Engineering, TU Delft, being either design students, graduates of an IDE design program and/or design researchers. An overview of the participants is presented in table 4. Participants generally took part in the evaluation individually, except for one group of two.

Data collection and analysis formal evaluation

Data was collected from participant observations, comments made by the participants and from the semi-structured follow-up interview. The data was collected in the form of handwritten notes. The data was analysed in several steps. First, the handwritten notes were analysed and initial, overarching topics were created and colour coded. Data snippets were related to one or several of the following topics: the speculative prototype criteria, the usability and understandability of the speculative prototype, and new insights. The data snippets were collected on a *Miro board*. Then the data snippets were clustered into themes and placed in a table (see *appendix* 10) showing the comments of each participant for every theme. The results and conclusions of the formal evaluation were derived per theme by comparing the comments of the different participants.

Table 4: Participants of the formal evaluation of the speculative prototype.

Participant ID	Participant description	Participated as
P1	MSc Design for Interaction graduate	Individual
P2	BSc Industrial Design Engineering student	Individual
P3	Assistant professor of Critical Design at the Faculty of Industrial Design Engineering	Individual
P4	MSc Strategic Product Design student	Individual
P5	MSc Desing for interaction graduate & researcher at the faculty of Industrial Design Engineering	Group (with P6)
P6	MSc Design for Interaction student	Group (with P5)
P7	MSc Design for Interaction student	Individual

Figure 63: Participants interacting with the speculative prototype during the evaluation.

Results

This section presents the results of the formal evaluation. Overall, the speculative prototype performed well with regards to criteria 1, addressing the notion of fairness, criteria 4, presenting a provocative proposal, and criteria 5, illustrating a believable reality. The overall usability of the speculative prototype also appears to be reasonably good. The speculative prototype did not perform well with regards to criteria 2, illustrating the effect of value change on the road rules and road use, and criteria 3, illustrating the roles and relationships between different components of the system. The results of the formal evaluation are presented in more detail in the following two sections:

- **Results section 1: Results about the speculative prototype criteria**
  This section presents the results of the evaluation for each speculative prototype criteria established in chapter 6 *Synthesis*.

- **Results section 2: Results about to the general usability of the speculative prototype**
  This section includes results such as what components of the design were used as intended and which cause confusion.

Some of the results are exemplified through quotes from the participants. Note that these are not direct quotes but have been recreated from notes of the participants' comments taken during the evaluation.

Results section 1: Results about the speculative prototype criteria

Results criteria 1: Triggers reflections and discussions relating to fairness
Criteria 1: The speculative prototype addresses the notion of fairness with regard to a fictional smart urban traffic management system governing the dynamic allocation of road space around civic values.

The exhibition appeared to trigger participants to reflect on several aspects related to the value of fairness. Almost all participants voiced reflections along the lines of: How should we prioritise the wishes and ideas of different stakeholders? How do we deal with stakeholder representativeness? How should we handle input from minorities or vulnerable stakeholders such as children? Participants seemed to build on their experience in the exhibition to explore potential risks of the system. Three participants for example concluded that defining the optimization goals using a majority vote approach can create undesirable outcomes. Participants also reflected on the role of the civil servant, recognizing that personal interests and beliefs may introduce biases to the process of defining the priority of optimization goals. Two participants wondered how to deal with the problem of scale, recognizing that an outcome that is regarded as good at the scale of a street, may create issues on the neighbourhood level or among other neighbourhoods. Another two participants questioned citizens' ability to to look beyond their short term wants and to consider what is good for them and the neighbourhood in the long term. The exhibition also appeared to provide participants with a base to suggest potential improvements to the illustrated traffic management system. Three participants noted that there should be ground rules regarding the things that can and cannot be done in certain streets. Another

two participants commented that the suggested decision-making process with the civil servant interpreting the stakeholder input and defining the optimization goals seemed too disconnected. They expressed a need for the civil servant and the stakeholders to be better connected and deliberate together. Overall, the comments of the participants indicate that they perceived participation and adaptability as a contributor to fairness.

"*People from the neighbourhood are more important - but you can also not just ignore the outsiders.*" - P7

"*Maybe regular people don't really know what they want ... they are focused on short term thinking.*" - P4

Results criteria 2: Values and the effects of value change are generally overlooked

Criteria 2: The speculative prototype illustrates the effect of value change on the rules governing the allocation of road space and how roads are used.

Overall, most participants did not seem to perceive values or related concepts such as norms to be core topics of the exhibition. They further appeared to be unaware of the effect of value change on the road rules and road use. However, participants may have at least had an indirect understanding of the relationship between values and the allocation of road space. At least some participants seemed well aware of the connection between the optimization goals and the associated values as two participants commented that they used the values to aid their understanding of the optimization goals. Choosing optimization goals to change the road level rules then also meant choosing values. Yet it is questionable to what extent participants were aware of this connection.

Results criteria 3: Lack of awareness for the AI component

Criteria 3: The speculative prototype illustrates the roles of and relationship between stakeholder participation, official decision making processes, smart technology and the rules at road level within the aforementioned smart urban traffic management system.

All participants appeared to recognize the roles of and the relationships between the stakeholders and the civil servant. However only three participants recognized the presence and role of the AI component within the system. The other four participants overlooked the presence of AI completely. They commented that the current exhibition made them think that they had direct control over the rules at road level. Subsequently, their reflections relating to fairness seemed to be focused on the relationship between the stakeholders and the civil servant. Reflections relating to the role of AI in the system seemed to be lacking among all participants. The three participants who did recognise the presence and role of AI within the traffic management system almost did so immediately upon entering the exhibition. They appeared to clearly understand that their role as the civil servant was to define the optimisation goals and thereby steer, but not fully control, the rules at road level which are defined by the AI. Several participants gave feedback on how the AI component and its role within the traffic management system could be made more prominent. Two participants commented that the AI component would become more apparent if there was more discrepancy between the chosen optimization goal and

the road rules and road usage. Another two participants expressed the need for more visual and auditory clues showing that the AI component is thinking or processing. Lastly, a participant suggested that the road scenario and rules should periodically change and show a diversity of rules and road uses while the priority of the optimization goals does not change. According to the participant, this would make the idea that the AI component is optimised for certain goals and makes decisions about the actual road rules at any given moment in time clearer.

"*We (the civil servants) make the optimisation and the AI makes the rules.*" - P6

"*AI isn't doing anything..... I made the priorities which define road rules.*" - P3

Results criteria 4: Presents a provocative proposal

Criteria 4: The speculative prototype is a provocative proposal for an alternative perspective on the current practice of road space allocation (Bardzell et al., 2014).

Three out of seven participants indicated that the exhibition made them reflect about the goals that are fostered by current road rules. Moreover, they commented that the exhibition made them realise that "it does not have to be this way", indicating that there may be desirable alternatives to current practices of road governance. Another participant indicated that the exhibition made them reflect on what future they want and that they might have a say about roads in the future. All participants indicated that they would like to see attempts to be made to realise the illustrated system.

"*It makes me think about what is important, what future I want. Maybe in the future I can have a say about roads.*" - P1

Results criteria 5: Illustrates a believable reality

Criteria 5: The speculative prototype is sufficiently believable for viewers to imagine themselves living in a world where the illustrated circumstances are reality. The scenario cannot be easily dismissed as science-fiction (Bardzell et al., 2014).

All participants commented that they believe that the reality illustrated by the exhibition is plausible. Participants noted that there are still lots of questions that the current speculative prototype does not address, but commented they believe that the presented traffic management system could be realised in Amsterdam. Furthermore, several participants described the exhibition as "immersive" and "intriguing", indicating that they were able to imagine themselves in the illustrated circumstances.

"*It could be done - but there are many questions that still need to be resolved.*" - P7

Results section 2: Results about to the general usability of the speculative prototype

Decent awareness for the core topics of the exhibition

Participants appeared to recognize most of the basic topics of the exhibition after interacting with the speculative design props. When asked to define the core topics of the exhibition in their own words they stated for example: “New way to make street policies”, “Participation”, “Future of road allocation”, “Adjustable neighbourhood” and “People having influence in policy making”. Only one participant mentioned values as a core topic of the exhibition. Another topic that was clearly lacking in their reflection was the AI component as explained in results section 1.

Road level design props cast participants into the road level reality

All participants appeared to understand that the road use scenario presented to them after entering the exhibition illustrated the current road use of a particular street in the neighbourhood *De Weteringschans*. Moreover, comments made by participants indicate that they felt like they were standing in this street when facing the road use scenario. Participants appeared to recognize the relation between the road use scenario and the road sign prop. Furthermore, they seemed to understand that the rules presented on the neighbourhood map and the road sign prop were the current rules indicating what the road space could be used for. The road sign prop and map however caused some confusion. Several participants mentioned that the rule shown on the road sign prop was not present on the neighbourhood map. This left them wondering where in the neighbourhood the road use scenario was taking place. Participants commented that the rule presented on the road sign prop should be taken up in the neighbourhood map. Furthermore, one participant commented that the placement of the map within the scenario projection somewhat broke the illusion of standing on this particular road, mentioning that the map should be placed on a separate screen. With regards to optimization goals illustrated below the map, participants seemed to understand their role in defining the current road rules, thereby influencing the road use. However, they were not sure what to make of this at that point. They revealed that this was only really clear once they encountered the optimisation goals in the control room. While this could mean that there is room for improvement, it can also be seen as a positive aspect as participants’ comments hint that the exhibition builds intrigue and curiosity by not resolving everything right away.

> “*I’m in the centre of Amsterdam… Weteringschangs. Seems like a residential area.*” - P2

Finding the control room proved tricky for some participants

Three out of the seven participants struggled to understand what to do next after having perceived the scenario at road level. One participant tried to interact directly with the projection illustrating the road use scenario, while another participant opted to look for clues behind the projection. All three participants stated that the oversized cable was not enough of a hint for them. On the contrary, the majority of the participants seemed to find the control interface without much second guessing by following the cable.

Improvements can be made regarding the initial orientation within the control room
When entering the control room, six out of seven participants walked past the intended starting point, ignoring the blazer and the instructions on the right side of the interface. These participants started by interacting with the control interface on the left side where the optimisation goals and the *save update button* was placed. This created confusion among participants as they had not read the instructions. All participants however ended up discovering the instructions eventually. Participants reported two reasons for this behaviour, stating that they were attracted by the colours of the optimization goals and that starting on the left side felt most natural as it coincides with how they read.

