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relationship between smart city visions and
cycling in Copenhagen and Amsterdam**

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Smarter cities, smarter bicycles? Exploring the relationship between smart city visions and cycling in Copenhagen and Amsterdam

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Interviewer: Often smart city visions do not include cycling.

Interviewee: Then it's not very smart, in my opinion. (laughs)¹

Abstract

In cities throughout the world, cycling is increasingly upgraded with smart technology and is included in smart cities visions and projects. This process has not been problematized in public discourse as smart innovation is seen as a potential booster of the known benefits of cycling. Drawing on critical literatures of smart city, smart mobility and degrowth and using the cases studies of Copenhagen and Amsterdam the paper opens up a more critical conversation on the smartification of cycling in the context of technosolutionism, technology push and pro-innovation bias.

Keywords: cycling; smart cities; cycling innovation; Amsterdam; Copenhagen

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¹ From the interview with an official from the City of Copenhagen, Intelligent Transport Systems team.

Introduction

‘Smart’ cycling innovations, from dockless bikesharing to smart helmets and data collecting devices mounted on bikes, have recently become a subject covered not only by specialised journals and blogs, but also by mainstream media, including *Guardian*, *CNN*, *Wired* and *Forbes* as well as numerous blogs and internet magazines. This attention peaked around 2016-2017 as the ‘boom’ and ‘bust’ of dockless bikeshare schemes facilitated by ‘smart’ locks and smartphone applications unfolded, first in China and then around the world (Campbell, 2018). The wider process of bringing ICT and Internet of Things (IoT) technologies in bicycles and cycling infrastructure continues, often as part of projects associated with the concept of ‘smart city’. Thus, urban authorities across Europe launch cycling innovation competitions under the direction of smart city offices (for instance, Dublin in 2016, Amsterdam in 2019) and participate in smart cities projects in which cycling is part of the portfolio (Helsinki, Manchester and Eindhoven to name a few). A virtual reality cycling simulator was nominated for World Smart City Award in 2017. Bike IT, an interactive platform for bike sharing services, won the main prize of the first large-scale Smart City Hackathon in Pakistan in 2018. Yet, not only smart city projects increasingly include cycling, also cycling itself becomes ‘smarter’: cities, where cycling is a mainstream mode implement various innovations from green waves to bike parking solutions using sensors and interactive message boards (Nikolaeva et al., 2019; Nikolaeva and Nello-Deakin, 2020) and cities which aspire to increase cycling rates run trials with cycling data collection facilitated by IoT and ICT (Lee and Sener, 2020).

The starting point of this paper is the observation that these processes of incorporating cycling into smart city visions, on the one hand, and of bringing smart technology into urban cycling projects on another, are often discussed in unequivocally positive terms by media and cycling advocates. ICT and IoT facilitated innovation is often seen as helping the momentum for urban cycling around the world as an allegedly benevolent transportation mode, having positive impacts on sustainability, public health and accessibility. Thus, the world’s largest bikeshare operator, Mobike, was awarded the Champions of the Earth award by the UN “for exploring market-driven solutions to air pollution and climate change” in 2017 (UNEP, n.d.). In 2016, the European Commissioner for Transport Violetta Bulc maintained that cycling needs to be incorporated into smart transport networks in smart cities of the future that “will be driven by technology” (Bulc, 2016). The main cycling advocacy organisation in Europe, European Cyclists Federation, has been writing for years about the “opportunities” offered by smart cycling innovation to make cycling easier, safer and more popular (Malovrh, 2018). This suggests that at least in Europe the process of smartification of cycling under the umbrella of smart cities visions has not been problematized,

quite the opposite. Behrendt (2019) even concludes her review of the EU policy documents with the call for including cycling “more consistently and centrally in policy documents concerning the Internet of Things, smart cities, connected vehicles and (smart) transport” as this would ensure that this “sustainable” mode of transport would keep challenging the dominance of the car (p.17).

