Urban Transformations

FRONTIERS PAPER Open Access

Deliberating the knowledge politics of smart urbanism

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Introduction

This Frontiers paper develops a synthesis on deliberating smart knowledge politics for urban transformations, based on a 3-year collaborative research project conducting case studies in cities in the UK, France, the Netherlands, Germany and Spain (de Hoop et al. 2017). Over the past decade, smart urban initiatives have been presented as a panacea for complex urban challenges (Kummitha and Reddy 2018; Evans et al. 2019). By producing continuous and ubiquitous digital information about the city, these initiatives claim to disrupt and transform the city towards extreme efficiency or an overhaul of existing systems (Evans et al. 2019; Datta 2015). Hence, smart urban initiatives are potential drivers of change but their transformative potential is limited by the existing urban fabric (Willis and Aurigi 2017), which has resulted in the reinforcement and normalisation of social violence during processes of urban transformation (Datta and Odendaal 2019). Promises of inclusion and participation are often proposed to overcome resistance and stimulate compliance (Haarstad 2017).

A striking example is the Toronto Quayside project that planned to equip a brownfield waterfront district with a digital layer, capturing and analyzing the behavior of anyone using public space in the district to "dramatically improve quality of life" (Sidewalk Toronto 2019). Sidewalk Labs, the key initiator of this project, claimed to respond to "18 months of public engagement" (Sidewalk Toronto 2019). Yet, the project met with fierce criticism (Goodman and Powles 2019) and was discontinued, ostensibly due to "unprecedented economic uncertainty" (Warburton 2020). Criticism primarily centered around the project's lack of transparency (Valverde and Flynn 2018) and accountability (Goodman and Powles 2019) with regard to data production, access and use. Underpinning these criticisms are concerns about the privatization of public space (Harris 2016), privacy implications (Lorinc 2018) and the undemocratic nature of using data to "circumvent democratic city-building" (O'Kane 2019).

The Sidewalk Toronto controversy is emblematic of a concern we have with the wider smart city literature that emerged during our own empirical research, and which misses opportunities for better understanding such controversies: where scholarship advocating smart cities is largely aligned with Sidewalk Labs' discourse on improving efficiency

and quality of life, the concerns of protestors resonate with critical urban scholars studying the political economies beneath smart cities (for an overview of this debate see e.g. Kitchin (2019a)). In recent years, the latter has shifted from a critical unpacking of existing smart urbanism initiatives towards the question of how more 'genuinely humanizing' (cf. Kitchin 2019b) or inclusive and emancipatory (cf. Joss et al. 2017) smart cities can be realized 'from the ground up' (cf. Saunders and Baeck 2015). While we sympathize with the latter move, we argue that controversies such as the Sidewalk Toronto controversy are symptomatic for a deeper and often hidden challenge that underpins smart urban initiatives, namely the limited understanding of how deliberative spaces can meaningfully help navigate *knowledge politics*: the power of, and over, the production, circulation and use of data, information and insightful knowledge about urban complexity.

This Frontiers paper therefore presents a set of observations about existing deliberations on smart city knowledge politics that emerged from our case studies in European cities. Based thereon, we *propose* a set of research questions about deliberative spaces for smart knowledge politics that may foster inclusive and sustainable urban transformation.

Investigating the knowledge politics of smart urbanism

Smart urban projects take many shapes and forms, are based on different kinds of digital technologies, and may be initiated, coordinated and funded by a wide variety of actors. Despite these differences, smart urban initiatives usually claim a strong (and unjustified) belief in the objectivity and neutrality of the data and information derived from sensors, platforms and data analytics tools, and which constitutes the algorithmic heart of smart urbanism (Kitchin 2014a). At the same time, such data is deemed to constitute a *better* basis for decision-making compared to non-smart knowledge production, because of smart data's ubiquity, comprehensiveness, and real-time nature.