Participants readily slip into the role of the civil servant
After reading the instructions in the control room, all participants seemed to understand their assigned role as a civil servant. They proceeded by considering the stakeholder input, adapting the optimization goal and pushing the *save update button*.

"*Now I'm a civil servant! I'm in charge - that is a weird feeling. It's like a game.*" - P1

Stakeholder quotes and profiles perform as intended
All participants noticed that the stakeholders presented on the control interface had different, somewhat conflicting ideas about what the roads of the neighbourhood should be used for. Comments from the participants also indicate that there was no clear bias towards a certain optimization goal within the quotes. This may indicate that the stakeholder quotes show sufficient diversity to make visitors aware of the tensions and trade-offs that must be made when allocating road space without favouring certain outcomes. Moreover, all participants recognized that not all of the presented stakeholders lived in the neighbourhood. This detail appeared to trigger reflections relating to stakeholder prioritisation and fairness as explained in results section 1.

Stacking stakeholders causes confusion
All participants picked up the stakeholder cards displayed on the control interface. They noticed that the stakeholder cards were stacked (each stakeholder represented with three emotions) and wondered if this was an interactive element they were supposed to manipulate. Unsure what to make of this, participants chose to ignore the additional cards.

Emotional expressions of stakeholders were generally overlooked
Participants generally appeared to overlook the different facial expressions of stakeholders. When pointing the emotions out after participants interacted with the speculative prototype, several of them commented that they found it a nice touch. According to one participant, the emotions illustrate trade-offs showing that their adaptations to the system can not make everyone happy. Other participants commented that they found the facial expressions confusing and, in their eyes, were not representing the facial expression they associate with a happy, neutral or angry emotional state.

Participating as a group seems to create rich discussions

Engaging with the speculative prototype as a group may result in participants having richer reflections and discussions. The two participants taking part in the evaluation together sat down and had a self-initiated, in-depth discussion lasting about 15 minutes about topics such as how to deal with stakeholder prioritisation and potential biases. Participants who visited the exhibition alone reflected on similar topics but moved on quicker. The critical design expert (P3) further confirmed this impression stating that the speculative prototype would result in richer discussions if visitors engaged with the exhibition in groups.

Conclusion

This section presented the evaluation of the speculative prototype. The main goal of this evaluation was to investigate how the designed prototype performs with regards to the criteria defined in chapter 6 Synthesis. Overall, the speculative prototype has performed decently regarding both evaluation points. During the evaluation, several issues of the current design surfaced that should be addressed in potential future iterations.

Key conclusions

Performance with regards to the criteria

The speculative prototype performed decently regarding criteria 4, representing a provocative proposal for an alternative perspective on current practices of road space allocation. Several participants commented that the exhibition made them reflect on past, current or future practices of road governance and allocation of road space. Similarly, the prototype seems to illustrate a believable picture of a reality in which the envisioned traffic management system governs the roads of Amsterdam. It is therefore concluded that the prototype also performs well with regards to criteria 5. The results from the evaluation further indicate that the speculative prototype addresses the notion of fairness within a smart traffic management system governing the dynamic allocation of road space. The exhibition sparked reflections and discussions relating to fairness among all participants as well as triggering some participants to ponder about how the system could be made fairer. It could therefore be said that the speculative prototype performed well with regards to criteria 1. However, the results also showed that while participants generally were aware of the role and relationships between stakeholders and official decision making, some participants completely overlooked the agency of the AI component in determining the road rules. This means that the participants' discussions and reflections about fairness sparked by the exhibition rarely extended to the smart aspect of the system. It is concluded that the design should be improved with regards to criteria 3 by emphasising the role of the AI component, which in turn may contribute to a better performance with regards to criteria 1. The results showed that participants lacked awareness of the effect of value change on the rules governing the allocation of road space and how roads are used. The speculative prototype therefore performs poorly with regards to criteria 2.

Usability of the speculative prototype

Overall, the speculative prototype appears to convey most (but not all) core topics of the exhibition and successfully puts visitors into the reality at street level as well as into the role of the civil servant. The stakeholder quotes and profiles conveyed the diversity of stakeholders and their

contrasting wishes. At the same time they do not seem to convey discernable hints regarding what optimization goal participants should choose. Some participants experienced moments of undesirable confusion. The identified issues are mainly concerned with the orientation within the exhibition and the representation of information. The evaluation also hints that the speculative prototype may spark richer reflections and discussions if visitors engage with the exhibition as part of a group compared to an individual basis.

Identified opportunities to improve the speculative prototype

Opportunities to improve the design of the speculative prototype in relation to the criteria.

- The role of AI and how it relates to the other components of the socio-technical system needs to be made clearer. This could be done in several ways as suggested by the participants. For example, by increasing the discrepancy between the chosen participation goals and the road level rules defined by the AI component.
- Value change and how it relates to road rules and road use could be made more prominent within the exhibition. This could be done in many ways, for example by changing the graphic design of the control interface to put more emphasis on values and/or by showing the values that the current road rules are optimised for instead of the optimization goals on the projection of the road use scenario.

Opportunities to improve the usability of the speculative prototype

- Include rules presented on road sign prop in the neighbourhood map alongside the other rules. Possibly remove the map from the road use scenario projection and present it separately, for example on a smartphone participants can hold.
- Participants appear to require better hints to find the control interface. This may be done by making the cable more prominent, triggering the light within the cable to attract attention or by other means.
- Mirroring the layout and re-designing the graphics of the control interface to aid orientation or digitalize the control interface all together.
- Stacking the stakeholder cards creates confusion. A simple fix to this issue may be to put only one stakeholder card for each stakeholder onto the control interface at any given moment in time instead of stacking them.
- Stakeholder pictures may need to be swapped out for pictures that better represent their emotional states. Alternatively, other hints could be given about how stakeholders feel.
- Engaging with the speculative prototype seems to create richer discussions. Future iterations of the design props and the general exhibition set-up could be designed to invite visitors to engage in groups.

Limitations

The exhibition as tested in this evaluation holds several limitations which are listed in this section.

- With a sample size of only seven participants, no conclusive statements can be made about the performance of the speculative prototype. The results can be seen as initial indications but need to be verified. This holds especially true for the result indicating that participants interacting with the exhibition together in a group have richer discussions and reflections as merely one group of two participated. It remains to be seen whether this was merely a happy accident or represents the norm.
- All the participants in this exhibition had a design background, being either design students, graduates of a design program and/or design researchers. It remains unclear how non-designers would experience the exhibition and if they would interpret and interact with the design props differently. The gathered results may give a general indication about the performance of the speculative prototype. Should the speculative prototype be used to allow the diverse stakeholders to join the discussion, more research is needed to better understand how non-designers experience the exhibition.
- Two of the seven participants had previously been involved in interviews or brainstorms for the project at hand. They therefore had some, although limited, knowledge of the speculative prototype and the general topics of the project. These participants were instructed to take on the perspective of someone who had no previous knowledge about the exhibition. During the evaluation, these participants regularly made comments from this perspective expressing comments such as "If I was completely new to this, I would struggle to understand...". It remains unclear to what extent they were able to disregard their prior knowledge.
- As mentioned in the results, several participants seemed unaware of the role of AI within the smart traffic management system. In all cases, this lack of awareness was detected during the early parts of the semi-structured interview and resolved by explaining to the participants the intended role of AI within the traffic management system. This means that during the subsequent questions relating to fairness, believability and other criteria, participants should have been aware of the role of AI within the system. However, participants' comments made while interacting with the speculative prototype before the interview might still lack understanding for the AI component. Their comments might have been different if they would have been aware of the AI component from the beginning.

8.3. Conclusion

This chapter presented the evaluation of the final design outcome of the project at hand. The system map and the speculative prototype were evaluated separately. The chapter described how each design was evaluated and provided arguments for the chosen evaluation approaches. Furthermore, the results and conclusions were presented and key limitations explained. The outcome of the evaluation will be picked up in the chapter 9 *Discussion & conclusion* where they are discussed in light of existing design literature as well as the *Code the Streets* project.

Chapter 9

Discussion & conclusion

This chapter presents the discussion of the carried out research and design work. The first section of the discussion looks back at the project in light of the general project scope *reimagine* and the research question. It reflects on the process and outcome of the project and includes my assessment to what extent the project's aim was achieved. The recommendations for the *Code the Streets* team of the municipality of Amsterdam are presented in the second section. This is followed by a discussion of the implications of the project at hand for research and design practice in the third section. The fourth section presents a personal reflection on the project. The chapter ends with the report conclusion.

9.1. General discussion

The general discussion starts by restating the overall aim of the project in the form of a short recap of the project scope and research question. This is followed by a reflection on the process, presenting the research and design activities carried out in the project in light of the approaches of the *6R framework*. Ultimately, I give my assessment to what extent the project achieved its aim and provide arguments for my appraisal of the project.

Recap project scope

The project scope *reimagine* was defined in chapter 1 *Introduction* using the *6R framework*. According to Kim et. al. (2022), *reimagine* entails imagining something anew, considering alternative futures that include radical system change. The project aimed to *reimagine* the smart allocation of road space in Amsterdam and was carried out as a case study within *Code the Streets*' long term vision of dynamic traffic rules designed to foster civic values. This is reflected in the project's general research question: How can we reimagine an urban traffic management system governing the dynamic allocation of road space around civic values in the context of Amsterdam? Fairness was established as the key value within this case study. The focus on fairness was inspired by the example of *The Dynamic Street* project presented in the introduction and is reflected in the project title. Looking back, the general research question lacked this specification. Ultimately, the simpler and more specific research question around which the project evolved was: How can we *reimagine* the smart allocation of road space in Amsterdam for fairness?