Building literatures on smart cities, smart mobility and cycling innovation this paper aims to open up a more critical conversation on incorporating cycling into smart city projects and the smartification of urban cycling planning. Scholars have problematized smart city and smart mobility visions as manifestations of technological solutionism, the growing power of tech companies in defining urban problems and offering solutions not grounded in local context (see Literature Review for more detail). The process of smartification of cycling may be related to these trends, and, in addition, may even be at odds with the very promises of cycling that make it so popular among scholars and activists in the mobility transition debate. For instance, dockless bikesharing schemes, perhaps most researched smart cycling innovation thus far, have been criticized for not delivering the sustainability benefits, for being exclusive and capitalizing on personal data (Médard de Chardon, 2019; Spinney and Lin, 2018). While environmentalists and degrowth scholars praised cycling for its energy efficiency, autonomy and self-limiting qualities (in contrast to driving), the logic of smart city, centered on interconnectedness and doing “more with less” (Shelton et al., 2015) may compromise those qualities. As cycling gets enrolled in smart cities discourse and as smart innovation enters cycling policy and planning, we thus need to ask what are the rationales and drivers of these processes, what the roles of different actors are and what choices about urban mobility futures they are making (Nikolaeva et al., 2019).

Thus, focusing on the cities of Copenhagen and Amsterdam as case studies, the paper will answer the following questions: *What is the role of cycling in envisioning smart city? What are the rationales for cycling planners and advocates to engage in the smartification of urban cycling? Does incorporation of previously seen as “low-tech” solutions into smart city projects or bringing in smart technology in the field of cycling change the very definition of smartness?*

The next section provides the literature review and grounds the paper in debates on smart cities, innovation and cycling. Section 3 presents the research design and methodology. Sections 4 and 5 answer the three questions posed above.

Literature review

So why problematize the convergence of smart city visions and the momentum for urban cycling? In this section I offer reasoning for investigating this process more closely based on literatures on smart cities and smart mobilities, innovation in urban planning and smart cycling innovation.

The smart city discourse – discourse on the key role of technology in solving urban problems from crime and pollution to accessibility and lack of participation – still forms one of the dominant visions of urban future (Cardullo and Kitchin, 2019; Hollands, 2015; Joss et al., 2019). The debate on the shortcomings of smart cities visions has been quite prolific and it is beyond the scope of this paper to touch upon all critiques (for an overview see Luque-Ayala, 2018; March, 2018). Yet, it is pertinent to highlight a few recurrent (and related) concerns that resonate with the concerns expressed by scholars writing on smart mobility: technological solutionism, technology push and a lack of embedding of smart city visions in the respective urban contexts. It has been argued that technological ‘solutions’ are often established before proper deliberation on a problem takes place, and that those actors who win from selling technological solutions exercise increasingly more impact on the very framing of problems and solutions in urban policy and planning in general, and in the mobility field in particular (Docherty et al., 2017; León and Rosen, 2019; Luque-Ayala, 2018; Sadowski and Bendor, 2019). The ‘solutions’ are often disconnected from the local context, the relevant grounded knowledge, the political, institutional, social and cultural fabric of the city (Aurigi and Odendaal, 2021; Shelton et al., 2015). The increasing introduction of smart innovation into the field of cycling field may be related to the growing power tech companies and thus be subject to similar critiques.

A related debate on the pro-innovation bias in urban planning and degrowth thinking offer another critical perspective relevant for considering smart cycling innovation. Thus, Ferreira et al. (2020) posit that innovation is increasingly seen as an “intrinsically positive value” in approaching challenges in urban planning. Instead of solving “wicked” problems, urban planners pursue “change for the sake of changing” which is easier short-term but eventually leads to the “proliferation of pointless novelties” with very little progress made towards key policy goals (Ibid). They argue that best solutions do not have to be innovative and frame cycling as a case in point, “a means to achieve sustainable and active mobility” that is already available (p. 3, also see Shove, 2012). Indeed, cycling is an activity that can be pursued without any IoT or ICT devices, and mature cycling cities, from Amsterdam to Copenhagen have seen rising cycling rates without the wide use of smart technology. This observation also suggests that we need to question the rationales for smartifying cycling: who is driving it and for what reasons, if it is not intrinsically

necessary for cycling to be supported by smart innovation in order to become a mainstream mobility mode?

