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The politics of smart expectations: Interrogating the knowledge claims of smart mobility

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ABSTRACT

This paper studies the performativity of smart mobility expectations in envisioning urban futures. Smart mobility, or ICT-enabled transport services, are increasingly considered a necessary ingredient for sustainability transitions in cities. Expectations of smart mobility's contribution to such a transition are constituted by a strong belief in the transformative potential of data collection and use. These knowledge claims embedded in smart mobility expectations tend to be unchallenged, yet contribute to a particular future vision of urban mobility. Our empirical analysis, which draws on two empirical smart cycling case studies in Utrecht, the Netherlands, and Bordeaux, France, underlines the politics of such smart knowledge claims in two smart cycling projects and identifies distinct processes as to how such claims may shape and structure mobility futures. We observe intimate entanglements between what is being developed in terms of technologies and services; and the societal needs that the projects' expectations promise to fulfil. At the same time, we witness a disentanglement of these interconnected knowledge claims when projects unfold, leaving the promise of (un)achieved societal benefits out of view. Indeed, smart knowledge claims carried strong inherent legitimacy in the cases studied, thereby risking to exclude non-smart alternatives.

1. Introduction

Today's urban mobility systems are increasingly associated with problems such as traffic congestions, pollution, accidents, noise, and competition for public space (Berger, Feindt, Holden, & Rubik, 2014; Gössling, Schroeder, Späth, & Freytag, 2016). Considering mobility systems' material and social obduracy, there is a rising and arguably hyped interest in digital interventions that promise to alleviate these urban pressures without having to tackle these obduracies (Docherty, Marsden, & Anable, 2018). Past research has highlighted, however, that smart mobility has the capacity to both disrupt and reinforce dominant modes of transport, transport systems, and urban mobility governance (e.g. Docherty et al., 2018).

The interest in digital interventions is often underpinned by smart knowledge claims: claims with regard to smart data's contributions towards an improved understanding of urban systems and towards better governance of these systems. More specifically,

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smart knowledge claims in the field of urban mobility express that new practices of real-time and fine-grained data collection will result in a better understanding, predictability and management of traffic; in better infrastructural planning; and in enhanced environmental performance and road safety (Kamargianni, Li, Matyas, & Schafer, 2016; Manders, Wieczorek, & Verbong, 2018). These knowledge claims present the data generated by smart mobility systems entangled with digital devices, as neutral, apolitical, and often real-time evidence of what is happening in the city. These data are therefore believed to provide robust empirical guidance for policy and practice to initiate actions (Kitchin, 2014; Lennert, Macharis, van Acker, & Neckermann, 2017), resulting in claims of superior decision-making for improved mobility and higher quality of city-life. The hype and hope of data use in traffic management can therefore be considered part of a transformation of how we know and govern the city – a transformation in which data is thought to assure a safer, more transparent and sustainable urban future. Interestingly, while these observations clearly demonstrate that the smart knowledge claim is an important constituent part in thinking about future urban mobility, research on the embeddedness of smart knowledge claims in specific smart urban mobility projects' expectations and their actualisation is limited. Furthermore, the performative role of knowledge is often left uncontested in both academic and societal discussions on smart mobility (de Hoop et al., 2018).

In response, we aim to come to a nuanced understanding of the role of knowledge in articulating smart mobility expectations. Secondly, this paper explores the performativity of these knowledge claims in detail: what role do these smart knowledge claims play in processes of legitimizing and actualizing smart urban mobility expectations (Kemp & Martens, 2007; Smith, Stirling, & Berkhout, 2005)? Consequently, we do not approach the early and high-rising expectations of the (seemingly limitless) potential of smart mobility as either inaccurate or accurate forecasts of future mobility systems (cf. Lösch, Grunwald, Meister, & Schulz-Schaeffer, 2019; van Lente, 1993); and we do not assume that smart data is an improved and politically neutral form of knowledge inherently capable of improving mobility systems (cf. de Hoop et al., 2019; Späth & Knieling, 2019). Through this dual research objective, we aim to contribute to the smart mobility literature by moving beyond the current dichotomy of overoptimistic smart mobility advocates and critical opponents; and to the sociology of expectations literature by focussing our attention on the productive role of knowledge claims in processes of expectation articulation and legitimation (de Hoop et al., 2019; van Lente, 1993).

The paper starts with a brief introduction to smart mobility and associated promises; and presents the conceptual foundations for our work, which we derive from the sociology of expectations. Next, we present our research design, which draws on two in-depth case studies on smart cycling examined in the chapter thereafter. For each of these case studies, we distil which knowledge claims underpin the projects' expectations, analyse how these expectations have, or gained legitimacy among key actors; and investigate the role played by the identified knowledge claims when projects' expectations do (not) unfold. Our discussion and conclusions reflect on the observed processes in which knowledge claims perform and proposes new insights on smart mobility.

2. Theoretical background: smart mobility and expectations

2.1. Smart mobility

The 'myth of big data' commonly proclaims that big data techniques generate entirely new and better forms of knowledge (Couldry, 2014). Recent endeavours in smart mobility centre around the generally unchallenged expectation that smarter management of information and decisions will result in better, more accessible, safer and more sustainable cities. A distinctive feature of smart mobility is its dual capacity to provide a) a new way of knowing the city and its infrastructures through measurement and quantification, and b) potential techniques for the reconfiguration of urban mobility systems towards greater efficiency and sustainability (Kamargianni et al., 2016; Krivý, 2018). Crucial to these coupled capacities of predictive or real-time smart mobility applications is the central position of datafication, calculation and analytics. These three processes are deemed critical by urban actors in making mobility infrastructures actionable in novel ways (Kitchin, Lauriault, & McArdle, 2015). In particular, promises regarding faster or even real-time management - in which data-based feedback is provided to users to prompt behavioural change, users who are in turn also the producers of the data - are mobilised to promote claims about optimising or reshaping the performance and utilisation of mobility networks. This expected capacity of smart mobility applications is presented by its advocates as a superior form of decision-making in which forms of calculation become critical in controlling mobility systems to meet objectives and expectations such as safety, security, reliability, optimisation etc. (Luque-Ayala & Marvin, 2016).