The field of Science and Technology Studies argues that the idea of politically neutral knowledge is conceptually and empirically unjustified: the production and use of knowledge requires making value-laden and contestable choices (Whatmore 2003). Such choices have an effect on what data is produced in smart cities and how this is interpreted – thereby shaping urban governance: what is visible, and how it is visible, affects what can be governed, how, where towards, by whom and in whose interests (Cashmore et al. 2019; Evans et al. 2019). *Smart* knowledge politics can be considered as a subset of knowledge politics, characterized by the prominence of data, information and knowledge produced with digital technologies (de Hoop et al. 2022). Indeed, existing critical urban studies research on smart urbanism has highlighted the unequal power relationships that get created or reinforced through objectivist understandings of data (Kitchin 2014b; Luque-Ayala and Marvin 2019); highlighted the way urban data extraction operates as a troubling new form of capital and how smart urbanism intensifies neo-liberal competition between cities (Sadowski 2020; March and Ribera-Fumaz 2014); highlighted how market-oriented and IT-based smart city agendas obstruct citizens' ability to participate in the city, including their ability to exercise their democratic rights (Cardullo 2021); and highlighted how smart cities may re-inscribe unequal power relations of e.g. sexism and racism (Datta 2019), and proposed to place the knowledges of those who are excluded from mainstream smart city discourses centre stage (McFarlane and Söderström 2017).

The study of controversies in STS and critical urban studies highlights the importance of spaces to deliberate differences in knowledge production and their politics. Such deliberations are no less important for knowledge claims in smart cities, especially since improved information and urban knowledge is a central part of their transformative capacity. Deliberative spaces for smart knowledge politics would strengthen the components of Wolfram's (2016) Urban Transformative Capacity framework (see also Castán Broto et al. (2019))[1]. In response, this Frontiers paper synthesizes our own research findings and makes the case for investigating the creation of new deliberative spaces[2]. To structure and give meaning to our diverse and heterogeneous research findings, we draw on Chilvers and Kearnes' relational approach to participation in science and democracy. This approach proposes that *how* participation (in our case participation in deliberations) takes place, *who* participates, and *what* the object of participation is are co-produced (Chilvers and Kearnes 2016). To these three dimensions, we add the dimension of *when*, drawing on the observation that timing for such deliberations is crucial to have an effect, and *where*, informed by our empirical observations and Wolfram's (2016) attention for the role of place and scale in fostering urban transformations. Analytically, we deal with each of these five dimensions in turn, yet remain attentive towards their interdependent emergence in practice, based on the premise that each of these five dimensions co-constitute each other in practice.

Realizing deliberative spaces for smart knowledge politics to foster urban transformations requires …

In the following five subsections, we highlight our key observations with regard to each of these five dimensions, discuss their implications for smart knowledge politics and raise suggestions for the realization of more inclusive deliberative spaces for smart knowledge politics.

…engaging with politics of inclusion: who

Some smart projects are more inclusive than others in terms of who gets to participate. We observed discrepancies between whose voice is considered legitimate and who is affected as well as differences to which extent diverse knowledges were taken seriously. These discrepancies build on and emerge from existing power relationships. Indeed, we also observed how the timing, location, use of language and jargon, group composition, skills required to understand and contribute to deliberations as well as institutional boundaries and responsibilities produced inclusions and exclusions of actors and what they can(not) say.

Discrepancies between whose voice is considered legitimate and who is affected were observed frequently. For example, Hamburg's city administration effectively, even if unintentionally, excluded publics and their differently experienced concerns about

[1] Primarily the components of inclusive and multiform governance (C1), empowered and autonomous communities of practice (C3), diversity and transdisciplinary co-production of knowledge (C5.1), reflexive and supportive regulatory frameworks (C7.3) and reflexivity and social learning (C8)

[2] Four years ago, social scientists from six different universities across Europe involved in an inter- and transdisciplinary project entitled "the KNOWledge politics of experimentING with smart urbanism" (KNOWING) set out to empirically explore and theorize such smart knowledge politics.

mobility policy from their activities to realize *smarter* mobility planning by substituting users' voices with observational data on their movements (Späth and Knieling 2020). In terms of Cardullo and Kitchin's (2019) 'scaffold of citizen participation', this implied that citizens did not participate through consultation or a partnership (had citizens' voices been considered legitimate) but as consumers through choice or even as non-participants through the use of their data about the way they made use of the city's mobility system. In response, we propose that whose voice is considered legitimate, in what form and on what basis needs to be rendered explicit and subject to debate.

Such inclusions and exclusions emerged from prevailing power relations and embedded in smart city project, as well as from smart projects' organizational structures, operational processes, ownership rights and so forth, and from the digital affordances of the technologies deployed (also see e.g. Cowley and Caprotti (2019) on the role of power relationships and e.g. Calzada and Cobo (2015) on the role of digital technologies). Who initiates and coordinates smart city projects, and these actors' relationships with other stakeholders, both play an important role in who gets to say what about the issue and its framing.