Discussion process and results

The project scope *reimagine* was operationalised through speculative design and research informed by VSD. The project thereby reflects several approaches from the *6R framework* shown in figure 64. Research played a key role in conceptualising fairness within this project as an ideal that can be approximated but not reached. Furthermore, research informed the project's focus on procedural fairness and the idea of operationalising fairness through continuous adaptation and stakeholder participation. Research thereby shaped the implicit vision for the scope *reimagine*: a *resilient* process allowing for the continuous approximation of a fair system through adaptation and stakeholder participation. The *reimagined* reality ultimately inspired a *redesign* of a traffic management system in the form of a system map and a speculative prototype. The design outcome therefore became a tool for communicating the *reimagined* reality.
The results from the evaluation presented in chapter 8 *Evaluation* lead me to believe that the project succeeded in reimagining the smart allocation of road space for fairness and that the *reimagined* reality was communicated rather well through the design outcome. Participants of the evaluation of the speculative prototype appeared to unanimously agree that the prototype represents a provocative proposal for an alternative perspective on the current practice of road space allocation. This appears to be in line with the definition of *reimagine* by Kim et at. (2022) previously presented. Several participants further described the exhibition as immersive and intriguing, indicating that they were able to imagine themselves in the illustrated reality.

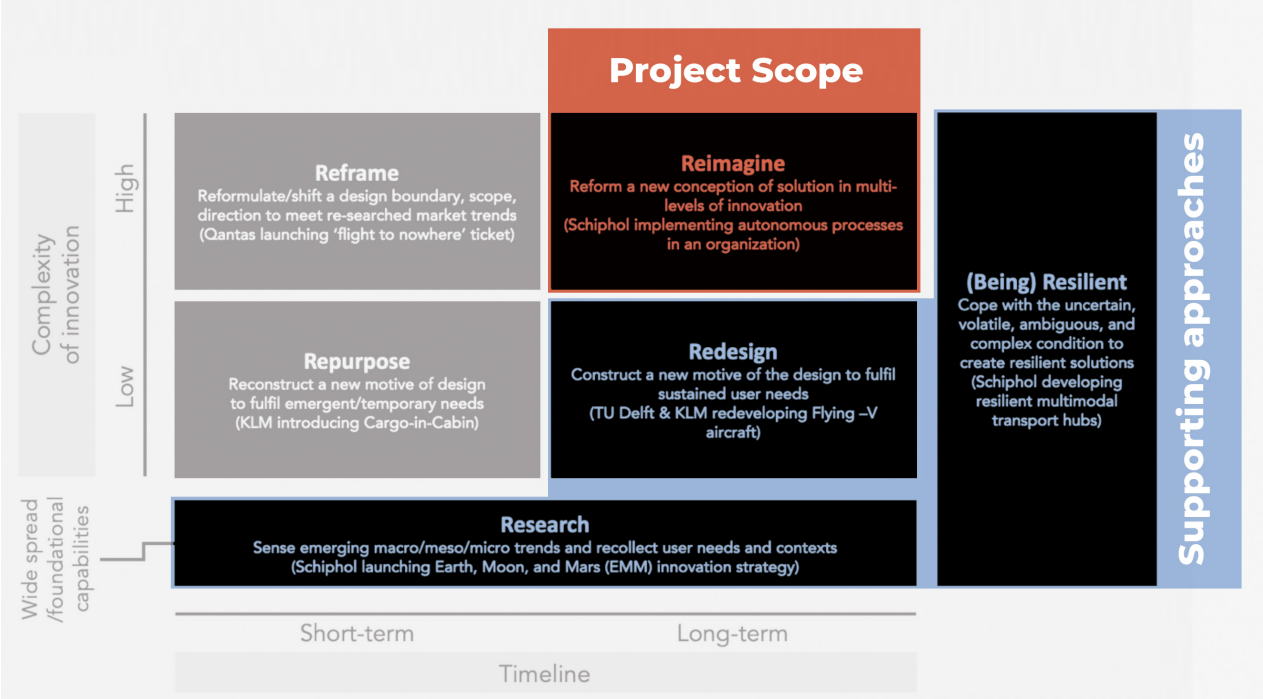


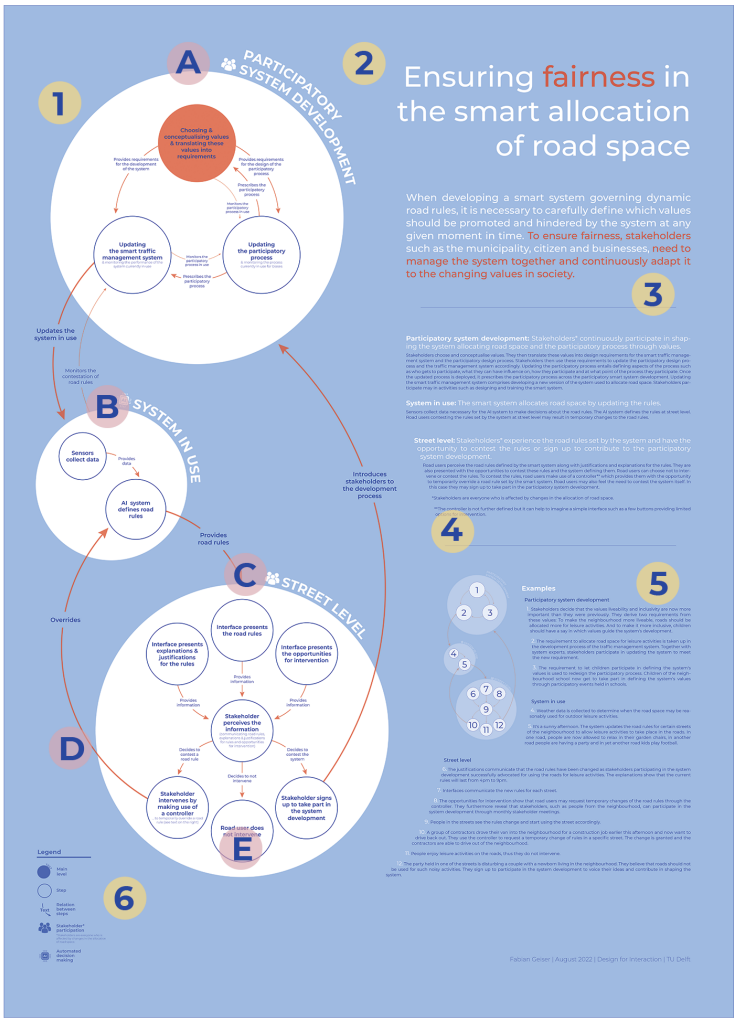
Figure 64: The project scope *reimagine* and the supporting approaches (own visualisation based on Kim et al., 2022).

Comments made by the participants also reveal that the speculative prototype addressed the notion of fairness in the context of a system governing the allocation of road space (note that the conceptualization and operationalization of fairness within this project had been previously approved by the philosophy of technology expert in chapter 5 *Expert Interviews*). With regards to the system map, The members of the *Code the Streets* team participating in the map's evaluation frequently referred to it as futuristic. More elaborate comments included for example "Civic participation is the holy grail, right?... And I think that's a really, really super thing and you have managed to map that out. But yeah, it is definitely speculative design, I think third horizon stuff". This suggests that the system map represents a *reimagined* reality in which stakeholders participate in shaping a smart traffic management system in Amsterdam.

That being said, the results from the evaluations also indicate that there is room for improvement. The evaluation of the speculative prototype uncovered that the participants were not aware of the effects of value change on the rules at road level and how roads are used. Furthermore, several participants overlooked the role of the AI component within the system and there were a few issues regarding the usability of the speculative prototype. A next iteration could be focused on improving these usability shortcomings and should better communicate the role of the AI component within the system and how it relates to the other components. Values and related concepts such as norms could also be highlighted with minor adjustments. The evaluation of the system map showed that the *Code the Streets* team of the municipality were positive about the map's content. They also indicated that the map could be useful to further explore the topic of stakeholder participation within *Code the Streets*. The map was however deemed to be difficult to understand and participants of the evaluation called for better explanations and pointed out the need for examples. Based on this feedback, an additional iteration of the system map has been created.

The final iteration of the system map poster (see figure 65 and 66) is intended to make the map more understandable. The map has changed little with regards to its content compared

to the system map iteration 4.0 presented in chapter 7 *Conceptualization*. In favour of reduced complexity, a few details such as for example, the AI lifecycle by Binns and Gallo (2019), were removed. Furthermore, the number of main levels of the map has been reduced from four to three. The first level (*Participatory process design*) and second level (*Smart traffic management system development*) of the previous iteration were combined into one level: *Participatory system development*. This was done as the separation of these two levels and the resulting two-fold step of choosing values and translating them into requirements seemed to create confusion during the evaluation. Besides these revisions to the overall layout, a main focus of the redesign was to provide better explanations. The wording of the map was revised, focusing on improving the previously abstract and theoretical terms such as *use time intervention*. The text on the poster such as the title and explanations was rewritten based on the informal explanations given during the evaluation of the system map as the participants seemed to understand those well. The final iteration of the poster now also contains examples as wished for by the participants of the evaluation. Last but not least, this iteration makes use of colour contrasts to guide the viewer's eye better.



System map poster

1. The system map
2. Poster title
3. Introduction
4. Explanation of the main parts of the system map
5. Examples
6. Legend

System map

- **A.** Level 1: Participatory system development
- **B.** Level 2: System in use
- **C.** Level 3: Street level
- **D.** Connecting arrows showing the relationships between levels and / or steps
- **E.** Example step

Figure 65: The final system map poster with annotations.

