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Heezen, Marjolein; Pesch, Udo; Correlje, Aad; Van Zoonen, Liesbet; Ten Kate, Janneke

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Adapting to changing values: a framework for responsible decision-making in smart city development

Marjolein Heezen[a], Udo Pesch [b], Aad Correlje [b], Liesbet Van Zoonen[c] and Janneke Ten Kate[d]

[a]Netherlands Organisation for Applied Scientific Research, Unit Strategy and Policy, The Hague, The Netherlands; [b]Department of Values, Technology, and Innovation, Faculty of Technology, Policy and Management, Delft University of Technology, Delft, The Netherlands; [c]Department of Public Administration and Sociology, Erasmus University Rotterdam, Rotterdam, The Netherlands; [d]Platform 31, The Hague, The Netherlands

ABSTRACT
Smart cities are proposed as a solution for problems of urbanization. Technologies associated with smart cities involve the monitoring of human activities and resulting data streams. These technologies affect certain public values, which may be subject to change depending on their sociotechnical development. This paper presents a method that enables decision-makers to anticipate on this pattern of value change. This method uses two axes that allow a technology to be plotted in terms of different value-laden functions: a first axis in which projects are classified that collect either personal information or impersonal information; a second axis that classifies projects as to whether they collect data for the purpose of service or surveillance. For 37 sensor-based projects in the city of Rotterdam, it has been studied how projects may shift from one quadrant to another. These shifts inform decision-makers so they are better capable of anticipating undesirable impacts of technological developments.

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Introduction

It is expected that by 2050 over 70% of our world population will be living in cities, causing considerable stress on infrastructures, resources, environment and the quality of life for those living in urban areas (Ritchie and Roser 2018). To tackle these issues and to achieve environmental goals, digital and data technologies have been proposed as solutions to make our future cities 'smart' and sustainable (Townsend 2013). These technologies employ a wide range of tracking and monitoring instruments that facilitate the more efficient management of urban traffic, city safety, waste and energy flows and enable effective forms of quality control in domains such as pollution (Miller 2020; Pesch 2021; Trindade et al. 2017). However, to an increasing extent, these technologies

CONTACT Udo Pesch u.pesch@tudelft.nl Department of Values, Technology, and Innovation, Faculty of Technology, Policy and Management, Delft University of Technology, Jaffalaan 5, Delft 2628 BX, The Netherlands

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are seen as challenges to values of cities' inhabitants, for instance with respect to data-ownership, privacy and the public character of the city. In fact, the smart city is often portrayed as a 'corporate narrative' that reduces space for alternative visions (see for instance, Hollands 2015; Luque-Ayala and Marvin 2019; Sadowski and Bendor 2019; Zuboff 2015). This corporate narrative may to be especially recognizable in the United States, while in Europe smart cities are more often conceived according to the 'living lab model' (Baykurt and Raetzsch 2020; Engels, Wentland, and Pfotenhauer 2019). Still, also the European approach to smart urbanism has been subject to the critique that it is not 'truly "citizen-focused"' (Cardullo and Kitchin 2019, 813).

To overcome these problems, scholars attempt to identify the public values that should be guaranteed in creation of the smart city. Common among these are inclusiveness, transparency, privacy and co-creation (e.g. Foth, Brynskov, and Ojala 2015; Keymolen and Voorwinden 2020). Despite broad support for these values, it remains unclear how they are to be implemented by local authorities involved in smart city development (Engelbert, van Zoonen, and Hirzalla 2019).

The approach of Responsible Research and Innovation (RRI) can be considered an appropriate point of departure to develop value-based methods to improve the design of smart cities, especially because the operationalization of public values is very much a key pursuit of RRI (Boenink and Kudina 2020; Stone 2021). A problem is that there seems to be little connection between the field of smart urbanism and RRI. For instance, Galdon-Clavell (2013, 717) states that 'in most instances public officials and decision-makers are ill-equipped to judge both the value and the externalities of the technologies being sold under the label "smart cities"'. The lack of RRI approaches in smart urbanism is also observed by Nagenborg (2018) who sees urban technologies as framed as sets of instrumental solutions to practical problems, without taking the specific character and needs of cities into account.

A further problem is that in case of technological development, it cannot be assumed that the values considered to be relevant for that development are static. As technologies change, so might values (Correljé, Pesch, and Cuppen 2022; Van de Poel 2018). New understandings and new demands about the value of privacy that followed the development of the internet can be seen as an example of such technology-induced value change, which prompt the need to reflect on them so to anticipate further consequences and qualities of technologies, which can be seen as a key goal of RRI (see Stilgoe, Owen, and Macnaghten 2013). Currently, it is hard to find methods that support decision-makers in evaluating technologies while anticipating on changing values.

This paper aims to address these two problems by exploring a method rooted in RRI that allows municipal decision-makers to reflect on possible value changes in smart city development. Following Taebi et al. (2014), we see that responsible innovation demands an interdisciplinary approach in which insights from philosophy of technology are connected to empirical disciplines such as STS and Technology Assessment. Building on these disciplines, we could analyse values, give empirical descriptions of sociotechnical practices, and develop scenarios to allow for anticipation of future developments. Within the context of our research, this interdisciplinary background has been used to: (1) identify relevant values; (2) make projections about potential value changes; and (3) construct scenarios so to provide stakeholder the opportunity to reflect on value changes. With regards to this last step, it most important to sensitize decision-makers about those cases in which the risks associated with a technical system may be subjected to a substantive increase. For instance, data gathered to increase the efficiency of traffic flows may end up being used for gathering information about when and where particular individuals are driving their cars. To comply with the outlook of responsible innovation, it is crucial that decision-makers anticipate such shifts that might happen in the long run.

