The Cooperative City

A Participatory Framework for Using Technology in the City and Beyond.

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Summary

In the ‘smart’ city, rigorous sensor networks optimize processes in the city such as traffic and electricity management. In the approach of the smart city, most residents are excluded and data is taken to be neutral and objective. Rather than this instrumental perspective, this thesis proposes a normative and inclusive framework for using technology: the cooperative city. The framework will be applied in a case study of the citizen sensing project *Hollandse Luchten*. The thesis examines the question ‘how can the participatory approach to using technology of the cooperative city be captured in a framework to evaluate the participatory practices in Hollandse Luchten?’.

To answer this question, three sub-questions are addressed in subsequent chapters. In the first chapter, the participatory framework of the cooperative city is developed, using participatory democracy as the political theory and citizen sensing as a technological practice. In the second chapter, the framework is applied to Hollandse Luchten, a citizen sensing project in which air quality is measured. In the case study, Hollandse Luchten is evaluated based on three criteria from the framework. In the third chapter, using the results of the case study, several tensions are identified that require attention in the framework. Overall, I argue, the cooperative city framework is promising because it emphasized important aspects of participation in the case study and helped to identify several tensions in Hollandse Luchten.

The case study highlights the applicability of participatory democracy in this context. This is relevant because a major challenge for participatory democracy theory is its feasibility, as it is often criticized for being unrealizable. The specific form of participatory democracy in this thesis that includes the use of technology, state funding, and mediation of participation by an external organization, provides promising outcomes. Contrasting the smart city approach, residents are actively engaged with their matter of concern in this form, which generates both new solutions and insights. The cooperative city framework, therefore, could be a promising addition to participatory democracy theory.

List of Acronyms

PD	Participatory democracy
PB	Participatory budgeting
CS	Citizen sensing
STS	Science & technology studies
CCB	The community champion from Beverwijk that was interviewed for the case study
CCW	The community champion from Wijk aan Zee that was interviewed for the case study
CCI	The community champion from IJmuiden that was interviewed for the case study

Introduction

A current trend in the urban landscape is that of the 'smart' city. Although there is no commonly accepted definition of the smart city, it is often identified with the use of sensor technology and big data to make a city more efficient (Hollands, 2008; Kitchin, 2014). One important organization in the smart city discourse is the tech-company IBM. The term started to resurface after 2008, together with IBM's 'a smarter planet' advertisement that framed cities as smart cities (Söderström, Paasche, & Klauser, 2014). This strategy followed from IBM's crisis in the 1990s and early 2000s, in which it had to move from hardware to software and consultancy due to large annual losses within the company ("Chronological History of IBM", n.d.). The advertisement framed cities as existing out of different systems that can be connected through data. In this way, IBM positioned itself as an 'obligatory passage point', because they could provide the required data to improve urban processes (Söderström et al., 2014). In the smart city discourse, networked sensor technologies are meant to optimize processes and resources in the city, such as traffic, electricity, and waste (Gabrys, 2014). Hence, tech-companies are unmissable actors in the smart city, which has become a billion-dollar market.

Examples abound, from IBM's 'a smarter city' campaign to Alphabet's (Google's) Sidewalk Labs and Cisco's smart lampposts. Such projects generally have a centralized and top-down governance form and exist through public-private partnerships. This public-private model "aims to govern or deliver a service in a way that is efficient from a market perspective; it is dominated by those who bring private assets to the financing of the process and tends to privatize gains and socialize costs" (Menser, 2018, p.228). City dwellers are generally excluded from such partnerships (Hollands, 2008). In the meantime, the concept of the smart city has been criticized in multiple ways and more inclusive city concepts have been proposed such as 'social cities' (de Lange & de Waal, 2013).

A common criticism of the smart city is the loss of privacy because the sensors are constantly tracking every move of citizens (Kitchin, 2015). Due to the tracking capacity of sensors, scholars also express worries of surveillance and control through sensor networks in smart cities (Kitchin, 2014). Furthermore, it is argued that the huge amount of networked technologies will create weak spots in the system which are vulnerable to hacking and failure (Kitchin, 2015). While these are pressing issues that need to be addressed, the focus in this thesis will be on political and social issues, such as the tendency in the smart city discourse to view data as objective and neutral (Kitchin, 2015). In a similar vein, Hollands (2008) argues that technology in itself is not smart; it is a specific use that makes it smart (Hollands, 2008).

The notion of 'smart', then, is a specific interpretation of how technology should be used and requires careful scrutiny. I will analyse the smart city approach to using technology through the lens of the 'smart citizen': people that use technology to make sense of their direct environment ("Public Research agenda", 2019, p.7). I use Grosz's (1998) definition of the city as a complex and interactive network that brings together a variety of social activities, processes, and relations, with a number of projected or real architectural, geographic, civic and public relations. Recognizing the need to involve dwellers in finding solutions to issues that arise out of such complex networks, the smart citizen approach has a participatory model in which residents can engage with these issues.

One organization that has such a participatory approach to the use of technology is *Waag* in Amsterdam. Waag is a non-profit foundation that focuses on the impact of technology in society. It does so through both research and projects, which are placed at the intersection of science, technology, and the arts. As their website states, Waag's "work focuses on emergent technologies as instruments of social change and is guided by the values of fairness, openness, and inclusivity" ("About us", n.d.). Waag does so by aiming to empower citizens through technology. The organization is composed of different research groups that work both on a local scale with grassroots initiatives and on a larger scale with institutions within the Netherlands and Europe. Waag, in other words, is a 'middle-ground organization' that acts as a mediator between communities and different institutions.

Waag's research agenda states that "Waag believes the public interest should be at the heart of innovation, and therefore society is the optimal research community" ("Public Research Agenda", 2019, p.3). Because society is taken as the research community such research is different from, yet open to scientific and industrial practices. Such public research "is fundamentally interdisciplinary, as it conducts research with heterogeneous and phenomenon-specific communities. In each case, it is not the matters of fact of scientists, nor the matters of interest of industry, but rather the *matters of concern* of citizens that are articulated through collaborative research" (p.7, original emphasis). Moreover, deciding "what methods and outcomes are relevant given a certain phenomenon is thus not a question of objectivity, but rather one of ethics. Therefore, Public Research positions itself as a fundamentally democratic mode of research" (p.7).

Waag's approach, in other words, focuses on participation and inclusion in the city and beyond, which is in line with participatory democracy (PD). PD is "that view of politics which calls for the creation and proliferation of practices and institutions that enable individuals and

groups to better determine the conditions in which they act and relate to others" (Menser, 2018, p.4). According to the view of PD, in other words, residents should be included in the decisions that make up their environment. A well-known and widespread example of PD in city politics is participatory budgeting (PB). In PB, citizens meet to agree on priorities for a part of the local government budget for their neighborhoods and help oversee the projects that they prioritize (Cabannes, 2015). In many cities, PB has reduced inequality and increased access to basic needs such as water, housing and education (Menser, 2018).

Whereas such a participatory model is a welcome alternative to the top-down model of the smart city, participation is not a straightforward process. Participation can take place in many different forms that are not beneficiary in all contexts. As Gabrys (2014) notes, for example, many smart city proposals have a strong focus on participatory media. However, participation in such proposals refers to being detectable by sensors in cities rather than active participation. The notion of participation thus requires careful scrutiny. Based on the outcomes of different PB processes, Menser (2018) proposes a social-public model, which is dominated by communities that are impacted by the governance process. In this model, local governments allocate resources to participatory processes in which residents decide about outcomes that impact them. The social-public model can be supported by the use of accessible technology, reversing the hermetic use of technology in the smart city discourse. This reversing frame will be referred to as the *cooperative city*, in which the matters of concern of citizens are taken as the starting point.

In line with the cooperative city, Waag acts as a mediator in multiple citizen sensing (CS) projects. CS refers to the use of low-budget and accessible sensor technology to monitor environments (Gabrys, Pritchard, & Barratt, 2016). Here, citizens are involved and engaged in determining important aspects of their direct environment. Using their expertise on participation and sensor technology, Waag guides communities in the practice of CS. One such project is *Hollandse Luchten*, in which the province of *Noord-Holland* allocated resources to set up a sensor network that measures air quality in proximity of a polluting steel factory ("Hollandse Luchten", n.d.). Hollandse Luchten is an experiment with a new political form in which the government collaborates with citizens to map air quality. The project fits the social-public model that Menser proposed. As mediator, Waag plays an important role in the participatory process of the project. In a case study, Hollandse Luchten and Waag's role in it will be evaluated in this thesis. The research question that the thesis addresses is '*how can the*

participatory approach to using technology of the cooperative city be captured in a framework to evaluate the participatory practices in Hollandse Luchten?'.

Overall, I will argue that the cooperative city framework offers a promising way to evaluate Hollandse Luchten. I aim to show that with the use of the framework, important aspects of the participatory process are emphasized and tensions within the project identified. In the first chapter, I will construct the frame of the cooperative city. The chapter addresses the question 'how can the participatory approach to using technology of the cooperative city be captured in a framework?'. In the second chapter, I will apply the framework in a case study of Hollandse Luchten. The sub-question in this chapter is 'how can Hollandse Luchten be evaluated with the use of the cooperative city framework?'. The main focus is on the role of Waag in the project. In the third chapter, discussion points are identified based on the results of the case study. The chapter addresses the question 'what lessons can be taken from the results of Hollandse Luchten in light of the cooperative city framework?'. In answering these questions, I aim to provide a starting point for a participatory approach to using technology in cities and beyond.

1. The Cooperative City: a Framework for Participation in the City

In this chapter, I will develop my framework of the 'cooperative city'. In the first section, I identify three issues concerning the use of technology in smart cities after which I propose a normative framework concerning the use of technology. In the second section I will link the framework to PD and describe benefits of PD together with possible pitfalls. The third section offers a conceptual analysis of participation. Participation has many different forms and can easily be 'misused' in the context of PD. Based on findings in PB, I propose a social-public model as approach to participation in the cooperative city. In the fourth section, I feed this social-public model back to issues of the smart city, and add insights from new media studies and science & technology studies (STS) to strengthen the framework. To deal with possible issues in participation, I propose organizational mediation and the use of accessible technologies. Finally, in the fifth section I add CS to the framework, a technological practice in which organization mediation and the use of accessible technologies can come together.

1.1 Politics and Participation in Smart Cities

The use of technology in the context of smart city solutions has a number of issues to be investigated A first issue is that smart city solutions are often perceived as apolitical because data are taken to be objective and neutral (Kitchin, 2015; Söderström, Paasche, & Klauser, 2014). According to this instrumental perspective of technology, data capture the world as it is. In this view, in other words, technological systems can replace other systems such as political ones. However, smart city measurements have certain goals and are situated within a socio-technical network and 'data culture' (Bates, 2017). Data practices have a specific frame, use a specific platform, have specific cultural norms and value systems, and include power relations, among others. This means that data are never 'raw', showing the world as it is, but are already 'cooked' (Kitchin, 2014). Therefore, data are never neutral because they are an interpretation of the world that is generated through such socio-technical networks and contain biases and power relations. By assuming neutrality, biases and power relations that underly such networks remain hidden, which leads to issues in matters as equality, access to the city, etc. (Hollands, 2015).

The second issue stems from the first one as the smart city has a technocratic form of governance, meaning that the city is perceived as existing out of systems in which all aspects can be measured and monitored (Kitchin, 2014). In this vision, technology is taken as the starting point and issues are treated as purely technical problems, which have technical solutions. However, many aspects of the city, such as biases, cannot be measured by these technologies directly. In this manner, complex relations in the city are reduced to quantifiable variables that can be measured, but only capture the manifestations of issues. By taking technology as a starting point, therefore, a smart city is only capable of dealing more efficiently with symptoms of problems but not able to address their root causes (Kitchin, 2014). Technological solutions cannot be produced in an apolitical vacuum and need to take into account social issues too.

The third issue concerns the organizational structure of the smart city. Smart city projects often are public-private partnerships between multinational technology companies, together with city governments, universities, and design firms (Gabrys, 2014). Such projects are driven by corporate interest and have a market-based approach to city governance (Hollands, 2008; Hollands, 2015). These partnerships often result in the privatization of public spaces as public services are transferred to corporations, which creates tension between corporate and public interests (March & Ribera-Fumaz, 2016). Indeed, it has been argued that

smart cities "can function to disguise entrepreneurial urban development and further privatization of urban services delivery under the veil of a new hype of ecological and technological branding" (March & Ribera-Fumaz, 2016, p.826). Furthermore, public-private partnerships have a top-down structure, in which a few experts make decisions on implementations that influence many (Hollands, 2008). City dwellers are therefore largely excluded from decision-making processes in the smart city and perceived as passive consumers.

These criticisms show that an alternative frame for the use of is required. Rather than viewing the use of technology as instrumental and neutral, it should be perceived as a normative agent of change. In line with this perspective, de Waal (2017) asks what the ideal city looks like, and how technology can contribute to this ideal. Matters of concern should be taken as a starting point and technology should be used together with dwellers in a way that fosters participation. Rather than treating city dwellers as passive consumers, this frame should allow dwellers to be active (co-)producers of the city. Such a normative perspective based on inclusion can address the structural issues in a city. I will refer to this frame as the 'cooperative city', which is a political and inclusive issue-based framework concerning the use of technology. The normative aspect acknowledges that while people build cities according to their needs, city dwellers are in turn 'citified' by the built city (Grosz, 1998). Residents, in other words, are shaped by the city they live in, because of which they should be included in its design.