This smart mobility narrative has started to inform futuristic thinking about (urban) transportation systems in European policy and practice (Späth & Knieling, 2019). There is an active debate about how emerging technologies such as automated vehicles, IoT and big data or Mobility as a service ('MaaS') may radically change individual and collective mobility (Docherty et al., 2018), including self-embarked missions of the private sector such as those of Google and Tesla to develop autonomous cars and public sector ambitions for more integrative city solutions that enhance collective values.[1],[2] Indeed, a multiplicity of opportunities and smart mobility futures are being imagined around key propositions such as an assumed move from ownership to use; decarbonising the mobility system and fuel substitution; optimising demand and inter-modality; and increased connectivity.

[1] For instance, in its 2017 roadmap and 'expert group report', the European Union positions smart mobility services as a key solution to reduce transport greenhouse gas emissions with 60% compared to 1990 (Lennert et al., 2017).

[2] Likewise, sustainable and smart urban mobility is a key focus of the European innovation partnership on smart cities and communities (EIP-SCC). EIP-SCC funded 'lighthouse projects' such as EMBERS and GrowSmarter explore the implementation of smart mobility services in cities across Europe.

Notably, research that critically and empirically interrogates how and to what extent smart mobility promises and policies are changing (urban) governance in practice is limited and has only been performed for motorized modes of transportation. Nevertheless, many have argued that smart mobility tends to overemphasize technological solutionism that solve mobility challenges through a move towards efficiency rather than transformative change (e.g. Cardullo & Kitchin, 2019; Kitchin, 2014; Morozov, 2013; Sadowski & Bendor, 2019; Späth & Knieling, 2020). Based on an investigation of how a transition towards smart mobility may challenge contemporary mobility governance, Docherty et al. (2018) argued that more deliberate governance mechanisms were necessary to harness public value in smart mobility in the light of increased private interest in mobility systems. In a similar vein, Marsden and Reardon's (2018) edited volume reflects on governance challenges in smart mobility transitions and conclude that there is a need for taking into account politics behind smart mobility as a solution, referring to issues such as 'who wins and who loses'; how to capture public value and; how to recognise the diverse and heterogonous conditions informing smart mobility governance across cities and countries. Manders et al. (2018) assessed the promises and expectations that drove 118 smart mobility experiments in the Netherlands and concluded that the directionality of the smart mobility transitions is still open, yet the involvement of mature entrants across a range of initiatives hint at the likely occurrence of substantial change.

2.2. Expectations, legitimisation and actualisation: conceptual foundations

Attention for these dynamics in malleable innovation trajectories are not new. The scholarly debate on the sociology of expectations has demonstrated that during a period of high-rising enthusiasm, new technologies – such as smart urban mobility applications – are often accompanied by *hyped* expectations, i.e. exaggerated and unachievable expectations of what the new innovation can deliver (Borup, Brown, Konrad, & Van Lente, 2006; Brown & Michael, 2003). Hypes fetishize newness and favours this a-priori over the advancement of prevailing solutions. According to the Gartner hype cycle (O'Leary, 2008), elevated expectations are usually followed by disappointment when these expectations are not met by actual outcomes or new activities (Borup et al., 2006). In this paper, we make use of the sociology of expectations to understand smart mobilities' hyped expectations. We particularly draw on this literature to conceptually distinguish between different types of expectations, that speak to different "levels" ranging from abstract sketches of the future (macro) to detailed elements (micro) (van Lente, 2012). Manders et al. (2018) have used the typology of expectations to explore the smart mobility hype and to disentangle complex, intertwined expectations. According to this typology (see Table 1), *project-level* expectations specify promises on performances and functions of a smart mobility project, answering the question "what is being developed?". *Function-level* expectations express which function the project would fulfil in the wider mobility system, answering the question "for what purpose?". Finally, *societal-level* expectations account for wider contributions to societal needs and well-being i.e. "what societal needs are fulfilled?" (van Lente, 1993; van Lente, Spitters, & Peine, 2013)

A central theme of the sociology of expectations is that expectations are *performative*, rather than being descriptive statements that may be true or false (Brown, 2003; Konrad, 2006; van Lente, 1993, 2012). Research on the sociology of expectations demonstrates the work that is performed by visions of a future state (see empirical studies of Bakker, Van Lente, & Meeus, 2011; Geels & Raven, 2006; Lösch, Heil, & Schneider, 2019; Selin, 2007). For example, Borup et al. (2006) argued that expectations are "fundamentally generative" (p.285), particularly during the initiation of experiments and research projects where practical utility and value has yet to be demonstrated and support to be mobilised. According to van Lente (2012), three forces of expectations may be discerned: they legitimise support and investments; they provide direction for search processes; and they have a coordinating role in attracting the interests of necessary allies and in building mutually binding obligations and agendas.

Whether an expectation becomes recognised as an attractive imaginary around which stakeholders choose to organise and provide support to mostly depends on the expectation's inherent legitimacy (in the prevailing context) or its ability to amass legitimacy (Kemp & Martens, 2007; Smith et al., 2005). Indeed, Garud, Schildt, and Lant (2014) claimed that expectations garner support on the basis of being "more or less 'meaningful' to stakeholders or more or less 'robust' depending on their connections with relevant and credible actors, meaningful data and ongoing developments" (p. 7). An expectation's legitimacy can further be amassed by building a supportive coalition, in which case the extent to which the actors constituting this coalition are considered legitimate influences the legitimacy of the expectation at hand (Berkhout, 2006; Selin, 2007; Smith et al., 2005). Such processes of building and

Table 1
Typology of expectations of smart mobility initiatives in the Netherlands (Manders et al., 2018, page 94&98).

Expectation level	Applies to	Expectation type
Project-level "What is being developed?"	Function of the smart mobility initiative	Information services Data management Travel services In-vehicle and roadside technologies
Function-level "For what purpose?"	Function of smart mobility initiative in the mobility system	Improved travel experience Improved accessibility Improved liveability Improved safety
Societal-level "What societal needs are fulfilled?"	Function of the smart mobility initiative for society	Mobility as economic opportunity Mobility for social activities Mobility for liveable cities Mobility connected to other domains

shifting legitimacy often continue throughout the process of enacting a vision in practice. Indeed, legitimacy can also be generated through successful (exemplary or partial) realisation of a vision. Considering the importance of a vision's legitimacy for its realisation through attracting stakeholder support, such processes of legitimisation take centre stage in our analysis.

