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Citizen repertoires of smart urban safety: Perspectives from Rotterdam, the Netherlands

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ABSTRACT

This article provides empirical research about the perspectives of citizens of Rotterdam, the Netherlands, on the emergent phenomenon of 'smart urban safety', which advocates advanced uses of digital technologies and data for urban safety management, and is gaining currency in thinking about urban futures. While smart cities affect many dimensions of city management, applications to safety management belong to the most controversial, revealing important tensions between disparate perspectives on technology and society in the context of urban living environments. Despite their influence, the concepts of smart cities and smart urban safety are largely unknown to the public. To gain insights into citizens' perspectives, this study uses smart urban safety vignettes to which participants are invited to respond. Using discourse analytical techniques, their interpretations of safety in the smart city are described, which center on functional designs, express lacking influence over technological developments, and reflect on benefits and risks and on their civic roles vis-à-vis technologically mediated urban safety management. Our article concludes by arguing how these findings complement, but also show limitations to traditional technology acceptance models that are as of yet dominant in research of smart urban safety specifically, and smart cities more generally.

1. Introduction

In ongoing debates about the future of cities in an urbanizing world, *urban safety* is considered a key challenge, demanding innovative approaches by city planners, administrators and safety organizations (c.f. Prislan and Slak, 2017). Safety is a multifaceted phenomenon, involving events, such as natural disasters, and continuous processes, like social cohesion and polarization. Moreover, safety threats can be caused intentionally and accidentally, and safety involves both the 'objective' likelihood of becoming a victim of such diverse events, and subjective perceptions of their occurrence (e.g. Pietre-Cambacedes and Bouissou, 2013). Because of their roles as cultural and economic hubs attracting large population sizes, cities are often thought to be particularly vulnerable to such manifold safety aspects (Murray, 2017).

Meanwhile, the notion of smart cities has become an influential paradigm in urban policy circles, business and academia as a possible answer to urban safety challenges. The notion of smart cities proposes that networked infrastructures and information and communication technologies (ICTs) can be leveraged as solutions to current and future social, economic and environmental challenges (Townsend, 2013). By harnessing the data-generating capacities of ICTs and using sophisticated techniques for analyzing an abundance of data about urban phenomena and activities, smart cities promote the idea that 'increasingly complex' urban processes can become knowable, facilitating rational, evidence-driven and efficient interventions (Kitchin, 2014; Kitchin, 2016). Consequently, the possibilities are explored of tapping the smart city's potential for a mode of ICT-mediated, information-based urban safety management (e.g. Lacinák and Ristvej, 2017; Prislan and Slak, 2017), which we will simply refer to as 'smart urban safety'.

While there is great enthusiasm about the potentials of smart cities, one of the main reasons for criticizing the concept is that its use in discourse and practice often excludes citizens' desires, aspirations and concerns. Excluding these 'citizen perspectives' problematizes the legitimacy of resource intensive smart city projects that may pull attention away from the priorities of citizens themselves (Shelton and Lodato, 2019). Despite research about citizenship in smart cities being well underway, there is little empirical information available on how citizens themselves react to the notion of smart cities. The limited explorative research available suggests citizens embrace the use of ICTs and data for the sake of convenience and efficiency in urban mobility (Thomas et al., 2016), yet much less is known about their reactions to

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applications in the domain of urban safety. This is surprising, as safety may be the pre-eminent topic to bring citizen perspectives to the surface. Not only do safety measures have direct, far-reaching consequences for individuals and groups of citizens, but safety practice is also inherently political in that it organizes social relations around 'enemies', risks, fears and anxiety (c.f. Huysmans, 2014, p. 4).

The purpose of this study is to gain insight into the ways that citizens react to smart urban safety. As a generally underresearched, yet societally and politically highly relevant phenomenon, our focus on citizen perspectives on smart urban safety constitutes a first contribution of our study. A second contribution is our use of interrelated vignettes, which we suggest as a useful methodology to elicit evaluative responses on the hard-to-grasp notion of smart urban safety. Third, by closely analyzing the discursive resources participants use in their reactions, we describe a variety of citizen perspectives, which have implications for the politics of smart urban safety and also challenge the appropriateness of trade-off models to explain citizens' acceptance of individual smart city technologies.

The paper proceeds as follows. In Section 2 we briefly review the existing literature related to our study, and argue for the necessity of research on citizen perspectives on smart urban safety. In Section 3 we account for our choice for using vignettes and discourse analysis to first elicit and then study perspectives on smart urban safety from citizens of Rotterdam, the Netherlands. In Section 4 the results of the study, citizens' interpretive repertoires of smart urban safety are described. The paper ends with the discussion and conclusions of the main findings in light of theoretical and practical implications of our research.

2. Background: accounting for citizen perspectives in smart urban safety

Critical inquiry into smart cities has increasingly become centered on the place and role of citizens in smart city discourses and practices. Here we highlight a few emerging insights from these studies, which are relevant to situate our choice for studying citizen perspectives on smart urban safety in the wider literature. Subsequently, we will address relevant previous research on perceptions of urban safety technologies and the scarce literature on citizens' reactions to smart cities.