Our research has been done on the basis of data collected in the city of Rotterdam, the second largest city in the Netherlands with a relatively young and diverse population. It has an ambitious smart city policy in which both large multinationals and various medium or small businesses are active, as well as knowledge institutes and the municipality itself.[1] Our data consist of 17 interviews with municipal stakeholders and cover 37 smart city projects using sensor technology.

The structure of this paper is as follows. In Section 'The challenge of changing values', we will make a theoretical exploration into values, so that we can come to grounded choices for operationalizing values and value change. Based on this exploration, we will specify our research question and explain our choice of data and methods. We will then discuss the main values that our Rotterdam respondents articulate for their smart city in Section 'Value scenarios to deal with changing values'. These inform the scenario analysis of 37 smart projects in Rotterdam (see Appendix) of which we present one in more detail in Section 'Value scenarios to deal with changing values'. We will conclude with an elaboration of the merits and limitations of our approach.

The challenge of changing values

The growing body of RRI-literature may support decision-makers engaged in smart city development in getting a more constructive command on values. The most used framework in RRI is the dimensional approach of Stilgoe, Owen, and Macnaghten (2013), but because of the focus on value, we have used the approach to RRI as developed by Taebi et al. (2014) in which it is maintained that new technologies should endorse specific public values. This value-based approach can be seen as an extension of the framework of 'value-sensitive design' (see Van den Hoven 2014), in the sense that relevant values are not only accounted for in specific technical artefacts and systems, but also in broader socio-institutional settings (cf. Correljé et al. 2015). While this approach is not used as intensively as the dimension-oriented RRI approaches that originate from the tradition of technology assessment (Cuppen, van de Grift, and Pesch 2019; Grunwald 2014), we believe it is helpful to support decision-makers in smart urbanism. Indeed, they are usually involved in the creation of sociotechnical systems by assembling existing technologies instead of developing novel technologies.

Still, before a value-centric approach can be made useful, we have to know what the concept of values pertains to and which values are relevant in sociotechnical systems. To answer these questions, we will take a practical approach to values, which according to Stone (2021) is the most constructive way to deal with values in complex urban challenges. Stone maintains that instead of looking at values, it is necessary to look at what is *valuable*. The hermeneutic account of values developed by John Dewey fits such a practical approach in which 'values' is shorthand for the 'things that we find valuable'. Values inform the *understandings* that allow people to give normative significance to a broader range of experiences and projections (Dewey 1922, 1927). As such, they can be considered as concepts that *aggregate* a variety of impressions that enable agents to prepare for future actions (Boenink and Kudina 2020; Pesch 2022), and give normative guidance to a societal collective in socio-political processes (cf. Veeneman, Dicke, and De Bruijne 2009).

Values emerge and are entertained in 'public debate', which is the set of practices in which civil society aims to discuss the matters that pertain to it. It needs to be acknowledged that the public debate is intrinsically intangible, it is based on the shared *imagination* that there is something like a public and it does so by articulating opinions using a wide variety of media (cf. Habermas 1999; Taylor 2002). As such, the questions about *who* decides *which* values become public cannot be answered unequivocally. We can basically only use 'proxies' to decide which values and which conceptions of values are current (cf. Pesch 2019).

Related to debates on emerging technologies, there is a distinction between the roles of experts on the one hand and the general public on the other. The first group of actors can be seen as 'insiders' that rely on their technical knowledge to make assessments about the future of a technology, while being unaware of possible societal concerns that emerge once the technologies are implemented in society (Garud and Rappa 1994; Pesch 2014). Indeed, as is claimed by Groves et al. (2016), the normative reception in society about how to understand technologies is deeply intertwined with their experience, which will grow over time as technologies become more deeply rooted in social life (also see Fernandez-Anez, Fernández-Güell, and Giffinger 2018; Hatuka and Zur 2020). In other words, the values that are entertained in a public debate may involve two different lifeworlds that should be brought together in order to have debate that is societally responsive. As such, it is crucial that expert knowledge needs to be contextualized by accounting for the further development of sociotechnical practices that give rise to new understandings of values.

Based on these considerations, we have come to the following research questions:

1. Which values do experts consider be relevant in the context of smart city development?
2. How can future value changes due to the ongoing sociotechnical development be anticipated by local decision-makers?

To answer the first question, we draw on the perspectives of local decision-makers themselves, specifically, on the basis of interviews held by the first author conducted in 2018 with civil servants of the municipality of Rotterdam. The respondents were selected via snowball sampling, i.e. we found them on the basis of reputation and recommendation. Eventually 17 interviews were held, of which 10 were with civil servants employed at the Municipality of Rotterdam and four were with Smart City collaboration partners in the city of Rotterdam. The other interviews were with another municipality, with a Smart City advisor or expert. The interviews were then thematically and inductively coded for values. In this, we have looked for those values that may be *compromised* by smart city solutions. The reason for this focus is that the goals of these solutions are expected to be clear, while decision-makers tend to see other values as conditions that should be respected. To further inform the categorization of the values found in the interviews, literature has been used (e.g. Couldry 2017; Kool, Timmer, and Van Est 2017; Van Der Sloot and Lanzing 2021), which resulted in eight intersecting categories of values: privacy, safety, autonomy, power relations, human dignity, justice, control and economic values.