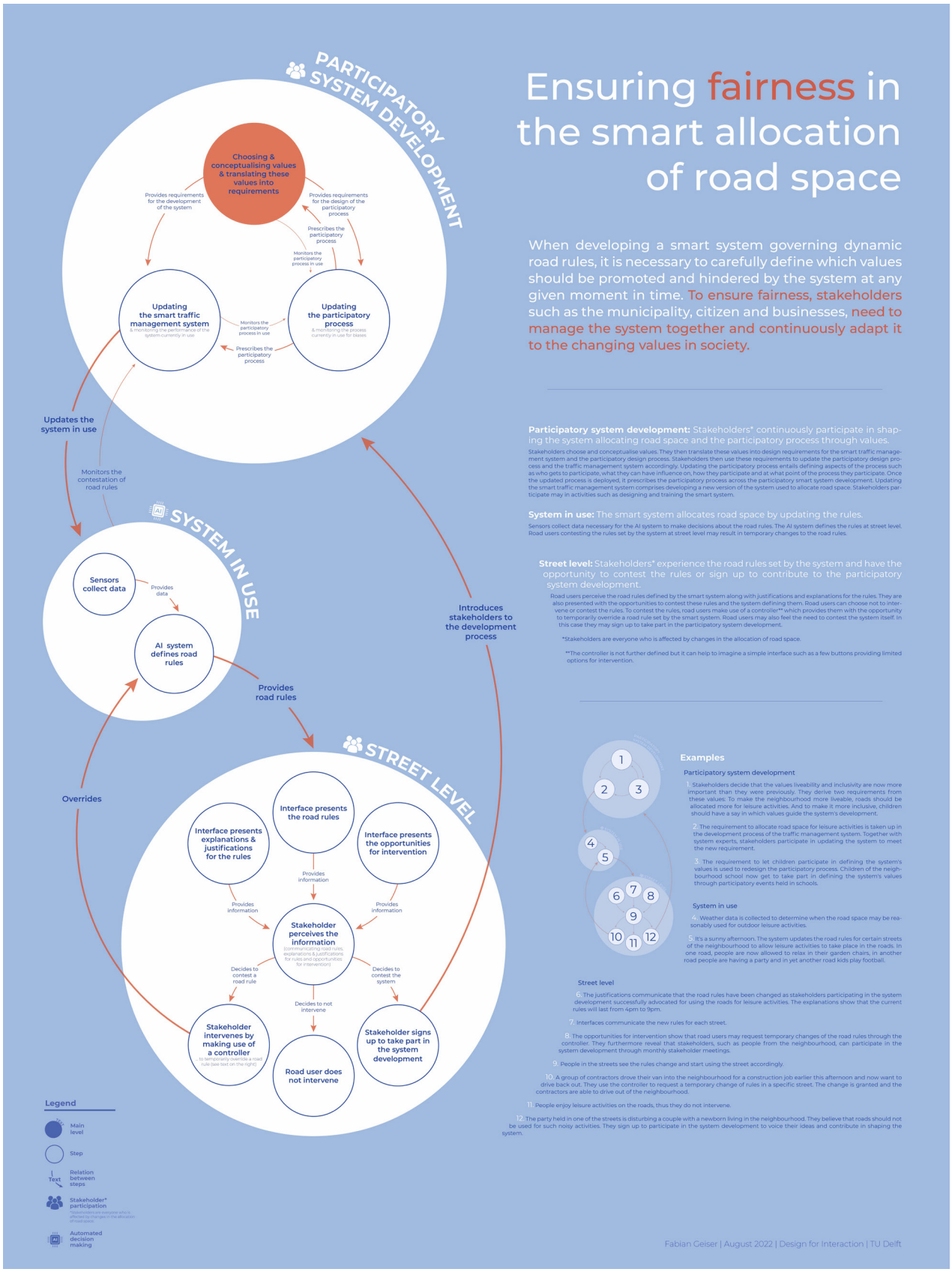


Figure 66: The final iteration of the system map.

Conclusion general discussion

In conclusion, the project presents a way in which we can *reimagine* the smart allocation of road space for fairness. The design and research process demonstrates that the approach *reimagine* can be supported by the approaches *research*, *redesign and (being) resilient* of the *6R framework* and successfully operationalised through speculative design. Furthermore, the project illustrates how the value fairness can be conceptualised and implemented in the context of a smart system governing the allocation of road space. The next section presents my recommendations for the *Code the streets* team.

9.2. Recommendations Code the Streets

This project was conceived as a case study within the *Code the Streets*' future vision introduced in chapter 1 *Introduction*. Throughout the research and design work, I gathered several insights that I believe are relevant for the *Code the Streets* project. This section introduces my recommendations to the *Code the Streets* team of the municipality of Amsterdam and their collaborators.

Think adaptive, not neutral.

Technology is never value free. Values are embedded into technology through design. Which values should be promoted and hindered by the system at any given moment in time need to be carefully considered. I therefore advise the *Code the Streets* team to shift their focus from a value neutral base system (see chapter 1 *Introduction*) towards creating a system that can be adapted to value change. This reorientation holds important implications for the design of the system as the design activity itself becomes a continuous process and the system's components need to be carefully chosen to allow for meaningful adaptation.

Consider values of the system, not just with regards to rules.

The original idea for the future vision of *Code the Streets* is to set road rules to foster specific civic values within the city of Amsterdam. Rules are however merely the outcome behind a lot of complex processes and interactions of system components. Aspects of the system such as whether detailed justification is provided for the rules or who can participate in shaping the system are choices that foster certain values. *Code the Streets* should therefore consider the values that are fostered by the entire system and its development process instead of focusing only on the road rules.

Use speculative design to enable stakeholders to take part in envisioning the future of Code the Streets.

High level design decisions made about the *Code the Streets* system today can drastically influence the emergence of fairness for when the system is in use. If we are to take the ideal of a citizen-centric, smart Amsterdam seriously, stakeholders need to start participating in the early stages of the development of a smart system allocating road space. Having an adaptive sys-

tem does not change this need as the choice for the system's components enables or hinders meaningful adaptation in the future. I therefore advise the *Code the Streets* team to use speculative design to engage with stakeholders affected by changes in the allocation of road space and let them take part in envisioning how they want to shape this smart system in their city. There are still many aspects of the mapped out system that could be explored through speculative design.

Recognise that road rules alone do not make for alternative road use.

Roads are part of an ecosystem which holds complex relationships between a variety of components. Research presented in chapter 2 *Related work* and 3 *Initial research* as well as comments made by participants in the evaluation of the speculative prototype indicate that dynamic rules need to be managed alongside changes to the physical road space. *Code the Streets* should reconsider the position of their future vision within this larger ecosystem as it holds important implications for the scope of participation: Should participatory processes designed to inform rules at road level also inform physical changes to the road space? Or should both of them be informed by other, higher level participation processes? How may we exchange input between different participatory processes?

Explore the the cognitive load of dynamic rule changes.

Most of us have experienced the complexity and confusion resulting from quick rule changes during the Covid 19 pandemic first hand. Dynamic road rule changes may similarly present a significant cognitive load for people using the road space. This was highlighted by participants of the pressure cooker as well as a TU Delft expert in safety of AI systems in policy contexts. How dynamic rules are experienced by people at road level was not explored in detail in this project but the results suggest that it is a relevant topic that should be investigated further within *Code the Streets*.

9.3. Contribution to design literature

This section presents the four main contributions of the project at hand to design literature. Each finding is introduced with suggestions for further research.

Operationalising reimagine through speculative design in public institutions.

This project demonstrates that the approach *reimagine* can be supported by the approaches *research*, *redesign* and *(being) resilient* of the *6R framework*. I therefore support the argument put forward by Kim et. al. (2022) that *research* is an enabler of reimagining, as well as the argument that *redesign* can be undertaken to support a *reimagined* reality. It was also shown that the achievement of resilience can act as a vision within the effort of reimagining. The project outcomes further indicate that the approach *reimagine* and the supporting approaches mentioned before can be successfully combined and operationalised through speculative design. Speculative design is commonly rooted in a thorough understanding of technology and/or social developments. *Research* can support designers in establishing the knowledge base needed to imagine a thoughtful and thought provoking reality. The *reimagined* reality finally takes shape in the form of speculative design props which represent a *redesign* of our current or a likely future reality. As Richard Blythe puts it: "Without the designing happening there can be no meaningful observation" (Hill, 2012). Speculative design therefore ultimately appears to be a viable way to engage with the long term approaches of the *6R framework reimagine* and *redesign*. Within this project, these approaches were carried out in the context of innovation in the public sector. Marianna Mazzucato, Professor in the Economics of Innovation and Public Value, criticises governments and policy makers for being too reactive. Mazzucato calls for public institutions to take a more active role in shaping the future through social and technical innovation (Bourgonje Live, 2022). Based on my experience within this project, I believe that the two long term approaches *reimagine* and *redesign* could be highly valuable for public institutions. As shown in this project, municipalities could operationalise these approaches through speculative design to take an active role in shaping the future of their cities. This idea seems to be supported by Hill (2018) who points out the need to engage in exploratory and provocative city making through speculative design alongside more traditional design approaches. Additional research could explore further applications of the *6R framework* within the context of public institutions. For example, I believe it would be useful to further investigate how the long term approaches of the *6R framework* can be connected to the approaches reframe and reuse and inform changes in the short term. Strategies such as backcasting proposed by the transition design approach may be a starting point for this exploration (Irwin, 2018).

Fostering fairness through long term participatory processes in the public domain requires the participatory process itself to be contestable.

The investigation presented in chapter 4 *Stakeholder participation in Amsterdam* shows that long term participatory processes in the public domain need to be re-evaluated and possibly updated over time. Furthermore, research carried out in this project suggests that designing a participatory process requires defining aspects such as who gets to participate, what they can have influence on and how the input of different stakeholders is compared in the decision

making process. These are decisions of prioritisation and thereby relate to the value fairness. This indicates that if we aim to ensure fairness within a public AI system through ongoing participation over long(er) periods of time, stakeholders should be able to contest the participatory design process itself. Stakeholders thereby influence the aforementioned questions of prioritisation. This is suggested in addition to levels of contestability previously identified in literature: at use time and at design time. Further research could focus for example on the associated practices and features that enable stakeholders to contest the design process. Or explore in more detail how contestation of the design process may be integrated with contestation at design time and contestation at use time in practice.

The need to consider value change over space when designing at city scale.

The project shows a need to manage value change across time and space when designing systems at city scale. Literature shows that values are perceived by individuals or groups within a cultural milieu. It therefore seems safe to assume that there is a variety of value present across a culturally diverse context such as a city at any given moment in time, suggesting that value change takes place over space. Further research could dive deeper into how we can deal with value change over time and space at city level, for example focusing on questions related to comparability and finding meaningful scales. Furthermore, it should be verified if the five different kinds of value change also hold true for value change over space as the current theory by van de Poel (2018) mainly appears to consider value change over time. For example, changes in priority of values is described as "the judgement on which values to prioritise or how to balance or weigh values may change in the course of time" (van de Poel, 2018). Similarly, it could be verified whether the three features (adaptability, flexibility and robustness) which allow products and systems to better deal with value change also apply to value change over space. The current description suggests that they were conceived with a focus on value change over time: "These features can be designed into products or systems so that they can better adapt to changing values in the later phases of the life cycle of a product or system" (van de Poel, 2018). Personally, I believe that both the five levels of value change and the features identified by van de Poel (2018) will hold true for value change over space. Additional research focusing on value change over space may however lead to discovery of additional kinds of value change or features that allow designs to better deal with value change also over space.