Second, with regard to the directionality of practices emerging with, and from expectations, Schot and Geels (2008) showed that expectations would be more likely to shape transformative change "if expectations were made (a) more robust (shared by more actors), (b) more specific (if expectations are too general they do not give guidance), and (c) have a higher quality (the content of expectations is substantiated by ongoing projects)" (pp. 541). Smith et al., 2005 work (2006) has shown that expectations are most successfully adopted and diffused if they are flexible enough to coordinate and accommodate for the needs and interests of different social actors, whose support is important to ensure adoption and diffusion. Moreover, Konrad (2006) and Späth and Rohracher (2010) observed more successful experimentation for transformative change when expectations were placed in the context of general societal debates and locally-specific societal challenges at the same time. On the other hand, and crucially, hype and expectations may focus on one new solution, thereby constituting a barrier to alternative, possibly more critical, solutions (Brown, 2003). For example, it is particularly difficult to imagine and empower counter visions in the context of a broad, all-encompassing smart vision that attempts to subsume those counter visions under its own umbrella (de Hoop et al., 2019). In our analysis, we will therefore be attentive towards exclusions emerging from these expectations-in-action. How expectations shape and determine future changes, and why certain knowledge claim-based expectations gain precedence over others is central to our analysis of the smart mobility system. Smart knowledge claims embedded in smart mobility expectations tend to be unchallenged, yet contribute to a particular future vision of urban mobility. By honing in on the knowledge claims of smart mobility expectations and exploring how these claims inherently have or amass legitimacy and play a role in reshaping urban mobility systems, we provide a deeper understanding of the politics of knowledge claims in envisioning urban mobility futures.

3. Empirical approach

Considering this papers' pioneering ambitions, namely investigating the productive role of knowledge claims in smart mobility projects, we draw on an exploratory case study approach in which we use case studies to come to an initial understanding of the issues and interactions at play with regard to our research ambitions. Specifically, we identified the smart knowledge claims underpinning each case studies' expectations and explored the ways in which these knowledge claims played a role in processes of expectation legitimation and actualisation.

Most research within the field of smart mobility focusses on smart solutions for motorized transportation. We reported above that such motorized smart mobility initiatives tend to be criticized for overemphasizing a form of technological solutionism that solves mobility challenges through a move towards efficiency rather than transformative change (e.g. Cardullo & Kitchin, 2019; Kitchin, 2014; Morozov, 2013; Sadowski & Bendor, 2019). To widen the scope beyond motorized transportation, and especially to ensure a richer empirical analysis, we selected smart cycling cases: although smart cycling may be criticized for technological solutionism, smart cycling can be associated with attempts to challenge contemporary car-dominated urban mobility systems. Indeed, considering the socio-material characteristics of cycling, a slow mode of transport, the 'smartification of cycling' in order to improve and transform cycling experience and infrastructures may call for a transformation of car-focused mobility systems. As such, smart cycling may have substantial consequences for how we know and govern the city. In turn, smart cycling also implies and builds upon a range of assumptions regarding cyclists' behaviour, the experience and meaning of cycling; and the relationship between the cyclist and his or her environment (Nikolaeva, Te Brömmelstroet, Raven, & Ranson, 2019).

3.1. Selected case studies

The two smart cycling cases which we selected are *BikePredict* in Bordeaux and *Fietstelweek* (EN: bicycle counting week) in Utrecht.

BikePredict uses artificial intelligence to improve users' experience of a recently established public bike-sharing network in the city of Bordeaux and to assist the city's provider of public transport solutions, Keolis, in optimising the network's infrastructure and operations. BikePredict is paid for by Keolis and ran by a Bordeaux based start-up company named QuCit (Quantified Cities) that deploys advanced data-analysis and prediction methods to provide users and decision-makers with information to address complex urban problems (Cherrier, 2016). The city of Bordeaux initially started the bike-sharing network to promote 'soft transportation' in the city, inspired by successful results in the city of Lyon, and contracted Keolis to build the required infrastructure and to manage the network (Cherrier, 2016). When the public bicycle network grew, both in terms of physical infrastructure and users, managing bicycle availability throughout the city's bicycle stations and bicycle maintenance became an increasingly challenging and problematic endeavour and resulted in dissatisfaction and frustration among users of shared bicycles. Thus, according to our interviews, the initiators relied on local start-up QuCit for support to address these problems to help them optimise station deployment and station balancing.

The ambitious project on cycling fits Bordeaux' mobilities agenda, put forward by M. Juppé, (now former) mayor and important promotor of cycling in Bordeaux (Le Chatelier, 2020). In national media, Bordeaux is often recognised a model city in terms of bicycle use and (soft) mobility and regularly quoted as a virtuous example of having a good, modern urban mobility policy (Le Chatelier, 2020).

The Fietstelweek (Bicycle counting week) was an initiative by a consortium of diverse actors including the Dutch cycling union, three private companies Keypoint consultancy, Mobidot ICT provider and Beaumont Communication and Management, and one research institute (NHTV university of applied sciences). Each year, the minister of infrastructure and environment and several provincial and regional governments in the Netherlands took part in the Fietstelweek. The project was framed by the commercial-civic collaboration as being essential for a country that has "more bicycles than inhabitants" (Fietstelweek.nl, 2017a; Keypoint.nl, 2016). Fieldwork for this paper was conducted for the Fietstelweek in Utrecht. Utrecht is a renowned cycling city. The city enjoys a high quality cycling infrastructure, with an extensive network of segregated cycling lanes connecting different parts of the city and spreading out to the rest of the region (Van Duppen & Spierings, 2013). Moreover, the largest bicycle parking in the world was recently opened in Utrecht, showing the city's high cycling ambitions in urban planning (GemeenteUtrecht, 2019). However, as a result of a constantly increasing number of cyclist, the city faces serious issues of cycling congestion and dangerous traffic situations (Van Duppen & Spierings, 2013). In Utrecht, both the municipal and the provincial office of Utrecht took part in the Fietstelweek.