To answer the second question, we first selected 37 smart Rotterdam projects via personal communication with the 10 municipal civil servants who had been interviewed earlier and who were most closely involved in the implementation of these projects. To describe these projects in more detail, we also used web research. Subsequently, we have developed a method to assess possible value change by adapting Van Zoonen's (2016) framework to privacy concerns in the smart city. This framework covers two dimensions of smart city technologies: the types of data (personal or impersonal) that it produces, and the purpose which it serves (service or surveillance). The resulting four categories of smart technologies (impersonal dataservice goal; impersonal data-surveillance goal; personal data-service goal; personal data-surveillance goal) produce different concerns for infringement of privacy. As such, the framework was originally used to identify different risks to General Data Protection Regulation (GDPR) breaches, which dovetails with the development that services are increasingly provided via digital platforms and ICTs, creating privacy issues by collecting immense amounts of data while the regulations and guidelines are lacking. Privacy concerns rise when data sources are combined and aggregated, thereby making impersonal information personal by recombination. Despite this clear focus on privacy, we think this framework also allows the inclusion of a wider set of values than only privacy and that it can serve as a convenient tool to plot sociotechnical developments in a graphic way that is elucidating for decision-makers and supportive in their deliberations. Such a graphical approach is especially helpful as the notions of values and value change are usually presented in an abstract way, making it hard for decision-makers to grasp them practically.

Key public values in smart cities

Our interviews and literature study produced eight categories of public values, which we describe here in general terms.

Privacy

The value that came up most prominently in the interviews was privacy, which is more generally the most discussed, most addressed and maybe most conflicted public value in smart cities. It has been identified as a key issue in terms of policy, legislation, regulation and a typical twenty-first century challenge (Van Zoonen 2016). At the time of the interviews, moreover, Dutch municipalities were assessing the implications of the EU GDPR framework, which was bound to become law on May 25 of 2018. They appointed privacy officers to investigate how the GDPR should be implemented in the municipality. This situation resonated in the interviews, and made clear that values change through time: 'privacy' in smart cities means different things before and after the GDPR and is therefore especially appropriate to investigate our question about value change.

Safety

Digitization and the increased use of ICT mean that there are also risks associated to these technologies that could hamper safety. This was the second biggest concern among our respondents. Hacks are usually associated with costly consequences or outright theft of money and can derail, due to the connectedness of systems and things introduced by 'Internet of Things' (IoT), not just the attacked system, but all things connected to it. This way, 'simple' systems in appliances such as a smart fridge or webcams, can give access to electronic locks on your house or car when hacked. Our respondents feared that if we do not sufficiently protect these simple systems and/or educate their users, we also risk exposing the more sensitive systems that actually *do* matter to us by their connectivity to other systems.

Autonomy

The risk of artificial intelligence taking over municipal processes without human interference also came up regularly in our conversations. In smart cities, increasingly decisions are being automated, without offering any transparency in terms of what is guiding the algorithms making them.[2] A related concern is so-called persuasive technology, such as creating an annoying sound when you forget to use your seatbelt in the car. The ethical dilemma is then whether it is desirable to change behaviour, even when it is for the greater good. Also, if we realize behavioural change through technology, our respondents feel, it might mean that the change is not because of an individuals' autonomous moral responsibility.

Equal relations

There are pre-existing and new power relations at stake in the smart city, according to our respondents: the classic asymmetry between governments and their citizens is exacerbated through smart technologies. Municipalities are collecting and processing more and more data with the aim to monitor, steer or control behaviour, with citizens often being unaware of this or unable to contest it. The service economy enabled by the rise of the mega platforms creates new inequalities and dependencies, especially between public and corporate stakeholders. On the one hand, the platforms step in where public provisions have disappeared, on the other they entertain exploitative business models and provide no service guarantee (Kool, Timmer, and Van Est 2017).

Human dignity

Some of our respondents feared technology and its potential to reduce persons to numbers, to data or a system. Citizens become objects of registration rather than living, breathing, rational beings, which obviously poses a risk of conflicting the value of human dignity.[3] Moreover, persuasive technologies that nudge certain types of behaviour exert a type of power and control that might compromise individuals in their right to decide for themselves what is wrong or right. Their principles and beliefs are surpassed by technically enforced moral standards.

Justice

A related problem is that of profiling and stigmatization created by the reduction of information about individuals to mere statistics and data from which incorrect conclusions are drawn. Prediction on the basis of address or postal code is notorious in this respect: benefit fraud, crime rate and other social problems have all been subject to data science experiments that identify whole neighbourhoods as populated with potential offenders. Such injustice is exacerbated by the lack of transparency that can explain on what these decisions, judgements and differences in treatment due to profiling and analysis are based.

Control

The discussions about human dignity and justice we had with our respondents, invariably brought up the issue of control. Who is responsible for these algorithms and the decisions that they make? Who takes responsibility? How can we make them transparent? Is it really revealing competitive information if these algorithms were open? The ability for people to still make their own decisions, to be able to control the technologies that impact our lives, is seriously being hampered by the algorithms used in the smart city and various other industries. There is a need for transparency and a critical stance towards the use and implications of these algorithms. In addition, algorithms that hamper the ability to express control, to get knowledge or that create power asymmetry benefitting particular involved actors might be equally disturbing.

Economic values

Some of our respondents underlined the possibility of new technologies rejuvenating the traditional port economy of Rotterdam, enabling a sustained competitive advantage for a relatively poor city. This is also an important legitimation of Rotterdam's overall smart city policy. These values are often contrasted with public ones and evidently create very different incentives for corporations, municipalities and citizens. But, in general, the civil servants we spoke to saw no inevitable contradiction between economic regeneration and public values.

Value scenarios to deal with changing values

The values identified above present a static view, but a sociotechnical system like the smart city is a dynamic, highly interconnected entity. This means that municipal stakeholders cannot just take account of a set of values, such as those presented in the previous section. They need to anticipate and reflect on the possible changes in values due to the further development of the sociotechnical system.

