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Quantified street: Smart governance of urban safety

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Abstract. The rapid deployment of technology in urban settings drastically changes the way urban safety is being governed. This article investigates smart governance of urban safety empirically through an in-depth case study of a project to improve the safety of a street in the Dutch city of Eindhoven. This collaboration between the city government, technology producers, knowledge institutes and owners of bars and restaurants entails the use of new technologies – noise detection, twitter analyses, data analysis, light interventions, gaming – for instantaneous monitoring and intervention. We analyze these smart governance practices from a socio-technological perspective. On the basis of our analysis, we qualify the case as a quantified street: enormous amounts of data are being collected to strengthen the governance of urban safety. The governance analysis showed that these actors shared the idea that more information results in better governance. External funding facilitated collaboration since money was no longer a scarce resource and technology became a 'lens' for building a shared understanding of the street. The relative absence of rules created the room for building innovative practices. In the conclusion, we raise questions concerning the strong focus on information as the key to a safer street and present an agenda for further research into the smart governance of urban safety.

Keywords: Smart city, collaborative governance, cybernetics

1. Introduction

The use of information and communication technologies (ICTs) for urban safety has a long history. The notion of surveillance has been dominant in these analyses [30]. Some authors have focused on Closed Circuit Television Systems (CCTV) and technologies for analysis of video material [1] and, more recently, new research has focused on the use of communication media for engaging citizens in the coproduction of safety [2]. The research on cameras, surveillance technology and social media has provided important insights in new forms of surveillance – or sousveillance – in an information age but current developments require new attention. The new wave of technology integrates various sorts of technologies (cameras, noise sensors, social media analyses) and used advanced forms of data analysis to obtain relevant information and insights. These technologies are not only used in a centralized control room but also by networks of public and private actors that are engaged in the production of safety. New technologies and new forms of governance result in the promise of what can be referred to as 'smart governance': the smart use of new technologies by networks of actors to make cities safer. At the moment, however, our empirical knowledge about these new – smart – surveillance practices is limited. This paper, therefore, aims to explore how this promise of urban safety through advanced technology

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actually works out in practice and to explore the benefits and pitfalls of smart governance for urban safety.

Rodriquez Bolivar and Meijer indicate that smart governance entails the use of ICTs for internal and external collaboration in government to realize societal value [31]. This paper investigates smart governance empirically through an in-depth case study of practices of a 'quantified street' in the Dutch city of Eindhoven. In this city, the hometown of the lighting company Philips, one street is full of new technologies to make it safer and cleaner. A collaboration between the city government, technology producers, knowledge institutes and owners of bars and restaurants uses new technologies – noise detection, cameras, twitter analyses, data analysis – for instantaneous monitoring to make a busy night area in Eindhoven into a safer and more pleasant environment. These new practices take the form of a living lab that explores the possibilities of this wide range of new technologies. We conceptualize this smart street as a socio-technical practice since it consists of technologies, roles, organizations, rules, etc. This paper analyzes these practices to enhance our understanding of how technologies are used to enhance urban safety. Our main research question is: how and why is a variety of new technologies used to construct a smart street? The answer to this questions will shed some light on the benefits and pitfalls of smart governance and provide the basis for a more specific research agenda into these new collaborative surveillance practices.

The academic relevance of this paper is twofold. This first ambition of this paper is to realize a systematic description of the new technologies that are used for smart governance of urban safety. The new uses of technology for producing urban safety are rapidly emerging but academic research has not yet provided a systematic description: there is a need for theory-based systematic academic descriptions of smart governance of urban safety. We will use the literature on cybernetics [3], crowd management [4–6], surveillance [1,7] to position these evolving socio-technological practices. This analysis contributes to the emerging body of literature on smart city governance [8,9] and (urban) surveillance [1] by analyzing a smart street and showing how this can be understood as a complex cybernetic system. The second part of the description is explanatory and aims to construct a theoretical understanding of the governance choices and emerging technological practices. The literature either presents smart governance as an instrumental approach to realize governance objectives or criticizes the neo-liberal foundations of these new forms of governance. An analysis that is based on a more sophisticated understanding of collaboration in the public sector is lacking. Building upon the four perspectives on governance developed by Bekkers [10], we will analyze the development of the smart street from different angles. These perspectives help to develop a rich account of the logics that have guided the development of the smart street. This contributes to the growing understanding of smart city practices as resulting from specific cognitions, interest, institutions and values rather than being inevitable outcomes of technological development [31,32].

The paper is structured as follows. Sections 2 and 3 present the descriptive and explanatory frameworks for the analysis of the quantified street in the City of Eindhoven. Section 4 presents the research strategy and the research methods and in Section 5 we will present the case and analyze it with the use of the descriptive and explanatory frameworks. To conclude this article we will reflect on the case and draw some conclusions in Section 6.