Much smart city critique is aimed at their top-down, technocentric underpinnings. Vanolo (2016) argues that instead of solving urban problems, many "hypertechnological" smart city visions may exacerbate inequalities by their ignorance of local socio-political structures. Moreover, Kummitha and Crutzen (2017) describe how many smart city approaches have not considered the intricate human aspects in technology-use. In response to such criticism, smart cities have been recast as 'citizen-centric'. In particular, the notion of 'smart citizens' is deployed to promote ICT-facilitated citizen-government interactions and the creation of open data platforms for communities of interest to participate in (and potentially transform) urban governance from the bottom-up (de Waal and Dignum, 2017). In turn, such approaches have been criticized for viewing citizens as human sensing nodes immersed in computational environments, reducing participation to the contribution and use of digital data (c.f. Gabrys, 2014). Notwithstanding challenges to the purported dichotomy between top-down/technocentric and bottom-up/citizen centric smart cities (Zandbergen and Uitermark, 2019), scholars often remain skeptical, arguing that smart city participation excludes most 'average' citizens and that there is little scope for meaningful contributions to policy formulation, the framing of urban issues and their translation into technological solutions (Cardullo and Kitchin, 2019; Shelton and Lodato, 2019). Consequently, much smart city discourse and practice is argued to remain adherent to a top-down version of participation that largely excludes the interests and perspectives of citizens themselves (Engelbert et al., 2019, p. 352).

The main concerns over excluding citizen perspectives from smart city discourse and practice boil down to possible conflicts between the interests and priorities of 'smart city advocates' (e.g. governments, technology and consultancy corporations), and those of the wider citizenry inhabiting smart cities. As a potential domain for smart city applications, urban safety may be particularly likely to make such tensions visible. For example, when governments and law enforcement agencies adopt ICT-based safety measures, questions over the ways insecurities are defined, assessed and acted upon become highly relevant and potentially controversial as the consequences may risk to entail severe social and racial discrimination (see Angwin et al., 2016). Hence, failing to account for citizen's perspectives potentially undermines the political legitimacy of engaging in smart urban safety, as there is a risk that plans and technologies are developed that have no connection with, or may even be directly opposed to what citizens want from their city.

Remarkably, however, urban safety has largely been neglected in smart city research (de Haan and Butot, 2020), and there is little known about how citizens react to smart safety systems. A few studies have focused on citizens' acceptance and use of specific smart city technologies unrelated to urban safety. These studies typically construct benefit-risk tradeoff models based on Davis' (1989) technology acceptance model (TAM), the unified theory of acceptance and use of technology (UTAUT) (Venkatesh et al., 2003) and information privacy theories (e.g. Belanche-Gracia et al., 2015; Sepasgozar et al., 2019; Yeh, 2017). The preoccupation with tradeoff models can also be found in one rare study focusing on the tradeoff between safety and privacy, which finds that citizens' fear of crime and the spatial contexts in which technologies are implemented are the strongest predictors for acceptance of smart city surveillance (van Heek et al., 2017). However, the authors also acknowledge that evaluations in "real world" scenarios (p. 189) are not based on individual factors, but more likely to follow from "concurrent" factors. Two explorative, more open-ended studies give some insight in citizen perspectives beyond value tradeoffs. Thomas and colleagues (Thomas, 2016) demonstrate that when not asked to trade one value in for the other, citizens expect both utilitarian benefits of smart city technology and information privacy. Lastly, Jameson and colleagues (2019) focus on citizens' experiences of surveillance in a smart city context, highlighting their uncertainty about opaque data practices and their associated feelings of "hypervisibility", as well as the contrasting reactions given on smart city surveillance for safety purposes.

While it is clear that relatively little is known about citizen perspectives on smart urban safety, discussions about experiences of technologically mediated safety management have a longer tradition in studies of CCTV surveillance. Researchers have explored the gendered experiences of CCTV and safety (Koskela, 2002), and the intertwining of social meanings attributed to urban districts, safety and the technology itself in evaluations of CCTV (Zurawski and Czerwinski, 2008). Moreover, focusing on CCTV experiences in nightlife districts, Brands and colleagues (2016) find that while awareness of CCTV may increase safety perceptions, it is not believed to be effective in acute safety threats, exposing a mismatch with formal rationales that CCTV ensures safety altogether. Taken together, these findings are relevant for our study to the extent that they highlight a greater variety of experiences of urban safety technology than considerations of its effectiveness and risks. Similarly, intricacies of personal characteristics, socio-spatial meanings and knowledge of safety technologies can be expected to play a role in perspectives on smart urban safety. However, whereas CCTV constitutes one specific group of safety technology, smart urban safety is predicated on the integration of various disparate technologies, urban data and advanced software-aided analytical techniques (Prislan and Slak, 2017), making safety technology more subtle and intense than visual forms of surveillance (Koskela, 2002). As computerized code, or "software-sorting techniques" (Graham, 2005) become prevalent in the governance of urban safety, this raises concerns about the social politics embedded in algorithms which classify urbanites and their behaviors in ways invisible and opaque to the public, but with potentially far-reaching consequences for them (Monahan, 2018). Indeed, such

concerns have partially been validated from a citizen perspective by previous smart city research quoted above (Jameson et al., 2019).

Given the high social and ethical costs at stake, citizens' perspectives on smart urban safety expectedly are more multifaceted than trading straightforward safety benefits against privacy. We do not deny the existence of tensions between efficiency and safety on the one hand, and citizens' surveillance, privacy and likelihood to face interventions on the other (c.f. van Zoonen, 2016). However, such tensions tell only part of the story. For instance, van Lieshout and colleagues (2013) argue how safety and privacy are multidimensional and contextual concepts that cannot be reduced to simplistic descriptions, and asking research participants to trade one for the other unjustly presupposes that citizens make informed judgements in these cases. Building on this perspective, Pavone and colleagues (2018) demonstrate that open and informed discussions of safety technologies reveal many different insights on the very concepts of safety and privacy, which tradeoff models typically fail to capture. With this background in mind, we took a distinctly interpretive approach to analyze citizens' perspectives on smart urban safety.