In this section, we examine 37 smart Rotterdam projects and explore if and how technological changes in these projects may affect the eight values we identified (also see Vieveen 2018). To do so, we have used the framework developed by Van Zoonen (2016), which has been introduced above. This framework uses one axis to indicate whether a technology collects *personal information* or *impersonal information* (the type of data); a second axis is used to indicate whether a technology collects data for a *service purpose* or for a *surveillance purpose*. These dimensions can be mapped out in a quadrant framework. In Van Zoonen's original approach, personal data gathered for service purposes (quadrant I) involve those data collected by local governments to monitor demographic patterns, to assess the quality of interactions with their residents and analyse civic moods in order to underpin city management and planning, to enhance city services and to support local citizens. Personal data used for surveillance purposes (quadrant II) covers personal data, collected and monitored for surveillance purposes, one may think here for instance of police data. Impersonal data used for surveillance purposes (quadrant III) concern all data that cannot be linked to an individual person and are used for surveillance and control purposes, for instance for controlling traffic flows. Finally, there are impersonal data collected for service purposes (quadrant IV), for which we may think of monitoring systems for air quality, energy or waste. In other words, data about 'things' instead of people are being collected in this quadrant.

Following Van Zoonen, we hypothesize that technologies that are created for a service purpose collecting impersonal data are less likely to raise value concerns than technologies that are installed for surveillance purposes collecting personal data. There is less risk that the condition that is set by the value of privacy challenged by a technology if this technology is found quadrant I than it would be in any other quadrants. However, given the presence of sociotechnical dynamics, it might occur that a technology changes its place in the quadrant over time, raising the possibility that a value is negatively affected. A situation which we call a 'value-risk' here.

As such, we can systemize these sociotechnical dynamics and possible problems caused by shifts in perceived value risk by: (1) plotting the technologies in terms of their data and purpose; (2) thinking about changes that occur over time due to the further development of a certain technology; and (3) reflecting on the impact of these changes in terms of the values that are relevant with regards to this technology. This is, in essence, the approach that we have taken in order to analyse the smart city initiatives in Rotterdam. First, we will position the 37 smart projects in one of the four quadrants, based on their usage of personal or impersonal information, and having a service or surveillance purpose. Subsequently, we will introduce scenarios of technological change, based on our own interpretations of the situation that were also informed by the results of our interviews, and discuss if and how these changes influence the position these technologies hold in the framework, shifting inside or outside of their original quadrant. Such shifts necessitate the reconsideration of the value risks attached to the further development of a given technology.

Classifying the cases

The classification of the 37 projects is presented in Figure 1. Of the 37 projects, 19 could be classified as being quadrant IV projects concerning the use of impersonal data for a service purpose. Three projects are on the borders of quadrants IV and III or IV and I. One project is on the border of all four quadrants, eight projects are classified as quadrant III projects, six projects as quadrant I and only one project is classified as quadrant II.

The distribution of the cases in the four quadrants does not necessarily mean that the smart city projects in Rotterdam are all about the improvement of services using impersonal data. The outcome is partly an artefact of the source of our cases, i.e. a selection of cases known by the municipality of Rotterdam that use sensor technology. But, in

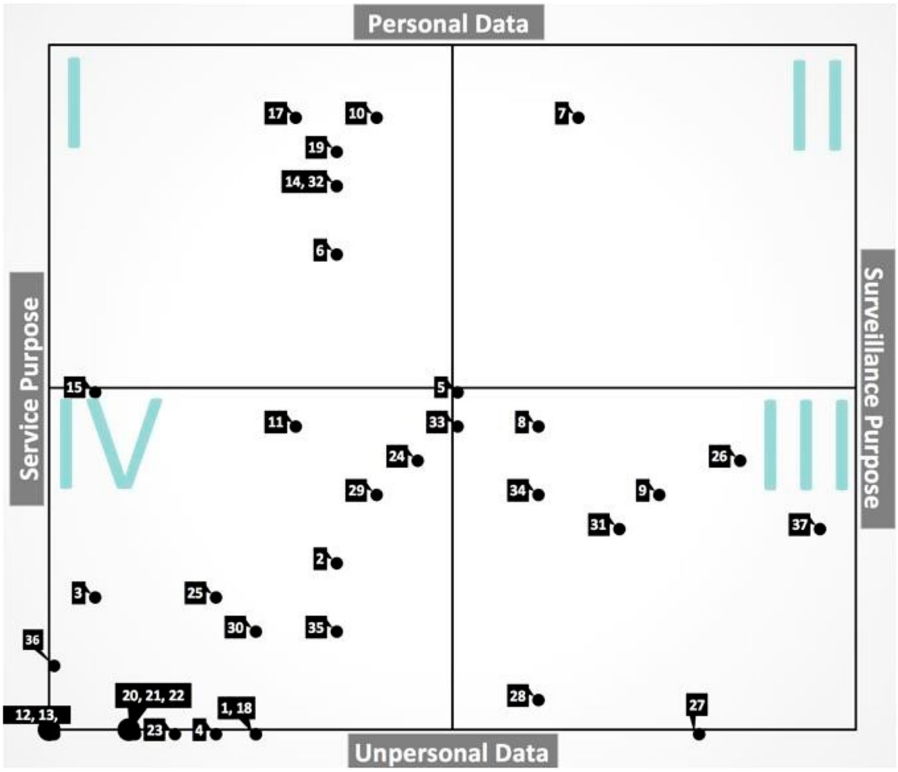

Figure 1. Classification of 37 sensor-based smart city projects in Rotterdam.

addition, quadrant IV projects have a low value-risk because of their absence of personal data and their deployment to service. It is also likely that they will be more easily developed because of their lack of value-risk. Projects in quadrant II have a much higher value-risk because they use personal data for surveillance purposes. Moreover, these projects may be designed and implemented by other branches of the municipality, such as the police or the social benefit agency, or they are developed by market organizations. Indeed, both are heavily involved in the development of predictive analytics to identify risks of crime or fraud (cf. Van Zoonen 2016).