In a recent book, the well-known sociologist and urban planner Richard Sennett takes up this issue of normativity. Sennett argues there is no fixed relation between form and function. From this, it follows that there is a gap between the built city (*ville*) and city life (*cité*) that creates a space for normativity (Sennett, 2018). In what Sennett calls a 'closed city', city planning aims to change city life by establishing a tight relation between form and function. This is an exclusive model in which the built form over-determines city life (Sennett, 2017). In an 'open city', alternatively, there is a loose relation between form and function, and there is room for experimentation and feedback. An example is the concept of modular buildings, which consist of basic building blocks and can be taken apart and transformed according to needs.[1] According to Sennett, the open city is modest, as "the urbanist [planner] should be a partner of the urbanite [resident] … [that is] both critical of how people live and self-critical about what he or she builds" (Sennett, 2018, p.16).

[1] An example is 'Just in case' ("JUST in CASE", n.d.)

Translating this perspective to the smart city, Sennet calls the closed smart city prescriptive, as it prescribes residents what to do as is the case in the smart city discourse. The prescriptive city is hermetic because the complex calculations that are required to make the city function are hidden away from citizens in closed feedback loops. The open smart city, on the other hand, is coordinative according to Sennett because the outcomes of the complex calculations are used together with residents to coordinate them. An example is the *Forcity project*, which uses computer models to show dwellers possible outcomes of city planning, and allows them to adjust the model on the spot according to the parameters (Sennett, 2018). This coordinative city is designed to aid people in decision-making, rather than doing it for them. Such a city has a hermeneutic dimension, whereby "people have to get engaged with the data, interpreting it and acting on it" (Sennett, 2018, p.166).

The coordinative city calls for a participatory model rather than a top-down model. Sennett's normative perspective and the open use of technology are in line with the cooperative city and provide a starting point for an alternative narrative to that of the smart city. However, it misses both a clear political and specific technological frame. Sennett (2018) argues that the prescriptive city is inherently totalitarian, whereas the coordinative city is inherently democratic. However, the exact shape that this democracy should take remains unclear. Also, a specific use of hermeneutic technology to go from issues towards participation in the city is missing. In the remainder of this chapter, I will propose participatory democracy (PD) as *the* political frame and citizen sensing (CS) as *a* technological frame for the cooperative city.

1.2 Participatory Democracy in the Cooperative City Framework

Although Sennett's concept of the coordinative city offers a useful starting point for the cooperative city framework, democracy can take many shapes that have contradicting underlying assumptions. Therefore, the framework requires a specific political approach. In the upcoming section, I will link the cooperative city framework to PD.

In aiming at inclusivity, the cooperative city appeals to the 'right to the city'. Coined by Lefebvre, the right to the city refers to the self-management or *autogestion* by citizens in the production of urban space (Heitlinger, Bryan-Kinns, & Comber, 2019). The right of the city includes access to the resources of a city (the right to appropriation) and to the possibility to remake it in a democratic fashion (the right to participation) (Harvey, 2012; Purcell, 2002). As Harvey shows, the neoliberal model of governance and its drive to expand to new markets

increasingly denies both these aspects. This is similar to smart city governance, in which capital is invested in technology to expand corporate profit. The top-down decision-making and privatization of public space increasingly deny people access to and self-determination over cities. The right to the city thus requires a model based on the opportunity of participation, which the theory of PD offers.

In his recent book "We decide" (2018), Michael Menser argues in favor of PD and describes its history and different applications. He shows that throughout the last centuries participation in democracy has become conflated with representation. Mouffe (2000) refers to this as the 'aggregative' model of democracy, which largely reduces participation in democracy to the electoral processes. Since then, many theorists have argued for different forms of PD to emphasize the importance of participation. In the 1960s, for example, a wave of PD arose that argued for its educational benefits and importance for the development of human powers of thought, feeling and action (Menser, 2018). In her seminal book "*Participation and Democratic Theory",* Pateman similarly argues that PD is a process through which individuals can exert more power over their lives, and which enhances their capabilities and agency (Pateman, as cited in Menser, 2018). Furthermore, Hirst (2002) argues that by outsourcing decision-making processes to local associations, the complexity of government is reduced and people with knowledge of the local context directly decide about issues that affect them directly. Overall, this requires what Pateman calls a 'participatory society' in which participation is in the core of decision-making rather than in the periphery (Pateman, 2012).

PD thus challenges the aggregative model that reduces politics to elections and views society as different interest groups that are represented by experts (Brown, 2009). Some anarchistic forms of PD even want to dissolve the state and focus on smaller communities, in line with communitarianism (Menser, 2018). In addition, the educational focus on the process of participation advocates a non-instrumental view of politics. A critique of communitarianism, however, is that it focuses on agreement and shared values, rather than conflict (Brown, 2009). As Brown shows, the focus on shared values means that it tends to exclude other values, and the focus on agreements has a depoliticizing effect. Also, the non-instrumental view of PD is criticized because it makes politics an end in itself (Elster, 2005). Without a goal, Elster argues, the meaning of participation evaporates and therefore non-instrumental gains can only be by-products of instrumental politics. It is thus important for PD to accept differences and include an instrumental focus.

These criticisms are captured in Menser's concept of maximal democracy (MaxD). In this concept, Menser identifies overlapping features of different forms of PD. He argues that while different forms of PD sometimes have conflicting views, they share an emphasis on four features: (1) collective determination, (2) capacity development and delivery of economic, social, and/or political benefits to members or constituents, (3) the replacement of unequal power relations by relations of shared authority, and (4) the construction, cultivation, proliferation, and interconnection of movements and organizations with overlapping normative frameworks. In this regard, Menser notes that:

> Collective determination means the right and the ability of a particular group of persons to define, justify, and concretely articulate the normative framework under which they reflect, deliberate, and act with others. For my view a group acting together to carry out some task is a collective if the group reflects on and discusses that task within itself. It is democratic if each has decisive power with respect to the process […] For MaxD, then, democracy is defined not just as a discursive procedure for justification, but as a set of practices that actualizes collective determination by linking together democratic procedures, capacity development, and material benefits. (Menser, 2018, p.57-58)

MaxD, in other words, is not only about a democratic procedure but also addresses the direct consequences of collective decision-making. Besides, practices and rules are meant to deal with inequalities and foster democratic procedures that allow differences. In line with the perspective of MaxD, the inclusive and issue-based framework of the cooperative city aims at both these aspects.

A well-known example of PD is PB in Porto Allegre, were it originated. Each year, a part of the budget is allocated to specific priorities according to a participatory process. Importantly, citizens are involved in all the steps of the process and everyone is allowed to participate each year (Pateman, 2012). The three principles of grassroots democracy, social justice in allocation, and citizen control underly the participatory process (Sintomer, Herzberg, & Röcke, 2008). Next to being successful in reducing inequalities, results show that many people participate, 30.000 in the early 2000s, of which a relatively high amount of people represent the poor population (Pateman, 2012). Lastly, a report on similar PB form in New York City writes that participants come out with a community perspective rather than a personal one (Kasdan & Cattell, as cited in Menser, 2018).

In PB in Port Allegre, the public makes the decisions and the government implements them, which is in line with the notion of MaxD. Moreover, PB is issue-based and voting is spread out over multiple arenas (Stortone, 2010). Therefore, PB contrasts with the current dominant political model in which people have one vote for all political topics. After the

initiation of PB in Porto Allegre, the model has spread to many other cities throughout the world and was adopted by over 1700 cities in 2013 (Cabannes, 2015). Whereas all these projects have a focus on participation, the meaning of participation is often different from that of Porto Allegre. As Pateman (2012) argues, many PB projects have become more about deliberation rather than actual decision-making. This deliberative form of participation is in line with the dominant political model of deliberative democracy. According to the view of MaxD, such processes might be participatory but undemocratic because there is no collective determination (Menser, 2018). Participation, therefore, is not a straightforward concept and its exact meaning and outcomes require careful scrutiny.

In this section, it has become clear that not all forms of participation satisfy the criteria of MaxD. To prevent 'misuse' of public participation in the context of the cooperative city, the framework requires a delimitation of participation that aligns with the framework. To identify the right participatory form, I will unpack the concept of participation in the next section. At the end of the section, I will propose a social-public model as the participatory form for the cooperative city framework.

1.3 Unpacking the Notion of Participation

One common way to scrutinize the meaning of participation is with the use of typologies. Multiple typologies of public participation have been made that address the meaning of participation. Based on the flow of information in public engagement, for example, Rowe & Frewer (2005) distinguish between public communication, public consultation, and public participation (Figure 1). Here, participation refers to the exchange of information between government and citizens. Also, a well-known typology of the level of participation from the community perspective is Arnstein's (1969) ladder of participation (Figure 2). This typology ranges from manipulation to different forms of tokenism, such as consultation and receiving information, to different levels of citizen control in which participation entails decision-making power. At the highest level of the ladder, citizens both have decision-making power and own the policy-making and managing processes. How does participation through deliberation proposed by deliberative democracy fit in such typologies?

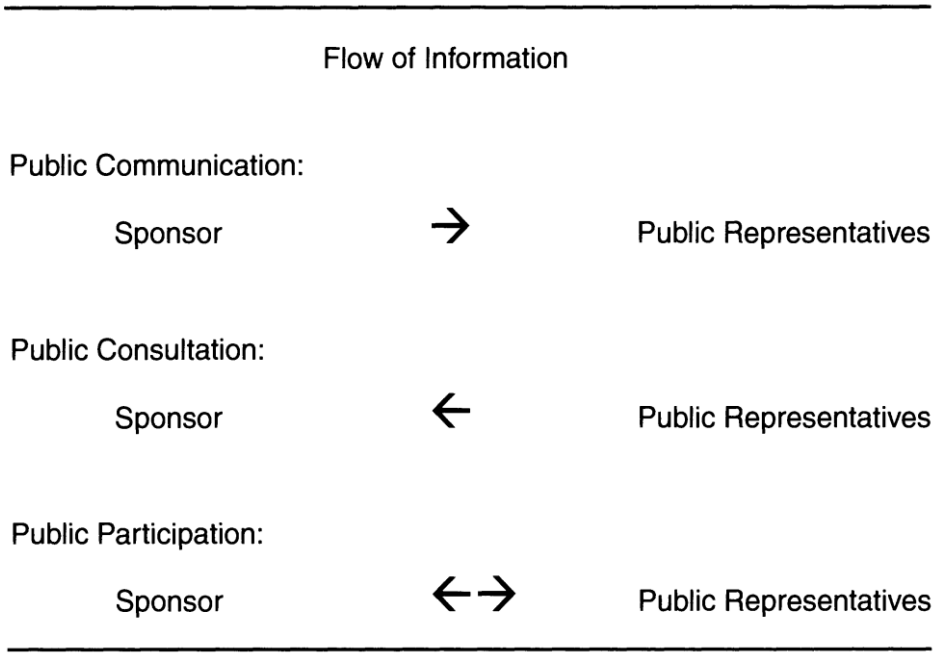

Figure 1. A typology of public engagement based on flows of information (Rowe & Frewer, 2005).

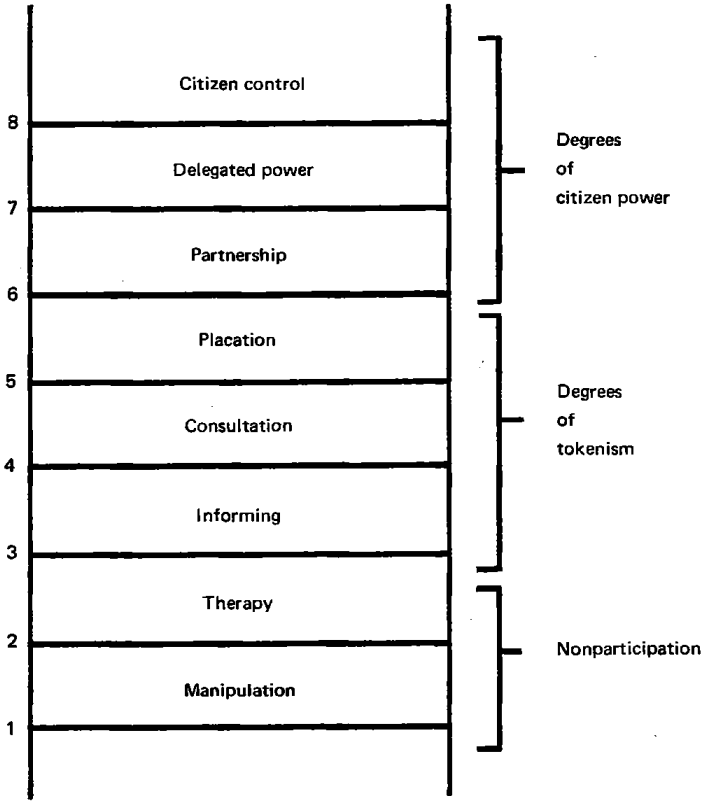

Figure 2. Arnstein's (1969) ladder of participation.

According to the model of deliberative democracy, individuals defend their moral and political arguments through deliberation in public space (Gould, 1996). Deliberative democrats argue that such deliberative procedures enable participants to reach forms of agreement that satisfy both rationality and democratic legitimacy and thus make participation compatible with liberal values (Mouffe, 2000). To do so, the main aim of deliberation is creating consensus among participants. In its institutionalized political form deliberation takes place in mini-publics. In mini-publics, a randomly selected group of citizens is asked to deliberate about solutions concerning and issue and reach consensus on this. The outcome will then serve as input for decision-making by representatives (Pateman, 2012). This decision is taken to represent the general opinion of the public. Deliberative democracy is thus only weakly participative since the voices of some stand for those of the whole (Hirst, 2002). An example is the Danish model of participatory consensus conferences, in which laypersons write a consensus report about a controversy based on expert opinions (Horst & Irwin, 2010).