3. Methodological considerations: discourse analysis and smart urban safety vignettes

3.1. Interpretive repertoires

Underpinning our analysis is Potter and Whetherell's (1987) approach to the study of *interpretive repertoires* (IRs), defined as "a lexicon or register of terms drawn upon to characterize and evaluate actions and events" (Potter and Wetherell, 1987, p. 138). The premise of this type of discourse analysis is that when making sense of the social world, people dynamically draw on "shared patterns of meaning and contrasting ways of speaking" (Burman and Parker, 1993, p. 2), which are designated with the term 'repertoires'. These discursive resources are not created anew, but are functionally "borrowed" and "refashioned" for the specific, contextual purposes of interactions (Burman and Parker, 1993, p. 4). When attempting to meet the functional requirements of discussions, people shift between various subject positions; social identities which are discursively produced when repertoires are invoked and manipulated (Charlebois, 2015). These pragmatic dimensions of language and the construction of versions of the social world is the thrust of the study of interpretive repertoires (Potter and Whetherell, 1987).

Analyzing repertoires enables to develop insights into the dynamic ways language is used in evaluations of smart urban safety beyond static judgments about acceptance or rejection. Rather than speaking about the prediction of behavior in the form of technology acceptance, we approach talk itself as a *discursive action* with consequences for political debates about smart urban safety, and eventual behavior in those emergent settings.

3.2. Eliciting citizen reactions: smart urban safety vignettes

While citizens generally perceive the term 'smart city' as distant and obscure (Thomas et al., 2016), smart urban safety technology is often inconspicuous and opaque (van Zoonen et al., 2019). To overcome the lack of public familiarity with smart urban safety for our purposes, we use vignettes, or short "sketches of fictional (or fictionalized) scenarios" (Bloor and Wood, 2006, p. 183). These vignettes convey to participants the outlines of smart urban safety as an "object of thought" (Potter and Whetherell, 1987), which they can direct their minds to and articulate their thoughts about. Speculative vignettes and scenarios have been produced in previous smart city research, for instance to describe the place and roles of citizens in "smart city imaginaries" (Vanolo, 2016) and to propose "human-centered" smart cities as alternatives to technocentric visions (Andreani et al., 2019). In our study, however, we use vignettes as a *methodological input* to elicit citizen perspectives.

The input for vignettes in this study is based on common defining features of smart cities, reconstructed from an analysis of over 30 influential academic publications on smart cities collected through Scopus. Before constructing the vignettes it was decided they should (i) convey the idea of the smart city as a living environment that is more than the sum of individual technologies, and (ii) should be general enough to facilitate broad interpretations, but also specific enough to generate reactions concerning urban safety as an application domain, implying a degree of ambiguity for facilitating diverse perspectives. Eventually a 'general' vignette was designed for each feature describing it in general terms, followed by a 'specific' vignette with a provocative potential manifestation of that feature in urban safety management (see Fig. 1 for an example). As such, the 'generality-specificity' requirement allowed to explore how smart urban safety as a focal point of smart city efforts may affect participants' discourses.

We developed three vignettes each addressing disparate aspects of smart urban safety. The first vignette is based on the feature of *system integration*, involving the instrumentation of urban space with 'smart'

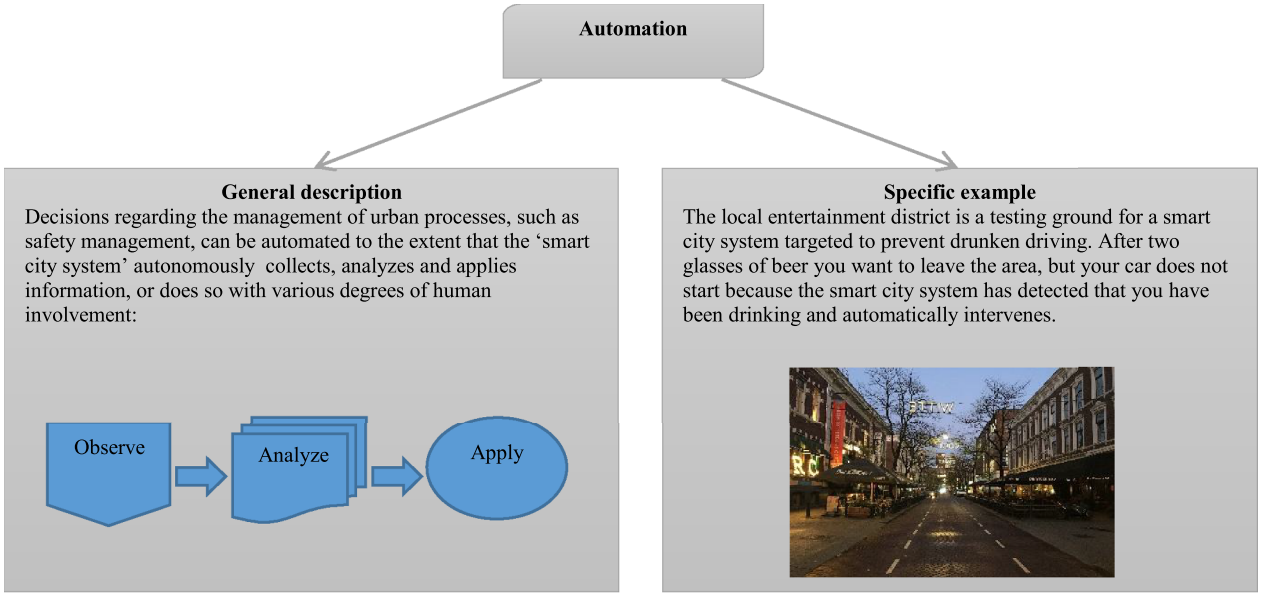

Fig. 1. Abbreviated illustration of the 'automation vignette'.

Table 1.
Overview of participants ($N = 32$).