For example, discussions with citizens on what smart data would be relevant did feature in projects initiated by civil society, such as the GammaSense project in the Netherlands and the Making Sense Project in Barcelona, while dusch discussions did not feature in the EU-funded and municipality-initiated and coordinated project MySmartLife in Hamburg (de Hoop et al. 2022; Späth and Knieling 2019). Notably, different stakeholders perceive these power relationships differently. For example, where municipal and company representatives in the Dutch *Jouw Licht op 040* ('Your lighting at area 040') project in Eindhoven felt they were providing citizens a much larger voice than usual, some citizens in the very same project considered their concerns to be systematically sidelined. Other examples illustrate how the production of information through smart technologies was observed to reinforce (e.g. MySmartLife in Hamburg; Späth and Knieling 2019) or subtly shift power relationships (e.g. GammaSense in the Netherlands; de Hoop 2020) by making some forms of data generation more actionable than others. Hence, we propose to be more attentive towards the role of power relations to regarding who facilitates and/or controls deliberation in a smart city project, the different kinds of data, information and knowledge that are considered and framed through this deliberation, and to what extent such deliberation explores how power relations may need to be transformed in order to accommodate for other relevant knowledges.

Inclusions and exclusions of actors and what they can(not) say further resulted from the timing, location, use of language and jargon, group composition, and from the skills required to join, understand and contribute to deliberations. Inclusive multi-stakeholder engagement requires resources, time, and the motivation to persevere, especially when difficulties or unexpected events arise (Evans et al. 2019). For example, in the Slim City project in Utrecht (de Hoop et al. 2019), outcomes were expected within a predefined time-frame of 10 weeks, which led to conflicts between actors who wished to speed up the process, typically those that had to report back to their organizations, and actors who felt the need for more in-depth deliberation. Hence, we propose that an active effort should be made on the part of major players such as government authorities, company representatives etc., to include people and perspectives that are currently being

excluded. This may require sufficient availability of resources and skills among hosts and participants, appropriate timing and location of events, use of accessible and sufficiently open-ended deliberative techniques, training, careful composition of groups, and hosts may need to learn to listen to diverse publics expressing themselves differently, including in forms involving embodied and tacit knowledge, from what hosts seeking codified evidence may be used to.

Finally, in multiple projects we encountered that institutional boundaries and responsibilities, too, can exclude relevant actors from deliberations, while successful transgression of such boundaries may indeed result in the inclusion of a wider range of relevant actors (also see Nicholds et al. 2017). Departments, sections, divisions etc. delineate responsibilities and often stipulate who is central and who is peripheral to the project – even when the boundaries between different parts of an organization do not reflect the multi-dimensional and cross-domain nature of challenges addressed by smart urban initiatives. Hence, we propose the need to reflexively navigate and reconfigure institutional boundaries and responsibilities in order to include relevant actors from all relevant domains.

...engaging with politics of recognition: what

The focus of smart knowledge politics deliberations - the what - entails setting boundaries, attentiveness towards the processes that shape what can and cannot be said and reflexivity regarding the values and priorities embedded in knowledge production. First, we observed how the use of varying, changing and sometimes clashing definitions and operationalizations of key terms had implications for the way in which knowledge could (not) be produced. Second, the empirical focus of a particular project with smart urbanism interacted with the 'who' discussed in the previous section. Third, in many projects integral deliberation was challenging in the context of smart urbanism experiments' effects cutting across institutional boundaries and communities of practice. Non-smart knowledges and solutions to identified problems as well as the strategies required along with data production to realize ambitions were often overlooked. Finally, a persistent belief in the objectivity and neutrality of facts obstructed discussion on the values and priorities embedded in smart knowledge production.

First, with regard to the diverse, clashing and evolving definitions and operationalizations of key terms (such as inclusivity, democracy, sustainability, privacy, human rights, safety etc.), we observed that which and whose definitions of these terms dominated had profound implications for the production of knowledge and the governance (in)actions that are produced, and whose interests these knowledges and actions serve (see also Echebarria et al.'s (2021) recent literature review on this point with regard to the way smart cities themselves are defined). In a different vein from Echebarria et al., who suggest working towards a single, albeit comprehensive, definition of the smart city, we propose explicitly discussing and jointly defining the meaning and the implications thereof in a way that is appreciative and respectful to systematic differences in positions towards these terms (cf ad hoc uses of buzzwords). This resonates with Cardullo's (2021) observation that if citizen participation in smart urbanism is to be beneficial to these citizens, rather than to corporations developing smart tech, the purposes for which technological

solutions are being developed need to be opened up for deliberation and meet citizens' needs.