A proposal for smart citizenship beyond instrumental participation.

This project relates to the current research into the role of citizens in a smart city. It can be seen as a proposal suggesting what the role of citizens and other stakeholders should be in the context of a smart system governing the allocation of road space to foster fairness. The system map and the speculative prototype propose a process in which citizens and other stakeholders have significant influence over the system. They become caretakers and designers of the collective good, similar to the commons approach presented in the *Participation scaffold* in chapter 2 *Related work*. Further research and design work could build on this to explore if and how the mapped out process could be used in the smart allocation of other public resources. As suggested by the philosophy of technology expert in chapter 5 *Expert interviews*, this could inspire fair processes which allow stakeholders to continuously engage in the allocation of a public resource in a smart city.

9.4. Personal reflection

This section presents my personal reflection on the project. It begins with a general reflection on the project and its outcomes. This is followed by some of the main challenges I encountered. The last part is focused on my personal ambitions for this project set before the kick-off.

I'm happy with this project and its outcomes. As mentioned previously, I retain that the project was successful in achieving its aim. The design outcomes, especially the speculative prototype, seemed to generate lots of enthusiasm among the designers and researchers of the faculty of Industrial Design Engineering as well as the *Code the Streets* team of the municipality of Amsterdam. Furthermore, I believe that the project delivered valuable contributions to design literature and *Code the Streets*. A personal highlight for me was to see how the mindset towards stakeholder participation seemed to change within the *Code the Streets* team throughout our collaboration. As previously explained, *Code the Streets* was not conceived around stakeholder participation. Throughout the project, I noticed how this slowly began to change. I was enthusiastic when I was told by a representative of the *Code the Streets* team during one of our chats that stakeholder participation will be a core research topic within *Code the Streets* for this year. I like to believe that I contributed to this change in perspective within the *Code the Streets* team. Overall, this was a stimulating project to work on for me. I think the main reason for this is that the project is situated at a rich intersection of several interesting domains, from mobility and urbanism over smart technology to ethics and values. At the moment of writing this section it seems that I will continue working on at least some of these topics in the near future at the AMS institute. I'm thrilled for the opportunity to continue on this path. This project helped me to get a better understanding of what I as a designer can bring to the table in this context and I also learned valuable lessons on how to communicate with project collaborators such as the municipality of Amsterdam.
Of course the project was not without its struggles. One of the main challenges was that a lot of the approaches were relatively new to me. I never really made a speculative design, an exhibition, or a system map before. Also the theory related to VSD and fairness was largely new to me. The project shifted a lot due to my lack of prior experience with the relevant theory and methods. I initially started this project thinking I will research and define the values around which the system would be created. The concept of value change and adaptability was only picked up in the first few months after starting the project. I struggled to figure out how I can start to design something that is constantly in flux. Ultimately, I believe I found a workable approach to deal with adaptability in my design work. However, familiarising myself with the relevant theory and processes at the beginning of the project took up a significant amount of time. This delayed the discussions with *Code the Streets* and other expert interviews, but ultimately I believe that this was a good approach as it helped me to establish my own vision for the project and allowed me to use the interviews strategically. Another aspect of the project that I would like to point out are the criteria, especially for the speculative prototype. I had worked previously with so-called *interaction visions*, often in the form of statements, pictures and metaphors about what a design should accomplish, but not a set of written criteria. Looking back, I notice that working with the criteria made me approach the speculative prototype in a very functional way. The resulting initial concepts were uninspiring and complex. It took a while to let go of this perspective and ultimately treat the criteria more as inspiration, similar to an interaction vision, rather than hard requirements.

My main learning ambition within this project was to look beyond the familiar design paradigm of user centred design and gain experience designing with a broader spectrum of stakeholders and values. Furthermore, I wanted to learn about how abstract values can be used to design a smart system. I think the project allowed me to engage with these topics and even dig deeper into theory relating to fairness and adaptability. Right from the beginning of the project, I started translating values into design requirements. I explored the idea of an adaptive system system and what it means for the design process before starting with the speculative design process. And while this initially was challenging, I can say now that I feel comfortable approaching a similar project in the future. Another personal ambition for this project was to work with my hands, building lo-fi prototypes throughout the process. This didn't work out as I had intended. While I made a few smaller experiments and held some creative sessions with fellow designers, I did not build many prototypes. Ultimately, I believe this is mainly due to the fact that it took me a long time to make sense of the theory and the design criteria mentioned above. During most of the project I felt like testing some prototype would not have added much and that I should focus on other aspects. I'm still content with the amount of manual labour I did within this project as there was plenty involved in creating the speculative prototype. But if I would do the project again I would try to spread it out more.
In conclusion, I'm satisfied with my work in this project. Sure, some things could have been done better but I'll carry that with me to improve my next project. I'm happy that I used this graduation project as a chance to learn rather than focusing on demonstrating skills and knowledge I had built previously. I believe it has helped me shape my path towards the designer I want to be.

9.5 Conclusion

This project aimed to reimagine the smart allocation of road space in Amsterdam for fairness. The approach reimagine of the *6R framework* was operationalized through speculative design and the process undertaken in this project was further influenced by the Value Sensitive Design approach. The project relied on research in the form of literature review, expert interviews and hands-on experimentation as well as the review of related design work. The main conclusions from the research were used to establish design goals and criteria. The project's design outcome is two-fold. Firstly, the project generated a system map showing how stakeholders should participate in a smart system governing the allocation of road space to ensure fairness. Secondly, a speculative prototype was created in the form of a low-tech user experience installation aiming to make (parts of) the mapped-out system tangible. The design outcomes were evaluated separately which delivered insights about their performance regarding the criteria and revealed points for improvement. The project ultimately produced several insights contributing to existing literature in the fields of public AI and design methodology research as well as delivering recommendations for *Code the Streets*. My hope is that this project inspires research and design work addressing fairness in the smart allocation of public resources and supports the *Code the Streets* team of the municipality of Amsterdam to define their vision for stakeholder participation.

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Appendix

Appendix 1
Project Brief

DESIGN FOR our future

TU Delft

IDE Master Graduation
Project team, Procedural checks and personal Project brief

This document contains the agreements made between student and supervisory team about the student's IDE Master Graduation Project. This document can also include the involvement of an external organisation, however, it does not cover any legal employment relationship that the student and the client (might) agree upon. Next to that, this document facilitates the required procedural checks. In this document:

- The student defines the team, what he/she is going to do/deliver and how that will come about.
- SSC E&SA (Shared Service Center, Education & Student Affairs) reports on the student's registration and study progress.
- IDE's Board of Examiners confirms if the student is allowed to start the Graduation Project.

USE ADOBE ACROBAT READER TO OPEN, EDIT AND SAVE THIS DOCUMENT
Download again and reopen in case you tried other software, such as Preview (Mac) or a webbrowser.

STUDENT DATA & MASTER PROGRAMME

Save this form according the format "IDE Master Graduation Project Brief_familyname_firstname_studentnumber_dd-mm-yyyy".
Complete all blue parts of the form and include the approved Project Brief in your Graduation Report as Appendix 1 !

family name	Geiser
initials	FG
given name	Fabian
student number	4604008
street & no.	
zipcode & city	
country	
phone	
email	

Your master programme (only select the options that apply to you):

IDE master(s):	( ) IPD (★) DfI ( ) SPD
2nd non-IDE master:	
individual programme:	- - (give date of approval)
honours programme:	( ) Honours Programme Master
specialisation / annotation:	( ) Medisign
	( ) Tech. in Sustainable Design
	( ) Entrepeneurship

SUPERVISORY TEAM **

Fill in the required data for the supervisory team members. Please check the instructions on the right !

** chair	Euiyoung Kim	dept. / section:	DOS
** mentor	Kars Alfrink	dept. / section:	SDE
2nd mentor			
organisation:			
city:		country:	

comments (optional): Working relationship with AMS institute and their Code the Streets project.

Chair should request the IDE Board of Examiners for approval of a non-IDE mentor, including a motivation letter and c.v..

Second mentor only applies in case the assignment is hosted by an external organisation.

Ensure a heterogeneous team. In case you wish to include two team members from the same section, please explain why.

Procedural Checks - IDE Master Graduation

TU Delft

APPROVAL PROJECT BRIEF

To be filled in by the chair of the supervisory team.

chair Euiyoung Kim date - - signature

CHECK STUDY PROGRESS

To be filled in by the SSC E&SA (Shared Service Center, Education & Student Affairs), after approval of the project brief by the Chair. The study progress will be checked for a 2nd time just before the green light meeting.

Master electives no. of EC accumulated in total: _____ EC

Of which, taking the conditional requirements into account, can be part of the exam programme _____ EC

List of electives obtained before the third semester without approval of the BoE

YES all 1st year master courses passed

NO missing 1st year master courses are:

name date - - signature

FORMAL APPROVAL GRADUATION PROJECT

To be filled in by the Board of Examiners of IDE TU Delft. Please check the supervisory team and study the parts of the brief marked **. Next, please assess, (dis)approve and sign this Project Brief, by using the criteria below.

- Does the project fit within the (MSc)-programme of the student (taking into account, if described, the activities done next to the obligatory MSc specific courses)?
- Is the level of the project challenging enough for a MSc IDE graduating student?
- Is the project expected to be doable within 100 working days/20 weeks ?
- Does the composition of the supervisory team comply with the regulations and fit the assignment ?