While Figure 1 does not offer a comprehensive distribution of all digital and data technologies that would be part of smart Rotterdam, we think it is a good starting point to explore the possibilities of value change due to the further development of a sociotechnical system. We examined all 37 cases for possible future uses of the technology involved and then colour-coded each of them to identify the degree of risk. This identification has been based on our own interpretation, admittedly making it a subjective evaluation that may not be free of bias. Projects that have been colour-coded in green have been identified as 'not likely' to cause any problems in the future, even if the technology gets widely implemented. The yellow projects have been identified as creating a 'plausible negative future scenario', in which the technology might come to challenge a key value. The red projects have been identified as creating an 'expected negative future scenario'. We also registered the responsible actors for these projects, distinguishing between public actors, public–private partnerships, triple-helix projects, citizen science and 'unknown'. To further explain our approach, we discuss one project in more detail, before presenting the overall risk-analysis for the 37 projects.

Example: talking traffic

Talking traffic is a national collaboration between private and public parties that together try to create solutions for all types of trouble experienced with traffic. The project consists of multiple tests, pilots and experiments, and it aims to create solutions for a sustainable, non-congested and economically viable future. The reason for initiating this project is the projected increase in congestion in the country. All over the Netherlands, congestion is expected to increase with 38%. In cities, this problem is even larger, and they expect to have an increase of 50% by the year 2021, which is barely 2 years away. Besides the fact that traffic congestion wastes time, they are frustrating to traffic participants and detrimental to the environment, while they also cause economic problems. The financial damage due to these congestion patterns is increasing from 840 million euros in 2017 to about 1.7 billion euros in 2021.

The project includes an application that can be downloaded to a smartphone, which allows one to be connected to traffic lights, road signs, traffic centres and other road users, creating an 'Internet of Things' environment for road users. It is believed that this application could enhance efficiency in traffic as well as safety and comfort. In this, Rotterdam is only one of the 60 cities that are connected to the project. Moreover, the project can be identified as a public–private partnership project, which is a monitoring project, mobility project and an application project.

In Table 1, more details about the case can be found.[4] This table also presents the argumentation for the evaluation of the case regarding its placement in one of the quadrants and the possibility of shifting towards another quadrant.

The project is positioned in the first quadrant because the data collected is connected to an individual mobility or user profile, which makes the data collected in this project *personal*. The purpose for data collection is however to help road users and logistics

Table 1. Characteristics of 'talking traffics'.

Project initiator	Talking traffics
Collaboration type:	Public–private partnership
Collaboration partners:	27 partners (public, private, NGO's)
Type of project:	Monitoring project; Mobility project; Application project
Project description:	By the use of intelligent Traffic Regulation Information systems, the flow of traffic will be adjusted to the users, making it more efficient and comfortable. Rotterdam is one of the 60 cities that are connected to the project. The project includes an application that could be downloaded onto your phone, which allows you to be connected to traffic lights, road signs, traffic centres and other road users, creating an Internet of Things environment for road users.
Original quadrant:	Quadrant I
Argumentation:	The placing of the project in the first quadrant is due to the fact that the data collected is connected to an individual mobility or user profile (personal data). The purpose for data collection is an example of service-based data collection.
Risk for quadrant shift:	To quadrant 2: Plausible negative future scenario
	Combining all this collected data on people's whereabouts in the city, individual profiles can be deduced and used for other applications than traffic flow. This database is of great commercial value for both marketing purposes and consumer behaviour analysis. The involvement of the large amount of private parties might create the incentive to use this data and experience for different applications.

companies in various ways to achieve more efficient, comfortable and safer transportation. This intention can be characterized as a *service* goal. For several reasons, we can make think of development which cause a shift of this project from a low to a high value-risk. One reason for this, is the strong involvement of private parties and the abilities to reuse data for other purposes. By combining all this collected data on people's whereabouts in the city, individual profiles can be deducted and subsequently used for other applications than traffic flows. Users have no choice to be excluded from this analysis. We expect that such a database, containing personal information and mobility patterns, can be of great commercial value for both marketing purposes and consumer behaviour analysis. The added monetary value may increase if this information is combined with other data sources. The involvement of the large number of private parties might create the incentive to use this data and experience for different applications. Another important implication is the fact that this technology is supposed to make traffic safer, while it is actually stimulating people to use their phone while participating in traffic. This is considered a hazard. In this scenario, we see how, with the risk of breaching the value privacy, other values are affected as well, in particular control, autonomy, safety and power relations. The shift in the quadrant framework is depicted in Figure 2 through the yellow dots.

Overall value-risks

We conducted a similar scenario exercise for all other 36 projects, exploring and anticipating their future developments and the perceived risks they pose to the eight values identified in Section 'Key public values in smart cities', as well as assessing the main responsible actors. In Table 2, we summarize the outcome of this analysis.

Table 2 shows that out of the 28 projects that have caused a value problem, 22 affect privacy. Other values that are potentially value-contentious are power relations (19

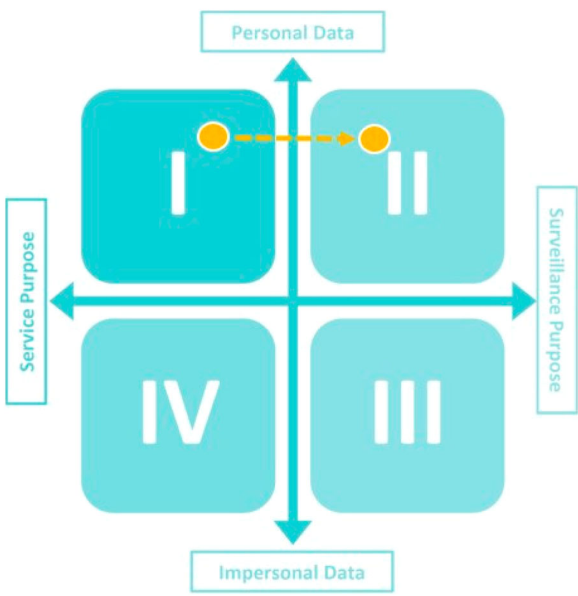

Figure 2. Possible shifts for Talking Traffics project.