2. Cybernetics as a framework for descriptive smart governance

The literature on smart cities is rapidly expanding [9,11–14]. Even though the term as such is still heavily debated, both technological and critical analyses of smart cities have been published. The basic

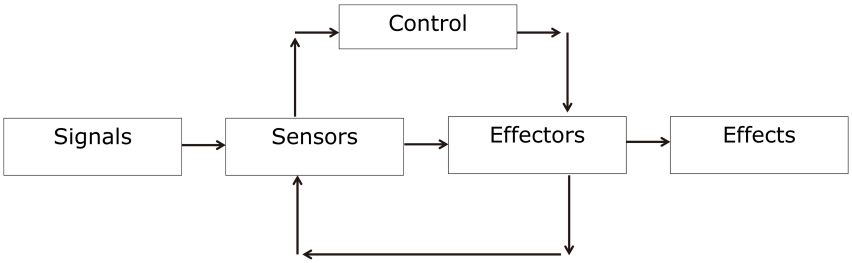

Fig. 1. Cybernetic perspective on smart safety governance.

idea of a smart city is that new technologies can be used to improve life in the city. Smart grids help to make better use of electrical power, transport systems aim to optimize the use of roads and smart apps provide tourists with information about sights. While many analyses of the smart city focus on the city as a system, some highlight that we also need to analyze developments at a more specific level. The smart neighborhood brings us to the level of technology for stronger neighborhoods and the smart street takes us to the level of a specific street in a city. The (limited) literature on smart street mostly focuses on the use of street lights to improve the use of energy and, at the same time, create more safety [15,16].

The smart street can, however, also be viewed as a miniature smart city: the same logic applies but at a much smaller scale. The basic argument about the smart city – the use of technologies to measure everything with the aim of intervening more effectively – can also be applied to the street. This would mean that the street turns into a technological street full of sensors to measure what happens on the street. The street becomes 'datafied': everything that occurs on the street is measured and the data can be used for new interventions. A street can then be regarded as an urban laboratory to test and develop new technologies for smart cities [17]. This view on the street as a site for experimenting can help to understand the logic of the smart street: a smart street is then not only a means to enhance safety and livability but also a test ground for new technologies to be applied at a larger scale.

A key ideal in the smart street is prevention of criminal activities by creating an environment – in terms of light, smell and gaming opportunities – that is not conducive to criminal activities. The idea of inhibiting crime by changing the environment is not new: classical work on the prevention of crime through urban design was already done in the 1970s. Newman [18] highlights how strategies of (de) limiting movement, defining areas of specific sorts of activities and providing for visual surveillance are crucial to building a safe neighborhood and these ideas have been enormously influential in urban design and renovation. The specific feature of this approach in smart streets is that the environment is created dynamically by changing the effectors in response to measurements of street conditions.

The basic idea of intervening on the basis of measurements in the streets is a cybernetic idea: the street is turned into a cybernetic system. For that reason, the cybernetic perspective can used to describe these emerging socio-technological practices. This type of perspective focuses on the information relations between an organization and its environment to study how organizations react towards changes, occurrences or incidents in the environment. Deutsch [3] emphasizes that governance requires information processing through *sensors* and *effectors*. Sensors are organizational functions – composed of technologies, organizational procedures, and organizational positions – that scan the environment for relevant information and effectors translate these signals into organizational action by formulating and enacting an organizational reaction. In addition, a control system is needed to coordinate the relation between sensors and effectors. The control function is needed to analyze the information that comes from the sensors and to control the effectors. An overview of the cybernetic model is presented in Fig. 1.

The cybernetic perspective is a general perspective on government action but it can used to conceptualize government reaction to safety and security problems. The literature on crowd management emphasizes that processing signals that may indicate (future) problems is crucial to crowd management [4–6]. The literature on crowd management aims to strengthen early warning systems that help the police and other government agencies to act quickly and to prevent or limit safety risks. In addition, the surveillance literature highlight that government uses a variety of informational means to observe society with the aim of being able to realize its policy objectives more effectively [1,7]. The cybernetic perspective can form a basis for systematically describing smart governance.

3. Four perspectives for understanding smart governance

The cybernetic perspective is useful for describing the smart street but does not provide the basis for developing an understanding of the emerging smart governance practices. A theoretical perspective is needed to develop an understanding of how and why specific forms of socio-technical collaboration between various actors are being constructed. Translating Bekkers' [10] perspective on policy-making, we can distinguish four different perspectives on governance: a rational, a political, a cultural and an institutional perspective. The key value of this perspective is that it facilitates us to develop an understanding of new forms of collaboration from different angles: rational choice, power struggles, meaning-making and rule following. These perspectives are not contradictory but help to develop a comprehensive understanding of how and why certain forms of collaboration between various actors are being constructed.