Although mini-publics allow participation through deliberation, these assemblies have no say in the decision-making processes that follow (Pateman, 2012). The representatives that partake in the decision-making process may or may not act on the outcome of the deliberation. Whereas the Danish model has been applauded by scholars of deliberative democracy, for example, it is hard to point to actual impact on decision-making by participatory consensus conferences (Horst & Irwin, 2010). If the outcomes are not taken seriously this form of participation thus takes on a manipulative form. The process is then promoted as participatory, while the participation has no influence. At best, participation through deliberation is consultative. As Gould puts it, “deliberation without decision-making is empty” (Gould, 1996, 176); if deliberation cannot influence the final decision, it is meaningless. Also, the outcomes of such mini-publics are often ignored by media and politics and the process is thus not integrated into the political system (Pateman, 2012).

There is also an issue with the representation of differences in deliberative processes because the main aim is reaching consensus (Mouffe, 2000). Mouffe argues that this focus on consensus denies the inherently conflictual and pluralistic nature of politics. Because of these two inherent aspects of politics, consensus always excludes certain groups and creates a new hegemonic force. Rather than striving for rational consensus, democratic politics should foster the debate that follows from conflict, according to Mouffe. She refers to this as agonistic pluralism, in which an agonistic space for differences is created, rather than an antagonistic one of consensus. As societies have many forms of citizenship, “to foster allegiance to its

institutions, a democratic system requires the availability of those contending forms of citizenship identification. They provide the terrain in which passions can be mobilized around democratic objectives and antagonism transformed into agonism" (Mouffe, 2000, p.16). Too much emphasis on consensus and avoidance of conflict lead to apathy and disaffection with political participation. Furthermore, Gould (1996) argues that consensus downplays the role of differences and the possibility to reach new frames of agreement. Any consensus reached should thus be a 'conflictual consensus' that is up for debate.

The mini-publics show that citizens are willing to partake in participatory activities. Yet, these assemblies lack decision-making power and are therefore undemocratic in the view of MaxD. Because of the focus on consensus, such assemblies are exclusive and deny pluralism. Moreover, a small group of people is taken to represent society as a whole. In this regard, Gould notes that "taking differences seriously in public life […] requires a radical increase in opportunities for participation in contexts of common activity, including not only in the discourse and associations, but also in the institutions of economic, social and political life" (Gould, 1996, p.181). In PD projects such as PB in Porto Allegre, every citizen can participate in any stage of the process. Such projects include both decision-making power for citizens and an agonistic space with room for conflicting forms of citizenship. The cooperative city should thus strive for participatory processes that focus on conflictual consensus and collective determination, rather than deliberation.

Nevertheless, participation should not be an end in itself because it is not a straightforward process. It is important, for example, to take the context into account because different forms of participation will work better in different contexts (Cornwall, 2008). Whereas purely providing information is seen as a 'lower' form of participation in typologies, for example, it might stimulate collective action and is a necessity for any form of participation. Also, higher-level participation such as self-mobilization might be regarded as a do-it-yourself project and get an allocation of few resources. Typologies as Arnstein's, therefore, are not a one size fits all. As White (1996) notes, in addition, participation can entrench inequality and power relations. One example of this is the 'participation paradox', in which the participants are those people that already have access to resources (Su, as cited in Menser, 2018). To prevent such issues, it is important to check who participates and how certain aspects, such as time and location, might hinder certain groups from participating (Cornwall, 2008). Also, an aspect to take into account is whether the participation space is created for or by the local community because the latter might be more stimulating to participate extensively.

Such issues are also present in PB, for which different cultures, issues, and government forms similarly require a different form of participation. In some cases, a 'higher' level of participation might not be the best form (Menser, 2018). As Menser shows, there are three main trade-offs involved in participation in PB. Firstly, there is a trade-off between the requirements of participation and the number of participants. While it is good to involve citizens in all parts of the process, having too many requirements for participation lowers the number of participants. When exactly has 'enough' participation taken place? Secondly, there is a trade-off between efficiency and inclusion. To generate usable outcomes, participatory processes should use methods that focus on reaching collective results. However, too much focus on results leaves less room for disagreement and differences. Depending on the context the focus could either shift towards more efficiency or to more inclusion. Cornwall (2008) similarly shows that there is a trade-off between 'depth' and 'width' of participation. Because it is often impractical to involve everyone in-depth in all stages, an optimum should be reached along both axes.

Thirdly, there is a trade-off between autonomy, and inclusion and transformation (Menser, 2018). Menser shows that in PB, associations that were freer from the state tended to be less inclusive in terms of race and class and had less state assistance to carry out plans. Autonomous PBs thus suffered most from the participation paradox and were the least transformative. Full autonomy and self-mobilization then go against PD, because the outcomes generally are less democratic than when the state is involved. The state and state-supported organizations, in other words, can foster democratization. PB and similar participatory politics should therefore not be described as entirely bottom-up because the resources and structure of the state are what make it possible. However, the support of the state should not be strictly top-down because then it imposes its agenda on such political processes. From this, it follows that a participatory form requires a combination of bottom-up and top-down processes.

Based on these trade-offs, Menser proposes what he refers to as a social-public governance model for public services (Menser, 2018). Social-public governance is dominated by communities that are impacted by the governance process. Moreover, the social-public model is situated within the bureaucratic hierarchy of the state as a democratic space. This model is 'public' "because it directly involves a function or asset under the authority of the state." (Menser, 2018, p.228). Furthermore, a "social-public process is 'social' because it is dominated by residents of the jurisdiction: that is, persons or groups that are members of some community and not elected officials or representatives of businesses or other economic

organizations" (Menser, 2018, p.229). In a social-public model, the state thus allocates resources to collective decision-making by citizens regarding issues that directly affect them, combining bottom-up and top-down processes. Within this model, there is flexibility in implementation in different contexts, as the trade-offs described above necessitate. The model should be in line with MaxD, however, and is easy to distinguish from models that are not social-public. The social-public model constitutes a new form of political power wherein space is created for decisions by the public: a nonstate space plugged into the state (Menser, 2018).

1.4 A Social-Public Model in the Cooperative City

The social-public model is an alternative to the public-private model that is prevalent in the smart city. As Menser (2018) shows, public-private partnerships took over public-state partnerships from the 1970s onward due to inefficiency and corruption. In many cases, however, the quality of services declined while costs rose after privatization, as happened in multiple infamous cases of privatized water services. Rather than an inherent issue in the public sector, therefore, it has been argued that a lack of democratic processes causes failures in public services (Kishimoto, as cited in Menser, 2018). After the 'Water Wars' in Cochabamba, for example, the water services in the city were de-privatized and replaced with a social-public model, which improved the water services (Gómez & Terhorst, as cited in Menser, 2018). In a social public model, democratic processes enable a community to define their priorities in relation to their context which creates a sense of ownership.

The social-public model as a form of PD offers a political frame for the use of technology in the city. Similar to examples of water services, technology-driven public services can be governed in a public manner. Replacing public-private partnerships with social-public ones would provide the inclusion that the current smart city structure lacks. Furthermore, it accepts the multiplicity of citizenship and the different interpretations this produces concerning issues and concepts in cities. In the smart city concepts such as sustainability and safety are determined through socio-technical networks that comprise its technology and are perceived as 'objective'. As a result, the smart city generates a technological consensus based on the output of its algorithms. This is not a conflictual consensus that is up for debate but is closed-off from city residents without the possibility to actively participate. Indeed, Sennett (2018) argues that smart cities make dumb citizens. A social-public model enables a normative model that accepts different interpretations of important concepts that make up the city. Rather than a smart city, the focus is on smart citizens.

A social-public model is in line with the concept of the 'social city', in which "urban technologies engage and empower people to become active in shaping their urban environment, to forge relationships with their city and other people, and to collaboratively address shared urban issues" (de Lange & de Waal, 2013). In their analysis de Lange and de Waal look at the city through a lens of citizen ownership. Their frame aims to explore how technologies can enable people to become co-creators of their city and acknowledges that issues in the city are not owned by a single actor. Rather, issues in the city are shared issues that are lived and interpreted differently by different people and require shared governance and ownership. This requires an inclusive definition of ownership, in which "city dwellers feel a sense of responsibility for shared issues and are taking action on these matters" (de Lange & de Waal, 2013). They argue for 'networked publics': groups of people that gather around matters of concern with the use of technology. They state that:

> The advent of digital media technologies in the urban sphere offers opportunities to organize citizen engagement neither in local bottom–up nor institutionalized top-down fashion, but in networked peer–to–peer ways. Instead of seeking consensus these tools allow room for managing differences. (de Lange & de Waal, 2013)

In other words, they similarly argue for an inclusive form of governance that challenges the aim of consensus. The analysis of de Lange and de Waal adds the concept of networked publics to the social-public model, which is issue-based and supported by technology. The social-public model, in addition, offers a way to ground such an issue-based politics. The state can provide resources to support collective decision-making through networked publics on a city-wide level. Likewise, a protected democratic space can overcome the issue of market dominance that often is present in participatory governance (Swyngedouw, 2005). Such issue-based networks can form a decentralized governance structure of local associations in the city to relieve the state of tasks and inefficient centralization (Hirst, 2002). In contrast with the public-private model, this is a democratic form of decentralization.

STS scholars have similarly argued for an issue-based participatory model. Michel Callon (2009), for example, argues that the development of technologies has brought about more uncertainties; things that simply cannot be known from a technological point of view. Complex algorithms in a smart city, for example, are non-transparent which creates uncertainty regarding their outcome. This means that the implementation of this technology is also a social issue because these uncertainties cannot be solved from a technical perspective. To deal with

such issues Callon proposes hybrid forums, in which experts, politicians, and laypersons come together to discuss the issue at hand. To do so, two divisions have to be challenged: the one that separates experts from laypersons, and the one that separates representatives from citizens (Callon, 2009). Although social-public governance can address both divisions, the former might require extra attention because it is not addressed inherently.

Next, Marres (2007) argues that issue formation is a fundamental part of democratic politics. As she shows, the pragmatists Lippman and Dewey argued that once institutions fail to deal with complex problems, these become the public's problems. In this way, citizens address institutional shortcomings when they articulate an issue. Likewise, she states that societal actors organize into a public "to the extent that they are implicated in a problem that requires their intervention" (Marres, 2007, p.768). This relates to Latour's (2005) argument that 'matters of fact' also are 'matters of concern'; matters like a clean environment in the city are not only scientific facts that are measured but also things that directly concern people. Issue articulation by the public, in other words, addresses matters of concern that institutions fail to recognize. By taking issues rather than technology as a starting point, the cooperative city recognizes possible institutional shortcomings and creates the possibility to solve them.

In line with the right to the city, the cooperative city allows city dwellers to be co-producers of the city and thus gives them the ability to remake it according to their interests. However, it should not be assumed that this right is inherently positive (Purcell, 2002). Because of the high diversity in city populations, for example, differences should be taken into account to prevent new forms of consensus and political domination. Also, Purcell warns for the local trap, the conception that local equates 'the good' (Purcell, 2006, p.1924). As he argues, localization is not equal to democratization, and local community control is not equal to democratic participation. In line with the trade-offs in participation outlined above, participatory processes in social-public governance thus require a structure that is both flexible and able to guarantee a democratic process. Two aspects that can support such a structure are mediation by external organizations and the use of accessible technology.

Firstly, organizations with expertise on participation or the issue at hand can act as a mediator between communities and local governments. Because both communities and local governments do not always have sufficient knowledge to set up a complex participatory process, such organizations can have a guiding role in this. Sennett (2018) gives examples where experts show what is possible in co-creative session, and communities make the decisions. In an open form of design, Sennett states, "people should be free to choose whatever

materials and components appeal to them. But because their knowledge of what's possible is limited, they tend to fall back on what's familiar and traditional" (p.249). Experts can show possibilities without partaking in the decision-making process. In this way, mediating organizations can bridge possible knowledge gaps between local governments and citizens. However, as Menser (2018) argues, there are also challenges involved here. Firstly, there is the issue of inclusivity, as organizations often do not reach all layers of the population. Secondly, the focus within organizations is often on direct outcomes and not on community empowerment. Lastly, through funding, local governments or other actors might exert power over the process. Because of such challenges, it is important to reflect on the mediating role of organizations when they are involved.

The second aspect that can support participation is the use of technology in the cooperative city. Political philosophy is often focused on abstract processes while forgetting about things themselves (Latour, 2005). Menser similarly focuses on political and economic processes but largely leaves out the role of science and technology. Material things are important in politics because they gather people around matters of concern. In this line, technology can bring people together to discuss issues. Furthermore, the use of technology and scientific knowledge can create new insights regarding the issue to aid decision-making. Science and technology, then, provide a form of engagement that supports collective decision-making in participation. Technology here refers to open and comprehensible technology, rather than complex closed networks of sensors. Such simple technologies can help communities to make sense of their environments. One example is found in the practice of CS, which is a form of citizen science in which citizens use sensors to measure their environment.