Second, the empirical focus on experiments with smart urbanism - the 'what' in terms of content - played a role in the way in which, and the extent to which diverse stakeholders deliberated the knowledge politics of such projects. t Whether this topic wasa direct concern to stakeholders involved, and the extent to which stakeholders felt this topic was their responsibility were particularly important here (also see, e.g. Ehnert et al. 2022). Very few Dutch citizens deliberated the development of the GammaSense tool to measure gamma radiation in the Netherlands, because at the time, they were not concerned with the risk of being exposed to gamma radiation (de Hoop 2020). In contrast, in the city of Utrecht, citizens concerned with the development of a high-density smart neighborhood near their homes unsolicitedly and loudly engaged with the knowledge politics around the city's calculations on the project (de Hoop et al. 2019). Furthermore, what aspect is put up for deliberation - ranging from deliberating what a smart technology collects data on, how, and for what purpose, to deliberating only one of these aspects or choosing between a small set of pre-selected options (de Hoop 2020) - also played a critical role in shaping the associated knowledge politics deliberations.

Third, as observed in Section "...engaging with politics of inclusion: who", issues of concern that relate to experimenting with smart urbanism tend to cut across existing institutional boundaries and communities of practice with different – sometimes clashing, sometimes complementary, often interdependent – approaches towards the issue at hand and its potential solutions. Although we were not able to identify substantial literature on this issue, we for example observed how the development of a multi-purpose sensor-network around a busy traffic junction in the city of Eindhoven required different departments of the city council and partnering companies to collaborate in jointly designing the sensor-network. This, in turn, required that actors realized how their input into the design of the system enabled and foreclosed the possibilities of others who were responsible for different aspects of the same system. This was a highly complex and unusual endeavor for the actors involved, and supporting infrastructures to do so were absent. We therefore propose the need for knowledge politics deliberations to explicate, engage with and build stronger interrelationships between different departments, areas of expertise, and plurality of knowledges about the phenomena that is to be governed in a smart way.

More fundamentally, we observed that in smart urban experiments, the deliberations about knowledge politics that took place as well as (critical) scholarship on smart urbanism rarely engage with other (non-smart, non-digital) knowledges, as detailed more elaborately by de Hoop et al. 2022. However, the production, circulation and use of digital and non-digital knowledges can take quite different forms, and each will frame and approach the urban challenge differently. Various forms of knowledge may also work together, and therefore need to be deliberated jointly.

For example, a community-led citizen science project that used open-hardware sensors to monitor noise in a public square in Barcelona found that enrolling participation and producing the data required deep sociological knowledge about life in the square. And whilst residents as 'smart citizens' felt empowered by the noise data they gathered, subsequently acting on that evidence required political knowledge to mobilizing

pressure for change and architectural and social knowledge about actions that could curb the noise nuisance, including knowledge about the leisure economy implicated in changes in the neighborhood associated with the noise data (de Hoop et al. 2022). Gabrys (2020) speaks of 'creaturing data', or the way in which data become creatures through perceiving and participating in environments in specific, non-digital ways. In addition, we observed that project ambitions may actually be reached in a more desirable, effective manner through non-smart means – something which is only possible when deliberation drives the selection and design of technologies after better specifying the ambition (also see Hollands 2015). This happened in the case of designing digital platforms for direct democracy in Madrid and Barcelona; Smith and Martín 2021). The success of the platform relied upon complementary offline processes, including old-fashioned community participation spaces and activities that mattered most to citizens. We therefore propose decentering smart technology and placing the ambition of the project in the lead instead, in deliberations which recognize and include a plurality of knowledges that may potentially be complementary to or more appropriate than smart knowledges, as well as both smart and non-smart pathways to reach participants' ambitions.

The successful production of data was often equated with a successful project as a whole – even if the project may be discontinued because the data was of little use-value for stakeholders, such as the Fietstelweek ('Bike counting week') in Utrecht (van Oers et al. 2020). In such situations, one risks losing sight of the original project ambitions, as the allure of generating large data sets becomes an end in itself, disconnected from achieving urban change. We therefore propose making explicit what is needed to realize the changes aimed for beyond solely generating data.

Finally, all projects teach us that deliberating knowledge politics is challenging in the context of a persistent belief in the objectivity and neutrality of (smart) knowledge. There is no evading the fact that agenda-setting, defining research goals, developing methods, analyzing results and rendering knowledge actionable all require making value-laden, and hence political, choices. We propose that it is important to recognize that knowledge is as much created as it is discovered, meaning that facts and values are intertwined throughout the process of producing and using knowledge.