Table 2. Overview of value conflicts and problems occurring in the analysis or 37 cases.

Values Pressured:	Total occurrence:	Projects in which this public value conflict or problem occurs:	Projects with municipal value conflicts or problems occurs:
Privacy	22 projects	1; **2**; **3**; **5**; *6*; **7**; **8**; **9**; *10*; *11*; *14*; 17; **19**; **21**; 24; *26*; 30; 31; **32**; **33**; 34; 37	
Power Relations	19 projects	**3**; **5**; *6*; *10*; *11*; 17; **19**; **21**; 24; 30; 31; **32**; **33**; 37	**2**; **5**; **7**; **9**; *25*; 30; **33**
Control	16 projects	**2**; **5**; *6*; **7**; **9**; *10*; *11*; *14*; **19**; *26*; 30; **33**; 34; 36; 37	**5**; **9**; 17; 30; **33**
Justice	16 projects	**3**; **5**; *6*; **7**; *10*; *12*; *14*; *16*; **21**; 24; *26*; 30; 31; **33**; 37	*4*
Autonomy	9 projects	1; **5**; **7**; **8**; 17; **19**; 30; **32**; **33**	
Economic Values	7 projects		**2**; *4*; **7**; *12*; *16*
Safety	6 projects	**5**; *11*; **19**; 30; **33**; 37	**5**; 30; **33**
Human Dignity	2 projects	*29*; 36	

Note: In this table, the colours of the project numbers correspond with the classification used for determining whether there is a risk for shifting and/or value problems (e.g. green, yellow, red). The projects that are 'bold', represent public–private partnership projects; the projects that are in 'italic', represent unknown collaboration structures, the projects with and 'underscore', represent triple helix or public–scientific collaboration structures, the projects using normal typing, are either public–public collaboration, or citizen science.

projects), control (16 projects) and justice (16 projects). When analysing the types of projects in which these risky value changes occur, it turns out that out of the 14 projects that collaborate via a public–private partnership, 10 of these projects cause value-risks. For so-called 'triple helix' collaborations, i.e. projects that are based on a cooperation between industry, government and science, all four projects hold potential value-risks.

These outcomes are differently presented in Figure 3 where green dots represent the absence of risk, yellow ones possible risks and red dots express high risk.

Though quadrant IV is considered low risk, as no personal data is used and the purpose of data use or collection is for service activities, some projects nevertheless turned out as possibly risky and threatening public values in the future. Out of the 22 projects that are located inside or on the border of quadrant IV, eight are posing a threat to shift and conflict values, and out of these eight projects, three projects are classified as creating a possible risk.

Conclusion and discussion

There is an increased appeal to innovate in a responsible way, entailing particularly the inclusion of public values in the design of new technologies. In this, it is crucial to

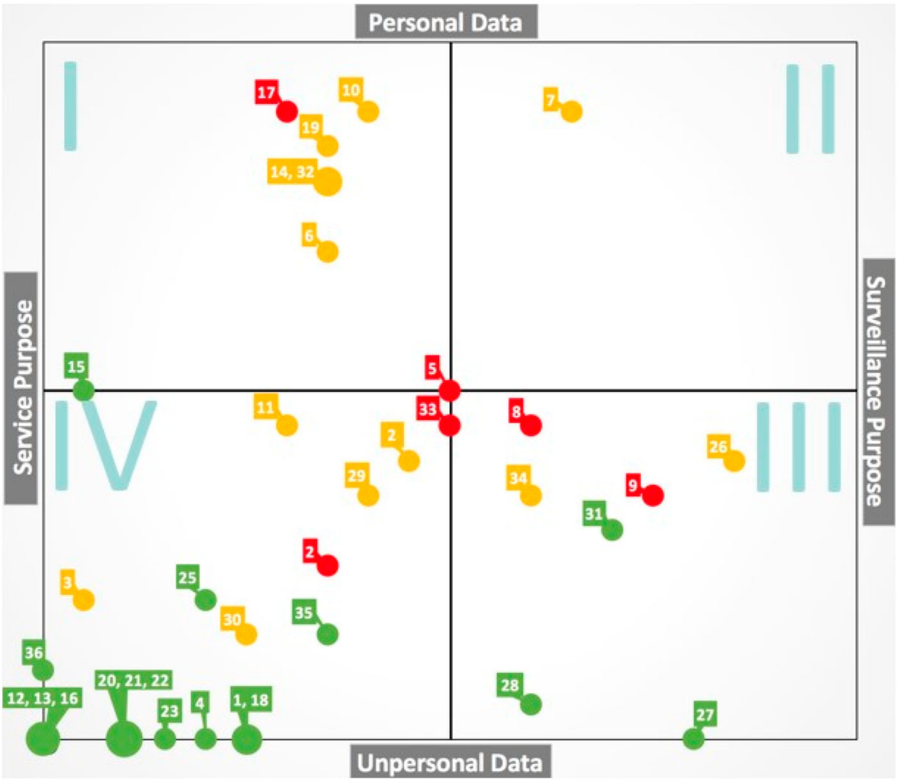

Figure 3. Scenarios of shifts in risks of projects.

acknowledge that such values will change over time – as noted by Van de Poel (2018). In our paper, we have taken on this challenge by narratively exploring the possibilities of such change in 37 smart city projects in Rotterdam, by developing a framework that is able to address and identify such potential value problems. The purpose of the framework we presented was to help decision-makers to anticipate these problems, by showing possible future developments in which values originally attended become compromised. As such, this method allows makes a contribution towards improving the capacity of decision-makers to anticipate and discuss the implications of technological change, coming to decisions that are more robust with regards to future scenarios (Ligtvoet et al. 2016).