Age		Education	
18 - 35	10	Primary	2
36 - 65	9	Vocational	7
66 and older	13	College +	23

Gender		Ethnicity	
male	13	Dutch	25
female	18	Turkish	2
non-binary	1	Dutch-Turkish	1
		Moroccan	1
		Dutch-Moroccan	1
		African/Ghanaian	1
		"Eurasian"	1

technologies, and the combination of various types of data into systems that monitor urban processes (e.g. Kitchin, 2014). The specific vignette involved showing the *Dublin Dashboard* (Dublin Dashboard, 2019), while asking participants to imagine its use for urban safety purposes. In the second vignette participants were told that through the feature of *automation,* monitoring, analysis and interventions in routine urban functions and services can become automated to various degrees (e.g. Batty et al., 2012). The specific vignette here involved car-locks for the prevention of drunken driving. Finally, the third vignette is based on the feature of *adaptivity*, conveying the idea that in its ultimate form, the urban environment becomes endowed with a certain 'sentience' and can adapt to changing situations and requirements (e.g. Gershenson et al., 2016). The specific vignette here concerns an imaginary system regulating human presence in public space for the prevention of unsafe situations.

While the vignettes are in essence speculative, they reflect current ideas and practices circulating in the domain of urban safety management, like preemptive policing and technologically-mediated safety self-management (Bayerl et al., 2017). The vignettes can therefore be typified as 'present-future' forecasting of contemporary trends (c.f. Kitchin, 2019), and as 'what if' scenarios of the middle to long term future (c.f. Wright et al., 2014). Fig. 1 explains the general process of vignette-presentation in abbreviated form. In appendix A, an overview of the remaining features and the respective vignettes can be found.

3.3. Data collection

Using the smart city vignettes, semi-structured interviews were conducted with 32 citizens of the Dutch city of Rotterdam. Research has shown that perceptions of safety and the effects of safety management can differ across age (van Heek et al., 2017), gender (Koskela, 2002) and ethnicity (Angwin et al., 2016). Hence, we aimed to accommodate this variation in our sample. The participants were recruited via Rotterdam's municipal neighborhood offices, a local university-affiliated organization for life-long learning and through snowballing via interviewees. Based on the principle of saturation (Starks and Trinidad, 2007), we stopped recruiting when we no longer received new reactions to the vignettes. The final sample of participants is presented in Table 1.

The interviews were held with an interview protocol containing the vignettes, general probing questions and more specific ones (see Appendix B). Importantly, as the interviews progressed, participants not only reacted to the last presented vignette, but gradually developed narratives compounding previously presented vignettes and given reactions. While our interest in smart urban safety and citizens' perceptions thereof necessarily entails some framing of the interviews, participants were encouraged to respond freely, which is reflected in the variety of reactions that were given. After the first three interviews in which the vignettes and questioning were tested, the vignettes were shortened and simplified. In order to react more flexibly to the emerging IRs, the first ten interviews were held by two researchers. All remaining interviews were held by the first author. The duration of the interviews ranged between 60 and 80 min.

3.4. Data analysis

All interviews were transcribed verbatim and coded using ATLAS.ti software. The analytical procedure can be divided into roughly one phase of coding and a second phase of actual analysis by closer examination of the results of the coding process. Throughout the process, the analysis was validated through investigator triangulation (Denzin, 1978) by regularly discussing the data, coding and findings between all authors of the present paper, and in five presentations to members of three affiliated research groups at different stages of the analytical process.

In the first analytical phase, the purpose was to develop an overview of the discourse data. This involved the use of open coding on a subset of ten interviews, identifying meaningful linguistic elements, such as commonplaces and metaphors. For example, participants often used words like 'is already happening', 'gradually' and 'growth' to describe processes of technology use. As their amount increased, the codes were compared and clustered or merged in cases of thematic similarity. For instance, individual codes for 'gradually' and 'is already happening' were merged into the broader code of 'gradual adoption and acceptance'. This resulted in a preliminary codebook which was used to code the remaining interviews. New codes were created when encountering talk not yet covered by the codebook. Eventually the coding of the interviews unfolded as an iterative process, alternating between selectively applying existing codes, creating new codes and merging and

Table 2.
Simplified rendering of the process from semantic coding to the description of the technology domestication repertoire.

Illustrative quotes	Coding 1: meaningful linguistic elements/semantics	Coding 2/analysis: thematic categories after comparison	Analysis: comparison of features and functions	IR after calibrations interpretations and data
"We're slowly growing into it together, I think." "maybe in the future […] step by step, growing into something which we're afraid of now, but in 50 years may find it normal."	already/gradually happening/ using, growing into, slippery slope, familiarization	gradual adoption and acceptance: reflections on the adoption and acceptance of contemporary technologies and expectations of further implementations	using notions of growth to talk about 'passively' accepting technologies with potentially undesirable consequences	**Technology domestication**
"you've always adapted, and survive and adapt, that's it right?" "and so you'll adjust, and you try to be smart."	inevitability, moving with the times, adapting/adjusting	inevitability of technology: talk about the inevitability of and adaptation to technological innovations	using notions of growth and biological evolution to talk about pragmatically gearing towards potentially undesirable technological futures	

clustering codes.

In the second phase, the codebook itself was analyzed in more detail. The codes were reviewed and compared for co-occurrence with other codes to develop further insight into the "variability and consistency" between accounts (c.f. Potter and Whetherell, 1987, p. 167). The coding results were thus used to organize the complex combinations of words and themes into repertoires that tell a story about participants' interpretations of the vignettes. As the analysis demands the synthesis of a great volume of discourse data related to the research objectives, this necessarily entailed a degree of framing by the researchers. However, by staying close to participants own discourses and through continuous self-awareness, we prevented forcibly applying our own frameworks on the research data (see also Dunne, 2011).