Furthermore, in the literature on degrowth and environmentalism the ‘humble’ bicycle is often seen as a simple, low-tech,² convivial tool that exemplifies perfect autonomy of an individual. Cycling is seen as part and parcel of ‘simple’ living, a prefigurative practice on a path towards degrowth and decarbonisation (Alexander and Yacoumis, 2018; Furness, 2005; Horton, 2006; Zoellick and Bisht, 2018). To quote the philosopher Ivan Illich (1974), unlike driving a car, “the use of the bicycle is self-limiting” and allows people to “become masters of their own movements without blocking those of their fellows” (p. 74). Smartification of the bicycle, one may thus argue may threaten this autonomy, the very feature that, according to many, makes the bicycle a solution to the wicked urban issues. A smart bike or smart cycling infrastructure in a smart city are part of wider systems; interconnectedness is, after all, is one of the hallmarks of smart mobility solutions and smart cities discourses. The way the literatures on pro-innovation bias and degrowth frame cycling thus suggest that there may be a tension between cycling and the smart city vision that somehow gets obscured in the celebration of smart cycling innovation.

Finally, mobility scholars have been critical of some of the claimed benefits of specific cycling innovations, like bikesharing and smart cycling innovation more generally. Some have argued that the effects of smartifying cycling may vary greatly depending on its ideological underpinnings and that the benefits may be distributed unequally (Nikolaeva and Nello-Deakin, 2020; Gironés and Vrscaj, 2019; Popan; 2019). Bikesharing schemes, in particular, have been criticized for not fulfilling their modal shift promises, for being exclusive and for questionable data collection practices (Duarte, 2016; Médard de Chardon 2019; Spinney and Lin, 2018). Smart cycling innovation, it has been argued, can be utilized to advance very different urban futures and politics of mobility, and it is pertinent to investigate the roles of state and non-state actors in smartifying cycling and their rationales for pursuing particular projects (Nikolaeva et al., 2019; te Brömmelstroet et al., 2020).

This literature review demonstrates that the ongoing process of smartification of cycling, often under the auspices of smart city visions, should not be taken for granted as a mere booster to the benefits of the humble bicycle. Instead, it should be problematized and its drivers need to be investigated. This process may potentially be related to technological solutionism, technology pull,

² Here I draw on a definition from Alexander and Yacoumis (2018): “a technology can be considered ‘low-tech’ if it does not require electricity or fossil fuels to operate, or if it relies on passive or direct (non-electric) solar, wind, or human-powered energy.” (p. 1841)

smart city visions divorced from local context and a manifestation of pro-innovation bias in urban planning. Moreover, smart innovation may even undermine the very core benefits for which cycling has been lauded by environmentalists and cycling activists. Informed by these arguments, this paper offers an exploration of the drivers and rationales behind the alignment between smart cities and cycling in the cities of Amsterdam and Copenhagen. The next section discusses case selection and methodology.