The need for such a method follows from the tendency of decision-makers only to consider the direct outcomes of projects, neglecting possible changes that take place once the project is implemented (cf. Cuppen et al. 2020; Pesch and Ishmaev 2019). This might give decision-makers the impression that they are acting responsibly, accounting for all relevant values. But genuine responsible behaviour demands the attention for value change as well. Indeed, as our method reveals, the original location of the project in one of the four quadrants framework is no guarantee for it that there are no future risks. This insight is a valuable lesson for any civil servant responsible for approving projects that seem to be harmless.

The merit of our approach is that it makes clear in a graphically appealing manner how technological developments can have undesirable outcomes. This is especially relevant as decision-makers often account for specific values during the design and development of a smart technology, but often appear unaware of possible future changes. However, this merit goes hand in hand with a number of simplifications that need to be acknowledged as well. Below we will discuss some of the most salient of the issues raised our approach. We note that these are very much interconnected.

First, we have focussed on the values that can be seen as pre-conditions for the ethical acceptability of a sociotechnical system. However, the range of values that is directly pursued by such a system has been reduced to only two functions: surveillance and service. This allows for a two-dimensional representation, but it also ignores the possible heterogeneity and interdependence of values that are intended in the design of the system.

Second, while we can make some inferences about which patterns give rise to value risks, such as the cooperation between public and private actors, the approach we have taken here is not systematic enough to identify patterns in a way that can be said to be exhaustive and decisive. So even though the future scenarios that we explored may be plausible, our analysis can be taken as an example of 'speculative ethics' (Nordmann 2007; Nordmann and Rip 2009) which is however unavoidable and necessary given the current pace of technological developments. Yet it also entails the risk of closing off alternative imaginaries and possibilities, a risk that can for instance be mitigated by using several methods that each highlight a different aspect of the problem at hand or by having different runs with contrastive scenario outcomes. This would help decision-makers to take a plurality of possible futures into account instead of just one future.

Third, the values we have identified have been based on the input of experts and academic literature. As was explained in Section 'The challenge of changing values', it is characteristic of the public debate on technological development, that there is a time lag between the evaluation by experts and by the general public. Members of the public, users and affected parties can only react to the values that have been accounted for in the design of a technology. The limited capacity to shape values autonomously, can give rise to societal controversy in which not only new values are added, but also dominant conceptions of the values used may be contested (Cuppen et al. 2015; Pesch et al. 2017). These reactions from society itself, in this case, the residents of the city and individuals and groups that somehow are affected by these smart city solutions, have not been taken into account in our analyses. We recognize the need to take the normative considerations of citizens more seriously in smart city development, and we would very much welcome methodologies that allow the incorporation of these considerations.

Fourth, we have used only one pattern of value change, namely the way a value is understood in the light of changes due to technological development. According to Van de Poel (2018), also other patterns of value change in the context of new technologies can be recognized. For instance, we can think of new values that come alive to make sense of an existing or emerging technology. Or we can think of adjustment in the prioritization of values connected to a particular technology based on ongoing experiences in its use.

The introduction of RRI in smart city development has been presented as a way to overcome the 'corporate narrative' in smart urbanism, as it is stated in literature. The identification of values that can be considered to be public is a first step to overcoming this narrative, but public values appear not to be static, especially within the context of evolving sociotechnical systems. Hence, making smart city development public instead of corporate brings about challenges about how to anticipate for value change. The method that we have presented helps decision-makers to address this challenge. Firstly, it provides a repertoire of values that are relevant within the context of smart cities, and it gives decision-makers the opportunity to engage critically and reflexively with these values with regards to potential future developments. As such, this method hopes to overcome some of the key problems in smart urbanism, making it more responsible and more public.

Notes

1. https://docplayer.nl/16156824-Smart-city-rotterdam-een-visie-op-een-slimme-toekomst.html, accessed on 11-11-2021.
2. https://benk.nl/ACTUEEL/TabId/139/ArtMID/875/ArticleID/321/De-AVG-in-een-notendop.aspx, accessed on 15-11-2021.
3. http://docplayer.nl/17861705-Pieter-ballon-smart-cities-hoe-technologie-onze-steden-leefbaar-houdt-enslimmer-maakt.html, accessed on 15-11-2021.
4. https://www.talking-traffic.com/nl, accessed on 15-11-2021; https://www.rootsadvies.nl/downloads/content/330/8d93d461e29d960/programma-beter-benutten-boek-2016.pdf, accessed on 17-22-2021.

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Notes on contributors

Marjolein Heezen is Junior Consultant and Researcher at the Unit Strategy and Planning of TNO (Netherlands Organisation for Applied Scientific Research). Her work focusses on the spatial implications of transitions, innovation capacity and (adaptive) governance – specifically concerning mobility and urban innovation. In 2018, she defended her Master thesis at the TU Delft on the responsible innovation of smart cities.