1.5 Citizen Sensing as Accessible Technological Practice

CS is part of the larger movement of citizen science, in which 'non-scientist' individuals or local communities make observations that are typically validated by scientific standards (Kasperowski & Hillman, 2018). Whereas citizen science traditionally is a top-down practice[2], two participatory forms have also emerged (Kasperowski, Kullenberg & Mäkitalo, 2017). One

[2] While there has been a renewed interest in citizen science in recent years, it has been practiced in science from the 1960s. A well-known example is the study of bird migration, in which many data has been gathered by citizens. In such cases, the participation of citizens aims to create more data and expand the scientific endeavor. Here, scientists produce the research plan with adequate research standards and procedures that are carried out by citizen scientists. Traditionally, citizen science thus is a top-down research method of gathering scientific data, which is still the most common form in scientific literature (Kasperowski & Kullenberg, 2016; Shirk et al., 2012).

is citizen science as a form of public engagement to create more legitimacy for science and science policy in society. The main goal is to bridge the gap between scientific knowledge and lay knowledge by involving the public as a stakeholder in scientific policy issues. In this form citizens are involved in scientific matters of concern, such as genetically modified organisms, that might influence society. The other is citizen science as civic mobilization around a public issue of concern. This community-driven form aims at mobilizing a community to collect data in order to influence political decision-making. The political frame, in other words, aims to use scientific tools and standards to address a societal issue. CS largely falls in this last category of citizen science but can also address the knowledge gap between scientific knowledge and lay knowledge.

Broadly defined CS, also called participatory sensing, refers to the use of low-budget and accessible sensor technology to monitor environments (Gabrys, Pritchard, & Barratt, 2016). Citizen measurements include air pollution (Pritchard, Gabrys, & Houston, 2018), noise pollution (Coulson, Woods, Scott, Hemment, & Balestrini, 2018), water quality (Jalbert & Kinchy, 2015), damp (Balestrini et al., 2017), and radiation (Kera, Rod, & Peterova, 2013). The price and accessibility of the sensor technology make it viable for doing DIY community-based measurements. Indeed, CS "has evolved as grassroots enabled approach to data collection for citizens with shared concerns" (Coulson et al., 2018, p.1183). Sensing communities use the sensor technology to collect, share and act upon data (Balestrini et al., 2017). CS thus generally is a bottom-up practice that is supported by new sensor technologies[3]. These new technologies enable new capabilities and practices, such as the production of new types of data, that give insight and provide a starting point for action (Gabrys et al., 2016).

An example of CS is the European project *Making Sense* in which air quality measurements were done in Kosovo and Amsterdam, and sound measurements in Barcelona (Woods et al., 2018)[4]. In this and similar projects, sensor technology is used to gather a community around matters of concern such as air and noise pollution. The sensors provide data that create new insights into the issue and give communities the leverage to bring about change. With low-budget sensors, more measurements can be done on more flexible locations, for example. In the Netherlands, the national institute for public health (RIVM) now supports CS measurements of air quality and tries to integrate insights from sensors into their official measurements ("Samen meten aan luchtkwaliteit", n.d.). Furthermore, because of the co-

[3] However, CS is also used for scientific research (Compas & Wade, 2018).
[4] Waag was one of the participating organizations in the project and is co-author of the *Making Sense* book.

creative nature of the pilots, new insights on air quality were gained from the perspective of citizens (Woods et al., 2018).

Sensing practices, in other words, create a 'shared space for discussion' between communities, experts, and politics (Gabrys & Pritchard, 2018), which is similar to Callon's notion of a hybrid forum. Accompanied by sensor practices air quality is no longer a simple technological issue but involves a plurality of stakes that are social rather than technical. Next to creating possible new insights, sensing practices can thus also engage communities with technical issues and reduce the gap between expert and lay knowledge. In this way, citizen scientists bring attention to issues that institutionalized arrangements fail to address (Marres, 2007). The sensor technology is open and hermeneutic because it requires engagement with the issue at hand, the technology, and the data. The data practices enabled by the use of sensors foster participation and have democratic potential in line with the frame of the cooperative city.

However, there are also some challenges involved in CS. Two issues are the quality of data and hindrances in participation. Firstly, because the sensors are low-budget, the generated data is of lesser quality than that of official measurement stations. This has led to issues of acceptance of sensing data by experts and politicians. On her discussion of CS, for example, Ottinger notes that "standards make experts' judgments and practices robust, in part by linking them to other powerful political and legal infrastructures; in the process, standards can provide grounds for excluding nonscientists from decision-making – not because they are not experts but because they have no relevant information to offer" (Ottinger, 2010, p.265). Kullenberg (2015) similarly argues that it is important for citizen scientists to create data that adheres to scientific methods and standards and to be connected to scientific institutes in order to create resistance. However, STS scholars also warn that such a focus can bring scientism into sensing projects, in which the controversy is around scientific facts rather than value-based judgments (Zilliox & Smith, 2018). With a focus on matters of fact, the room to voice matters of concern becomes limited.

In terms of participation, one study reveals that in completely bottom-up organized CS projects, technological issues and the lack of sensor reliance hindered participation (Balestrini, Diez, Marshall, Gluhak, & Rogers, 2015). To deal with this issue, the authors propose a 'community champion' approach. Community champions are community members that take on a more extensive role in the sensing process. In the approach, some parts of the sensing process are orchestrated in a collaboration between community champions and experts to prevent specific hindrances. As the authors show, one project that used this approach overcame

technical hindrances and had positive outcomes in terms of meaningful participation[5] (Balestrini et al., 2015). Both the issue of data quality and hindrance in participation can thus be resolved by combining bottom-up and top-down approaches. In a social-public model, CS can be connected to scientific institutions to meet scientific standards and expert-guidance can foster meaningful participation.

In sum, CS as a technological practice has potential for the cooperative city framework. Indeed, it has been argued that citizen science and DIY community science offer a democratic alternative to the smart city (Haklay, 2015). The traditional smart city concept is built on networked sensor technologies. The sensors used in CS, therefore, stem from the same technological trends as those in the smart city, but with a radically different view. Rather than creating a closed network that perceives dwellers as passive citizen sensors, CS creates new sites for active participation and interpretation. In the cooperative city, then, sensors make some of the participatory processes possible that form the basis for collective decision-making. Here politics and technology come together in the form of PD through sensor technology. Additionally, in the previous section, an important role was identified for the mediation of the participatory process by an external organization.

The question remains what the participatory processes in the cooperative city should look like exactly, and what types of issues it can tackle. To address this question, and to test the cooperative city framework, I will describe a case study of a CS project with a social-public structure and discuss what can be learned from its participatory processes. These processes were designed and guided by Waag. The design of the project and the role of Waag in it will be assessed with criteria based on crucial aspects of the cooperative city frame. The first is whether the CS methods produce usable outcomes in terms of collectively mapping air quality and whether they adhere to MaxD. The second criterion is the choices made in the trade-offs between autonomy, and inclusion and transformation, requirements to participation and accessibility to participation, and efficiency and depth of participation. The last criterion is the issues in organizational mediation of participation that are identified by Menser (2018). These are independence from funders, inclusivity, and community empowerment.

[5] This study refers to the outcomes of a sensing project that was designed by Waag.

2. Hollandse Luchten: a Case Study of Participation Through Citizen Sensing

Having established the framework of the 'cooperative city', the thesis now turns to Hollandse Luchten as a case study to apply and evaluate my initial findings. Because the framework concerns participation in everyday life it is important to test how it works in practice. The chapter addresses the question 'how can Hollandse Luchten be evaluated with the use of the cooperative city framework?'. The main focus is on the role of Waag in the project. After shortly introducing the project and linking it to the cooperative city framework, I will assess the outcomes of the initial stages of the project using the criteria that I developed in the previous chapter. In doing so, the aim is to evaluate both the participatory processes in the project and the framework of the cooperative city itself. The outcomes, in turn, serve as the basis for a discussion on how to improve both the specific participatory processes in Hollandse Luchten and the cooperative city framework in general.

2.1 Structure & Methods

Hollandse Luchten is a CS project in which citizens measure air quality in the province of North Holland ("Hollandse Luchten", n.d.; "Burgerplatform Hollandse Luchten", n.d). The case study concerns one of the three pilots in the project. This pilot is based on the IJmond region and is the largest of the three, which receives 150 sensors (Figure 3). The IJmond pilot was chosen because I worked on it during my internship at Waag and it was the first pilot to start before the summer of 2019. The case study consists of the following structure: first, I will describe the general design of the project, the goals of the project, and the role of Waag in the project. Next, I will assess the participatory processes in terms of the criteria that were formulated at the end of the previous chapter. To do so, I will describe both the design choices made by Waag and the actual outcomes.

For the general description, I will use public documentation on Hollandse Luchten and my personal experiences of working on the project. The design choices are based upon two interviews with a technical expert and a co-creation expert at Waag. Both interviews were semi-structured and focused on Waag's role in Hollandse Luchten in providing technical and participatory expertise, and on the criteria of the cooperative city. The outcomes of the case

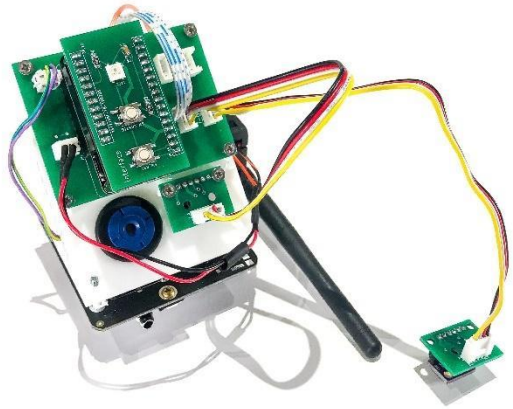

Figure 3. The sensor kit that is used in the IJmond pilot.

study are based on a combination of field notes and interviews with three community champions. The field notes were made during co-creation sessions in the project. The interviews were semi-structured and focused on the participatory process in the co-creation sessions and the thee criteria. To maintain the anonymity of participants, pseudonyms are used for the interviewees[6]. Each interview is cited once, after which the pseudonyms refer to the subsequent interview. The research was approved by the *BMS Ethics Committee* of the *University of Twente*.

2.2 General Description of the IJmond Pilot

The pilot in the region IJmond mainly focuses on industry due to Tata Steel, a large steel factory in the region. Local residents have resisted against the pollution caused by Tata for years and air quality is a visible matter of concern[7]. Due to economic reasons, the regulations have been relatively weak and enforcement inconsistent (Kreling & Schoorl, 2019). This has led to a polarized discussion in the region. Yet, the exact pollution in the area remains unclear for residents due to two reasons. Firstly, the limited number of official measurement stations cannot cover the whole area. Secondly, the measurements and reports are largely expert-based and residents are kept at a distance. The sensor measurements can thus generate new knowledge to

[6] The names of the interviewees are known by the researcher
[7] As Grymonprez, Sengers and de Vos (2017) show, for example, Tata Steel is the largest producer of dust (PM10) in the Netherlands.

aid the discussion in the region and reduce the gap between experts and laypersons. Also, new measurements can challenge the current local political consensus on regulating air pollution.

To address the issue of pollution, Hollandse Luchten is initiated by the province of North Holland as an experiment to use data from low-budget sensors, which has two main aims: (1) testing the possibilities and limits of these data, and (2) as experiment with a new type of collaboration between citizens and government ("Veel gestelde vragen over het project", n.d.). The first aim is meant to evaluate whether the data from the sensors are usable for political ends. As noted above, the data from low-budget sensors is of lesser quality than data from official air quality measurements. Due to the lower quality of the data, the sensors do not yet have any legal basis ("Sensoren voor Luchtkwaliteit", 2019). However, a high-density network of low-budget sensors can detect phenomena that official measuring stations miss or create a more detailed picture of a phenomenon. In Hollandse Luchten, therefore, the goal is to use the data to start a new conversation with the government rather than a legal procedure[8]. Moreover, the goal is to test which conclusions can be drawn from the data. This, in turn, could provide a starting point for a legal framework.

Secondly, Hollandse Luchten is an experiment with a new political model in which the government collaborates with citizens. In this approach, the government allocates resources to provide citizens with tools to measure their environment. The residents thus gather and analyse the data in a bottom-up manner. Therefore, the local community actively engages with the issue, the technology, and the data. In doing so, the community can learn about air pollution, different viewpoints regarding the issue, and how it is measured. Additionally, the knowledge gap between laypersons and experts can be reduced which enables the community to directly address air quality. By engaging citizens in the project, new questions and possibilities can arise that experts overlooked or were not possible in official measurements. The local knowledge of residents about the area, for example, can create insight into the issue at the local scale. If the experiment is successful, and the outcomes of the project are useful, the province will expand the scale of the measurements.

In Hollandse Luchten, resources are allocated by the government to map air quality through a participatory process that involves collective determination, which means that the project has a social-public design (Menser, 2018). Throughout the project, matters such as

[8] While the legal status of the sensors is an interesting and relevant topic, it goes beyond the scope of this thesis and will not be covered in-depth.

project goals, the measurement strategy, and the data-analysis are chosen collectively by local residents. However, it is not yet clear whether residents will be involved in the decision-making process after the project. This might be a limitation in the social-public sense since the final decision concerns possible policy changes. The consortium of the project consists of multiple partners, among which local government bodies, the RIVM, and Waag. The connection to local government bodies prevents possible antagonism between communities and governments. Also, the RIVM is a scientific institute that examines air quality, which creates a direct source of legitimacy for the sensor data.

Waag covers some technical aspects of the project and leads the participatory processes. The technical aspects consist of providing the sensors and creating a data platform. The participatory processes that Waag guides are made up of different meetups in which the community decides on the different aspects of the project. These participatory processes are taken up by Waag's Smart Citizen Lab (SCL). The SCL explores technologies and applications that help citizens to make sense of their environment. The SCL has been involved in multiple CS projects concerning air quality, sound, radiation, and water quality ("Smart Citizens Lab", n.d.).