The Fietstelweek annually collected (local) data on cycling routes and infrastructure during one particular week. Cyclists actively participated in the data collection process by installing a free application on their mobile phone that automatically collected information on their cycling behaviour (including speed, hours and location). The data was subsequently analysed with the use of CyclePrint, an analytical tool developed by the NHTV university of applied sciences that processed, analysed and visualized the collected data (Cycleprint.nl, n.d.). The visualisations provided through CyclePrint provided policymakers with quantitative insights on the current cycling infrastructure and associated behaviours in their city or region. During the week, rankings on city performance were presented daily – e.g. busiest cycling route, average speed of cycling per region etc. (Keypoint.nl, 2016)

These two cases were primarily selected because they both voiced high expectations with regard to the potential role of cycling in future mobility systems and involved and/or were backed by multiple actor groups. The latter is important for case-selection because smart cycling projects generally involve various urban actors, including start-ups, local and national decision-makers, researchers and (cycling) communities. The cases were similar in the sense that they both tracked cycling behaviour, but Fietstelweek tracked cyclists as they cycled – mostly on their own bicycles – while BikePredict documented the availability of shared bicycles at bicycle stations over time.

3.2. Data collection and analysis

Data collection took place between December 2017 and December 2018 and consisted of project documents, websites and grey literature and was complemented with semi-structured interviews and site visits All interviews were conducted face-to-face during which notes were taken. Site visits involved a combination of observing the initiatives in practice, attending meetings with case study actors and informal interactions with case study actors. Table 2 provides a brief overview of our key data sources.

Our data analysis followed a three-step approach. Specifically, we used Manders et al. (2018) adjusted typology of expectations (Table 1) as a frame of reference in our efforts to disentangle the different expectations and the knowledge claims embedded therein, that underpin our smart mobility projects. Second, we analysed the role of these knowledge claims in legitimisation processes by exploring the extent to which these claims were, or became supported, contested or ignored. As discussed before, we study the perceived legitimacy as either an inherent characteristic of a smart claim; as well as the legitimation evolving from actors 'support (Kemp & Martens, 2007; Smith et al., 2005).

Finally, we explored the roles played by these knowledge claims when these projects unfolded and expectations were (not) met. This approach allowed for a targeted, systematic analysis in order to enable comparative research across cases, but also provided sufficient flexibility for the empirical material 'to speak back'.

4. On the knowledge claims of two smart cycling projects

4.1. BikePredict in Bordeaux

4.1.1. Knowledge claims and articulated expectations

The BikePredict project predominantly made knowledge claims that underpin expectations at the function-level (see Table 3). With BikePredict, Keolis and the city of Bordeaux expected an improvement of users' experience of the public bike-sharing network through two different channels. First of all, by anticipating user demand through BikePredict's artificial intelligence algorithm in the

Table 2
Data collection overview.

	Description		Description
1. Interviews	Interviews with key actors directly involved in the projects; relevant urban/regional public administrators; knowledge institutes, private actors and citizen organisations related to or affected by the projects (4 interviews in Utrecht; 7 interviews in Bordeaux)	**2. Grey literature & Scientific literature**	Communication regarding the project by third parties such as local and national newspapers, scientific publications and policy documents
3. Official documents	Official documents released by the project itself including official website(s); press releases, online presence on e.g. twitter; newsletters and presentations	**4. Site visits**	Site visit and informal interaction with case study actors.

Table 3
Summary table: Expectations on BikePredict.

Expectation level	Expectation
Project level	Real time and predictive information about bicycles' locations and state of repair
	Database of rental behaviours
	Optimised infrastructure management for public bicycle networks
Function level	Improved user travel experience
	Improved user access to well- maintained bicycles Improved reliability of bicycle availability at rental locations Increased use of the bike-sharing system
	Reduced operating costs
Societal level	Traffic and pollution prevention
	High quality of city life
	Sustainable city
	Attractive and smart Bordeaux

context of rising user complaints with regard to difficulties in finding a bicycle or parking spot at the nearest station during peak hours (Delassus, Giot, Cherrier, Barbieri, & Melançon, 2016). Secondly, BikePredict claimed to enhance user experience by providing users with information on where and when to find a bicycle, thereby also "encourag[ing] travellers to go to stations where the probability to find an available bicycle is the highest" according to QuCit's CEO. Concurrently, BikePredict made a number of efficiency-oriented claims for Keolis as operator of the bike-sharing network, namely to improve general bicycle availability because the algorithm enables more efficient bicycle allocation to stations by the operator; to increase overall use of the system through improved user travel experience and safety, and to reduce the amount of kilometres run by operator trucks and therefore costs based on the algorithm's calculations (Cherrier, 2016).

These expectations were based on three project-level knowledge claims, namely conducting large-scale, real-time and predictive data collection on the location of bicycles and the condition of these bicycles; building a database of users' rental behaviour; and developing an optimised management infrastructure based on the collected data. This data-based infrastructure was expected to anticipate the optimum number of bicycles to be removed or added for the system's rental locations, and to identify broken bicycles. In essence, BikePredict thus claimed to rationalise the management of urban services through a computational approach to user's behaviours. QUCIT's algorithm was considered of crucial importance to do so: our respondent from Keolis explained that they already collected large amounts of data before they started collaborating with QUCIT, but Keolis did not know how to "make them talk". They only started understanding the bicycle movements they observed and impacts of different variables on bicycle use during the BikePredict project.

At a societal-level, BikePredict is advertised on the QuCit website as a tool to enhance the liveability of Bordeaux by making soft and active transport modes more attractive in a city currently dominated with cars. In our interview, QuCit claimed to "develop concrete applications (such as BikePredict) for companies or local authorities aiming for more sustainable, more efficient and more comfortable ways to live in the smart city". Here, QuCit's expectations were informed by the larger endeavours of Bordeaux's city council as voiced in their city council report to protect the environment, reduce traffic congestion, and preserve a high quality of life through the improvement of the bike-sharing network using BikePredict.

4.1.2. Legitimation process

As discussed, an expectation's legitimacy depends on the extent to which it is 'meaningful' to stakeholders and on connections with relevant and credible actors (Garud et al., 2014). Legitimacy can further be amassed by building a supportive coalition; and depends on the legitimacy of the actors constituting this coalition (Berkhout, 2006; Smith et al., 2005). BikePredict's knowledge claims held substantial inherent legitimacy: they were almost universally considered meaningful by the stakeholders involved and rarely challenged. A notable exception, though, were company workers in charge of maintaining and redistributing across the system's parking stations. According to our respondents, some workers challenged the algorithm based on their own experiential knowledge, arguing they were doing a much better job of ensuring bicycle availability when they drew upon their own knowledge of the city's geography and people's rental behaviour.