Case Studies and Methodology

This paper presents an exploratory study, drawing on two cases that can be considered ‘extreme cases’ (Flyvbjerg, 2006). Amsterdam and Copenhagen are seen as world primary cycling cities due to the high proportion of cycling in the modal split and their important symbolic function for cycling activism as well as their role in cycling policy knowledge transfer (Bruntlett and Bruntlett, 2018). Both cities are also prominent players in the European and global smart city field, receiving awards and delegations from different parts of the world eager to learn about their smart technology as well as their cycling planning and culture. In 2014 Copenhagen received the World Smart Cities Award in for its Copenhagen Connecting Project that includes smart cycling solutions around data collection. According to the study by Joss et al. (2019), both Amsterdam and Copenhagen belong to the group of cities that shape global smart cities discourse. Copenhagen is often praised for centering sustainability (Joss et al., 2019), while Amsterdam “presents itself to the world as a citizen-driven smart city” (Raven et al., 2019, p. 264). The prominent role of both cities in knowledge transfer on both cycling and smart urbanism makes these two cases particularly interesting and important for understanding the current and possibly future relationships between cycling and smart urbanism. Also, the chosen approach allows focusing on “actually existing smart cities” and understanding policies and projects in their local context, rather than pursuing a more speculative mode of reflection on smart urbanism (Shelton et al., 2015).

The professionals involved in smart city projects and in cycling policy, planning and advocacy as well as a range of actors building the links between the two worlds in the two cities were identified using internet search and snowballing technique. In total 24 professionals were interviewed for the Copenhagen case study and 33 people were interviewed for the Amsterdam case study (see Appendix 1).³

³ The number is slightly higher for the Amsterdam case as I included interviews from a parallel research project on smart cycling technology in which I added a block of relevant questions.

The transcribed interviews were analysed thematically to answer the three questions set in the introduction. A number of policy documents, visions and reports were analysed with the same questions in mind next to the interview research, however, the main focus was on the actual experiences and views of players in the field and the analysis of documents played only a supporting role.

Smartification of cycling in Copenhagen

The role of cycling in Copenhagen smart city and smart mobility initiatives

In Copenhagen smart cycling innovations such as green waves, cycling counters, messaging boards for cyclists and smart data collection projects are frequently highlighted both by the smart city-related actors and cycling ambassadors in a variety of publicly available texts (Colville-Andersen, 2014; Weinreich, n.d.). The report “Mapping Smart Cities in the EU”, commissioned by the European Parliament (Manville et al., 2014), provides a detailed discussion of cycling in Copenhagen as an important “solution” in the context of smart cities, and discusses extensively cycling policy and planning in the city. Yet, the interview analysis has shown that what may look as a coordinated set of interventions aligned with a smart city vision from the coverage in media and in grey literature, is, rather, an assemblage of projects not linked to a single actor or a vision.

According to most interviewees, one of the key drivers behind the investment into smart traffic management in Copenhagen, including testing and introducing various ICT solutions for cycling, was CPH 2025 Climate Plan that has set the goal for the city to become “the world’s first carbon-neutral capital city by 2025” (The City of Copenhagen, 2012). Cycling is given a lot of attention in the document; of the four areas of action within the mobility theme, the “City of Cyclists” initiative received by far the largest share of funding (Ibid, p. 57). The document prescribes that by 2025 “at least 50% of all journeys to the place of work or study must be by bicycle” (Ibid). Making cycling more attractive is presented as one of the means of achieving such modal split, and, according to the interviewee who was involved in developing Copenhagen’s first Traffic Management System, this ‘attractiveness’ often translated into travel time savings as a key objective (C1⁴). Also, next to the goals set in the Climate Plan, the sheer presence of cyclists in the city in such large numbers necessitated taking them into consideration during the development of traffic management system:

[According to the Climate Plan]...we should have reduced the number of stops for cyclists. We should have improved the travel time for them and so on... You cannot ignore 50% of your travelers...It was necessary for us to collect data from bicycles and also integrate

⁴ Hereinafter interviewees are referred to by their code name, for the overview please see Appendix 1.

it somehow into the traffic management as a whole. (C1, similar point made by C6, C19, C20)

Political prioritization of the travel time reduction goal resulted into a variety of projects, both incorporating technology and not, and thus being initiated by different departments within the city administration (for an overview see van Vlerken, 2018). According to the majority of interviewees, most applications of smart cycling innovations in Copenhagen have not originated within the smart city related initiatives.