The *rational perspective* conceptualizes governance as the outcomes of rational analysis. Governance plans and programs are seen as important 'neutral' instruments for realizing goals and the choice for a specific intervention is explained on the basis of the goals it aims to realize. The rational perspective stresses that an analysis assesses the relation between means to ends. The main criteria for evaluating the success of governance are efficiency, effectiveness and (internal) cohesion. Knowledge and information are very important within this perspective since they are essential to the quality and depth of governance plans. The main idea in this perspective on governance is that better information about a problem and the effectiveness of interventions will result in better governance. ICT's are seen as neutral or value free instruments that could more or less be used 'of the shelf' to strengthen governance.

The *political perspective* departs from the viewpoint that governance is the result of a trade-off between different important values. Power protects or imposes certain stakes and positions or ideas. Choices are not made on basis of a rational analysis but subject to a permanent struggle between actors. This struggle takes place in arenas or governance networks in which the different actors are interdependent. Strategic behaviour and the use of power are part of everyday reality. Governance instruments are therefore not neutral but important sources of power that can be mobilized to realise certain advantages. The most important criterion for the evaluation of governance is stakeholder support and ICTs are not neutral instruments but symbolic resources that are used strategically to impress relevant stakeholders [19,20, p. 492]. Governance, in this perspective, is not the result of rational analysis but of political interactions [21].

The third perspective on governance that Bekkers discerns is the *cultural perspective*. Central is the idea that governance is above all sense-making between stakeholders. Governance is seen as a social construction that results from the interaction between different stakeholders (see also [22]) and certain meanings and interpretations are coagulated in governance arrangements. Based on processes of framing and reframing, actors try to build a common understanding. Within this perspective, governance is not only conceptualised as 'language' but also as 'images'. The main instrument is the organisation of an

'open' dialogue which can lead to a collective learning process. Whether governance is considered a success depends on the degree in which stakeholders are successful in developing a common, shared understanding of the character and the size of the problem at hand and the possible solutions for it. Storytelling is important in bringing order because different realities are connected to each other into a shared reality [22].

The last perspective is the *institutional perspective*. This perspective conceptualizes governance as the result of a combination of practices, values, rules, routines, conventions and processes that were shaped and made in the past. Because of this, there is not much room for making new choices in governance. In line with the sociological perspective [23,24], Bekkers sees institutions are sets of formal and informal rules that shape the behavior of social actors. These institutions such as the rule of law condition the behaviour of individual organisations and in this way they contribute to the predictability of their behaviour (see [23]). Information systems can be seen as the embodiment of solidified definitions of reality and items or issues that are not registered in these systems are therefore seen as not important. Furthermore within this perspective it is also important to look at the rules that determine how, in what way, knowledge and information should be shared or exchanged. There are two criteria for determining the level of success of governance: the logic of consequence (focus on efficiency and effectiveness) and the level of appropriateness (legitimacy) (see [24]). Characteristic for this perspective is 'path-dependency': a new governance approach tends to follows the footsteps of earlier developed and implemented approaches since switching costs are often high.

The perspectives on governance are complementary rather than competing ways of understanding social reality [10]. A combination of these perspectives can be used to understand the smart street as a socio-technological practice that is constructed on the basis of actor preferences, strategic behaviour, sense-making and (institutional) rules.

4. Research methods

This paper explores the topic of smart urban safety governance through an in-depth case study. The selected case should be considered as a most advanced case in terms of use of new technologies for urban safety [25,26]. The involvement of high tech companies such as Philips and top knowledge institutes such as Eindhoven University of Technology makes for innovative use of new technologies. The results of this case can by no means be generalized to other cities and other policy domains but provide insights in new developments that will possibly also play a role in other cities.

The case study is based on interviews and document analysis. The interviews started with the civil servant who manages the Living Lab Stratumseind (15 May 2014) and proceeded through snow ball sampling. The selection of respondents will be ended when no new names are mentioned by the respondents. This resulted in nine extensive – often more than two hours – interviews with key participants. In addition to the managers of the Living Lab Stratumseind, the following interviews were conducted: the director and an advisor of the key consultancy firm (21 August 2014), the key civil servant of the City of Eindhoven (25 August 2014), the responsible alderman of the City of Eindhoven (24 October 2014), an independent project consultant (14 February 2015), the contact person at Philips (23 February 2015), the principal investigator at Eindhoven University of Technology (26 May 2015), the owner of a bar on the street (2 December 2015) and a citizen who lives there (3 December 2015). The interviews are referred to with R1, R2, etc.

In addition, we analyzed all the available policy reports and documents. Documents were retrieved both through the interviews and through an Internet search on the term 'Living Lab Stratumseind' on

Google (20 August 2014). The number of policy documents was surprisingly limited and this may result from the fact that in an urban laboratory there is more focus on experimenting than writing policy plans. Our search for relevant documents resulted in three policy documents, three website and one newspaper article (see list of documents).