Legitimacy was further amassed by building a supportive coalition of legitimate actors. The start-up QuCit, as provider of the smart application, strengthened the Keolis-Bordeaux collaboration in light of their current issues with managing the bike sharing network. As the success and wide use of the bike-sharing network generated unexpected problems, users became dissatisfied and frustrated. In this context, Qucit presented itself to Keolis, promising a data-driven tool that would lead to better understanding, predictability and management of urban flows. In response, Keolis came to think of BikePredict as the necessary technological intervention to overcome critical issues related to the bike-sharing network. QuCit's claim to expertise on datafication put it in a position to develop a data-based application to address some of the complexities of the bicycle network, adding further legitimacy to Keolis' system and Bordeaux Metropolis.

BikePredict's legitimacy did not only arise from the legitimacy inherent to its knowledge claims and the successful construction of a supportive coalition of legitimate actors but also from the fact that the three actors constituting that coalition were able to cross-legitimize each other based on their different roles and competencies in the context of the City of Bordeaux' overall goal of improving cycling conditions and rates. For example, Keolis' ability to create a public bike-sharing system, which is highly visible through the easily recognisable bikes parked at stations every 300 m, enabled Bordeaux Metropolis to show it was actively working on realising their promises to transition the city towards a more sustainable future. As a local start- up and academic spin-off, QuCit functioned as a symbol of expertise on smart city and artificial intelligence for Bordeaux Metropolis. In this context, Keolis mentions that QuCit's competencies in data-analysis represented an opportunity to improve the quality perception of their newly established bike-sharing system through innovative operation management and smart applications.

4.1.3. Enacting knowledge claims in practice

The BikePredict project reached some uncontested achievements in practice, especially with regard to project-level expectations: it produced real-time and predictive information about bicycle locations and rental behaviours, which was used for a well-performing infrastructure management for bicycle redistribution and maintenance. In practice, BikePredict was able to analyse large sets of data and visualise the results efficiently, and predicted station needs for re-balancing 12 h ahead accurately (Cherrier, 2016).[3] This performance in practice – rather than a knowledge claim-based expectation – was an important source of legitimacy for the bike-sharing network as a whole among users renting bicycles, who were supplied with relevant, real-time, information on bicycle availability at desired hours.[4] Similarly, initial resistance from the workers in charge of maintaining and redistributing the bicycles gradually reduced after discussions between these workers and QuCit software developers resulted in an adjusted design and interface of the BikePredict that better met the needs of the workers.

The predictive dimension was equally appreciated by Keolis: their head of marketing particularly stressed that "the prediction, that we tested, has an incredible reliability" (Jacot, 2017: translation authors). Keolis presented BikePredict as a successful smart mobility experiment fulfilling its function-level expectations in the forms of e.g. increased user-experience but also, an overall expansion of bike-sharing in Bordeaux area. In this context, the bike-sharing network and BikePredict were associated with increased bicycle use by the BikePredict coalition (34 % since 2014 according to the city of Bordeaux lis (Barthélémy, 2018)). However, others questioned the extent to which the joint action of the City of Bordeaux, Keolis and QuCit contributed to increased cycling in Bordeaux. For example, the increased bicycle use could also be attributed to stricter car-parking regulations or improved bicycle lanes (Barthélémy, 2018).

Indeed, increasing the actual use of the system was not at the forefront of developing BikePredict in practice – which was focussed on realising availability of bicycles at stations when there was demand for them. The assumption that improved data-based management of the system would automatically result in realising the projects' function-level and societal-level expectations largely remained uncontested. This was further complicated by the reliance on smart technologies to resolve issues and the absence of a strong cycling community; this made it particularly difficult to steer the project towards actually meeting the interests and needs of (potential) cyclists through other, non-smart, ways. A great illustration of users working to counterbalance the system's deficiencies resulting from this situation is that many turned the saddle backwards to indicate that a particular bicycle is not worth renting.

4.2. Fietstelweek in Utrecht

4.2.1. Knowledge claims and articulated expectations

The Fietstelweek aspired – at project-level – to become the largest data-driven research project on cycling behaviour, and according to our respondent from the cycling union, a lighthouse project for other countries to model after. According to the website, the Fietstelweek was guided by three principles: faster – save cycling hours by showing infrastructural bottlenecks; better – improve cycling networks by showing cycling routes; and Smarter – data in Cycleprint shows cycling behaviour. Voicing a pragmatic desire to obtain more accurate and intelligible data on cycling, the Fietstelweek also aimed, through smart visualisation, to supersede traditional, static methods of understanding cycling behaviour (Fietstelweek.nl, 2017a; 2017b; Keypoint.nl, 2016). An example of such traditional methods of understanding cycling behaviour, used by the province of Utrecht, are 'counting loops' which merely measure the number of bicycles crossing a particular spot.

At function-level, the Fietstelweek claimed that more and smarter data collection on cycling behaviour will contribute towards the development of a cycling infrastructure with better and faster conditions (Fietstelweek.nl, 2017a, 2017b). In particular, the Fietstelweek worked with municipalities who can use the collected data to prioritise cycling in decision-making processes. The quantitative nature of the project was hoped to carry associations of being politically neutral and authoritative.

The cycling union expected to benefit from the collected data in their lobbying efforts for improved cycling infrastructure throughout the Netherlands. Their expectations were based on project-level knowledge claims that big data on cycling behaviour allows for more detailed insights into the ways cycling is practiced in the city of Utrecht. For example, and according to one respondent who used the data, visualisation of how cyclists' movements have changed because of new cycling routes being opened-up provides credibility and justification for future interventions in the cycling infrastructure. Based on this argument, the Fietstelweek, on their website, claimed to contribute, through data visualisation, to the design of more targeted cycling policies and to make the effects of interventions in the city more transparent.

Societal level expectations were not explicitly pronounced by actors involved in the project. However, cycling allegedly results in health- and environmental benefits (Behrendt, 2016). For example, in an informal meeting of EU ministers for Transport (2015),

[3] Accuracy measures: the accuracy of presenting the availability of bicycles and parking slots in stations 12 hours in advance. The results show that this availability is predicted with an accuracy per hour of 97%, according to Cherrier, CEO of QuCit.