To continue our explanation with the example used above, passages coded as 'gradual adoption and acceptance' and 'inevitability of technology' both often contained notions of growth to talk about technology acceptance. By also examining the dominant functions and effects of these expressions, codes were further compared and investigated for consistency in the patterns and overlaps between the core terms and descriptions. In this way it was found that both 'gradual adoption and acceptance' and 'inevitability of technology' often contained hints to a lack of influence over technological developments, sometimes concealed by more overt pragmatist expressions of adaptability. Eventually both codes were thus clustered in a general 'technology domestication' repertoire (Table 2). In this way, the coded data was used to look for linguistic evidence of the emerging interpretations of IRs, and such emerging findings were continuously calibrated with the coded data. By painstakingly analyzing the data in this way and reflecting on it through investigator triangulation, eventually five main IRs with related sub-themes and functions could be described (Table 3).

4. Results: interpreting smart urban safety to come

In participants' reactions to the vignettes, common underlying dimensions and themes were found that together constitute five main repertoires. As participants switched back and forth between previous reactions and new talk, we found that these repertoires recurred throughout the interviews and cannot be easily attributed to any of the particular vignettes (i.e. different aspects of smart urban safety). Therefore, the repertoires will be presented as emerging reactions to smart urban safety generally as conveyed through all vignettes combined. Relatedly, the ordered presentation of the repertoires below is only intended for readability purposes and should not be interpreted as a sequential, linear model of participants' reactions or an indication of their relative importance to participants.

Smart urban safety figures differently in each of the five repertoires, which we will explain in more detail in the remainder of this section. *System design* repertoires represent the ubiquitous questioning of the setup of smart urban safety systems. Generalized reactions regarding acceptance are given in *technology domestication* repertoires. Reasons for acceptance are given more substance in the expected potentialities of smart cities in *instrumentality* and *risk* repertoires. Lastly, *civic responsibility* repertoires describe participants' considerations of the roles of citizens in relation to smart urban safety management. Table 3 summarizes the main themes and functions of each repertoire.

4.1. Smart city setups: system design repertoires

Wonder and skepticism about smart city technologies and information systems often combine in system design repertoires; accounts that revolve around the functionality of the presented vignettes, where participants ask and deliberate about how urban phenomena to which smart city systems are applied are defined, measured and analyzed, and who decides on such matters.

> "[…] when you're talking about a smart city where everything becomes digitalized […] the downside I think is also that a computer can't estimate all situations well. The computer does everything on […] the basis of numbers or something that has been entered into it, they might take out a problem, or a certain […] deviation, but if it's about for instance those machines that flash cars, then it's very […] clear, what is good and what is bad, because if you drive through a red light you're just acting badly, then it's very clear to digitalize that […] but I think that […] it can be more troublesome with other subjects or other kinds of problems." (female, 22 years old)

This account is constructed around the notion that because of their numerical basis, computer systems "can't estimate all situations well", which is explained by distinguishing between phenomena that can be easily categorized in good or bad behaviors, and phenomena which are "more troublesome". Such accounts then raise boundaries to 'datafication', signifying that not all urban phenomena can be known and improved through quantification (see also Bunders and Varró, 2019). Urban safety is often seen as too complex for such smart solutions, prompting questions, doubts and suspicions about who designs such systems and who defines what safety is, surfacing the politics of smart urbanism. Thus, through functions of questioning and doubting designs and proclaiming complexity of urban realities, system design repertoires reflect and produce positions of skeptical opposition to data-driven solutions, which become more pronounced when applied to urban safety. However, lacking knowledge and transparence of the setup of such systems also sets limitations to articulate definite answers regarding acceptability:

> "[…] as long as it's all properly made known in advance. Because you might become convicted, and that might have consequences. So it needs to be made very public […] also on the street […] So I would have some conditions regarding this […] because you might get a criminal record […]." (male, 77 years old)

Here, notions of knowledge and transparency about data practices function as a condition for accepting smart urban safety. However, in the absence of such knowledge and transparency uncertainty remains, precluding the willingness for definite acceptance. Thus, while opacity produces skeptical opposition, more knowledge and transparency potentially mitigates this position, and can also involve a repositioning to what could be called 'conditional reluctance' to accept smart urban safety.

In conclusion, system design repertoires 'set the stage', discussing some form of conditionality for other reactions. However, where system design repertoires usually do not settle the issue of acceptance, in *technology domestication* repertoires participants articulate acceptance in a particular form.

4.2. How to react to the smart city: technology domestication repertoires

To articulate how they would react to the portrayed scenarios, participants often spoke about (a) the gradual adoption and acceptance of extant and future technologies and (b) the inevitability of technological development and the necessity of adapting to what is perceived as an inexorable force. Together these types of talk make up technology domestication repertoires:

> "I think it's almost inevitable. We're slowly growing into it together, I think. But that's the way I see it. And I think I'm already using it in a very subtle way […]" (male, 70 years old)

The terms that stand out in this passage – the inevitable adoption of new technologies, references to present uses of ICT and notions of growth – are exemplary for the language used in technology domestication repertoires, which generally provide the argument that computer technologies have become ubiquitous and normalized in everyday life and security, even if there once were concerns over their

Table 3.
Interpretive repertoires, main themes and functions.