In order to understand this relationship between smart city visions and cycling innovation in Copenhagen, one needs to understand the character of smart city projects in the Danish capital. In 2014, the city has set up a cross-departmental team “Copenhagen Solutions Lab” working on smart city projects, described as follows by the former employee:

We identify and coordinate smart city-needs in the municipality’s departments and match them with existing knowledge and solutions on the market. In this way, Copenhagen Solutions Lab acts as a bridge between external partners and Copenhagen Municipality’s initiatives concerning smart city (C5).

Of the five themes and six laboratories listed on the website of the Copenhagen Solutions Lab there is only one initiative linked to cycling: a market dialogue with companies which could offer data on pedestrians and cyclists in relation to opening new metro stations in 2019 (Copenhagen Solutions Lab, 2018). In the short overview of Copenhagen Smart City approach, cycling is not mentioned, though smart mobility is listed as one of five focus areas, with IT-based traffic management system highlighted as a key example (Copenhagen Solutions Lab, 2014). As an interviewee from “Copenhagen Solutions Lab” puts it: “A lot of what you could call ... ‘smart solutions’ is actually done by our traffic management team. (...) I think the smart solutions for bikes come out of the need to manage traffic” (C5). The question why (despite appearances) cycling is not a strategic part of smart city vision in Copenhagen has been countered by many with an observation there is no coherent smart city vision in Copenhagen in the first place.

... We don’t have a smart city strategy. ... In Copenhagen we are focusing on all the things ... like improving conditions for cyclists and for pedestrians and making sure there’s a nice proper public infrastructure and good public spaces and all of these things. Then in some of the projects we use technology as enabler, but we just don’t have the strategy of putting smart city as a goal in itself. (C5)

Other interviewees show a similar attitude, even those who are very much involved in smart technology projects, one interviewee calling smart city a “fluffy” concept (C13) and another commenting: “Nobody knows what it is, but it's very hype” (C19). A smart city for them is a means to serve other goals:

...If you've seen the City of Copenhagen's publications on where they want to be in 2025, et cetera. Then you have to close your eyes and say, "Okay, how can smart city thinking assist us in reaching these objectives?" So smart city in itself is nothing. (C13)

And yet, despite this emphasis on the technology as an “enabler” and an outright lack of support for technosolutionism, a few interviewees acknowledge that they do experience some technology push and that smart city visions driven by the supply of the technological solutions rather than by policy priorities are indeed present in the debate as a default option. According to them, the city of Copenhagen has been resisting taking that option, and a pro-active stance towards the deployment of technology has strengthened with years.

... I use the term [smart city] even though I don't like it. I think first of all, it was probably invented by tech companies that wanted to sell devices. Then for a while, we maybe joined the hype... Now we're a bit more mature... Back then you had this idea that you'll just need a lot of sensors that collect data about this and that and as long as we have sensors and data then the city would just become smart. I think now we've flipped the perspective and started looking at problems and areas where we could either save money or improve service and then see what technology can enable that. (C5, similar point made by C19)

There are companies who have all kinds of technologies that they'd like to sell. As such, of course, the interesting thing has been for Copenhagen to see, "How can you actually introduce some of those in a manner that makes counting for instance, or planning more efficient and more reliable?" (C2)

We thus see how technological solutionism and technology push are ever-present in the urban policy and planning in Copenhagen, yet it appears that a more pro-active approach grounded in local policy priorities has developed.