[4] The BikePredict system and its algorithm are invisible to the end-users of the bike-sharing network. Hence, the QuCit system only added to the legitimacy base of the bike-sharing network as a whole for this group.

Table 4
Summary table: Expectations on the Fietstelweek.

Expectation level	Expectation type
Project level	Large scale data collection on cycling behaviour Smart visualisations of cycling behaviour Innovative data collection method
Function level	Improving the cycling network in the Netherlands (better, faster and smarter). Prioritising cycling in urban governance Legitimising intervention in the cycling network / improved transparency
Societal level	Better management of increasing numbers of cyclists

cycling was presented as being beneficial for society: "through congestion easing, emissions and noise reduction, public health and infrastructure cost savings, cycling benefits even those who don't practice". The website of the Fietstelweek stated: "the Netherlands is cycling country par excellence, which is positive given that cycling is sustainable and healthy" (Fietstelweek.nl, 2017a). Interestingly, the societal-level expectation as voiced on the website, were not about promoting cycling, but addressed the barriers that emerge from rising number of cyclists (and the promise of big data in doing so). Subsequently, increased cycling practices is what drove this smart cycling project and the societal-level expectation was that such an increase does not need to be problematic because of the Fietstelweek that provides city planners with data visualisation on e.g. infrastructural barriers. This understanding underpinned project level and function level expectations. An overview of the expectations on the Fietstelweek is presented in Table 4

4.2.2. Legitimation process

As discussed before, whether an expectation becomes recognised as an attractive imaginary around which stakeholders choose to organise and which they support largely depends on the expectation's inherent legitimacy in the prevailing context (Kemp & Martens, 2007; Smith et al., 2005). In the Fietstelweek, we clearly see that the act of data collection in itself was perceived legitimate by our respondents, given the position of the Netherlands as a unique cycling country. A typical argument that we came across in our interviews, was the disconnection of, on the one hand, having a high-quality, and wide-spread cycling infrastructure and, on the other hand, having so little data on cycling behaviour. Indeed, the Fietstelweek's project-level claims of large data collection, data analytics and visualisation were backed by these arguments of 'non-knowing'. In particular, the use of mobile phones to collect data, thus linking the non-smart bicycle with a common, smart application, was perceived as an innovative way to collect cycling data. Indeed, as we show in our theoretical section, hypes commonly fetishize newness and favour it a-priori over the advancement of prevailing solutions (O'Leary, 2008).

With regard to actor-induced legitimacy, the legitimacy of the Fietstelweek expectations was further amassed through a process that was similar to the BikePredict case: by building a heterogeneous coalition of actors that brought together the required capacities to develop and legitimise the Fietstelweek project. Keypoint initiated the Fietstelweek in collaboration with other commercial parties, the Dutch Cyclist Union and NHTV university of applied sciences. Involving the Dutch Cyclist Union increased the credibility of the project's expectation of improving the cycling network because this organisation has the strongest ties with the cyclist community in the Netherlands and is perceived a credible organisation in the sector. The idea that large-scale data collection on cycling behaviour results in an enhanced capacity to understand cycling infrastructure, made the project appealing for municipal and provincial bodies to join the Fietstelweek. This, subsequently, provided legitimacy to the expectation that the Fietstelweek contributes to devising better cycling policies.

The Fietstelweek depended on cyclists to provide data by installing a tracking-app on their mobile phone; and on public authorities to make use of the data. On both levels, the Fietstelweek, according to our respondents, lost relevance over the years to the point that the initiative did not return in 2018. Whilst the amount of participating cyclists was deemed promising in the year of initiation (2015: 50.000 participants), the following two years were considered less successful by our respondents as ambitions to increase participants were not met. And while the Fietstelweek was initially endorsed by various regional and local-level governments, their interests to participate had dwindled by 2018 when, according to our respondent at the local municipality, most of the participants indicated that 'enough data' had been collected, seeing no use in collecting data for another year.

These developments were underpinned by difficulties to amass and maintain legitimacy for some function-level expectations over the years. For example, the Fietstelweek had no feedback mechanism towards those who collected the data (i.e. cyclists) regarding how the data is used in practice, which made it difficult to legitimise function-level expectations to this actor group. In response, the app was updated in 2017 with a 'plus mode' that allowed participants to continue participation after the indicated week and to manually reflect on their cycling routes. In the plus mode, users of the data (e.g. provinces and municipalities) could pose tailored questions on, for example, the perceived safety of selected bicycle routes. While spurring more active participation by data-collecting cyclists, this was insufficient to increase the number of participating cyclists.

Our respondents also argued that difficulties in demonstrating the usefulness of the collected data for infrastructural change delegitimised the project's knowledge claims in the eyes of governmental actors. One respondent, however, argued that the data could be used to justify infrastructural changes in hindsight, and illustrated this with an example from the City of Amsterdam. The city used CyclePrint's data to demonstrate that the opening of a cycling tunnel had affected the city's cycling behaviour in a positive way: the route through this tunnel was clearly preferred over other routes. Similar to our BikePredict case such realisation of the project's knowledge claims in practice was an important source of legitimacy for their decisions among urban planners and thereby in turn legitimised the Fietstelweek project.

4.2.3. Enacting knowledge claims in practice

The Fietstelweek set out as a highly ambitious data-collection project, but was cancelled after three years. Project-level expectations of innovative, large-scale data collection clearly materialised, yet the knowledge claim that such a large data set and the visualisation thereof can improve the cycling network and prioritise cycling in urban governance was left unrealised. However, these function-level expectations, as well as the societal-level expectation, did have a productive role in mobilising diverse actors around a smart cycling project. In turn, working with local and regional policymakers allowed the Fietstelweek to claim effects on urban governance and cycling policy from the start.

As parties left the consortium one by one, and fewer municipalities and regional governments joined the Fietstelweek, the project discontinued after the 2017 edition. From the user's perspective, a lack in translation from data to meaningful knowledge (as defined by local and national policymakers) challenged the expectation of the Fietstelweek being able to contribute to improving cycling conditions. One of our respondents even argued it would make more sense to invest money in researching a specific location where you have a specific question (e.g. did the number of cyclists decrease due to the construction of new cycling routes?) rather than investing in a national, large-scale project such as the Fietstelweek. In addition, our respondents observed no effects of the Fietstelweek on the governance of urban mobility and cycling. In this context, one of our respondents pointed out that there are very few bicycle officials in Utrecht, and this may partly explain the lack of the anticipated effect.