Content: APPROVED NOT APPROVED

Procedure: APPROVED NOT APPROVED

comments

name date - - signature

Initials & Name FG Geiser Student number 4604008

Title of Project Reimagining the smart allocation of road space in Amsterdam for fairness

Personal Project Brief - IDE Master Graduation

TU Delft

Reimagining the smart allocation of road space in Amsterdam for fairness

project title

Please state the title of your graduation project (above) and the start date and end date (below). Keep the title compact and simple. Do not use abbreviations. The remainder of this document allows you to define and clarify your graduation project.

start date 11 - 11 - 2021 11 - 05 - 2022 end date

INTRODUCTION **

Please describe, the context of your project, and address the main stakeholders (interests) within this context in a concise yet complete manner. Who are involved, what do they value and how do they currently operate within the given context? What are the main opportunities and limitations you are currently aware of (cultural- and social norms, resources (time, money,...), technology, ...).

Currently, roads are governed by a set of fixed, relatively static rules which are communicated via road signs, road surface markings and navigation apps. The Code the Streets project by the AMS institute proposes a digital system for managing urban mobility (in the city of Amsterdam) that would allow rules and signs to be dynamically adapted to improve efficiency and effectiveness of traffic management. The system is intended as a digital public infrastructure that is explicitly designed around values [1]. Thereby, it creates opportunities to reimagining the public governance of urban space and the relationship between citizens and the government.

The Code the Streets system can be described in 4 layers:
- A city wide digital infrastructure, which allows the enforcement of dynamic rules that govern the use of public roads.
- A set of dynamic rules that are intended as digital manifestations of values.
- Touch points and interfaces through which citizens experience the rules.
- The mobility behaviour exhibited by road and transport users as a result of their perception and understanding of the rules

The graduation project is proposed as a case study within the Code the Streets project with the aim to investigate the dynamic use of road infrastructure. The project is therefore focused on the sub-set of rules that directly relate to the allocation of road space (for example: no access for motor vehicles, pedestrian zones, parking and unloading rules) [2]. This scope is inspired by the recent trends sparked by the Covid 19 pandemic with several cities closing of streets and allowing businesses and citizens to make use of the space [3, 4].

This project is situated in the context of Amsterdam. As of now, it appears that the stakeholders are: the municipality of Amsterdam, the AMS institute together with their partners in the Code the Streets project [5], the citizens and businesses of the city of Amsterdam, and everyone else using the public roads in the city.

[1] Zuckerman, E. (2020). What is Digital Public Infrastructure?. The Center for Journalism and Liberty. https://www.journalismliberty.org/publications/what-is-digital-public-infrastructure
[2] anwb. (2020). Verkeersborden in Nederland. Retrieved from: https://www.anwb.nl/vakantie/nederland/reisvoorbereiding/verkeersborden
[3] Spin. (2020, December 14). Spin: Bringing Open Streets to Life with Street Lab's PLAY NYC Program [Video]. YouTube. https://www.youtube.com/watch?v=mrL2pvwKHlY
[4] Bloomberg Quicktake. (2020, June 18). Why Car-Free Streets May Be Here to Stay [Video]. YouTube. https://www.youtube.com/watch?v=b2HvW2iGNRk
[5] AMS Institute. (n.d.). Code the Streets. Retrieved from: https://www.ams-institute.org/urban-challenges/smart-urban-mobility/code-streets/

space available for images / figures on next page

Initials & Name FG Geiser Student number 4604008

Title of Project Reimagining the smart allocation of road space in Amsterdam for fairness

introduction (continued): space for images

Guests dine on Glassell Street outside of Citrus City Grill and Smoqued California Barbecue in Orange on Wednesday, July 8, 2020 after the city closed off sections of Glassell Street to allow restaurants in Old Towne Orange to offer outdoor dining on the sidewalk and streets to comply with the state's COVID-19 guidelines. (Photo by Leonard Ortiz, Orange County Register/SCNG)

Source: https://www.dailydemocrat.com/2020/07/22/from-internet-rights-to-streeteries-how-the-pandemic-is-changing-working-from-home/

image / figure 1: Example of so called "streeteries" which gained popularity during Covid pandemic - Orange, CA.

Source: https://www.spin.app/blog-posts/spin-joins-forces-with-street-lab-to-open-city-streets-for-families

image / figure 2: People using temporarily closed road space for recreation during Covid pandemic - NYC.

PROBLEM DEFINITION **

Limit and define the scope and solution space of your project to one that is manageable within one Master Graduation Project of 30 EC (= 20 full time weeks or 100 working days) and clearly indicate what issue(s) should be addressed in this project.

This project aims to investigate the dynamic use of road infrastructure. Let's assume there is a system that dynamically allocates road space. In the morning, it could allocate space for delivery vans unloading their goods. And in the evening it might allow the people living in the street to organize a barbecue. This is what the Sidewalk Lab of Google and Carlo Ratti Assiciati have been working on with their concept "The Dynamic Street". They developed sensors to measure traffic/occupation ("Pebbles") and ways to communicate the changing rules to the people ("Tiles") [1].

But based on what considerations (i.e. values such as sustainability, inclusivity, etc.) are the rules adapted and space allocated? Willa Ng, director of mobility at the Sidewalk Labs, declared in a podcast about flexible road use that we need to "allocate that space fairly, and not just to whoever has the loudest voice» [1]. Yet, what is meant by fair allocation of space and how we can design a fair system governing the allocation off space remains undefined. According to Cennydd Bowles [2], striving for fairness might be a dead end as "any definition of fairness will be unfair from a different perspective. We must choose intelligently and consider the potential consequences and externalities of your choices."

This shows that there is a need to carefully consider the mechanisms behind the system responsible to continuously re-allocate road space which represents an opportunity for valuable research and design work.

[1] Quirk, V., Jafe, E. (Hosts). (2020, December). Flexible Streets (Episode 15). SIDEWALK LABS. https://www.sidewalklabs.com/insights/episode-15-flexible-streets
[2] Bowles, C. (2020). Future Ethics. NowNext Press.

ASSIGNMENT **

State in 2 or 3 sentences what you are going to research, design, create and / or generate, that will solve (part of) the issue(s) pointed out in "problem definition". Then illustrate this assignment by indicating what kind of solution you expect and / or aim to deliver, for instance: a product, a product-service combination, a strategy illustrated through product or product-service combination ideas, ... In case of a Specialisation and/or Annotation, make sure the assignment reflects this/these.

This project is a case study withing the Code the Streets project by the Advanced Metropolitan Solutions institute (AMS) investigating the research question: How can we reimagine an urban traffic management system governing the dynamic allocation of road space around civic values in the context of Amsterdam?

Sub-research questions:

> What are the key values that should govern the allocation of space?
> What are the design requirements that can be derived from these values?
> What would a design proposal designed with these requirements look like?

Foreseen outcomes:

>> Design knowledge and insights
>> System map describing the assemblage of mechanisms that are necessary to govern the allocation of road space according to the defined values.
>> A speculative prototype in form of a low tech user experience installation.*
>> Design recommendations for Code the Streets at large.

*The speculative prototype is intended to allow stakeholders to join the discussion that would struggle to give meaningful criticism based on a system map alone.

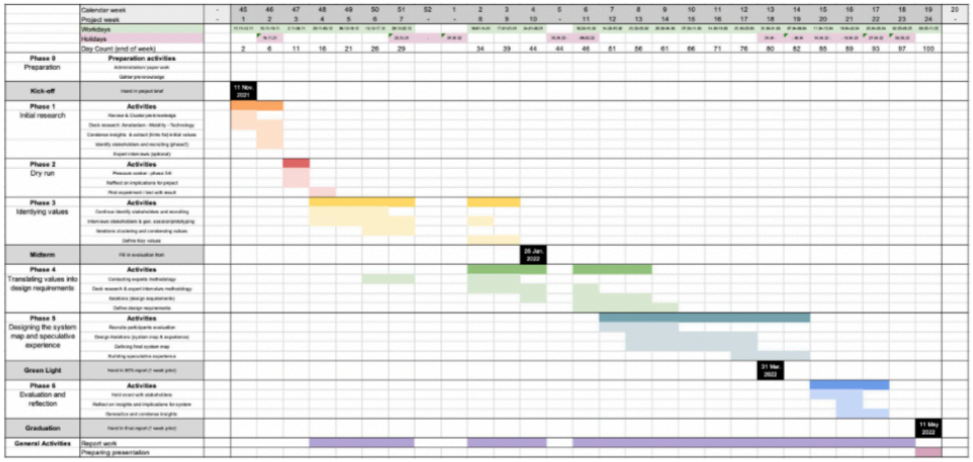
Initials & Name FG Geiser Student number 4604008

Title of Project Reimagining the smart allocation of road space in Amsterdam for fairness

PLANNING AND APPROACH **

Include a Gantt Chart (replace the example below - more examples can be found in Manual 2) that shows the different phases of your project, deliverables you have in mind, meetings, and how you plan to spend your time. Please note that all activities should fit within the given net time of 30 EC = 20 full time weeks or 100 working days, and your planning should include a kick-off meeting, mid-term meeting, green light meeting and graduation ceremony. Illustrate your Gantt Chart by, for instance, explaining your approach, and please indicate periods of part-time activities and/or periods of not spending time on your graduation project, if any, for instance because of holidays or parallel activities.

start date 11 - 11 - 2021 11 - 5 - 2022 end date



Key dates: Kick-off meeting: Nov. 11 // Midterm: ~Jan. 25 // Green Light: ~Mar. 31 // Graduation: ~May 11.

The project is planned for 100 days of full-time project work (5 days per week). The project can be divided in six different phases. While the illustration suggest a linear process, I aim for a more iterative process, going back and forth between phases and making revisions. Throughout the project, I will carry out small, hands-on experiments (e.g. with triggers, scenarios, low fidelity prototypes, role playing).

>> Initial research: This phase is about diving into foundational literature and the context of urban mobility, traffic rules and technology: Main goals of this phase are to get a better understanding of the context, to start identifying stakeholders / experts as contacts for later and to get a first understanding of the values at play.
>> Dry run: Building on the context knowledge and initial values identified in the previous phase, a quick run through of all project phases is carried out This is intended as a first iteration, contributing to understanding about the upcoming process.
>> Identifying values: Identifying key stakeholders (and representatives) and working with them (context mapping tools) to create a set of values that should inform the allocation of road space in Amsterdam.
>> Translating values into design requirements: Relevant design approaches are taken into consideration and values are translated into design requirements for a system responsible to allocate road space.
>> Designing the system map and the speculative prototype A system map will be designed based on the design requirements defined in the previous step. The map will be accompanied by a speculative user experience prototype.
>> Evaluation and reflection: The design outcome is evaluated by experts (system design and mobility) and stakeholders (user experience).