...engaging with politics of space and place: where

When we write metaphorically about spaces for deliberation, it is not by chance that we activate a spatial vocabulary. We observed that the specific places in which smart city projects were conceived, planned and operated played a key role in how data was generated and what data emerged, and that this had implications for the ways in which smart city projects may be transferred or scaled to other localities.

While science students learn that the results of 'objective' measurements and respective conclusions differ depending on where you measure or how you delineate a sample area, this insight is often overlooked in debates about smart ways of knowing the city – except for those rare projects that aim at the creation of a 'science literate' public, like the GammaSense project (de Hoop 2020). Indeed, locality and boundary drawing are not only crucial for the quality of data, but also to understand how the locality shapes the data generation process and leaves traces in the data (Tironi and Criado 2015; Mörtenböck and Mooshammer 2020). At the same time, the creation of large datasets

erases the visibility of these local particularities in the data, which in turn has political implications in terms of a shift in or reduction of the intended actionability of the data. For example, in Utrecht, the collection and aggregation of data on cycling flows within and around the city disconnected data points from the cyclists and their motivations to prefer certain routes over others. Instead, these aggregated data points were primarily understood as indications for potential infrastructural flaws. As a result, the data turned out to be considered ill-suited to help improve infrastructural decisions, which was the original aim of the project, and the project was halted (van Oers et al. 2020).

Indeed**,** data transfer and up-scaling information, which is only possible when local specificities are erased, is a dominant ambition across many of the projects studied, and such ambitions are likely to meet with pluriform locally situated socio-material obduracies and resistances (Lombardi and Vanolo 2015). Broader architectures of knowledge generation and decision-making are furthermore highly path-dependent and historically shaped, and therefore differ from place to place, reflecting local political practices, expectations and traditions. In sum, we suggest that all four dimensions of socio-spatial relations – place, scale, territory and networks (Jessop et al. 2008) - need to be systematically considered when deliberating the generation, aggregation, transfer and use of data. Taking these spatial dimension seriously requires attentiveness towards the other four dimensions of this paper as well: shifts in place, scale, territory and networks in a smart urbanism experiment (where) may also foster different kinds of inclusion (who), a different focus (what), different timing and timescales (when) and different processes of institutionalization (how).

...engaging with politics of time: when

The temporal dimension, i.e. the timing and the order of smart urban projects' activities is important to consider. We observed that knowledge politics are evident in all stages of such projects, and that choices with regard to the timing of deliberation have effects on what the deliberation may or may not contribute towards. We also noted that the time-demarcated nature of most projects limited possibilities to deal with urban challenges in a comprehensive and long-term manner.

First, with regard to the role of knowledge politics across all stages of such projects, we observed that choices with important future implications for the potential effects on the socio-material urban fabric of a smart experiment are continuously made, for example with regard to problem formulations, methods of data collection and analysis, reporting and communication, critique and validation, translation between settings and circulation, and applications in institutional practice and decision-making (de Hoop 2020; also see Chilvers and Kearnes 2016). However, in the projects that we observed, open deliberation on these issues only happened occasionally, and often in the form of a specific event, like a kick-off brainstorm meeting with multiple stakeholders, as we have seen in the Utrecht Slimcity project (de Hoop et al. 2019), or with regard to specific aspects of the project's and technology's design, as we have seen in the GammaSense project in the Netherlands (de Hoop 2020). Instead, we argue that deliberation should be a continuous endeavor and on the agenda of multiple moments of interaction before, during and after the project.

Second, we observed that the timing of deliberation in the context of the specific temporalities of smart urban experiments has implications for what such deliberations may and may not contribute towards. We saw that early deliberation allows stakeholders to join in steering the dimensions and underlying assumptions behind a project and to critically discuss potentially irreversible effects of an experiment from the start, but that it may be difficult to identify relevant stakeholders as well as areas for future conflicts in these early stages. Especially in district planning, such as in the SlimCity project, future residents are difficult to target. And if they were included, like in Brainport Smart District in Helmond, it was difficult for them to oversee repercussions or contribute alternative options (de Hoop et al. 2019). Planning deliberations later, however, makes it difficult to still adapt the project to issues voiced during such deliberations. We suggest that the timing and frequency of deliberations should be carefully considered in the context of what role deliberation is envisaged to play in the overall project.