From the start, the project did not connect its data generation practices with broader, explicitly normative societal-level claims such as environmental and liveability claims associated with cycling, but strongly focused on supposedly neutral promises of removing barriers to cycling. For the latter purpose, large-scale data collection was deemed helpful for urban administrators to locate these barriers. Furthermore, and according to our respondents, the assumption that infrastructural barriers are experienced in the same way by different users, legitimised the expectation of large-data sets (rather than balanced data-sets) being able to locate infrastructural barriers, negating questions on representativity or reweighting.

Moreover, and as a trait of anonymous big data collection, the interpretation of cyclists taking unlikely routes, for example, was generally subscribed to such infrastructure barriers, rather than those routes being more pleasant, safe etc. (Fietstelweek.nl, 2017b). This can be observed in CyclePrint's visualisations, in which data is processed into maps of what they refer to as cyclists choosing either 'the most logical route' or the 'shortest route'.

5. Discussion and conclusions

Smart mobility comes with optimistic expectations of immanent and revolutionary change. There is a rising belief in smart mobility as a legitimate – and often inevitable or ideal – intervention in the urban context to enhance efficiency, sustainability and quality of life in cities (Manders et al., 2018). Participating actors are actively creating, re-creating and negotiating numerous future imaginaries, any one of which may or may not actually materialise. In fact, many of the expectations and the knowledge claims embedded therein in this paper's case studies have not materialised so far. But instead of explaining why these expectations did not materialise, this paper studied 1) the knowledge claims of smart mobility expectations; 2) how these particular expectations inherently have or amass legitimacy; and finally 3) the roles played by these knowledge claims when these projects unfolded and expectations were (not) met. This approach allowed us to reveal a number of insights which contribute to the sociology of expectation literature and are relevant for understanding the (urban) governance of smart mobility.

5.1. (Dis)entangling levels of expectations

Smart expectations underpinned by knowledge claims present a unique case in the sociology of expectations given the alleged predictive capacity of neutral, a-political data in imaging urban futures (Alvial-Palavicino, 2016; Lösch, Grunwald et al., 2019). Studying smart knowledge claims through the expectation typology (Table 1, cf. Manders et al., 2018) resulted in an interwoven picture: function-, project-, and societal-level expectations mutually informed each other as the promise of new information services (BikePredict) and large-scale data collection (Fietstelweek) were effective mobilisers in themselves. Indeed, claims at the function- and project-level co-constituted overly optimistic claims of the projects' transformative potential for the mobility system and the city. For example, in the BikePredict case, we witnessed disconnections between the computational and operational logic of project- and function-level expectations and the larger, societal benefits expected at the societal-level. And, where the Fietstelweek voiced expectations of being able to deal with increased number of cyclists and associated dangerous and unfavourable situations, these expectations were closely intertwined with knowledge claims on project level, here large-scale data collection.

However, during the process of actualisation, interwoven smart mobility expectations disentangled. Data tools and analytics (part of project-level expectations) were presented as a *sine qua non* to deal with cycling challenges in the city in both cases: issues with the bike-sharing network in the BikePredict case; and the unforeseen obstacles faced by cyclists who made use of the current infrastructure in increasing numbers in the Fietstelweek. As the materialisation of these projects' expectations unfolded, we primarily witnessed promising results on the project-level, while function- and societal expectations faded to the background - the intimate entanglement of the expectations' three levels was lost. For example, the Fietstelweek did not generate data that was suitable for its knowledge claim-based expectations at function level; and failed to express societal-level claims in relation to the broader infrastructural politics that were central to the municipality's interest in the project. As a result, the project was unable to move beyond results in the form of data generation.

In sum, the typology of expectations was useful to structure our analysis of articulated knowledge claims and to understand how societal-level discursive claims were embedded in project-level aspirations. Based thereon, our analysis brought to the fore how expectations expressed at different levels decoupled through the process of actualising these expectations, and highlighted that this resulted in a failure to protect and ensure projects' higher level promises of societal impact. The project-level and most function-level expectations were often unchallenged (and might even appear unchallengeable to actors). The legitimacy inherent to specific project- and function-level knowledge claims seemed to avoid societal debate on societal-level knowledge claims as the intimate relationships between different knowledge claims, as we observed in the paper, are usually hidden from view.

5.2. Legitimising knowledge claims and actor coalitions

First, we witnessed that the knowledge claim of large-scale (Fietstelweek) and real-time and predictive data collection (BikePredict) played a productive role in legitimising the expectations of these smart mobility projects. In particular, the assumed neutrality and authority of the large quantity of data that were to be generated rendered promises of an improved computational basis for decision-making (i.e. project-level expectations) and an improved mobility system (function-level) powerful and largely uncontested – with the notable exception of those who worked with smart mobility solutions on a day-to-day basis such as workers redistributing bicycles in Bordeaux.

Second, expectations based on knowledge claims had the capacity to mobilise a diverse array of actors in heterogeneous coalitions. We particularly observed that actors within these coalitions took on different roles and responsibilities than those which are traditionally considered legitimate. Indeed, the formation of heterogeneous coalitions around urban mobility challenges is not specific to *smart* urban mobility in itself, but the shifts in roles that different actors play within smart mobility coalitions can – at least in part – be attributed to *smart*. The idea that data collection and use are politically neutral activities with rightful authority allowed both public and private actors to move into terrain that is sometimes far beyond their usual activities. For example, Bordeaux Metropolis' alliance with Keolis and BikePredict shows how a public authority delegates the design and management of public services to private companies rather than procuring clearly pre-specified products and services. In turn, Bordeaux Metropolis could delegate responsibilities of sustainable city planning to infrastructure managers from the private sector.

The complexity of developing and managing the bicycle sharing network generated space for private actors Keolis and QuCit to actively engage with delivering public, user-oriented services. In a similar vein, the Fietstelweek case shows that Keypoint aimed to directly interfere in the cycling politics practiced by the Dutch Cycling union on the premise of producing politically neutral representations of movements through quantitative data collection. In addition, all parties involved took part in defining the problems the Fietstelweek was going to address as well as how Fietstelweek constituted a (partial) solution to those problems. Similar shifts in relations between private and public sectors have been observed also elsewhere in low-carbon transitions in urban infrastructures (Bulkeley, Castán Broto, & Maassen, 2014).