Initials & Name FG Geiser Student number 4604008

Title of Project Reimagining the smart allocation of road space in Amsterdam for fairness

Personal Project Brief - IDE Master Graduation

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MOTIVATION AND PERSONAL AMBITIONS

Explain why you set up this project, what competences you want to prove and learn. For example: acquired competences from your MSc programme, the elective semester, extra-curricular activities (etc.) and point out the competences you have yet developed. Optionally, describe which personal learning ambitions you explicitly want to address in this project, on top of the learning objectives of the Graduation Project, such as: in depth knowledge a on specific subject, broadening your competences or experimenting with a specific tool and/or methodology, ... Stick to no more than five ambitions.

Broadly speaking, one of my learning ambitions for this project is to look beyond the by now familiar design paradigm of user entered design and gain experience designing with a broader spectrum of stakeholders and values. As mentioned, by Dan Hill in the article the city is my home screen, "User-centered design works for individuals, yet not for people living together in cities". I'm especially curious to learn about how somewhat abstract values such as fairness, openness or sustainability can be translated into concrete design requirements and ultimately characteristics of a system.

After graduation, I see myself working on systemic challenges in the domain of mobility. I would like to engage with technologies and explore their social and environmental potentials. One aspect that makes me excited about this project is that it holds important implications for our relationship with mobility in the urban context at large. As the domain of mobility is experiencing disruptions (due to technology, but also societal changes and events such as the COVID 19 pandemic), opportunities open up to re-consider and consciously re-design the narrative between mobility and society.

I like to work with my hands, and I enjoy building and experimenting with low-fi prototypes, trigger objects and role-playing. Next to the research activities, I would like to start with little experiments early in the process (already during Initial Research). I think it will make the project more enjoyable and varied as well as contribute to the overall quality of my research and design outcome.

Next to that, I think this might be the right project to consider some of the ethical principles (Utilitarian, Deontologic, Virtue and the veil of ignorance), tools and suggestions presented in the book "Future Ethics" by Cennydd Bowles. But note that I see this more as a "nice to have" and not a strict learning ambition.

FINAL COMMENTS

In case your project brief needs final comments, please add any information you think is relevant.

Initials & Name FG Geiser Student number 4604008

Title of Project Reimagining the smart allocation of road space in Amsterdam for fairness

Appendix 2

Sources used in the exploration of stakeholders and values at stake

Original title of publication	Translated title of publication	Type of publication	Reference
Amsterdam (NL): pilot smart use of loading and unloading zones	--	Online article	(City Logistics, 2018)
Amsterdam Aantrekkelijk Bereikbaar	Amsterdam Attractively Accessible	PDF document	(Gemeente Amsterdam, 2013)
Amsterdam Agenda Autoluw	Amsterdam Agenda Car Free	PDF document	(Gemeente Amsterdam, 2019)
Amsterdam announces plans to ban all non-electric vehicles by 2030	--	Online article	(Menezes, 2019)
Amsterdam test zelfrijdend vervoer	Amsterdam tests self-driving transport	Online article	(Gemeente Amsterdam, n.d.b)
APT tests intelligent solutions for traffic congestion	--	Online article	(Amsterdam Practical Trial, n.d.)
BuurtHub: deelvervoer voor de buurt	BuurtHub: shared transport for the neighbourhood	Online article	(Gemeente Amsterdam, n.d.c)
City Data Standard - Mobility (CDS-M)	--	Online article	(Gemeente Amsterdam, n.d.d)
CityFlows: Improving liveability off crowded pedestrian spaces in 3 European metropoles	--	Online article	(Amsterdam Institute for Advanced Metropolitan Solutions, n.d.b)
Green Deal for Zero Emission City Logistics	--	Online article	(Amsterdam Economic Board, n.d.)
Municipality of Amsterdam to lower speed limit from 50 to 30	--	Online article	(Séveno, 2021)
Omgevingsvisie 2050	Regional plan 2050	PDF document	(Gemeente Amsterdam, 2021b)
Policy: Smart mobility	--	Online article	(Gemeente Amsterdam, n.d.e)
Policy: traffic and transport	--	Online article	(Gemeente Amsterdam, n.d.f)
Slimme mobiliteit met MobiLab	Smart mobility with MobiLab	Online article	(Gemeente Amsterdam, n.d.g)
Smart mobility	--	PDF document	(Gemeente Amsterdam, 2016)
Smart Urban Mobility	--	Online article	(Amsterdam Institute for Advanced Metropolitan Solutions, n.d.c)
The innovative quest for mobility solutions	--	Online article	(Amsterdam Institute for Advanced Metropolitan Solutions, 2019)

Appendix 3
Description system map pressure cooker / iteration 1.0

The map can be read from the top, starting with the section *Vision and Values*. Here, the municipality and stakeholders interact to discuss and define what values should guide the system's character (How values) and the allocation of road space (Why values). The decisions made in this section are then transformed into concrete plans and actions to change the system in the section *Operationalization*. The datasets for training the AI model are prepared in the section *Training data* and channels for the necessary *Input data* which the system ultimately needs to make decisions are set up. The section *Main processing system* is where the AI lies responsible for governing the allocation of roads space. The decisions made here are communicated in form or dynamic traffic rules to the people in the street in the section *Street level communication*. The rules can be contested by people in the street through the *Use time contestability interface*. In the section *Quality control*, traffic rules and the input from the contestability interface are reviewed and feedback is channeled into the *Main processing system* where adaptations changes can be made to improve the performance of the system. Via the *Information campaign interface*, stakeholders are informed about the system and their opportunities to influence it, connecting back to the first section *Vision and Values*. The yellow arrows emphasise how the influence of stakeholder participation trickles through the system.

Appendix 4

Written scenarios speculative prototype pressure cooker

Introduction

It's the year 2035

The municipality of Amsterdam has introduced a smart road management system. That system can dynamically change road rules depending on what it thinks is needed. The municipality held some discussions and sessions with people in the city and it was decided that all measures taken by the system – so the way it changes road rules - should ultimately improve livability in the city and the world in general. That means that to some extent, uses and users (businesses and people) that contribute to making the city livable, get prioritized. I will talk you through a couple of scenarios that show how this system might change road rules to assign road space. Remember this is all speculative – all I ask you to do is to think along. We can have a chat about it afterwards. I'll walk though all scenarios first – then we can redo some of them if you want:

Scenario 1: McDonalds

Imagine you are hungry and craving for some burgers or some other junk food. You walk inside a McDonalds, but there is no place to sit. There is also no place to sit outside. There are chairs and tables, but they are for the restaurant next door. A healthy salads, sandwich and juice place using local ingredients and supporting urban farming in the city. You can go sit down and eat there – or have your McDonalds on the way.

Scenario 2: Employees

In this street there are offices from Amazon and Patagonia, a certified B-corporation. It is a nice and sunny spring day. One of the road lanes has been closed for traffic and the employees of the Patagonia office have been invited to use the road space for meetings and breaks. The Amazon office is not granted these privileges to use the road space.

Scenario 3: Getting to work

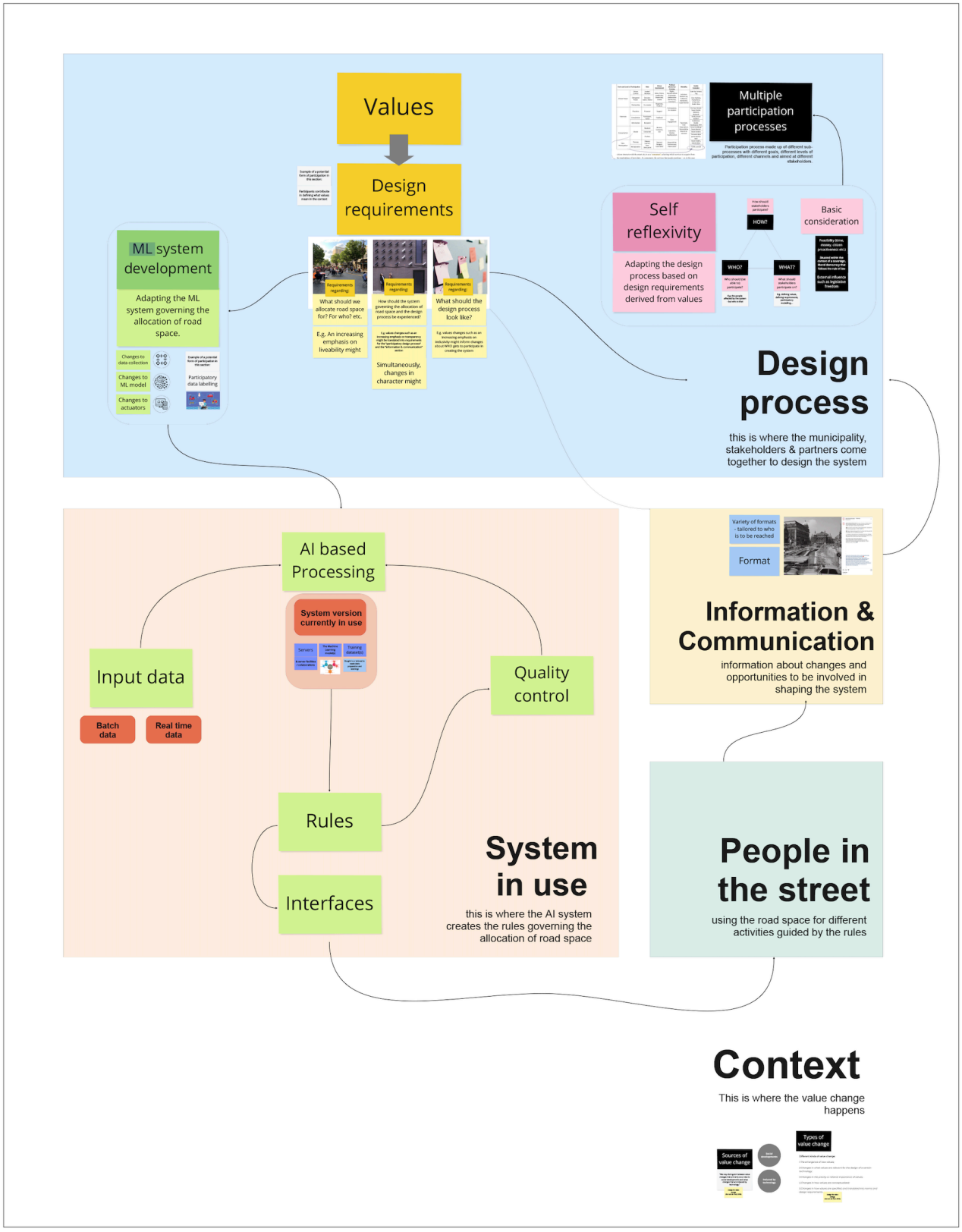
In this street lives a doctor who works at the hospital in the city and an oil drilling engineer who works at an office of shell. The city believes that these jobs contribute very differently to a livable city and world. Therefore, different rules apply to them. The doctor gets to park the car close by and can drive pretty much straight to the hospital. The oil drilling engineer on the other hand first has to take a bike to the mobility hub and form there can drive – taking a longer route to work.