Finally, smart urban initiatives often take the form of experiments and time-demarcated projects, resulting in a way of dealing with urban challenges that hardly stretches beyond the timespan of the project, limiting the depth of knowledge politics deliberations as well. In addition, projects' short timespans also had consequences for the timeframe that was up for deliberation as foresight was highly limited. This, in turn, had implications for the other four dimensions discussed, particularly with regards to the breadth and depth of the empirical focus of deliberations (what), whose concerns are deemed relevant (who), which locations and scales are taken into account (where), and for the institutionalization of such deliberations (how). Furthermore, projects limited timespans, and the limited timeframes that were up for deliberations, made it difficult to continue activities at the location of the project itself, let alone scale or translate the project to other locations. We therefore propose it is crucial to be aware of the project boundaries and to work on relevance and continuity of the experiment beyond its formal duration and scope. Urban problems often require continuous effort and deliberation instead of specific events or a series of scattered projects. Ongoing controversies and conflicts can be a fertile ground for deepening deliberation (Verloo 2018).

...engaging with politics of institutionalization: how

Overall, we found limited examples of explicit deliberation of smart knowledge politics in our studied cases, and spaces for such deliberation were rarely institutionalized. If such spaces were institutionalized, we observed that existing arrangements, such as institutional boundaries or the timing of deliberations (see "...engaging with politics of time: when"), played a key role in what knowledge politics can and cannot be deliberated upon (see "...engaging with politics of recognition: what") and by whom (see "...engaging with politics of inclusion: who"). Finally, we observed that traditional technology assessment approaches may not be suitable to take the data produced through citizen science projects seriously as well as adequately address concerns about future forms of urban governance, ownership of knowledge and urban lifeworlds that may emerge from widespread application of smart technologies.

With regard to the limited instances in which knowledge politics were deliberated, we observed that ways in which these deliberations took place differed substantially, ranging from formal approaches though public-private partnership negotiations (Smart District

Eindhoven) or policy programs (Smart Hamburg) to emergent or uninvited deliberations such as in citizen science projects (GammaSense) or citizen protests (SideWalks project). Crucially, such plurality of formats allowed for different voices to be heard and issues to be discussed. Hence, we suggest that a more explicit institutionalization of knowledge politics deliberation can be helpful, but inevitably emerges with and through the wider urban politics in which such deliberations are situated, which in turn require reflection. In particular, pleas for institutionalization may overlook the importance of plurality in deliberation, seeking to standardize and demarcate possibilities for deliberation instead. However, we argue that ensuring plurality as well as adaptability and appropriateness should be a core consideration when designing institutions for deliberation of knowledge politics. Such a plural approach was for instance visible in our Barcelona case studies, where strong ideas about democracy, citizenship and open-source and commons-based technology development have been productively integrated into the evolution of smart city platform policies and infrastructures.

The second observation is that existing arrangements in and through which spaces for deliberation are constructed and institutionalized also play a role in when, on what and by whom knowledge politics can be deliberated upon. On the one hand, we argue that such existing arrangements may need to be redrawn to enlarge the space for knowledge politics deliberations. For instance, Mysmartlife in Hamburg demonstrated that formal requirements from European funding programs excluded the possibility of early-stage deliberations at the regional and local level (Späth and Knieling 2020). The proposed implication is that major funding bodies should consider a more plural and distributed approach to engaging with different types of stakeholders as part of their funding requirements. At a more fundamental level, there is a need to more broadly reconsider the role of the state in smart knowledge politics within a plural social landscape. At the same time, the design of deliberative spaces will often need to be considered pragmatically in the short term, within the possibilities, constraints and transformations of existing institutional arrangements. A number of our case studies evolved in relation to European discourse, policies and funding arrangements towards the smart city, such as the Mysmartlife case in Hamburg discussed in this paragraph, which are likely to be an exogenous environment that cannot be reshaped at will for a specific smart project seeking funding.