As the SCL proclaims, CS as a smart citizen approach aims at answering local questions and increasing the local knowledge level[9]. Related to this aim, technology is used as a means of empowerment, rather than an end in itself which is often the case in the smart city discourse (Kitchin, 2014). If empowerment is achieved this can lead to action perspectives for the community, enabling them to act upon their environment. Additionally, by working with the same data and standards as institutions, the aim is to create a shared reality with these institutions. Lastly, the aim is to create new insights and space for new solutions based on sensor data. The perspective of the SCL, in other words, fits the framework of the cooperative city and offers an approach to the use of technology in a hermeneutic way.

2.3 Criterion 1: the Co-Creation Meetups

For the pilot in IJmond, the region is split up into 3 parts: *Wijk aan Zee, Beverwijk, and IJmuiden.* These are all places that surround the steel factory (Figure 4). Each area has its own community within the project that will pose its own goals, create its own measurement strategy, and do its own data analysis. This is done through co-creation, a "collaborative process between

[9] The SCL goals are obtained from a presentation by Waag that was given during the first meetup.

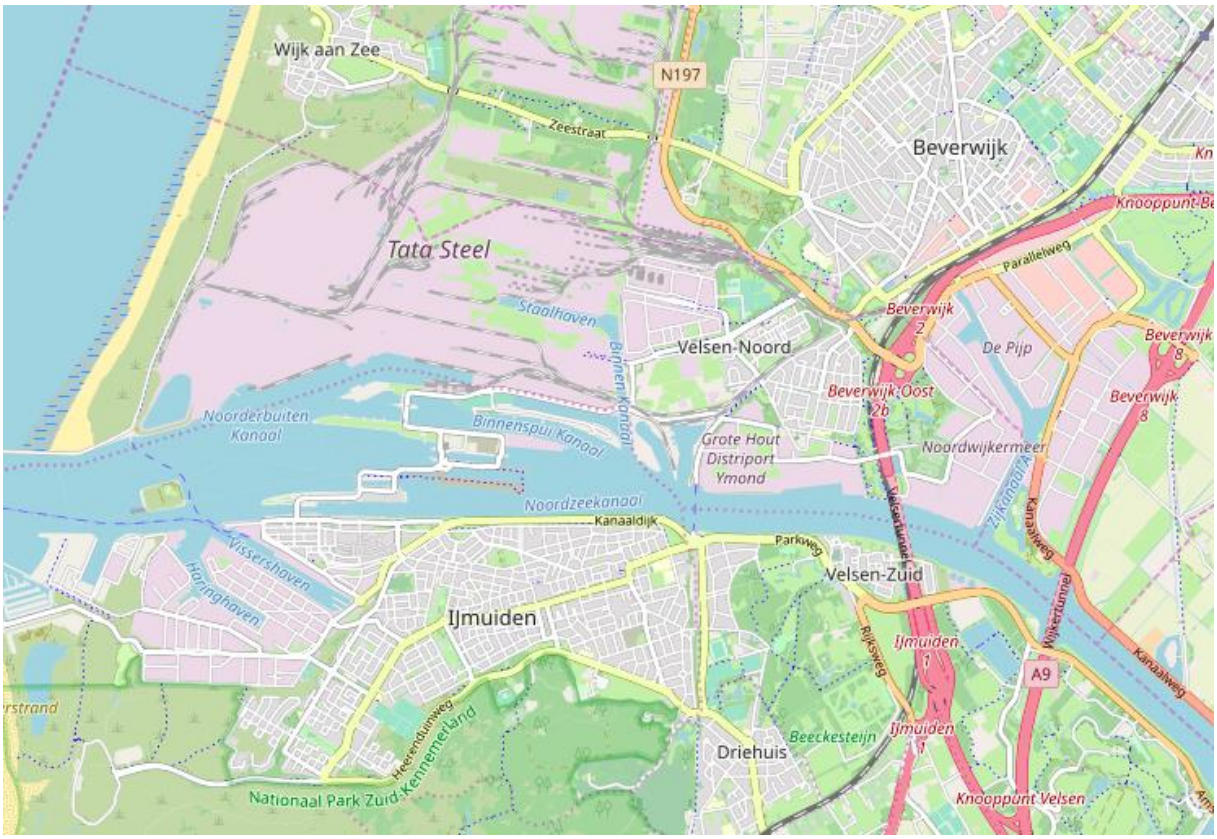

Figure 4. A map with the three areas in IJmond where the measurements will take place. All three areas surround Tata Steel.

multiple individuals using a wide range of resources and ideas to create new actions and objects" (Woods et al., 2018, p.15). Co-creation is an inclusive approach to gather different societal actors around matters of shared concern ("Public Research agenda", 2019). Co-creation in Hollandse Luchten is done within three consecutive meetups. Each community has its own meetups, meaning that there are nine meetups in the pilot. In organizing the meetups, Waag decided to take a community champion approach. Community champions are participants that take up an extensive role in the project[10]. The community champions helped to organize and facilitate the meetups. Likewise, they are the first point of contact for possible technical issues that occur during the measurement phase. The community champions were chosen by Waag from a pool of registrations, based on availability in the earlier phase of the project.

For the first two meetups, co-creative methods were designed based on the toolkit of *Making Sense* (Woods et al., 2018). These methods were adapted to the specifications of

[10] As I described in section 2.5, Balestrini et al. (2015) found that the community champion approach overcome hindrances to participation in a CS project.

Hollandse Luchten (Appendix A). The goals of the first meetup are acquaintance within the community, posing community goals, and posing questions for the measurements to come. First, there is a presentation by Waag about their approach and a presentation by the RIVM about air quality. These are meant to give grips for the co-creative sessions. Through a co-creative method, goals are then formulated that the community wants to achieve once the data has been gathered[11]. These goals are meant to go beyond measuring air quality itself and answer the question of what the community wants to achieve with the data. Lastly, a co-creative method is used to explore what the community wants to measure as well as identify the relevant locations to be measured. In this collaborative process, participants pose different questions that they want to answer with the measurements.

In the second meetup, the community uses the measurement questions from the first meetup to create a measurement strategy. In this strategy, the participants decide where to place the sensors and which question each sensor will address. During this co-creation method, the sensors are divided within each community. After strategically placing the sensors, they are divided among participants or allocated to public spaces such as schools or sports clubs. Next, the community will assemble the sensor kits to learn about the technology and in turn create ownership. The first two sessions are hosted within 2 weeks of each other. The third one is hosted a few months later and is focused on analysing the data. However, the focus in the case study is on participation in the first two meetups.

As the design of the co-creative methods shows, there is an emphasis on collective decision-making within the meetups. Despite some issues due to the complexity of the methods and terminology, the meetups had positive results. In the first meetup, both co-creation methods led to different goals for the project and measurement questions. The community champion from Beverwijk (CCB) states that "it stood out to me that [the co-creation methods] worked out great. I really enjoyed seeing that everyone enters with the wish to have a sensor in their backyard and leaves with the wish to have good data […] In this way, a community has been formed with sensors on strategic places" (CCB, interview, June 2019). Coming up with concrete goals was difficult for participants. The community champion from IJmuiden (CCI) states that 'society has never been asked this question, which makes the project unique' (CCI), interview, July 2019). Extra exercise would, therefore, be helpful to come up with such goals. The CCB

[11] This method is referred to as community level indicators (CLI's) and has been found to overcome multiple issues in participation (Coulson et al., 2018). The results came out of the EU project *Making Sense,* of which Waag was a project partner.

was positively surprised by the measurement questions. The champion states that "[we] noticed that people started to think deeper after the presentations by Waag and the RIVM".

In the second meetup, a measurement strategy was created based on the three main questions and the sensors were divided among the participants. However, as the CCB notes, the second meetup was very chaotic due to many different factors involved and a lack of time. This chaos limited the quality of the strategy since many participants again opted for a sensor in their backyard. As the community champion from Wijk aan Zee (CCW) states, "during the first meetup, a couple of measurement models were designed. I would have taken these as a starting point, because now the starting point was an empty map" (CCW, interview, July 2019). Because of the lack of a frame, he says, people quickly start thinking about their backyard again. The CCI similarly notes that some models based on the expertise of Waag and the RIVM could have been provided using the goals and questions from the previous meetup[12]. According to the CCI, designing a measurement strategy is extremely complex and was now reduced to something too simplistic. Assembling the sensors worked out well, as the CCW states that "people are more inclined to open up the sensor if it gives strange data because they know how to open it and how it works. By assembling the sensor people understand how it works, which creates ownership".

Overall, the community champions are happy with the outcomes of the first two sessions. As the CCW states, "the meetups make that the project is carried locally and that people are participating". The CCI similarly states "I feel ownership [over the project], and I notice that others that are present do too […] which creates nuance". Moreover, he notes that "the co-creation sessions help because they make [the project] collective". The meetups thus resulted in usable outcomes for the sensing process. Despite some drawbacks, such as a lack of time in designing the measurement strategy, these co-creation methods thus work in the context of measuring air quality. Also, enough information was provided for the community to participate and decisions were made collectively. The meetups, in other words, were in line with MaxD and had a 'high' level of participation in terms of typology. Overall, the results are positive in terms of the first criterion. Next, I will go into the second criterion concerning the trade-offs in participation.

[12] This is similar to Sennett's argument that experts can show residents the possibilities, that was described above.

2.4 Criterion 2: the Three Trade-offs in Participation

The pilot uses a combination of top-down and bottom-up processes. The locations, hardware, co-creation methods, and certain goals were largely decided by Waag and the consortium[13]. However, as the co-creation expert says, the participants play a large role in the pilot. They are co-owner, the expert states, "from deciding on the scope and community to making the measurement strategy and plans, from gathering, analyzing and interpreting data to reflection and documentation" (Co-creation expert, Interview, June 2019). As the technical expert notes, Waag follows the steps of Making Sense, which starts with the communities and what they want to do (Technical expert, Interview, June 2019). In this approach, the process should act to serve these goals. In this way, the community becomes engaged with the technology within the sensing practices. This, according to the expert, contrasts the smart city approach in which technology already contains the answer. The trajectory of co-creation that Waag uses thus includes the community in problem-solving, which makes the approach 'citizen-driven'.

The co-creation expert notes that with the community champion approach, knowledge of the local context is enrolled in the project. Additionally, the expert states that this approach is meant to create a sense of ownership within the project and to create sustainability. Ownership means that people feel concerned over the project and take responsibility for the next steps after co-creation. In terms of sustainability, the aim is to create a measurement infrastructure that will continue after the official project is finished. With the community champion approach, Hollandse Luchten is carried locally and the infrastructure will not collapse once Waag leaves. Likewise, multiple community champions are part of local initiatives[14]. In this manner, Waag can use the local enthusiasm and knowledge, and the connections between initiatives can be strengthened.

The community champion approach in Hollandse Luchten is thus one potential way of dealing with the trade-off between autonomy, and inclusion and transformation. In the approach certain processes that require expertise such as setting up co-creative sessions and technical matters are orchestrated in a top-down fashion. The co-creation expert argues that one advantage of this top-down aspect is that "there are enough resources and space available to invest more time and energy in [the organization of] a project". However, within this orchestrated frame there is much room for bottom-up processes concerning things that are

[13] The province of North-Hollands and the RIVM helped to decide about the hardware and locations, but not the co-creation methods.
[14] These are Brak! IJmuiden, Studio-O, Stofmelder, and Pieter Vermeulen Museum.

important for the community, such as formulating goals and determining what to do within the possibilities of data analysis. Furthermore, orchestration is done together with community members in the community champion approach, which creates a link between communities and experts (Balestrini et al., 2015).

To support the community champions, Waag organized a special training. In this 'train the trainer' session, the community champions learned about air quality, the technical aspects of the sensors, and the co-creation methods. Moreover, Waag provided a special package to the community champions with information about co-creation and air quality. In this regard, the co-creation expert argues that it is straightforward to organize meetups but understanding and carrying out the methods is often difficult. Therefore, Waag made a design for the co-creation meetups based on their earlier experience with CS projects. The structure was meant as advice and the community champions within each community were free to change it. In consultation with the community champions, it was chosen to keep the design. Overall, Waag thus had a leading role in designing the co-creation methods and in facilitating the meetups.

The top-down aspect also establishes a direct link between the sensing practices, and the government and RIVM. As the technical expert notes, the involvement of the province of Noord-Holland means that there is a direct entry point into the government to start a conversation about the results. Also, the technical expert argues that CS projects come down to the data that is gathered and Waag does not have enough knowledge to accurately interpret these data. To be able to say something legitimate about the data, therefore, the expertise of the RIVM is needed. These top-down aspects thus have some advantages over purely bottom-up processes, in line with Menser's notion of a social-public.

The combination of top-down and bottom-up also relates to the trade-off between requirements to participation and the number of participants. Overall the requirements for participation are low in Hollandse Luchten. With the community champion approach and orchestrated parts, the general community is relieved of technical and organizational aspects. However, more involvement would create a more in-depth form of participation. So, when is there enough participation in Hollandse Luchten? For the co-creation expert, the most important thing in terms of this trade-off is that people become part of the project and have a sense of ownership. Participation should include people in the decision-making process and ensure that people are willing to participate in the next step. In addition, the co-creation expert states that it is important that the community feels a sense of urgency towards the theme, no matter if it is organized for the community or by it.