The research started with a reconstruction of the development of the Living Lab Stratumseind over time. The reconstruction focused on the role of the various actors, their cognitions, their value orientations and objectives and their strategies [27]. The respondents were asked to recount the origins and development of the Living Lab Stratumseind and to reflect on their own role and the roles of the other actors. In addition, the respondents were asked about current practices and the specifics of the various technologies used in the living lab. Additional information about current practices was obtained from the documents. This data collection was structured by a cybernetic focus on signals, sensor, effectors, controls and effects [3]. The data were analyzed at the level of the socio-technological practices to describe the use of systems and their embedding in the organization. In addition, the data were analyzed on the basis of the four perspectives on governance to develop an explorative understanding of the choices made in this process of using a range of new technologies for smart urban safety governance.

5. Case description and analysis

5.1. Living Lab Stratumseind 2.0

Eindhoven has developed into a city of 220.000 inhabitants and it is one of the leading actors in what is called the Brainport Eindhoven Region, which is considered to be the centre of technology in the Netherlands. In this city, Stratumseind is one of the most important nightlife areas in the city of Eindhoven. It is the longest 'pub' street of the Netherlands where you can find over 50 pubs, café's, discotheques and restaurants located in one street. It is well known for many years now, but the last couple of years Stratumseind faces some challenges that have to be met. Not just with regard to safety, but also with regard to cooperation and economic viability. That's why the city of Eindhoven has started the Stratumseind 2.0 project in which the local authority works closely together with businesses, the police, breweries, the owners of the real estate property in the street and local residents living on and around Stratumseind.

The main goals of Stratumseind 2.0 are making this specific area more liveable, safer and more attractive for visitors as well as for businesses. In one of the plans it is formulated that Stratumseind should be a vital street focused on entertainment in which everyone that is young at heart can find something that he or she likes, at every day of the week and at every moment of the day (Municipality of Eindhoven, 2014). In 2013 the Living Lab Stratumseind (LLS) was started as a part of the Stratumseind 2.0 project. The LLS has its own angle and scope, but it contributes to the broader goals of this overarching project. The LLS aims at three broad objectives (Van Gerwen, 2013a & 2013b, R1):

1) Collecting facts and knowledge about different aspects that (possible) have to do with the liveability, safety and attractiveness of Stratumseind. With specific measuring equipment anonymous data are collected about the visitors of the street, the surroundings and the local circumstances. By measuring and connecting data of f.e. the level of noise, temperature, number of incidents, occupancy rate of parking places, number of visitors and the origin of visitors, a broad pallet of information is created. The data can also be used as a baseline assessment for trying to measure if a certain intervention has any effect in practice.

2) Offering a platform for (scientific) research. The street becomes a testing ground for scientific research that looks at the influence of light on the behaviour of people (De-escalate project). The expectation is that the intensity and perhaps also the colour of the light used in public spaces will have a positive effect on the possible aggressive behaviour of people in a street. With the results from the living lab substantiated choices can be made with regards to the appropriate scenarios of the use of light for a better and safer experience of the visitors of Stratumseind. This can be done in a preventive but also in a more reactive way.
3) Creating an environment that gives a boost to innovation. This innovation is needed to reach the goals that are stated in the Stratumseind 2.0 project. Partners of the LLS (entrepreneurs) that have an idea about the way to increase the liveability, safety or attractiveness of Stratumseind can test products, equipment, concepts and ideas in real life practice. This initiation role is important for the LLS because this kind of innovations increases the attractiveness of the street. It also broadens the scope of the LLS beyond measuring of data and it helps to make clear that the LLS is not just about safety alone. Examples of this kind of innovations are the use of big interactive display panels on the street and the development of apps like for example 'pub advisor' and 'Feedback Stratumseind'. For some of these innovations the lab works closely together with other organizations like students of the Fontys University of Applied Sciences.

Two metaphors were developed to describe what the living lab is about (R1; Municipality of Eindhoven, 2014); the 'basecamp' and the 'engine block'. The 'basecamp' (also referred to as 'board computer' or as 'measuring station') refers to the fact that by using sensor technology on Stratumseind as well as external information from different kind of sources, a lot of data is collected about lots of different aspects regarding the liveability, safety and attractiveness of Stratumseind. These data is brought together so that different kinds of analysis can take place. These kind of baseline measurements will then be used to predict the behaviour of the 'crowd'. They are also needed to evaluate specific interventions aimed at changing the behaviour of visitors. The image of the 'Engine block' is the second metaphor used by the lab manager to describe the way in which the LLS operates. R1 highlights that this metaphor means that the living lab also has the function of initiator for renewal and innovations in the area. Within the network associated with the LLS new ideas about the development of Stratumseind can be generated. The engine block function of the LLS means that this living lab is supposed to actively create and support the idea of community building among people that can contribute to innovation.