Finally, we observed that existing approaches to what constitutes 'good' or 'valid' data were often ill-suited to provide room for a diversity of knowledges and data. For example, our case studies on nuclear radiation (GammaSense) in the Netherlands and on noise levels (Making Sense) in Spain demonstrated that data produced in citizen science projects often lack legitimacy within established institutional arrangements (de Hoop et al. 2022). Furthermore, existing technology assessment often focuses on specific risks and is therefore narrowly framed, which provides insufficient space to explore concerns over the forms of future governance, ownership of knowledge, and urban lifeworlds that widespread use of smart technology might enable. We therefore argue that ensuring plurality in the institutionalization for deliberating smart knowledge politics could also be shaped through strengthening technology assessment capabilities at various governance levels. We propose moving away from dominance by private actors and formal experts in the articulation of visions, needs and demands for smart knowledge tools, techniques

and platforms to include a wide variety of stakeholders (Smith and Martín 2021). As a consequence, constructive technology assessment capabilities should consider a broader approach and include assessments made, formally and informally, in other realms of society, including in the forms of citizen science projects or citizen protests. We propose technology assessment practices should consider such forms of smart knowledge and advice procedures more explicitly, even if they may not live up to the dominant framings around quality standards for evidence.

From understanding to co-constructing deliberative spaces

In seeking structural change for city-scale sustainability, urban transformations inevitably involve (un)invited deliberations over the design, implementation, and consequences of their projects, programs and processes. Our *Frontiers* contribution, with our focus on the *who, what, where, when* and *how* of deliberating knowledge politics in urban transformation, argues for reflexivity over the kinds of knowledge involved in these deliberations, and attentiveness towards absent or marginalized knowledges - smart or non-smart.

Sensitivity towards the politics of knowledge is made newly salient by the growing ubiquity of smart technologies embedded in our urban environments and generating data and real-time representations of urban activity. The promotion of smart cities inhabited by smart citizens re-casts long-running questions about whose knowledge counts in urban governance, and why some forms of knowledge come to count more than others. Growing reliance upon Big Data, for example, not only raises ethical questions about how information is gathered, by whom and for what; but also how ostensibly synoptic Big Data representations of the city can actually introduce distortions and partial renderings of phenomena that remind us about the importance of 'thick data', qualitative information, and situated and plural knowledges about urban life. Similarly, exciting technical possibilities for orchestrating collective intelligence across digital platforms must not eclipse consideration of the incommensurable qualities of different knowledges: especially those that are not so readily codified and interrelated in digital forms, such as (bodily) experiential knowledge.

Next, questions about what and whose knowledge counts imply related questions about historical, economic, social, cultural and material power relations that shape the landscape for and politics of knowledge production (also see, e.g., Luque-Ayala and Marvin 2019; Bulkeley et al. 2016; Wiig and Wyly 2016). Indeed, Cardullo (2021) even argues that the move towards what he calls "intelligent cities" - cities that draw on smart (digital and analogue) knowledges to become just and inclusive - requires restructuring the governance systems of such cities in the sense that power and technological knowledge get decentralized and decapitalized. In the context of fostering meaningful deliberation of smart knowledge politics, we argue that such deliberative spaces must help reflect upon the kinds of power already structuring the information, data and knowledge that gets prioritized in urban change, and explore ways in which these power structures could be reshaped to work towards more inclusive, just cities. Spaces where different kinds of smart (digital) and non-smart (analogue), knowledges can be brought into deliberation – codified, tacit, abstract, situated and local, experiential, routine, transformational, and so forth – and where the different

Table 1 Observations and questions regarding deliberative spaces for knowledge politics in urban transformations