Interpretive repertoire	Description and main themes	Functions	Thematic organization
System design	Talk about the functional design and transparence of smart urban safety systems	Questioning and doubting designs, claiming complexity of urban realities	Smart urban safety setup
Technology domestication	Accounts of the uptake of current and future computer technologies through gradual adoption and acceptance and the inevitability of smart urban safety technology	Indirectly lamenting powerlessness (agency), pragmatically gearing towards smart urban safety norms	Generalized reactions
Instrumentality	Ruminations about the utility of smart urban safety systems in terms of informativity and communicativity and effective and efficient urban organization	Stressing potential benefits	Expected potentialities
Risk	Evaluations of smart urban safety systems in terms of the implications for surveillance, privacy and security and social justice	Juxtaposing perspectives, articulating affective objections (discomfort)	
Civic responsibility	Talk of citizens' own capabilities and responsibilities regarding urban safety, and autonomy to act accordingly	Projecting undesirable effects of smart urban safety technology on human responsibility and autonomy	Citizen roles

desirability. Usually, notions of growth implicitly naturalize these processes of technological adaptation. In the following quote this is made explicit by incorporating it in an account of evolutionary survival:

> "[…] I mean I'm rarely pragmatic, but with these kinds of things I think pragmatically. You never know how the future will take its course, and you've always adapted, and survive and adapt, that's it right? […] I mean… a human will always survive, and so you'll adjust, and you try to be smart. Well, that's how I've always done it. So I think I'll be fine, with these things I'm… In whatever kind of system, I'll be fine." (male, 72 years old)

Notwithstanding the potential undesirable consequences of technological safety and security innovations, technology domestication repertoires are often used to reason that in the past concerns did not prevent technological normalization, and contemporary controversial technologies, regardless of their purpose, are likely to follow the same path. In consequence, smart urban safety is constructed as an imminent future with uncertain consequences, which demands adaptability. A perhaps more unintended consequence of these accounts is that they reflect a coping strategy that could preclude political engagement. Analyzing technology pundits' discourse, Morozov (2013 , p. 220) calls this *technological defeatism*, which "downplays the utility of resistance" and "conceals the avenues for seeking reform and change". Thus, by addressing feelings of disempowerment indirectly, naturalizing technological innovation and emphasizing pragmatic adaptability in the face of uncertainty, technology domestication repertoires reflect and produce positions of technological defeatism. Seen in this way, the main function of domestication repertoires is to gear towards a potentially undesirable, but also inevitable future of smart urban safety.

In short, technology domestication repertoires can be seen as a general way to discuss acceptance of smart urban safety as part of a broader prospective living environment. However, participants also gave more substantive reasons for articulating acceptance or more critical perspectives.

4.3. Smart city potentialities (I): instrumentality repertoires

Participants also imagined the potential benefits of the smart city, articulating such expectations through *instrumentality* repertoires, consisting of the themes of (a) *informativity* and *communicativity* of information systems for individual and collective uses, and (b) expectations of efficient and effective urban organization and management. The emphasis on such instrumental benefits mostly comes from a position of utilitarian optimism. When individual benefits are emphasized, terms stressing convenience are most prevalent. In contrast, terms revolving around a sense of necessity and urgency are more prevalent when discussing public benefits. These kinds of collective-level benefits of the smart city are mainly illustrated with examples from domains like mobility, energy management and health care, and are often drawn from professional experience. Thus, instrumentality repertoires mostly concern non-safety related smart city applications. However, while proving to be contentious, in a few cases participants happily did provide instrumental perspectives for safety purposes, some of which went farther than technology, society or law currently allows. Take for instance the following passage from an interview with a volunteer at a community center in a relatively deprived area of Rotterdam:

> "I'd like to have a camera at the gate […] But you need to let software look at the images […] So we need software that can indicate that somebody is fiddling with the gate […] and wants to enter because there are computers here that he can steal […]" (male, 59 years old)

Other examples relate to experienced and observed safety issues in the city, such as sexual intimidation or general street crime. Moreover, participants also contemplated on the usefulness of technological interventions when people fail to act responsibly, for instance in cases of alcohol-related violence or drunken driving. Such interactions between instrumentality and civic responsibility repertoires (discussed below) are quite common. However, most participants switched to other repertoires when confronted with smart urban safety, effectively raising a boundary for acceptability of smart city technology. More generally, instrumentality repertoires stand in a reciprocal relationship with risk repertoires, meaning participants recurrently abandoned one in favor of the other throughout their accounts.

4.4. Smart urban safety potentialities (II): risk repertoires

Instrumental safety benefits are often directly associated with potential challenges and risks, articulated through three main themes: (a) talk about the surveillance of citizens and their data, (b) privacy and data security and (c) concerns about discrimination.

Risk repertoires are commonly constructed by juxtaposing instrumental safety benefits with surveillance and privacy related terms, illustrated by "on the one hand – on the other hand" formulations:

> "I think that in practice this can be very useful. On the other hand this also evokes the image of Big Brother. Big Brother is watching you, how's privacy regulated? In the wrong hands…" (female, 65 years old)

Unsurprisingly, as an archetype of surveillance, 'Big Brother' is recurrently used to articulate an "on the other hand" perspective of a potential dystopian urban future. As Vanolo (2016, pp. 31–32) notes, fantasies of urban dystopia are firmly embedded in popular culture and are grounded in collective ideas about the kinds of life we may experience in the future. However, drawing in particular on media reports on contemporary surveillance practices in China, sometimes

participants argued that such surveillance is more actual than is usually admitted. In this way, by juxtaposing perspectives the smart city is constructed ambiguously as a place where expectations of instrumental safety benefits are bound up with concerns over mass surveillance and creeping totalitarianism. Concommittantly, risk repertoires involve switching between positions of utilitarian optimism and civic anxiety.