5.2. Describing the Living Lab Stratumseind from a cybernetic perspective

While the two metaphors provide insight in how the participants view the living lab, the cybernetic perspective can be used to describe the socio-technological practices in Living Lab Stratumseind from a more systematic perspective as a cybernetic system consisting of sensors, effectors and controls.

5.2.1. Sensors

A broad range of sensors are used in Eindhoven. Cameras have been positioned at the five entranced of Stratumseind. The video images are not preserved but they are used to count numbers of people. Specific software is used to convert the video images in information about the number of visitors to the area. Wireless noise detectors have been positioned at the same five positions as the cameras. The data from these detectors can be used to generate a three dimensional image of the noise in the area. In addition, light sensors for measuring light intensity are planned to be positioned at two or three positions. When a mobile phone has chosen to open its access to Bluetooth or wifi, a macadres reader can

read the telephone's unique code. Five readers have been positioned at the same places as the cameras and the sound detectors and since these readers work up to 150 meters, the whole area is covered. Social media analysis is also part of the living lab. In collaboration with a commercial firm, a web crawler has been developed to search for tweets and posts with search strings such as 'Stratumseind', 'Stratum' and the names of the bars. The software analyzes these tweets to generate a sentiment analysis which indicates whether the posts are generally positive, negative or neutral. The perceptions of the inhabitants of the neighborhood will be measured on a weekly basis with a digital survey. This survey is meant to measure the subjective perceptions of the situation on Stratumseind. In addition, data about whereabouts of mobile phones are purchased. Aggregate and anonymized data about the town where people live are bought from Vodaphone. These data provide insights in the origins of the visitors to Stratumseind. The department Intelligence of the Eindhoven police provides the police reports about Stratumseind. Respondent 1 – the project manager – would like these to be more specific to know where exactly incidents took place but he thinks this will demand to much from police reporting. Data from the garages in the area provide information about traffic flows at certain times and number of visitors who go to Stratumseind by car. The Municipal Cleaning Department provides information about the amount of waste and glass collected at Stratumseind per day. The beer breweries who provide the beer to the bars provide information about the beer consumption. The public events calendar provides insight in specific events in the city that may have an impact on the number of visitors or the timing of their visit to Stratumseind. This list is not complete since other open data from the city such as counts of the numbers of cyclists can also be used to monitor Stratumseind.

5.2.2. Effectors

A variety of technological effectors is used to improve urban safety. The first one is light (color and intensity). Twenty-eight lamps have been positioned in Stratumseind to influence the behavior of visitors through their color. These lights can be directed at the level of the individual LED. The second one is smell. The possibility to influence people through smell has been explored with a small company (Smartnose). This company wanted the LLS to pay the development of an application and therefore this option has not yet been developed any further. The third one is gaming. The idea is that games might distract people and move them away from trouble. This idea has not yet been developed. In addition, traditional intervention through police action can be used to act upon the information that is gathered through the various sensors. Interestingly, this line of action has hardly been developed within the context of the LLS.

5.2.3. Controls

Various technologies are used for data analysis and visualization for control. Tools for big data analysis have not yet been developed but the Eindhoven Technological University, the Fontys University and the Police Academy are exploring the development of such tools. A small company, Open Remote, has developed a dashboard to bring all the bring information together in an accessible format. R1: 'It has been built in such a way that new applications can easily be added.' A mobile phone app has been developed that presents key information in an accessible manner. This app can be used by the police on the street and by the security of the bars on Stratumseind. In addition, a technology has been developed to control the effectors: the same app that provides information to the police and security can also be used to steer the light on the street.

Technologies are leading in this approach and surprisingly little has been thought about who is to use and control these technologies (R2). For some sensors this is quite clear. The local government can use

the data about noise to plan its garbage collection and to inspect events and bars. Citizens can use the data also to inspect whether events remain within the legal noise levels. For most of the other sensors, however, this is much less clear. Information about numbers could be used by various actors for various goals but no clear usage patterns have been developed or even planned yet. In that sense, the practice is really a living lab: ideas are being developed and organizational embedding is to follow later.

This description highlights that a technological system is being constructed that consists of a variety of sensors, effectors and controls. The objective of this system is to control the behavior of visitors to the area. This system is a 'living lab' in the sense that different components are loosely connected and they are added to the system if they provide additional value. The intensive use of technologies is such an experimental setting is quite unique and raises the question how the different actors came to develop this socio-technical practice.

5.3. Understanding the Living Lab Stratumseind from four perspectives

Different perspectives on governance can be used to analyse how and why these socio-technological practices were developed in the City of Eindhoven. We will apply the four perspectives identified by Bekkers [10] to develop a rich understanding of the logics behind the construction of this smart street.