The presence of technology push and technological solutionism has been also recognized by a city officer working on application of smart solutions in transportation and cycling: “We've been approached by companies like Strava... they are ...like ‘See it's very nice don't you want to use it in Copenhagen?’ ” (C19). However, in the field of cycling in particular, the technology push has been minimal most likely due to cycling not representing a particularly lucrative business case:

...This whole smart city area, it's driven by technology companies and they are looking at areas where there's potential for large investments and where you need some kind of technology. I think you're right when you say that cycling is a low-tech solution already. Perhaps that's not the first area to look in. I think that's probably why that we don't see so many solutions for bikes. (C5)

Bicycle is very cheap. It's cheap to run and maintain. It's all good but it means that there's not a lot of money in the industry as a car industry. (C19)

Nobody earns money from anything cycle related. (C20)

This low-tech nature of cycling is even seen by some as an obstacle for it to become more visible and be taken seriously:

There are not so many commercial interests in cycling...For the car industry there are also huge commercial interests from the industry [side] If you go to the ITS [Intelligent Transportation Systems] congress, you could see the money involved, it's not bicycle companies. It's too cheap. It's too low-tech. There is an issue to get cycling up and level with the other modes of transportation. (C6, similar point made by C24)

At the same time, a number of interviewees expressed a belief that cycling *should be* a part of smart city related projects (also see the epigraph). According to one of the major ITS companies involved in smart mobility projects in Copenhagen,

[Cycling] should have its place. It should be part of the vision of Smart City. We see that it's becoming part of that Smart City vision more and more. I think we can be happy that that's the change that's happening because without cycling I don't think you'll have an effective Smart City. (C23, also C24)

This leads us to an interesting provisional conclusion that cycling is in fact not that prominent in smart city and smart mobility initiatives in Copenhagen, and, according to actors involved or driving such projects, there is an unfulfilled potential there. The next section discusses how actors in the field of cycling look at this issue.

The Rationales for Cycling Planners and Advocates to Engage in Smart Tech Projects

The interviewed professionals responsible for cycling policy and planning in Copenhagen have been involved in consultations around smart innovations in traffic management and in the research and market consultation processes set up by Copenhagen Solutions Lab. On the basis of the interviews, their attitude could be described as being wary and critical of technosolutionism, and yet being open to solutions that could help them with their key priorities. They seem to be critical of adoption of innovation for the sake of innovation, yet ready to set aside their skepticism. Thus, one of key persons defining cycling policy in Copenhagen admits some personal resistance to high-tech solutions for problems that, in their opinion, could be resolved by traditional means, for instance, a “good old communication campaign”. And yet the openness prevails:

But all these sort of, "I'm a little bit skeptical," I have to combine that with the curiosity... In innovation, you never really know what the final outcome is. I have this double

approach. On one hand, why should we have a high-tech solution if it really a low-tech solution that is more cost-effective and can do the same job but then again, I also need to maintain an open mind for some added benefits that maybe I did not see because I'm used to thinking in a certain way.(C6)

An example of such openness has led that officer to spot an opportunity in a situation in which initially they felt they had to accept a pre-defined solution, a typical manifestation of technology push and technological solutionism:

I was a little bit critical, I must confess because I felt that the private companies that were chosen for the project in some way already had defined the solution. Then, it was my job to apply a need on the pre-existing solution. The company that was originally part of the variable message size they wanted to develop a whole new signage concept inspired by the tube in London but for cyclists with different colors of different routes. We chose not to develop that further because we already have pre-existing bicycle infrastructure route schemes, we have green cycle highways, we have supercycle highways. To me, it did not bring added value but one of the minor elements were these dynamic message boards that was then developed as a prototype and throughout the process, we do have a need to enhance traffic flow for cyclists. That is a real need. (C6)

Another example of pro-actively employing smart technology for policy priorities is the fact that already prior to the creation of city-wide ITS programme⁵ and the development of digital traffic management system, the municipality cycling team had initiated pilots with green waves for cyclists to see if they “could improve the travel flow for bicycle traffic in the rush hour without having too many negative impacts for buses, and cars.” (C6)

Another officer working on cycling in the city of Copenhagen mentions that there are a number of needs they have – for instance, understanding route choice better and planning bicycle parking – with which smart technology, perhaps, could help and they would be very interested in such solutions (C11). The interview with municipality officer in Copenhagen working on super cycling highways provided another example of resisting the pro-innovation bias and looking for solutions grounded in the local context. Even though one of the goals of their project was to search for “innovative solutions” that could be later applied elsewhere, they did not feel forced to use smart technology (C11). Instead, they first defined a specific need of their target audience, based on surveys and then looked for solutions across the spectrum of possibilities.