Risk repertoires often blend fictional references from books and movies with references to current affairs' media coverage. References to privacy are often used to inquire about the technological or legal protection of data collection, storage and usage to prevent abuse when it falls "in the wrong hands". In these instances, the use of privacy often coincides with, and is amplified by concerns over cybersecurity (c.f. Jameson et al., 2019). Such assurance-seeking uses of privacy are often supplemented by referring to known information system abuses and data leaks. However, limits to the knowledge of smart city systems (see design repertoires), and the perceived opacity of surveillance also made participants use privacy to articulate concerns more affectively, as a general feeling of discomfort:

> "Yeah, you don't think about it often because you would think, well, I don't do anything wrong so it's alright for them to know where I am and what I buy, but on the other hand it's, well, a violation of your privacy, it's very […] strange really to think about it that people can know what you do and where you are and what you buy and what kind of things you're interested in, just like that […] so it's kind of strange to think about it that people can access that." (female, 22 years old)

In discussions of smart urban safety participants became especially concerned with risks for social justice. This is done particularly by drawing on knowledge of social profiling and discriminatory practices in policing:

> "A while ago New York was very unsafe, a couple of areas. Well then a police apparatus was put on it ruthlessly and they indeed increased safety tremendously. But with what damage? Very many people were innocently arrested and thrown in jail […] and then you can say that it's great, it's been cleaned up, you can walk around there safely now, and that is so, but does it outweigh all injustice? And that's my point." (female, 76 years old)

Interestingly, social justice is often articulated from a third person perspective, talking about groups (immigrants, minorities) who expectedly will bear the brunt of smart city surveillance. Only one participant argued her Muslim identity made her feel personally unsafe when imagining the smart city vignettes. This gives reason to believe that people likely to feel socially profiled and marginalized are more sensitive to potential privacy infringements. In this study, such concerns were predominantly expressed by participants who do not belong to a minority-group themselves, and were thus expressed from a position of concern for and solidarity with other citizens, indicating that social justice is a generalized concern, and not only relevant for 'vulnerable groups'.

4.5. Citizen's roles in the smart safe city: civic responsibility repertoires

The four repertoires described above involve decided reactions to smart urban safety, but also highlight issues of smart cities more generally. However, *civic responsibility* repertoires involving reflections on the roles of citizens, relate exclusively to smart urban safety. These repertoires are used to talk about people's responsibility to (a) develop abilities to know and 'read' the city's safety and behave accordingly without causing danger for oneself and others, and (b) act without technpological interventions that undermine human competence, autonomy and freedom. Civic responsibility repertoires often involve individual intuitions regarding personal safety, such as developing safe routines and avoiding potentially unsafe places and situations, as well as collective responsibilities, such as keeping an eye on each other. Such individual and collective civic responsibilities for navigating and managing safety are then usually juxtaposed to smart urban safety as depicted in the vignettes:

> "No, I just think it's unacceptable. Because I think that social safety… if as a girl you cycle through the woods alone, well then you're taking a risk, somewhere, I think, then you should say in advance, well I'm not going alone, we're going through the woods together, you know, so much more an individual decision you take, and not a decision on the basis of all kinds of data which are made available through a computer." (male, 73 years old)

In this quotation, unsafe places and situations are assumed as part of urban life which should be familiarized and dealt with. "Social safety" is used to designate the more responsible, civic alternative to computer-induced decisions. From a position of civic realism, citizens should know what to realistically expect of urban safety and act accordingly as far as possible. Also interesting is the use of the second or third person perspective, designating the self-identification with such competences and responsibilities and the expectation of others to develop the ability to act autonomously in consideration of safety, too. While often a hypothetical fellow citizen is invoked, sometimes a third person is drawn from personal experience:

> "[…] it's about the means in this case […] what you're saying now, we would be raised with it […] I have a granddaughter, she's 20 years old, and she has her drivers' license and not long ago, she was sitting there and she isn't drinking anything. She says: "I can have zero percent", zero percent! And she says it in a very convinced manner […] And then it's like… she does it out of her own initiative." (female, 76 years old)

Giving an example of civic responsibility in practice, this account prioritizes the socialization of safety related behavior over "being raised" with technological systems that intervene in unsafe situations. In this quote, the participant expresses pride of her granddaughter because she lives up to societal expectations of civic morality. Self-discipline is prefered for otherwise human incompetence and dependence on safety technology might take root. Ultimately, then, notions of human autonomy feature in civic responsibility repertoires. In this regard, sometimes participants spoke of people becoming like robots or string puppets, merely reacting on technologically mediated behavioral stimuli:

> "I have a lot of trust in people, that they all can do it. And sometimes one falls out of the system, yeah, that happens. For me you're a human, you make mistakes, those can be dangerous, have fatal consequences. Yeah, that happens. Should I then say we all should be hanging on strings? No, you have your own responsibility, and own decisions, competence. It's logical there is some control on it,

but how that is done is debatable for me." (non-binary, 67 years old)

While the expectation of failing civic responsibility led some to invoke instrumentality repertoires in relation to urban safety, in most cases the interventions described in the vignettes were not deemed justified. As the above participant describes it, the vignettes would lead citizens to become like marionettes "hanging on strings". Hence, by projecting the undesirable effects of smart city technologies on people's civic competences and responsibilities, civic responsibility repertoires construct smart urban safety as a mechanistic future where human competence gives way to a reliance on external mechanisms for managing safety, opening discussions about the outsourcing of safety to technology, which ultimately undermines citizens' autonomy, as well as their behavioral and moral freedom.

5. Discussion and conclusion

Our aim was to understand how citizens react to the notion of 'smart urban safety'. We found that participants' reactions can be organized into repertoires concerning smart city setups, generalized and more safety-specific reasons for acceptance, and citizens' roles in relation to 'smart' urban safety management. Some of these repertoires resonate with reactions known from general information systems research. For instance, constructs focusing on performance expectancy and social influence in UTAUT (Venkatesh et al., 2003) resonate with instrumentality and technology domestication repertoires, respectively. Furthermore, the interaction between instrumentality and risk repertoires resonates with the cost-benefit models underlying information privacy theories (e.g. Dinev et al., 2013). Both models are often used to construct benefit-risk approaches to citizens' acceptance and use of individual smart city technologies.