Finally, with regard to cyclists as the providers of data in the Fietstelweek the 'activists sampling' of participants (i.e. cycle enthusiasts) was unchallenged at the start and no reweighting of the data to counterbalance this sampling was discussed or planned. Interestingly, the promises of the political neutrality and authoritativeness of the large-scale data collection silenced potential concerns with regard to the politics of the knowledge producers (the sample of participants) at the outset. According to our observations, actors' claims on neutrality were legitimised by the large data collection sample and the universal experience of cycling.

5.3. The politics of smart mobility's knowledge claims

While the formation of heterogeneous actor coalitions around an almost all-encompassing concept such as 'smart' foregrounds inclusion of actors and visions, we also witnessed exclusions. In earlier research, we argued that expectations based on smart knowledge claims left little space for the imagination of non-smart solutions and of problem statements that cannot be addressed with datafication (de Hoopet al., 2019). Indeed, Fietstelweek's focus on large-scale data collection of present-day practices implicitly reinforces urban mobility governance geared towards optimisation of the use of road space to facilitate incremental increases in existing cycling flows. More explicitly, societal-level expectations in the Fietstelweek are legitimised through the argument that an increased number of cyclists comes with infrastructural challenges, which may be known and controlled through smart tools. It does not enable foregrounding non-motorised, or 'slow' forms of transportation altogether – a political choice that is left unarticulated and unchallenged. The BikePredict case started from expectations that the mobility system could be changed fundamentally, in terms of optimising and facilitating a city-wide bike-sharing network that challenges the urban arena currently dominated by cars. These case differences are difficult to understand or interpret through the logic of the cases as such, calling attention to specific urban contexts and how they inform the knowledge production process. For example, bicycle policy is high on the political agenda in Bordeaux. With the 'cycling mayor' of Bordeaux resigning recently (Le Chatelier, 2020), bicycle policy has become an obligatory passage point for new candidates to position themselves. In turn, cycling in the Netherlands, and especially in urban centres such as Utrecht, is generally not a political issue but an accepted reality.

Next, we observe exclusions of non-smart alternatives. Where Keolis and QuCit tried to develop a function in the BikePredict app which would enable users to mark defect bicycles, users turned out to continue turning the bicycle's saddle backwards to indicate this – a non-smart solution which Keolis and QuCit did not incorporate into their system. Our research, thus, draws out the knowledge politics of smart visioning processes in that only those alternatives obeying to the overarching smart hype can propose new urban imaginaries. What alternative solutions were proposed? Were other non-smart solutions to the bike-sharing network considered? These observations and challenges render questionable to what extent smart cycling projects can move beyond technological solutionism (e.g. Morozov, 2013) and towards actually transforming the urban mobility system.

With regard to the inclusion and exclusion of actors, expectations underpinned by smart mobility knowledge claims – like any performative expectation – specify relevant actors, dictating who should (or: is allowed to) play a role in constructing and realising these expectations (Borup et al., 2006). For example, our cases showed that local governments often represented the user of data-analytics that the initiative promised to provide. As they were entitled to determine the framework conditions for infrastructural developments, gaining local governments' support and active participation seemed particularly critical in the acquisition of legitimacy of such initiatives. At the same time, and crucially, this rendered the (political) interests of private parties such as QuCit, who actively contributed to shaping these infrastructural developments and data, much less visible.

5.4. Implications for future research and practice

Based on this paper's unpacking of the politics of knowledge claims in smart mobility, we argue that similar lines of investigation should be set up for other smart and/or urban infrastructural domains. Moreover, whereas our work has honed in on the knowledge politics of particular cases, future work could take more longitudinal approaches that follows the knowledge politics of innovation trajectories across a range of smart mobility projects in particular cities and regions over longer time. Indeed, while the sociology of expectations suggests that expectation-dynamics take place over longer periods of time, our cases ran for a rather short period of time. Consequently, knowledge politics embedded in hype cycles may only come to be unravelled to their full extent when traced over longer time across multiple projects and initiatives. Furthermore, while we studied the performativity of knowledge claims at the level of specific initiatives, it would also be highly relevant to understand how these knowledge claims play a role in changes in participating actors' overall reputation, know-how, finances etc.

The observations raised above imply a number of implications for smart (and non-smart) mobility governance practices. First, actors in the cases under study often claimed that data would have transformative effects based on an implicit assumption that realised project-level claims would automatically result in positive impacts on the mobility system, the city and society. This paper has demonstrated that these transformative effects do not materialise automatically in practice. We therefore argue that future endeavours in the smart (mobility) field should reflect on the claim that the generation of data will have transformative effects – or more specifically, why a project's claim of societal or functional benefits are thought to result automatically once project-level claims in the form of data-generation are realised. This can be done by unpacking the relationships between societal-level expectations on one hand, and function- and project-level expectations on the other hand, to understand whether these links are actually valid in practice or merely based on larger discursive processes and taken-for-granted ideas of smart mobility, coloured by current conditions and discourses of the smart city.

Second, given that hyped expectations generally focus on one specific solution and, as such, form a barrier to critical thinking about alternative solutions or approaches, we recognise that it becomes inherently difficult to empower counter visions – especially in the context of a seemingly all-encompassing smart vision (Brown, 2003; de Hoop et al., 2019; Hollands, 2008). We have observed that traditional ways of knowing and governing are getting de-legitimised while the expectations associated with digital ways of knowing did not always materialise in the projects studied in this paper. In this context, we would like to encourage practitioners and researchers to critically reflect on future ways of knowing the city and to question datafication's present appearance as an *obligatory passage point* for legitimate futures. In essence, this is a call to re-politicise not only mobility futures, but particularly to open up alternative ways of knowing the city and to explore their potential for imagining a much wider range of mobility futures.[5] This includes questioning the neutral and a-political character of smart data. We encourage to ask, for example, whose futures are prioritised through particular ways of knowing, what futures may be legitimately imagined and constructed; and whose voices are heard in these processes (and whose are not)?

Declaration of Competing Interest

None.

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[5] The 'myth of big data' according to Couldry (2014) entails the claim that big data techniques generate new and better for of knowledge. In his dissertation on big data in society, he argues that we need to disenchant such rhetorical claims about the new social world that big data techniques make possible.

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