The *rational perspective* stresses that plans and programs are important for realizing governance goals. An important role for reaching the stated goals is played by the collection of 'hard' and 'objective' data (R1, R2, R3). Within the 'Basecamp' activities of the Living Lab, these data are collected from as much sources that are available. And also on as many issues that possible are related to safety and liveability. An underlying implicit assumption, is that guaranteeing safety is better understood if these (baseline) data are collected and are related to each other. This kind of assumptions are characteristic for the rational perspective on governance. The data are used for measuring the effects that interventions have in practice and they should lead to a more predictable planning of emergency services. For an important part, the choice for light intervention can also be seen from this perspective. It is about exploring light scenarios which refer to possibilities to intervene in safety on the street by changing the colour and intensity of the streetlights (R7). In essence the assumption is that interventions based on the collection of different kinds of data, lead to a decrease in the number of safety incidents. So, fitting within the rational perspective, the idea that is widely shared among the participants is that more information leads to better governance.

The *political perspective* provides important additional insights into the dynamics of the Living Lab Stratumseind. The key stakeholders each have a different interest in this project and they try to win others for their ideas through strategic actions. For the municipality the project is mostly about safety and also a bit about liveability of the area (R2, R3, R4). The interest for the residents is mainly liveability while economic viability is the main interest of the owners of the buildings and of the entrepreneurs that are exploiting the bars (R2, R8, R9). Each actor alone is not able to reach its own goal independent of the others. Although the actors managed to see the shared interest, there was still the problem with money: it turned out that financing the initiative was a problem with just the municipality and the entrepreneurs on board (R5). This changed when the university was able to get funding for their research on the effects of light on aggression. This opportunity opened up the way for a close cooperation between the different stakeholders. Looking back it can be concluded that with the funding also a policy window opened that made the development of the Living lab possible. There was no struggle over scarce resources since external money provided the 'oil' for collaboration in the Living Lab Stratumseind.

The *cultural perspective*, aimed at sense-making and creating a learning environment provides additional insights. The Living Lab Stratumseind can be seen an initiative in which a number of different

stakeholders develop a shared understanding of the mechanisms that determine a successful approach of safety and liveability. It is not by coincidence that an appealing name like 'Living Lab' was chosen. It expresses that this project is a learning environment in which the different stakeholders, in close interaction with each other, have to find out what works well and what does not work and in what kind of circumstances an intervention can be successful. The name Living Lab, but also the used labels like 'Basecamp' and 'Engine Block' are not only well chosen names, but at the same time they are associated with powerful images that make clear what this project is about. In combination they express that the different involved organizations share a learning process together. A close cooperation of many different organizations is necessary to reach the ultimate goal: a safer and more attractive street (R2, R3, R5). This kind of activities is the focus of the so-called 'Engine Block'. Even more, it is explicitly pointed out that this part of the Living Lab is aimed at 'actively create and support the idea of community building'. Finally, building a common understanding is an important aspect of the cultural perspective. Within the case, ICT is used as a crowbar to build such a common understanding. Some respondents pointed out that the main value of using sensors and Big Data in this Living Lab is not so much of a technological nature (R2, R5). In the Living Lab, these technologies are primarily used as instruments to help the different involved stakeholders to build a shared understanding of what they want for this street.

Finally, the *institutional perspective* provides some insight into the role of rules. The Living Lab is an innovative project that takes place in a relatively shielded environment but even in such an innovative environment, some institutions cannot be ignored. Although it is all about innovation in this living lab, some important procedures and rules that are associated with the use of ICT have to be followed. This is especially true for matters that have to do with themes that are important in our Rule of Law like for example ethics or privacy (R1). When it comes to linking data it is very important that the prevailing rules and opinions are applied in a decent way. To guarantee this, the Living Lab makes use of specific knowledge on the area of ICT and Law that is available within a research centre of Tilburg University. By doing so the Living Lab articulates that certain legal themes are important for the acceptance and future use of the innovations that are developed in the lab. At the same time, the number of rules that actors need to work with in this shielded environment is limited and provide room for experimentation. The analysis highlights that the construction of a living lab helps the actors to develop forms of collaboration that are less hindered by path dependencies and existing rules.

6. Conclusions: Quantified Street

Stratumseind can be characterized as a Quantified Street: enormous amounts of data are being collected to generate not only more safety but all kinds of other outcomes such as more consumers in the area and a higher consumption of beer. Smart governance in this quantified street showed patterns of goal-shifting: new goals were added on the basis of an analysis of what the data could do. In addition, this socio-techno practice illustrates Morozov's idea of 'informationism' [28]. The dominant reasoning behind the approach is that more information will result in better urban governance. There is surprisingly little attention for the question whether the safety problems – and all the other issues – are due to a lack of information. In the cybernetic perspective on governance information gathering is seen as the key to success. This practice illustrates the emphasis on concentrated intelligence rather than distributed intelligence. There is some but surprisingly little attention for active input from citizens and stakeholders in safety governance. Most technology is used to 'objectively' collect data about practice that are in one way or another relevant for smart safety governance.