However, our study suggests that when the context is broadened and citizens evaluate a prospective living environment of smart urban safety, a richer palette of perspectives is revealed than is typically captured by such tradeoff models. Citizens' reactions to our smart urban safety vignettes foreground interactions between meanings attributed to safety as an urban challenge and the proposed 'smart' solutions of digital technologies, data and analysis. While studies of 'non-smart' safety technology also foreground the intertwining of social meanings of safety and technological solutions (c.f. Zurawski and Czerwinski, 2008), the prospect of 'software-sorted' urban safety (c.f. Graham, 2005) means that such perspectives acquire a new dimension. While the participants in our research stressed many benefits for personal convenience and efficiency, smart urban safety applications tended to change their discourse. Similar to some of the major early concerns about smart cities (c.f. Graham, 2005), participants raised concerns about the invisibility and opacity of software sorted safety measures; the boundaries to data-driven urbanism; the risks of social and spatial discrimination; and the undermining of civic responsibility and autonomy. However, despite their vivid expressions of these concerns, in general participants did not see much opportunity to influence the development and introduction of such potentially harmful and disruptive smart urban safety solutions.

Instead of ascribing definite statements regarding the acceptance of single smart urban safety technologies to individual participants, our findings illustrate how interpretive repertoires are used variably and interactively and ultimately form accounts about urban life foreseen by citizens of Rotterdam. Based on these results, we argue that the tendency to research citizen perspectives on smart urban safety foremost in terms of technology acceptance risks obscuring the variability and complexity of multiple, interacting arguments. This carries implications for how smart urban safety and smart cities more generally are researched. Rather than focusing on the relevance of discrete, individual factors on accepting single smart city technologies in isolation, we suggest that research of citizens' experiences of smart cities should go beyond individual technologies and services (c.f. Edge et al., 2020, p. 9; Van Heek et al., 2017, p. 190) and instead foreground the many interacting factors that together create smart city environments.

To provide convincing and democratically urgent moral frameworks for smart city practitioners, it is beneficial to anchor research in civic lived experience. The repertoires described in this study provide smart city stakeholders with some initial guidelines for accounting for citizen perspectives in their safety-related programs and technologies. One of the key issues is the way that smart urban safety makes reactions especially pronounced, exemplifying a particular sensitivity of this application domain, which contrasts sharply with the typical framing of smart city projects as politically benign and commonsensical (Kitchin, 2014). Our study suggests that smart urban safety might be the pre-eminent topic to surface important tensions in smart city practice; thus, integrating it more firmly into the public discussion holds the potential to engage citizens more critically and hence foster a more transparent and democratically legitimate smart city (c.f. De Haan and Butot, 2020).

We end this paper by pointing out some limitations and possible future research directions. First, as our objective was to explore and inventory the potential range of repertoires about smart urban safety, we did not investigate the relative prevalence of repertoires across interviews or their distribution among participants. We acknowledge the value of such an analysis to better understand the respective importance of repertoires and their interrelations, and believe our study can help design an approach suited for such an endeavor. Second, more in depth analysis of the 'tilting points' where people switch repertoires could further illuminate how citizens' reactions might change depending on the situation, framing or prior experience. For instance, what kind of system setups or events may alter participants' discourses? Third, our participants often reasoned from a third person perspective, instead of relating the implications of the vignettes to themselves. Future studies could explore such 'third person narratives' as a linguistic strategy in citizens' narration about ambiguous smart city themes. Lastly, to add to the understanding of citizen perspectives on a concept as elusive as smart urban safety in an open-ended manner, we recommend further exploration of creative and speculative methodologies, including, but not limited to vignettes and scenarios.

Author statement

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Appendix

A) Smart city vignette presentation style (for features of system integration and adaptivity)

System integration

General

In the smart city, technological and informational systems will become increasingly integrated. Technologies are integrated into the physical city itself. Various technologies of diverse parties (citizens, municipality, corporations etc.) are made interoperable. Lastly, various types of data, from the smallest, continuously uploaded activities, to data collected over a larger time period and over a larger scale, are also integrated.

Specific

Imagine an urban dashboard system will become available for Rotterdam. The dashboard system contains real-time information on many different urban phenomena and events, including safety. This can be used by the municipality, law enforcement agencies and citizens themselves.

Urban adaptivity

General

In its ultimate state, the smart city will also be a city where data is utilized for the mutual reactivity between citizens, the built environment, urban policy and the processes of automation. This leads to adaptivity in the city, both in the short term (instantaneous adaptations) and in the long term (adaptations that are gradual and prolonged).

Specific

Imagine an extension on the dashboard system aimed to prevent unsafe situations. The system can monitor the whereabouts of its users and ask them to take certain routes in order to make sure there are always 'eyes on the streets'. In this way the system modulates itineraries to optimize the experience of safety and the prevention of unsafe situations.

B) Interview protocol
Background questions

- Date of birth
- Gender
- Ethnicity
- Occupation
- Education
- Civil status
- Neighborhood of residence

Background questions spatial activities and knowledge of smart cities

- What kind of activities do you regularly do?
- Do you know what a smart city is?

Recurrent questions:

- What do you think about this scenario?
- Can you imagine this scenario for Rotterdam?
- What would you do if this scenarios would become reality?

Vignette 1: System integration
Questions:

- Would you use such an urban dashboard system?
- What would you (not) use dashboard system for?

Vignette 2: Automation of decision-making
Questions:

- Why is automation acceptable or not?
- What if automation technologies described in the scenario prove to be effective in public safety management? In other words, what if it works?

Vignette 3: Adaptivity
Questions:

- Why is adaptivity acceptable or not?
- What if urban adaptivity is effective in public safety management? In other words, what if it works?

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