Udo Pesch is associate professor at Delft University of Technology. He is head of the section of the Ethics and Philosophy of Technology of the faculty of Technology, Policy and Management. His disciplinary interests include responsible innovation, environmental politics, public policy and ethics. Recently published work includes articles on energy justice, citizens initiatives in sustainable innovation and the role of emotions in participatory risk assessment. He has published a wide range of articles and book chapters, among others in *Social Studies of Science* (SSS), *Science, Technology & Human Values* (STHV), *the Journal of Responsible Innovation* (JRI), *Science and Engineering Ethics* (SEE) and *Technological Forecasting and Social Change* (TFSC).

Aad Correlje is Associate Professor of Economics of Infrastructures at the Faculty of Technology, Policy and Management (TBM), TU Delft. He has been a Member of the Dutch Mining Council since 2013 and of the Editorial Board of the journal Energy Policy since 2002. He is a part-time professor at the Florence School of Regulation of the European University Institute. His research involves an institutional economics approach to public policy and private strategy development in infrastructure bound sectors (particularly energy and water). He is involved in several projects on Socially Responsible Innovation in the energy transition, with a focus on the interaction between public policy and societal acceptance. Correljé is involved on a regular basis in media coverage of energy and sustainability issues.

Liesbet van Zoonen is professor of Sociology and dean of the Erasmus Graduate School of Social Sciences and the Humanities at Erasmus University Rotterdam. Professor Van Zoonen joined the department as professor in Popular Culture in March 2009. Previously, she worked at the University of Amsterdam, most recently as head of the Department of Communication, and till December 2015 she was professor in Media and Communication at Loughborough University (UK). She also held various positions at other universities in the world, most notably as professor II at Oslo University, and as visiting professor at the University of the West Indies (Jamaica) and the Hochschüle für Film und Fernsehen (Germany). Her research covers a wide range of issues in the social sciences and humanities, but all concern the question whether and how popular culture is a relevant resource for civic understanding and social participation. Her work currently is focused on public and individual taboos and desires around 'identity management'; research which is funded by the Engineering and Physical Sciences Research Council of the UK.

Janneke ten Kate is project leader space and economy at Platform 31, which is a knowledge and network organization that aims to facilitate the interactions between various decision-makers related to urban and regional issues.

ORCID

Udo Pesch http://orcid.org/0000-0002-8980-5205
Aad Correlje http://orcid.org/0000-0003-2722-1877

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Appendix

List of smart city projects in Rotterdam. This list is based on personal communication with municipal civil servants and further elaborated by desktop study.

Name	Type or project	Quadrant	Quadrant shift	Risk of quadrant shift
Rain Gain	Environmental project	IV	Not applicable	Not likely
Pilot Project Havenspoorpad	Smart lighting project	IV	II (via I)	Expected
Filling Degree of Waste Containers	Environmental project; Asset management project	IV	III	Plausible
High-speed cameras for monitoring load on assets	Asset management project	V	Not applicable	Not likely
Multi mast	Smart lighting project	Centre of all quadrants	II	Expected
QR-coded benches	Application project; Social media project	I	II	Plausible
City Traffic	Monitoring project	II	II	Expected
Beter Benutten – Cyclists	Monitoring project; Application project; Mobility project	III	II	Expected
Use of Public Transportation	Monitoring project; Mobility project	III	II	Expected
Scanning-cars for license plates	Monitoring project; Mobility project	I	II	Plausible
Sensor analysis for parking space availability	Monitoring project; Mobility project	IV	II	Plausible
Rain sensor for cyclists	Mobility project	IV	Not applicable	Not likely
Comfort measurements for cyclists	Monitoring project; Mobility project	IV	Not applicable	Not likely
Comfort measurements for road users	Monitoring project; Mobility project; Application project	I	II	Plausible
Road salt sprinkler	Mobility project; Asset management project	I and IV	Not applicable	Not likely
Heat camera for cyclists	Mobility project	IV	Not applicable	Not likely
GoBike	Mobility project; Application project	I	II	Expected
Sensors in the Erasmus Bridge	Mobility project; Application project	IV	Not applicable	Not likely
Talking Traffics	Monitoring project; Mobility project; Application project	I	II	Plausible
Smart electricity Grid Merwevierhavens	Energy project	IV	Not applicable	Not likely
Overflow sensors	Environmental project; Asset Management project; Monitoring project	IV	Not applicable	Not likely
Underground Sensoring	Environmental project; Asset Management project; Monitoring project	IV	Not applicable	Not likely
Groundwater level Sensoring	Environmental project; Asset Management project; Monitoring project	III	IV	Not likely
Sensored City	Asset management project; Monitoring project	IV	III	Plausible
Vibration Meter Application	Monitoring project; Application project	IV	Not applicable	Not likely
Fireworks Sensoring	Monitoring project; Safety project	III	II	Plausible
Monitoring Maastunnel	Monitoring project; Environmental project; Asset management project	III	Not applicable	Not likely

(*Continued*)

Continued.

Name	Type or project	Quadrant	Quadrant shift	Risk of quadrant shift
Drone Inspections of Civil Structures	Monitoring project; Asset management project	III	Not applicable	Not likely
Election day Application	Monitoring project; Application project	IV	III	Plausible
RUGGEDISED	Smart lighting project; Monitoring project; Mobility project; Environmental Project; Asset management project; Energy project; Safety project	IV	III (or even II)	Plausible
Citizen Science Project	Monitoring project; Environmental project	III	Not applicable	Not likely
Buiten Beter Application	Monitoring project; Environmental project; Application project	I	II	Plausible
Lamppost of the Future	Smart lighting project	III and IV	II	Expected
Heatmaps of the City Centre	Monitoring project	III	II	Plausible
Trams communicating with traffic lights	Mobility project	IV	Not applicable	Not likely
Waste Shark	Environmental project; Asset management project	IV	Not applicable	Not likely
PS – CRIMSON	Safety project; Monitoring project	III	II	Plausible