This research identified governance practices that could be described as next generation surveillance. The basic idea behind this form of surveillance is that continuous – and maybe even predictive – control is possible through full information and sophisticated interventions. The metaphor of a 'governance cockpit' best catches the key features of this approach to urban safety. The social environment is observed through a variety of technologies and the information that is gathered forms the basis for interventions. There is little attention for (communicative) interaction with society. The ideal is one of subtle and unnoticed influence: less violence and crime due to adequate use of light, smell and gaming interventions based on rich information about the crowd and contextual conditions. Subtle forms of surveillance are connected to sophisticated forms of intervention to create a seamless safe environment. One could argue that this type of surveillance is attractive and brings us safe cities but there is also reason for concern about the desirability of this type of safety that is created for citizens rather than with citizens.

The cybernetic perspective is about steering and control and largely ignores the idea that community engagement and police-community relations are at the heart of building a safer environment for the long term [29]. Visitors to the Stratumseind are conceptualized as 'objects' to be observed and steered rather than as 'subjects' that government interacts with. This approach is largely in line with findings in the literature on surveillance that highlights that government agencies aim to obtain maximum information in order to be able to intervene more intelligently [30]. An interesting difference with many previous examples is that different actors such as companies and universities are involved in developing the living lab. Surveillance in the smart city should not be understood as a government practice but rather as a collaborative practice where all actors benefit from collecting data about citizen activities (see also [33]).

The governance analysis showed how a varied set of actors – the municipality, Philips, smaller companies, the university and local entrepreneurs – came to collaborate and to develop this type of socio-technological practice. The rational perspective showed that these actors shared the idea that more information result in better governance, the political perspective highlighted that external funding facilitated collaboration since money was no longer a scarce resource, the cultural perspective showed that technology became a 'lens' for building shared understanding of the street and the institutional perspective showed that the relative absence of rules created the room for building innovative practices. These favorable conditions in a city that 'loves' technology provided the setting for this smart street experiment.

Remarkable absentees in the collaboration for urban safety are the citizens that visit this area. They were studied but played no role in the collaborative process. At the same time, there were no signs of resistance or protest against the next generation surveillance practices based on new technologies and network collaboration. These citizens seem to have so much faith in the use of new technologies and support the stated goals of a safe street that they do not object to the fact that they are being turned into the objects of this sophisticated surveillance experiment. They seem to be happy to pay this price for urban safety. This observation runs counter to the idea that citizen engagement is only becoming more important and that citizens want to have an influence on their own neighborhood. The contrasting image of the happily passive citizen is provocative and not yet well developed in the literature.

This explorative research calls for more research to understand the nature of smart urban safety governance. Further research is needed to investigate to what extent this form of smart urban safety governance is becoming dominant in practices of urban governance. Comparative research of practices of smart governance of urban safety in cities around the world in needed to investigate whether the practices that we identified indeed represent a broader trend. More specifically, the position of citizens as objects rather than subjects of urban safety needs to be investigated more in depth. In-depth qualitative – possibly even ethnographic – research is needed to study how the role of citizens in urban safety changes. Finally,

addition research is also needed into surveillance as a collaborative practice. International comparative empirical research can show to what extent companies and academic institutes collaborate with governments to develop high-tech collaborative surveillance practices. This explorative research has portrayed the contours of one specific quantified street in the Netherlands and further research is needed to test the generalizability of these findings.

7. Document analysis

Financieel Dagblad (2014), *Slim licht moet agressiviteit in uitgaansstraat indammen*, 30 april 2014.
Gerwen, A. van (2013a), *Stratumseind 2.0: Actieplan*, Eindhoven.
Gerwen, A. van (2013b), *Stratumseind 2.0: Plan van aanpak 2013–2017*, Eindhoven.
Municipality of Eindhoven (2014), *Living Lab: Keuze in scenario's, overbrugging periode jan–juni 2014*, Eindhoven.
http://www.eindhoven.nl/stad/evenementen/Stratumseindwordtproeftuin.htm
www.brainport.nl
www.Intelligentcommunity.org