Next, regarding the depth of participation, each meetup lasts around 2,5 hours. In this regard, the co-creation expert notes that it is always a consideration of how much time people are willing to spend and what you want to achieve in co-creative sessions. This consideration clearly demonstrates a trade-off between efficiency and depth of participation. According to the co-creation expert, time-pressure works well in making decisions. In the process, the procedure might be less democratic but there will be a result in the end. The expert acknowledges that this can lower the quality of the strategy in the project. Yet, the co-creation expert also notes that experience has shown that people accept the outcomes of these sessions as legitimate because it resulted from a group process. In dealing with this trade-off, in other words, Waag aims to use time pressure as a way to push decision-making.

In the end, Waag hosted the meetups and the community champions helped in the facilitation of the co-creation methods. One the one hand, this top-down aspect was experienced as convenient. The CCB says that he appreciated that they were unburdened of many things: the meetings were organized, the presentations were prepared, the RIVM was present, and the sensors worked. As the CCW notes, the community champions originally were supposed to do the presentations in the first meetup. He disagreed with this design because Waag and the RIVM have more expertise on the topic. Afterward, the CCW appreciated the fact that Waag was open to change the design.

On the other hand, however, the CCB notes that there was unclear communication towards the community champions regarding their role in the meetups up to the day of the event. He [the CCB] states that initially, he thought the community champions had to host the meetups, whereas this was done by Waag. Moreover, the CCI notes that they prepared an alternative program in IJmuiden. This turned out to be for nothing because Waag hosted the whole night, which was not the initial agreement. While the CCB says that it worked out fine this way, he also states that "it feels a bit strange that all sorts of things are now expected of us". When a sensor is not working, for example, the community champions are responsible to fix it. Therefore, the CCB states that "it would have been convenient if we had been more visible for the community". The CCW similarly notes that, in hindsight, he preferred a more extensive role for the community champions as hosts of the evening to show that the project is carried locally.

The CCI expected more training sessions for the community champions. More extensive involvement in the participatory process is necessary, he states, because allows the community to continue once the official project finishes. According to the CCI, Involvement creates a

strong community core with authority, which is important to balance diverse interests that might form. Next, as 'ambassador in the area', the CCB had preferred to be more involved in processes such as creating the data platform. Also, he noticed that the co-creation methods were too complex for the local community, especially due to the terminology. This led to some confusion during the meetups, which could have been prevented by including the community champions in the design. More extensive and explicit involvement of community champions could have has benefits such as adjustment to the local context.

The CCB thinks the involvement of the province mainly has negative consequences. Many people want the province to start enforcing the factory rather than doing an experiment with sensors that have no legal authority. The experiment, therefore, creates suspicion in the region, which affects the size of the community. The CCW agrees that the province has stood too much on the side of Tata Steel and failed in its role as enforcer. However, according to him, its involvement ensures that the province knows what is going on and they have to take the outcomes seriously. The CCI states that there is too little pressure on the province, and most of the pressure is based too much on emotion and has little bearing with the actual issue. Hollandse Luchten can thus create new pressure based on a better grip on the actual problem. He is positive about the involvement of the province. All three community champions are happy with the involvement of the RIVM because they provide the necessary information and will be essential in the data analysis.

Although the community champions wanted more involvement in some parts, their overall appreciation of the top-down aspects was positive. The CCI states, for example, that what Waag "has done concerning the sensors is extraordinary good. That could not have been done in another way than imposing it from the top". Next, the top-down aspects clearly lowered the requirements of participation, relieving the community of technical hurdles. Also, there were no special requirements for participation in the meetups. In this regard, CCI notes that more requirements are not needed because society already makes the selection in Hollandse Luchten. People that attend are those that are interested in the topic and some people quit during the meetups. Because air quality is a niche topic, in other words, there is no need for special requirements for participation.

Regarding time, the CCB thinks that the duration of the meetups and the evening planning are a hurdle for the younger and working population. However, the champion also states that "I don't see how the meetings could have been shorter, the time was required". Furthermore, he notes that the methods were strongly focused on time, preventing people to

think out of the box. The CCW similarly thinks that the methods should not be shorter. However, concerning time pressure, he states that "keeping the pace high prevents people from not making decisions [… and] in this way essentials and side issues are quickly separated". However, as the outcomes of the second meetup show, time-pressure caused chaos during the measurement strategy. In more complex methods, therefore, it can be counterproductive. The CCB similarly notes that people need time in the end. According to him, the time in between meetups can be used more explicitly.

2.5 Criterion 3: Issues with Organizational Mediation

Three possible issues with the mediating role by external organizations outlined above are the influence of government, inclusivity, and lack of empowerment of the community (Menser, 2018). Because the government is the main sponsor in the social-public model the influence of funding is a highly relevant risk. As Hollandse Luchten is fully financed by the province of Noord-Holland, they could assert influence the process. On this point, the co-creation expert notes that Waag aims to establish partnerships in projects rather than working client-based. This creates an equivalent collaboration with the province within Hollandse Luchten. Therefore, Waag has enough room to shape the process and is to a large amount independent of the government. The province did make decisions regarding locations and the number of sensors but Waag was free to implement their vision on the participatory processes.

Regarding inclusion, the co-creation expert notes that on the one hand, the aim is to be inclusive and to have a representative community. However, on the other hand, a project like Hollandse Luchten requires extensive participation. The expert states that "we are looking for people that understand what we are doing and that want to invest energy, which is sometimes hard to combine". In past projects, the co-creation expert saw that only a small percentage of participants were actively engaged and co-owner of the project. "In the end, [CS] is about the impact of technology on society, which is still a niche and does not appeal to everyone. However, this interest is broadening". Waag, in other words, aims at a community that feels urgency towards the topic and is willing to fully participate.

Likewise, the approach to participation by Waag in Hollandse Luchten aims at community empowerment. With the community champions, the aim is to create ownership over the project together with a sustainable network of sensors that will keep measuring after the project is finished. Besides, including the community in all steps of the process and providing

them with information about air quality is an investment to establish local knowledge about the topic. Waag's technical expert notes that the goal is to empower people with knowledge about the topic and breach their dependence on experts. One goal of the design of Hollandse Luchten, therefore, is to bridge the gap between experts and laypersons and in turn empower the community. However, as the technical expert notes, measuring air quality is very complex, which is an issue for empowerment. The expert states that in addressing air quality, there are few people that have the required knowledge to make decisions, which maintains a dependency on experts.

The community champions do not question the independence of Waag. The CCW notes, for example, that during the meetups it was clear that Waag operated independently from the province. While a representative of the province was present at the meetups, the representative did not partake in the discussions and decision-making. According to the CCW, it is clear that the province is mainly a financier. Regarding the diversity of the population, the participants mainly were 'senior white men'. As the CCB notes, the community is not representative of Beverwijk. However, he states the community is representative of people that worry about air quality. In the community of the local platform *Stofmelder*[15], for example, the same population dominates. The CCI notes that in the end, what matters is that people feel responsible and are socially engaged. According to him, the younger population is interested but unwilling to invest time. In Wijk aan Zee the community is somewhat more diverse, and the community thinks that the people represent the average population. Overall, senior white men in IJmond seem most willing to participate and host a sensor.

Regarding expertise, the community champions indicate that Hollandse Luchten is reducing the gap between experts and laypersons. As the CCB states, people that came in with little knowledge about air quality learned a lot. He says that now, "people put their barbeque under a sensor to see what the effect is, for example". This suggests that awareness about air quality is increasing. However, he states that some people will keep yelling at Tata and the gap between these groups will remain. The CCW similarly states that the gap in the provision of information has been reduced. This has enabled the community to create an independent data flow next to the official one in which citizens do not have to worry that it is influenced by external actors.

15 Stofmelder is a local platform that has facilitated the process of making a complaint about air quality in IJmond. Originally, making such a complaint involved a complicated set of actions on multiple media. Stofmelder reduced this to one action on one medium. Stofmelder has led to an active Facebook community, to which the CCB refers here.

In this sense, Hollandse Luchten contributes to community empowerment. As the CCW states, apart from reducing the gap, it provides up-to-date information on public locations to the inhabitants in the village. For example, he notes that there are several kindergartens, and "if it is possible to show that it is healthier to play in one or the other than people want to know this". Having information about the situation can thus empower people to act in accordance with that information. Furthermore, many things are already happening independently from the project. The CCW says, for example, that they aim to create their own platform where pollution is visible in real-time, and which creates alerts based on this information. The community champion from Beverwijk similarly states that "we are already thinking about what needs to happen next year". Hollandse Luchten thus has set multiple things in motion that are independent of the project. In terms of citizen science, therefore, it has both reduced the knowledge gap and enabled people to mobilize around a political issue.

2.6 Concluding Remarks

As the case study shows, the meetups resulted in a bottom-up sensor network as the design of Hollandse Luchten envisioned. During the meetups, the participants learned about air quality and were actively engaged with the issue. In addition, goals and measurement questions were formulated by the community and implemented in a measurement strategy. In accordance with this strategy, the sensors were divided among the community. In this process, the focus was on producing data collectively rather than hosting a sensor individually. Within the meetups, in addition, the emphasis was on (bottom-up) collective decision-making by participants. The community champions did identify possible improvements in the interviews, such as providing models for the measurement strategy, but overall the outcomes are positive. In accordance with the first criterion, the outcomes are usable in terms of CS and the meetups were in line with MaxD.

In terms of the trade-offs in participation, the combination of bottom-up and top-down works well in the context of Hollandse Luchten. With the top-down aspects, the community and community champions were spared from technical and organizational tasks. With this partly orchestrated community champion approach, the community has to give up some autonomy but has more resources available to bring about change. Likewise, because of the little requirements for participation and efficient design of meetups the hurdle to participate was low. Concerning the issues of organizational mediation, the interviews and outcomes show that these issues are present to a limited extent. In a social-public model, it is important that

organizations operate independently from the government, which Waag did to a large extent. Next, the diversity within the communities is not very high, but this seems to be due to a limited interest group rather than a lack of inclusivity. Lastly, Hollandse Luchten generates community empowerment, but this empowerment is limited due to the complexity of measuring air quality.

Overall, the outcomes of the first two meetups are promising in terms of CS as a practice in the cooperative city framework. Moreover, the use of the framework in the case study highlighted important aspects of participation and revealed several tensions. The results show that the social-public approach works well in the context of the initial stages of Hollandse Luchten. With the funding of the province, the expertise of the RIVM, and the mediation by Waag a sensing network was quickly developed. With the community champion approach, the local community was also involved in the organization of the meetups. In the end, Waag's knowledge of co-creation and sensor technology was crucial in community building and planning aspects. Despite the promising outcomes, some tensions came to the fore that should be addressed.

3. Discussion section

In this chapter, I identify five discussion points based on the outcomes of the case study. These discussion points are aimed at sharpening the cooperative city framework. The chapter addresses the question 'what can be learned from Hollandse Luchten in light of the cooperative city framework?'. In this regard, the case study of Hollandse Luchten reveals certain tensions and challenges. Whereas the community champions were generally positive about Hollandse Luchten and Waag's role in it, for example, they also had some critical remarks. Some of these challenges are practical, such as which methods to use exactly in the meetups, and mainly relate to the project itself. However, other challenges are more fundamental and should be discussed in relation to the framework, which is done in the upcoming sections.

3.1 Time pressure & complexity

In the trade-off between depth and efficiency in participation, there is dissension concerning the use of time pressure in the co-creation methods. On the one hand, the CCI and CCW both argued that time-pressure is a useful way to get results quickly. However, the CCB noted that the focus on quick results was too strong and hindered out of the box thinking. In the second

meetup, the time-pressure created a chaotic situation and limited the quality of the measurement strategy. Time pressure, in other words, is not an added value in every method and context. In this line, the co-creation expert notes that in a more open-ended form of co-creation there often is more room for democratic procedures. Because time in Hollandse Luchten is limited, the approach to co-creation is more result-driven. In the cooperative city, time pressure can be used as a means of efficiency, but this should not compromise the outcomes. What is a good way to use time pressure?

Strikingly, little research has been done on the influence of time-pressure on decision-making. One model that is based on multiple findings on the effect of time pressure is the attentional focus model (AFM) (Karau & Kelly, 1992). Time pressure, according to the AFM, narrows down the focus to salient features in the decision-making process. With time pressure, group members filter out what they judge to be less important information (Kelly & Loving, 2004). However, for many tasks (especially those that are complex) the restriction by time pressure is likely to reduce decision quality (Kelly & Karau, 1999). Time pressure, in other words, increases performance but can decrease performance quality. Additionally, Kelly and Karau note that time pressure creates a stronger focus on initial preferences. The AFM confirms that time-pressure can negatively influence the more complex co-creation methods, such as setting up a measurement strategy. Likewise, it suggests that for time-pressure to be an effective means, the participants should understand the terminology used in co-creation, be knowledgeable of the topic, and be familiar with the methods, because this creates salience. If participants lack these aspects, their focus will likely narrow down to irrelevant aspects, which hinders effective participation.

In light of MaxD, then, time pressure can limit capacity development and the process of collective determination and in turn the democratic potential of participation. In line with the CCB's criticism, the AFM does not predict out of the box thinking with time pressure, which limits the capacity to generate new insights that the method of CS presumes to have. Besides, the focus on initial preferences that the AFM predicts in using time pressure conflicts with the goals of co-creation, which aims at connecting different lifeworlds. Moreover, a strong focus on initial preferences suppresses the role of differences that is crucial for MaxD. This, in turn, risks to support the current consensus or to generate a new form of domination (Gould, 1996; Purcell, 2006). In sum, because of limited resources and to lower the hurdle to participate, time pressure can be an effective means. Simultaneously, it can also hollow out the process of participation. In stimulating creativity, with complex methods, and in situations where there is

initial disagreement, time-pressure might therefore be counterproductive. It can be more so because CS is a highly complex practice.