Deliberative dimension	Observations	Questions
Who?	· There are discrepancies between who is affected and whose voice is considered legitimate in smart urbanism · Existing power relationships play an important role in who gets to say what about the issue and its framing · The timing, location, use of language and jargon, group composition, skills required to understand and contribute to deliberations as well as institutional boundaries and responsibilities produce in- and exclusions of actors and what they can(not) say	· How is 'inclusion' understood by different actors and whose voices are considered legitimate, in what form and on what basis? · How do the quality and quantity of participating actors as well as power relationships between them shape the diversity of data, information, and knowledge being produced? · How is the transformative knowledge framed by different actor framings? · What actions are being taken to learn to listen to marginalised actor knowledges?
What?	· Different actors' definitions and operationalizations of key terms may clash · The potential effects of experiments with smart urbanism cut across institutional boundaries and communities of practice · Potentially fruitful non-smart knowledges and solutions are often absent from deliberations · Realizing smart ambitions requires a strategy to go with the production of data · A persistent belief in the objectivity and neutrality of facts obstructs discussion on the values and priorities embedded in smart knowledge production	· How are the terms and boundaries of deliberation being set? · How much attention is paid to processes shaping knowledge production – including providing room for cross-sectoral implications, non-smart knowledges, non-smart solutions and strategies required to realize the ambitions aimed for – compared to knowledge about the focal object? · How is the validity of different knowledge claims deliberated, and what theory of information and knowledge is used to do so?
Where?	· Localities leave traces in data generated through smart city projects, although their visibility is erased when data gets aggregated · Data transfer and scaling often meets with obduracy and resistance · Broader architectures of knowledge generation and decision-making are historically shaped and embedded in long-term networks	· How influential is the setting in which knowledge is produced for which kind of knowledge output? · What happens when data or knowledge moves to other locations and situations? · How locked-in are our knowledge production methods, and are they still appropriate to new transformational challenges?
When?	· Knowledge politics stretch across all phases of project development · The timing and timeframe of deliberations has consequences for what such deliberations can(not) contribute towards · Smart urban initiatives often take the form of experiments and time-demarcated projects	· How often should we deliberate over the generation and use of knowledge? · If knowledge politics is perennial, at what points in a transformative cycle should we open up to deliberation? · How to ensure continuity of successful projects beyond the timeframe of experiments and pilots?
How?	· Instances of explicit knowledge politics deliberations are rare and rarely institutionalized · knowledge politics can be deliberated in various formal and informal ways, with implications for what voices are (not) heard and which issues are (not) addressed · Existing arrangements such as funding programmes' formal requirements, (in part) shape the space available to deliberate knowledge politics · Existing technology assessment approaches by and large fail to recognize the value of non-expert (citizen-based) data, and to address concerns about future forms of urban governance, ownership of knowledge and urban lifeworlds that may emerge from widespread application of smart technologies	· How is deliberating knowledge politics different from other deliberations? · How to institutionalize deliberative norms and processes for knowledge politics? · How to change the modalities of urban transformation programmes, so that knowledge deliberation is possible before and after key commitment activities (such as research and development agendas)? · How to recondition institutional capabilities for constructive technology assessment?

bases of validity and legitimacy for different knowledge claims can be debated. Spaces in which to deliberate (and debate) assumptions, interests and priorities; problem-solution framings; the plural social values underpinning the facts of the matter; the different methods used to delineate matters of concern and care; and the robustness, complementarity, and politics of different knowledge claims.

In this Frontiers paper we have drawn on the empirical insights from a 3-year research project, informed by a conceptual apparatus building on Science and Technology Studies and critical urban geography. We invite future work on smart knowledge politics to engage with other relevant literature and debates to advance this agenda. For instance, scholarly work in urban and environmental planning, and in particular the work on Communicative Planning, has raised similar concerns around the challenges of participation, and the practical context in which planning occurs, 'thereby assuming away, rather than engaging with, the politics-laden and power-laden interests that infiltrate planning practice' (McGuirk 2001:195). Healey (2003), in her review of earlier work on collaborative planning, argues for an ongoing need to engage with the practical action and particularities of situated governance dynamics. Purcell (2009) calls for more attention to the transformation of power relations rather than to neutralise them through communicative and collaborative planning. Future research could make a concerted effort to bring such useful insights on collaborative modes of planning into dialogue with the particularities of smart cities and associated knowledge politics. There is a wealth of insight, analysis, practical experience and critical reflection in the construction and operation of deliberative spaces that can be fruitfully engaged with the knowledge politics of smart urbanism.

Here, in using a simple who, what, where, when and how approach to deliberate 'knowing the city', we identified issues that each underscore *why* reflexive deliberation is so important (see Table 1). Urban knowledge controversies are a perpetual reminder that questions about deliberation are ever present. Our point is that any improvement in the democratic quality of urban transformations will need an opening-up of spaces for actively deliberating the knowledge politics involved.

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s42854-022-00035-7.

Additional file 1.

Acknowledgements
We would first of all like to thank all stakeholders involved in the case studies that informed our analysis. Furthermore, we would like to thank all researchers from the ORA KNOWING project for their participation and contributions over the course of the project.

Authors' contributions
All authors contributed to data collection, analysis and writing. The first author took the lead in analysis, writing and coordination. The author(s) read and approved the final manuscript.

Funding
The project was funded by the national research councils of the Netherlands, the UK, Germany and France, as well as Open Research Area (ORA) funds. Open Access funding enabled and organized by Projekt DEAL.

Availability of data and materials
The paper is based on a combination of ethnographic observations, interviews and documents. Fieldnotes, interview transcripts and documents are available upon request from the respective author.

Declarations

Competing interests
We have no competing interests to declare.

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Received: 25 November 2020 Accepted: 16 March 2022
Published online: 25 April 2022

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