References

[1] Webster CWR, Topfer E, Klauser FR, Raab CD, eds. Video Surveillance: Practices and Policies in Europe. 18th ed. IOS Press; 2012.
[2] Meijer A. New Media and the Coproduction of Safety: An Empirical Analysis of Dutch Practices. American Review of Public Administration. 2014 January; 44(1): 17-34. DOI: 10.177/02075074012455843.
[3] Deutsch KW. The nerves of government: Models of political communication and control. New York: The Free Press; 1963.
[4] Momboise R. The problem of crowds and mobs. Police. 1967; 11(3): 80-89.
[5] Smith RA, Dickie JF, eds. Engineering for Crowd Safety. Proceedings of the International Conference on Safety. Amsterdam: Elsevier; 1993.
[6] Adang O. Openbare orde handhaving. In: C.F.C.F. F, Muller ER, Rosenthal U, Torre Vd, eds. Politie. Studies over haar werking en organisaties. Deventer: Kluwer; 2007. p. 803-824.
[7] Lyon D. Surveillance Studies: An Overview. Cambridge: Polity; 2007.
[8] Caragliu A, Del Bo C. Smartness and European urban performance:assessing the local impacts of smart ubran attributes. Innovation: The European Journal of Social Science Research. 2012 October; 25(2): 97-113. DOI: 10.1080/13511610.2012.660323.
[9] Hoon Lee H, Phaal R, Lee SH. An integrated service-device-technology roadmap for smart city development. Technological Forecasting and Social Change. 2013 February; 80(2): 286-306. DOI: 10.1016/j.techfore.2012.09.020.
[10] Bekkers V. Beleid in Beweging. Achtergronden, benaderingen, fasen en aspecten van beleid in de publieke sector. 2th ed. Den Haag: Lemma; 2007.
[11] Inayatullah S. City futures in transformation: Emerging issues and case studies. Alternative City Futures. 2011 September; 43(7): 654-661. DOI: 10.1016/j.futures.2011.05.06.
[12] Winters JV. Why are smart cities growing? Who moves and who stays? Journal of Regional Science. 2011 May; 51(2): 253-270. DOI: 10.111/j.1467-9787.2010.00693.x.
[13] Walravens N. Mobile Business and the Smart City: Developing a Business Model Framework to Include Public Design Parameters for Mobile City Services. Journal of Theoretical and Applied Electronic Commerce Research. 2012 December; 7(3): 121-135. DOI: 10.4067/S0718-18762012000300011.
[14] Mellouli S, Luna-Reyes LF, Zhang J. Smart government, citizen participation and open data. Information Polity. 2014 June; 19(1,2): 1-4. DOI: 10.3233/IP-140334.
[15] Müllner R, Reiner A. An energy efficient pedestrian aware Smart Street Lighting system. International Journal of Pervasive Computing and Communications. 2011; 7(2): 147-161. DOI: 10.1108/17427371111146437.
[16] Pizzuti S, Annunziato M, Moretti F. Smart street lighting management. Energy Efficiency. 2013 February; 6(3): 607-616. DOI: 10.1108/17427371111146437.

[17] Sengers F, Berkhout F, Wieczorek AJ, Raven R. Experimenting in the city: unpacking notions of experimentation for sustainability. In: Evans J, Karvonen A, Raven R, eds. The Experimental City. London: Routledge; 2016. p. 15-31.
[18] Newman O. Defensible space: Crime prevention through urban design. New York: Mac-Millan; 1972.
[19] Kraemer K, King J. Computers and public organizations. Public Administration Review. 1986 November; 46: 488-496. DOI: 10.2307/975570.
[20] Homburg V. Politics and Property Rights in Information Exchange. Knowledge, Policy and Technology. 2000; 1(3): 12-22.
[21] Cohen MD, March JG, Olsen JP. A garbage can model of organizational choice. Administrative Science Quarterly. 1972 March; 17(1): 1-25. DOI: 10.2307/2392088.
[22] Stone D. The Policy Paradox. New York: Norton & Co; 2003.
[23] Scott RW. Institutions and Organizations. Thousand Oaks: Sage; 1995.
[24] March JG, Olsen J. Rediscovering Institutions. New York: The Free Press; 1989.
[25] Yin RK. Case Study Research. Beverly Hills CA: Sage; 1984.
[26] George AL, Bennett A. Case studies and theory development in social sciences. 4th ed. London: MIT Press; 2005.
[27] Koppejan JFM, Klijn EH. Managing uncertainties in networks: A network perspective on problem solving analysis and decision making. London: Routledge; 2004.
[28] Morozov E. To save everything, click here: Technology, solutionism, and the urge to fix problems that don't exist. New York: Allen Lane; 2013.
[29] Van de Klomp M, Adang O, Van de Brink G. Riot management and community relations: policing public disturbances in a Dutch neighbourhood. Policing and Society. 2011 September; 21(3): 304-326. DOI: 10.1080/10439463.2011.588708.
[30] McCahill M. The surveillance web. London: Routledge; 2013.
[31] Bolívar MPR, Meijer AJ. Smart Governance: Using a Literature Review and Empirical Analysis to Build a Research Model. Social Science Computer Review. 2016; 34(6): 673-692. DOI: 10.1177/0894439315611088.
[32] Meijer A, Rodriquez Bolivar MP. Governing the smart city: a review of the literature on smart urban governance. International Review of Administrative Sciences. 2016; 82(2): 392-408. DOI: 10.1177/0020852314564308.
[33] Staples WG. Everyday surveillance: Vigilance and visibility in postmodern life. Lanham MD: Rowman & Littlefield; 2013.