As became clear from the interviews, the complexity of measuring air quality is a limitation to community empowerment in Hollandse Luchten. The technical expert notes that once people start to explore air quality, they find out how extremely complex it is. Therefore, according to him, citizens are put in a difficult position regarding a process that they know little about. The CCI similarly says that 'the' air quality does not exist and that the concept blurs once people zoom in on it. Empowerment comes with knowledge, the technical expert says, but in addressing air quality there are few people that have the necessary knowledge. He notes that because of this domain expertise, communities are dependent and manipulatable. This dependency maintains the expert-layperson division, which can cause issues of trust and noise (due to the introduction of extra parties) in the practice CS and the cooperative city framework.

Next to the use of time pressure, complexity thus also raises the question to what extent the community should be informed about the topic. In this regard, the technical expert states that "once people come to know more [about air quality] the confusion starts. A small step then might create more confusion than clarity". Therefore, he notes, it is important to offer the community comprehensible information which they can use. Nonetheless, the complexity of the concept should not be reduced too much because that misleads community members. This points out a trade-off that will differ per topic and community: at what point does knowledge allow people to better understand their environment and to be critical in the cooperative city? CS thus requires that the complexity of a concept is reduced to what is measurable and comprehensible, which is similar to the second critique on the smart city that I presented in section 2.1. CS measurements, in other words, are a specific interpretation of a concept as air quality that capture a limited aspect of it. While CS does actively engage residents with an issue, this limitation should be taken into account in the data interpretation.

Overall, experts will be required in CS and similar practices in the cooperative city. Top-down orchestration and a direct connection to expert institutions help to overcome technical hindrances and to generate high-quality data and interpret it. With regard to community empowerment, it is important to have a frame of what CS can offer the community. One issue, for example, is that the complexity of CS can lead to high expectations that are not met at the end (Eleta et al., 2019). Similar disappointment due to high expectations is common in participatory projects (Cornwall, 2008; Griffin & Jiao, 2019). Therefore, the technical expert states that it is important to know the value of the process that an organization brings to people

and what it can guarantee. Still, the power of experts to rule out community findings based on standards can generate scepticism (Ottinger, 2010), as it does in IJmond. Although this would be less of an issue in a more embedded social-public model, such scepticism should be taken into account in the cooperative city.

3.2 Inclusivity

The majority of participants in the first two meetups were 'senior white men'. The community champions acknowledged this aspect and argued that this group feels most urgency towards the topic of air quality and is most willing to spend time on it. In this line, the co-creation expert argues that CS and similar technological projects are niche topics and attract a specific population. For Hollandse Luchten, a relatively small-scale experiment with limited resources, this is not necessarily an issue. However, for the cooperative city framework, which covers multiple issues and communities throughout cities and society, this creates a problem: if the use of technology supports participation on a large scale but only attracts a specific population, this runs the risk to introduce the participation paradox (Menser, 2018). This issue is also present in the broader frame of citizen science, in which many communities are not representative of society (Pandya, 2012; Sorensen et al., 2019). Inclusivity is a general issue in public participation and leads to negative outcomes such as discrimination against women and minorities, among others (Jasper Tran, Zewde, Mankoff, & Rosner, 2019; White, 1996). Including a diverse population in such participatory practices is thus an important challenge for the cooperative city.

One part of this challenge is situated in the design of the participatory process. Depending on the context, an organization as Waag can focus on a more diverse population in recruiting participants and setting up practical aspects of the participatory process. As Cornwall (2008) argues, for example, aspects such as timing, duration and location are common causes of non-participation. In this regard, the CCB thinks that the time of the meetups, from 19:30 – 22:00 on a working day, has discouraged the younger population to participate. After a working day, a participatory meetup is a hurdle, which is why a Sunday could attract a wider population. In addition, he thinks that a wider range of events can be organized to attract a more diverse group of people. For Hollandse Luchten a hackathon was organized on clean air day, for example, that attracted more diverse participants based on age, sex and ethnicity than the meetups did. During this hackathon, the participants were challenged to visualize the sensor data in a new and publicly visible manner.

The hackathon highlights another way to include a more diverse population: the use of the sensor data. The open-source design of the sensors with a focus on the commons allows a wider group to participate. The data that are produced are open and thus digital commons: "shared artifacts which can be taken over and self-governed by concerned people" (Teli et al., 2014). Also referred to as data commons, open data enables the visualization of collective issues (de Lange & de Waal, 2013). During the meetups, the focus moved from individually hosting a sensor to collectively creating useful data. This data can be used by any individual or group in society. As the hackathon showed, organizing events to solve challenges concerning the data can attract a more diverse population independent of the sensing community. Similarly, during one of the meetups, it was proposed to use the sensor for assignments in high schools. Whereas the sensing community plays an important role in the project, the scope for the data use can be much wider.

Both examples highlight ways to make technologically supported participation more inclusive. Likewise, the focus on creating collective data in the meetups of Hollandse Luchten confirms the argument of PD that people come out with a collective mindset rather than with an individualistic one in public participation. As the co-creation expert states, the topic of the impact of technology on society is gaining momentum and the interest in practices such as CS is growing. Furthermore, subsequent experiments with CS could provide a legal basis for the sensor data. When a stronger emphasis on such technology is created and people can exercise political influence through it, the interest in CS might increase. This is visible in the successful examples of PB in Porto Allegre and New York City. As Menser (2018) shows, both PB projects have a relatively high and diverse level of participation[16]. Still, many groups are excluded from participation in such popular participatory systems and diversity in the cooperative city should be watched closely.

3.3 Community Autonomy

In combining bottom-up and top-down aspects in Hollandse Luchten, one choice that came to the fore in interviews is how much room is left by Waag for the community to take responsibility for the participatory process and the possibility to design it. In the end, the community champions were not involved in the design of the first two meetups. Also, the

[16] Menser presents evidence that inequality decreases and that the population participating in PB is more diverse than in local elections (Menser, 2018, p. 74-78).

meetups were hosted by Waag. On the one hand, this is a limit in terms of the level of participation with consequences that reflect the benefits of PD. By involving the community, for example, the local context can be taken into account in the design. As the CCB argued, now methods were not fully adjusted to the community. Besides, the involvement of the community champions and accompanied training sessions generate more skilled and visible community champions. As the CCI noted, the community champions were not very visible in the project and are less skilled to deal with future parts of the project when Waag leaves.

One risk of full involvement of the community, on the other hand, is that a lack of knowledge about co-creation, participation, and CS generates low-quality methods and meetups. With the community champion approach, for example, the quality of facilitation might decline because community champions are not experienced with these methods. In this regard, Menser (2018) notes that good facilitators can be the decisive factor in a participatory process. Moreover, Kaner (2014) argues that facilitators are key in reaching an outcome when participants have a different frame of reference, which is commonplace in co-creation. As the co-creation expert notes, it is straightforward to organize meetups but understanding and carrying out co-creation methods is often difficult. If community champions claim an important role in organizing and hosting the participatory process, in other words, the quality might decline. Depending on the context and available resources trainings can be offered, but this does not guarantee a qualitatively strong participatory process. For the cooperative city, then, a clear framework for community autonomy in involvement is needed.

As the CCW notes, the required autonomy depends on which people sign up as a community champion. Therefore, flexibility concerning different possible contexts is required. People with different backgrounds have different needs, meaning that it is always a search what role you give to people, according to the CCW. Because the community champions are unknown prior to the project, in other words, their role should not be fixed in advance. Asking the community champions to do a presentation on a topic that they have no expertise on, for example, can lower the quality of information that is provided to the community. Therefore, the role of community champion could be open in Sennett's terms: a form that can take shape according to the needs of the community (Sennett, 2018). In such an open design, the determination of the trade-offs regarding combining bottom-up and top-down aspects is done together with community champions.

While Waag aimed at an open form, it failed to provide this due to a lack of effort and resources. After the trainer session, no close contact was maintained which led to uncertainty

concerning the role of the community champions and diminished their opportunities of involvement. To prevent this from happening, a clear plan with different possibilities for community champions can be designed at the start of the process. Then, in consultation with the community champions, a plan can be made and executed according to their needs. This can be an active role that includes multiple training sessions, but also a more passive role. Also, the question of who chooses the community champions should be addressed. Next, rather than blindly handing over a project to community champions, this consultation can be done with the critical eye from the experts involved. Such a format, again, is in line with Sennett's view that experts should both be critical on themselves and on the outside world. This is in line with MaxD because the community champions decide over the conditions of the participatory process. In addition, such an open design allows transcending pre-set typologies of participation and adjustment based on community needs.

3.4 Political context

The community champion interviews suggest that not all topics and contexts may be suitable for CS and the cooperative city framework. As the CCB noted, for example, Hollandse Luchten is a strange project for a region in which air quality is such a sensitive topic. Because the province has failed to properly enforce Tata Steel up to now and the sensors have no legal status, many residents are sceptical about the project. Therefore, some people refer to the sensors as a 'sop' to local residents. Rather than allocating resources to an experiment, they argue that the province should start enforcing Tata. Hence, in a sensitive political context, a social-public model in an experimental form as Hollandse Luchten can backfire. Nevertheless, the CCB states that when Stofmelder announced to build sensors to measure air quality, residents were enthusiastic about the plan. It was only when Tata got negative publicity due to the graphite rains and the province came with a similar plan that people became sceptical, because of the history of Tata's regulation.

The initial positive reactions to a sensor network by Stofmelder show that the practice of CS has potential in a polarized region. The CCW says, for example, that the community is enthusiastic about maintaining the sensor network after the project because it offers insight into the situation. According to him, this does not mean that Tata has to close down, but that one knows which place is healthier. Also, the CCI similarly notes that the project empowers society to act towards the province and thus provides political support. CS thus supports residents to mobilize around a shared matter of concern, as can similar technological practices. Moreover,

in the social public model there is less need for scientism and debates over standards, as often is the case in independent CS communities (Ottinger, 2010; Zilliox & Smith, 2018), leaving more room for shared matters of concern. The practice of CS itself thus seems suited for a social-public approach, whereas the political context causes resistance in the IJmond case.

Apart from context, technology-supported participation is limited in the issues it can address. CS, for example only addresses the direct environment that can be measured with sensors. While it does so in a way that enables other structural issues to be identified, in contrast to the smart city, the issues that can be addressed directly are limited. Other technologically mediated practices can supplement the number of addressable issues. De Lange and de Waal (2013) also pose data commons, common-pool resources, and digital media that enable a sense of place as means to address shared issues. Nonetheless, shared issues that cannot be addressed by such technologies should be identified and dealt with in a different manner. Next, the scale of the cooperative city is also limited. In theory, each sensor that is used in the smart city could also be used in an engaging manner in the cooperative city. In practice, however, the number of residents willing to participate is limited, meaning that not all issues that can be addressed in theory can also be addressed in practice.

Similarly, the CCI notes whereas open participation is very ideological, there is a chance that groups want to use the project for their own goals. Some people in IJmond, for example, want to close down the steel factory, which is not in line with the project goals of Hollandse Luchten. Such diverging interests can hinder constructive participation in the cooperative city. As the CCI states, he noticed that the collective sense of ownership in the co-creative meetups generated a nuance and side-lined personal interests. However, these interests are still present in society and the CCI is uncertain whether the balance can be maintained in the sensing network once the project finishes and Waag leaves. Community ownership and skilled community champions could thus maintain this balance, but diverging interests should be taken into account in the cooperative city frame. This also brings up the question of responsibility. Whereas in a centralized top-down structure the responsible actor for the process is often known, this is less evident in a decentralized structure. From this perspective, it should be recognized that not all issues are suited for a participatory approach, as not all topics are suited for PD (Menser, 2018). Choices that can severely damage other people, about personal preferences, or that otherwise seem unsuited should be left out of the cooperative city frame.

As these examples show, technologically supported participation is no panacea, as both the political context and addressable issues offer possible limitations to the framework. While

sensing-based practices in a social-public model might provide political support, the history of the local government in relation to the issue is an important factor, as the scepticism in IJmond shows. In doing similar sensing experiments, therefore, choosing less politically sensitive contexts seems advantageous. Once sensors have a stronger legal status, more sensitive areas can also be targeted. Additionally, the cooperative city cannot capture all aspects that comprise the complex socio-technical network that makes up a city or system. As is the case for smart city solutions, the cooperative city frame cannot replace the political systems in society. Instead, it can complement the political system and smart systems to stimulate a more inclusive understanding of certain shared matters of concern that exist in society.

Conclusion

This thesis set out to ask the question '*how can the participatory approach to using technology of the cooperative city be captured in a framework to evaluate the participatory practices in Hollandse Luchten?'*. To answer this question I developed the cooperative city framework and applied it in a case study of Hollandse Luchten.

In the first chapter, I addressed the question of how the participatory approach to using technology of the cooperative city can be captured in a framework. Based on three critiques on social and political presuppositions of the smart city, I argued for a normative framework concerning the use of technology in cities and beyond: the cooperative city. Opposing the contemporary neoliberal model in planning and technology development that increasingly denies people the right to the city, PD was chosen as the political fundament for the framework. After unpacking the notion of participation and related challenges, a social-public model was proposed as an alternative to the dominant public-private one. In the city, a social-public model for services in the form of networked publics allows residents to engage with shared matters of concern. Both expert mediation of participation and the use of open technology can support such participation in the cooperative city. The participatory practice of CS was chosen as a technological approach.