Scenario 4: Shoes

Two people ordered shoes. One ordered from Nikes from Amazon. The other person ordered Allbirds – very sustainable shoes. Both shoes arrive at the warehouse at the same time. But the person who ordered the Allbirds gets the shoes earlier: Merchandise that is sustainable and comes from sustainable shops is prioritized for unloading in the tight city streets. The person who ordered the Nikes needs to wait a day longer.

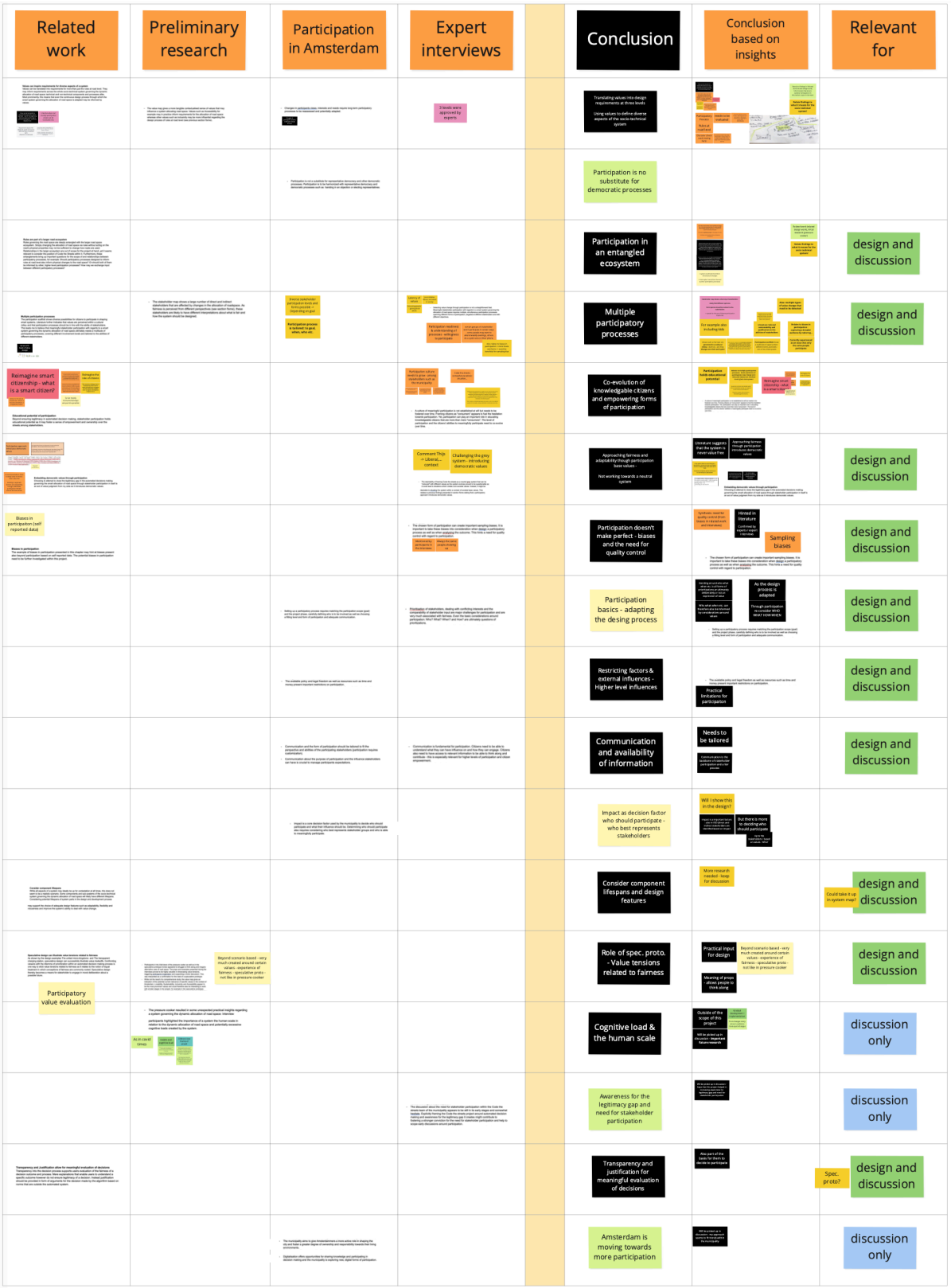
Appendix 5

Preliminary version of the system map shared during some of the expert interviews



Appendix 6

Synthesis research findings



Appendix 7

Questions evaluation system map

General

- What do you think of the system map?

Understandability

- What does the system map show?
- Can you explain the processes in the system map in your own words? (how would you summarise it)
- What parts or aspects are clear to you and which ones not?
- What makes these things clear or unclear?
- What should be included or excluded to make it more understandable?

Content

- You described the things the the system map shows, mechanisms, components, steps,... What do you think of them?
- What do you agree with? (or anything that you find particularly intersting?)
- Is there anything that you don't agree with?
- Does this map accurately represent what you told me during our previous interviews? Which parts yes? Which parts not?
- Is there anything missing content wise? (Something you would have like to have seen in the map)

(Potential) Usefulness

- What do you expect the map to be useful for?
- What do you see yourself using the system map for?(for what purpose, in which settings,...)
- For what else might this map be useful for or for who else?
- What about discussions about the role stakeholder participation could and should play within the Code the Streets?
- Do you think it could be useful for discussions focused at forming a better understanding of the value fairness within Code the Streets?
- What would make the map more useful?
- What are the core insights that you take away from the map?

Closing the discussion

- Anything else you want to share?

Appendix 8

Summary of the pilot evaluation speculative prototype

Several visitors came to see the exhibition during the informal pilot event on day one. Four of the visitors engaged with all components of the exhibition, similar to the participants of the formal evaluation held on the next day. The feedback of those four visitors was predominantly positive. They commented that the introduction and instructions were clear to them and that they did not recognize any major issues with the resto of the exhibition. No drastic changes to the content of the exhibition were made. The overall layout of the exhibition was adjusted during the pilot, technical issues were fixed, and the exhibition space was cleaned, removing potential distractions as much as possible. Besides that, the pilot allowed me to practice managing the exhibition: switching on light signal in cable and box, reading changes to the optimisation goals by the participants and changing the rules and street scenario projection.

Appendix 9

Introduction and questions evaluation speculative prototype

Introduction

Hi, welcome. Thank you for helping me out with this evaluation. My exhibition is in there – I'll let you in there soon – but first a couple of things. Once you are in there I'll let you move around quite freely in there – I'll just give you a goal that I would like you to try to achieve. For the rest: will be in the background and won't say or interfere much. There might be cases in which I have to stop you for a short time just to manage the exhibition but there shouldn't be anything go wrong. Afterwards we will have a little interview. Maybe good for you to know: With this evaluation I'm mainly trying to figure out if the speculative design I created meets the criteria that I set myself beforehand and also find out how I could improve it for the next iteration

Instructions

While you are in the exhibition, I ask you to:

- Think out loud (verbalize your thoughts)
- Your goal: Update the road rules – might seem a bit vague now but I'm sure you'll figure it out.

Before starting

- Any questions?
- Sign Consent form

Note to self: While participant interacts with exhibition, observe and listen for clues related to the criteria:

- addresses the notion of fairness.
- illustrates the effect of value change on the rules governing the allocation of road space and how roads are used.
- illustrates the roles of and relationship between stakeholder participation, official decision-making processes, smart technology.
- is a provocative proposal for an alternative perspective on the current practice.
- is sufficiently believable

Questions semi structured interview

So, we'll start off with a very general question:

1. What did you think of what you just did and saw? WHY?

2. What do you think is all of this about?
   - If you would have to name the core topics of this exhibition – what would they be?

3. (Criteria 3)
- Now this exhibition illustrates a futuristic, a possible traffic management system. Based on what you just did - can you tell me: What or Who are the parties or actors involved in this system? Explain why you think this way.
- How do they relate to each other?

4. (Criteria 2)
Why did the rules change? What is behind it?
Why do you think this way?

5. (Criteria 1)
Do you think this, this process illustrated by the exhibition to determine the rules. Do you think this is a good way to make this decision about the rules at road level? WHY?
- Do you think it is fair?
- What are the sources of fairness / unfairness? (How does it come about? From which components, processes etc.?
- What would you change about this to make it fair or fairer?

6. (Criteria 5)
Do you think a traffic management system like the one illustrated by the prototype can be done? (Could we create a system like this?) – Do you think something like this could be there one day in Amsterdam?
Why yes / Why not?
What might be issues? What might be benefits?

7. (Criteria 4)
Should we create a traffic management system like the one illustrated in the exhibition? Why yes / Why not?

8. Any doubts about things / stuff that was unclear? -> Why is it unclear / what do you think?

9. Anything else you want to share about this exhibition?

Optional
- Why did you choose this combination of priorities?
- The stakeholders have quite contrasting opinions - How did you decide which stakeholder to prioritise?
- Did you see the values / did you pay attention to them?
- Things that you liked or disliked? Things that you found pleasant or disturbing? WHY?

Appendix 10

Analysis results evaluation speculative prototype