Next, to apply and evaluate the framework, the CS project Hollandse Luchten was examined in a case study. In the project, Waag acted as a mediator of the participatory process and provided technological expertise. Using the three criteria that were identified in the framework, the participatory processes in the project were evaluated. As the case study of Hollandse Luchten showed, the mediation by Waag introduces top-down elements into the

traditionally more bottom-up oriented practice of CS. As predicted by the cooperative city framework and its social-public orientation, the resulting combination of bottom-up and top-down showed promising results in terms of CS. With Waag's expertise, participatory meetups were designed with usable outcomes that resulted in a collective mindset and a sense of ownership. Moreover, the three issues concerning organization mediation, which are of independence, inclusivity, and community empowerment, were largely absent in the project.

Using the criteria of the cooperative city framework, several challenges and tensions came to the fore in the case study. In the third chapter, five discussion points were identified with the aim to sharpen the cooperative city framework. These were time pressure, complexity, inclusivity, community autonomy, and political context. Despite such challenges, the case study confirms that organizational mediation of participation and the use of accessible technology can support the participatory process in the cooperative city. However, these aspects might not be supportive of participation in a different context. Therefore, criteria such as those used in the case study should always be taken into account in organizational mediation of participation and new criteria should be identified. To return to the research question, the cooperative city framework emphasized important aspects of participatory practices in Hollandse Luchten and offered a useful means to evaluate it.

In considering these findings some limitations of the research method and framework should be taken into account. An obvious limitation to the case study is that the final outcomes of the project are not yet known at the time of writing, as the case study covers the initial participatory stages of the project. However, the absence of final results allowed focussing on the foundation of the project, which is formed in these initial stages. This includes community building, which is important for CS and co-creation as these are collective approaches to tackle a matter of concern (Woods et al., 2018). Also, the results are largely based on five interviews, which generates a specific interpretation of Hollandse Luchten. Considering the available resources for the research, doing more interviews was not feasible. Furthermore, the interviews introduce the perspective of the community in the case study, rather than only examining the project from an expert point of view.

Next, I was personally involved in the design of the project during my internship at Waag. Because of this involvement, the case study was not done fully independent from the organization studied and my personal preferences and assumptions might have influenced the results of the case study. At the same time, however, I had first-hand knowledge about the design and understood the technical aspects of the project. This knowledge reduced the risk of

misinformation in the case study and allowed me to identify the relevant issues that formed the basis for the interviews. During the interviews, I aimed to distance myself from Waag and to take on the role of a critical observer. Whereas this is not fully possible, my detailed knowledge about Hollandse Luchten enabled me to do a more thorough reflection on the project.

Lastly, the use of the case study supposes that the cooperative city framework can be captured in an empirical project. However, as became clear in the discussion, some dissimilarity exists between the case study and the framework. In addition, a case study is one specific application of the framework, which limits the possibility to generalize the findings to other applications. Nonetheless, the case study is an empirical validation of the cooperative city framework. Empirical tests of theories are often absent in philosophical writing, which can obfuscate the connection to society. In this regard, the limited scope of the research question and case study enabled a concrete assessment of the framework. Likewise, because of the limited scope of the research, the findings are not restricted to the cooperative city, as they pertain to participation in a wider context. To further test the framework, more research should be done that tests the frame in multiple contexts and scales.

The empirical findings are an addition to both the fields of PD and CS, as recommendations can be distilled for participatory processes in general and sensing practices in particular. Specifically, the findings can be put to use by refining the co-creation methods that were used in Hollandse Luchten. In dividing sensors, for example, a model can be drawn based on the outcomes of the first meetup. Next, as the methods are focused on a shared matter of concern, a similar project design could be tested in a different technological context. Similar methods could be tested with the use of new media technologies or sensors measuring noise pollution, for example. In the specific context of the cooperative city, different aspects of the participatory process could be examined, such as a different form of expert mediation, the question of responsibility, or a different political context. Lastly, research could focus on establishing clear guidelines for mediating organizations. In the cooperative city, mediating organizations play an important role and become ‘obligatory passage points’, similar to technology companies in the smart city. The role of these organizations thus requires careful attention.

On a more general level, several tensions were identified in the discussion section that require further research. Such research need not necessarily be within a social-public, but can also examine a different participatory approach that combines bottom-up and top-down processes. One point of tension is the use of time-pressure in co-creation and other forms of

decision making. While time-pressure can make a participatory process more efficient, the AFM suggests that it can have undesired consequences. As unambiguous empirical evidence is missing, more research is needed on effectively using time pressure. Another point of tension is community autonomy in a participatory process. The combination of top-down and bottom-up processes is promising in terms of participation, but the exact application and determination of the involved trade-offs depend on the context. Creating a flexible and reliable open frame to deal with this context-dependency requires additional research. A last point of tension is the risk of the participation paradox. In this regard, the use of digital commons to foster inclusivity is a promising practice that needs additional research. As inclusivity is a challenge in public participation for different reasons, digital commons offer ways to involve a more diverse group into a participatory project.

The commons, in a more general sense, further are an interesting concept for the cooperative city. Because value is created outside traditional market mechanisms in a commons, such a system can remove the tension between private and public interests that exists in the smart city (March & Ribera-Fumaz, 2016). Currently, however, many (digital) commons still intersect with capital and are appropriated by market mechanisms (Birkinbine, 2018). Creating a commons-based social public system in the cooperative city can create a legal basis for the commons, which is currently lacking (Foster & Iaione, 2016). Such a legal basis could prevent the appropriation of commons by capital. In this thesis, the relationship between the cooperative city and the commons has only been touched upon slightly, however, and this relationship should be explored more rigorously. Good follow-up research on this thesis could be to explore the connection of the cooperative city to the commons and extend the framework. This framework can be tested in a case study that focuses on the use of data commons is CS or similar projects.

Finally, one of the major goals of this thesis was to combine insights from political philosophy and STS. This resulted in a framework of PD that is grounded in the use of technology. PD, furthermore, offers the possibility to use the rather abstract notions from STS theory in a specific context. This combination resulted in a usable framework that captures the Hollandse Luchten project. A major challenge for PD theory is its implementation, as it is often criticized for being unrealizable (Menser, 2018). The cooperative city framework, therefore, could be a promising addition to PD theory. Still, political theory is slightly underrepresented in the thesis. In the future, therefore, comparative analysis could be used to ground the framework more firmly in political theory.

Overall, the combination of political philosophy and STS in the cooperative framework offers a good starting point to enable more participation in local politics. The cooperative city frame itself still has multiple aspects that require careful examination, and adjustments. Nonetheless, it offers a concrete alternative to the use of technology in the smart city discourse. As such, it is a voice to move from profit-oriented solutions and privatization towards people- and environmentally oriented solutions.

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Appendix A. Co-creation methods of meetup 1 & 2.

Structure of the first meetup (2,5 hours):

- Introduction (5 min)
- Acquaintance (15 min)
- Presentation SCL by Waag (15)
- Presentation air quality by expert (30 min)
- Community level indicators (CLI's) (30 min)
- Mapping air quality (45 min)
- Wrap up (10 min)

CLI's

In CS it helps to formulate collective and measurable goals within the community that are maintained throughout the process. Apart from measuring and gathering data we also want to achieve something with the project. What do we want to achieve and how do we formulate the impact? This is the main goal of formulating community level indicators. This helps to show the community why their measurements are relevant. Moreover, it helps to create a link between the data and their everyday lives.

Main question: What change do we want to achieve, how do we formulate it, and how is it measurable?

Duration: 30 minutes

Materials: post-its, pens and markers, voting dots, large sheets of paper, CLI canvas (fig).

Implementation:

Split up the community in groups of 4-5 people. Within these groups everyone individually formulates two goals that they want to reach in the project. After formulating the goals, people shortly present their goals to the group. In the process clusters of similar goals and links between overlapping goals can be made. After a short discussion, everyone votes 2 times on the a goal of another participant. The group continues with the top two goals.

Subsequently, the groups think of one or two indicators of each goal; what is a good measurement of the goal? For every goals the groups come up with how the measurement is done, who does the measurement, when it is done, and how often. After formulating indicators for the two goals each group presents their goals and indicators to the community.

Mapping air quality

The goal of this method is to offer participants a way to visually map their questions and concerns regarding air quality. In this manner the relevant theme's and places are literally mapped, through which the range of the issue comes to the fore. This helps to create a measurement strategy.

Main question: what are the questions of participants concerning air quality in the area?

Duration: 45 minutes

Materials: A3 maps of the area, post-its, markers, colored sticky dots, icon sheets, scissors, paper glue.

Implementation: in groups of 4-5, participants will visualize their questions on a map of the area. First, ask the participants to formulate questions that they want to answer with the measurement. Do they want to know the different sources of air quality for example, or the air quality at schools? After formulating questions, the participants use sticky dots to suggest relevant places to measure these aspects, and formulate why the places are relevant. Use different colors for each question. It is also relevant to ask where it is possible to measure; where do people of the community live or do we know people that want to measure? If time allows, participants can pose more questions. It helps to have an expert on air quality present to guide participants.

After the groups have mapped their questions and concerns, each group presents their map to the community. Are there overlapping questions and concerns?

Structure of the second meetup (2,5 hours)

- Acquaintance and introduction (15 min)
- Measurement strategy (45 min)
- Presentation about sensors (15 min)
- Assembling the sensors (60 min)
- Wrap up and legal formalities (15 min)

Determining the measurement strategy

To create good quality data a strategy is necessary. The goal of this method is to divide the available sensors among participants according to the main measurement questions that were posed in the previous meeting.

Main question: What should the sensors measure, and where, how, and by whom?

Duration: 45 minutes

Materials: A3 maps of the area, one A0 map of the area, post its, markers, sticky dots, sensor strategy cards.

Implementation:

Create a map with the address of every participant at the beginning of the session. To do so, ask each participant to place a sticky dot with the number that they get on the A1 map. Now there is a map with the addresses of all participants that is directly linked to the persons.

The main measurement questions from the last session are chosen and divided over different tables. Each measurement question gets the amount of sensors divided by the amount of measurement questions. The participants are divided among the different tables, preferably based on expertise. In 15 minutes, let the participants divide the sensors over the area in a way that is relevant for the measurement question. The location is marked on the A3 map with a sticky dot. Check any participant lives close to the location, or if anyone knows someone that could do the measurement. Fill out a measurement strategy card for each sensor, with the owner of the sensor and what it will measure.

Next, each group presents their placement of the sensors. After all the presentations, overlapping sensors are identified. For these overlapping sensors a new location is found. In this way, a dense network of sensors can be created.

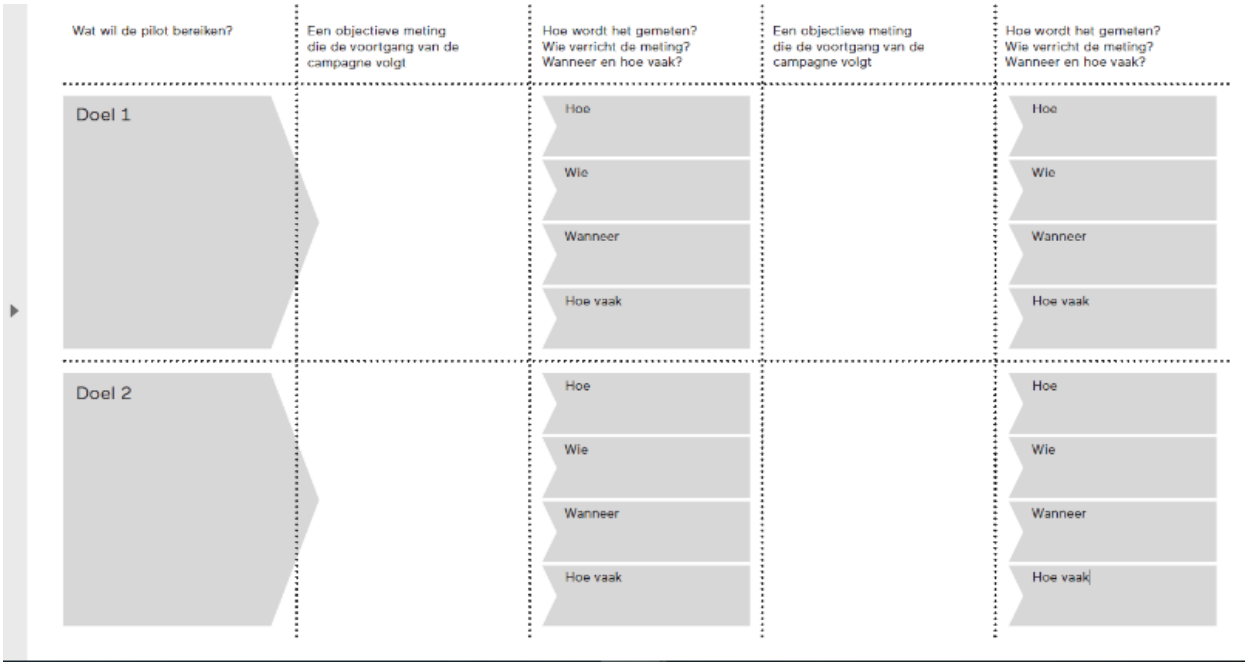

Figure 5. The CLI canvas.