Next to the main reason – the possibility that technology will help to achieve policy goals – there are two other closely related reasons to partake in the smartification of cycling for cycling planners

⁵ See <https://www.thelocal.dk/20150202/copenhagen-to-roll-out-new-smart-traffic-systems/>

and advocates: the perception of inevitability of smartification of urban mobility in general and the desire to keep the central role of cycling in mobility split, also in relationship to the emergence of AVs:

...Technology is what is driving cities and the future in mobility right now. What we hear is that detection of cyclists is one of the big challenges for autonomous vehicles. Cyclists are the hardest to actually detect and for the car to judge what is the person trying to do. There is a challenge there to making sure that these manufacturers actually take the bicycle seriously and into consideration so that we don't end up with streets where it's necessary to fence off the streets to make sure that these cars can go without being stopped all the time. (C24)

This commentary suggests a complex dynamic at play: on the one hand, cycling may be forced to become “smarter” as everything else – a form of indirect technology push, yet, on another, this also may represent a potential moment for empowerment. Thus, an officer from the municipality working on cycling and Intelligent Transportation Systems suggests that even though currently smart technology may be used to support the system in which car traffic is prioritized, it can also be used to prioritise cyclists, for example, through reducing waiting times (C19). Relatedly, one of the key officers in cycling planning in Copenhagen argues that the lack of cycling data keeps cycling behind developments in other modes and that technology may help:

...The technology is already in place for motorized transport and has been for a long time... Cycling is just invisible because we don't have the data to bring them up in the screen to see the bicycle traffic. In the city like Copenhagen where 48% of all trips is done by foot or by bike, it's quite a lack of proportion of traffic that is just completely invisible. (C6)

One of the interviewees takes this idea even further and argues that smart technology can be a tool of reconfiguring mobility politics towards a system in which people on vehicles will have more priority that vehicles is articulated:

I think it's very important to keep talking about the human element of mobility. That is pedestrians and cyclists because as soon as you put people into vehicles, it's no longer about a person. It's the vehicle. I think that's the biggest transformation that has happened within the 18 years I've worked with transportation and mobility is that now we have, hopefully, in most of the places, stopped talking about transport of vehicles and how to get those through but about how can we get as many people safe and fast through a city. I think that's where smart technology can really play a role as an enabler for us to make better and more sustainable mobility choices as the users.... We can use technology to also make sure that it's safe to be a cyclist. This should benefit people. (C24)

This is an interesting aspiration in dealing with the technology push: to try to use it towards a mobility future that centers people, not smart technology. In the next section we will look closer at what “smartness” means in this context.

How is Smart-ness Understood in the Context of Cycling Projects in Copenhagen?

The enthusiasm about smart cycling innovation in Copenhagen is moderate. One interviewee juxtaposed smart technology to the “basic common sense” and maintained that Copenhagen already has “not technologies but techniques, and they work” (C2). Another interviewee refers to “boring” and “low-tech” solutions that are indispensable for a city that wants to have high cycling rates such as separated infrastructure (C6). This point is supported by a specialist on cycling safety working at the Danish Road Directorate who admits that cycling innovation can improve cycling experience, but other, already known measures, may be more effective.

One thing we tried was this right-turn thing, where we had lights in here and close to the curbstone that would blink, because there were some loops here for turning cyclists... That was a trial project we initiated because it's really popular among politicians to have things that blink.

(...)

Really what we have known all the time is that you just need safer vehicles, you just need better vision, you need lower windows, everything has to be better. Why do you put a man in little box and give him one hole to look out through though? It's really bad the way car trucks are designed for urban traffic. This is what is being worked on in EU, but it's just not as sexy as putting lights. (C14)

Another cycling expert at the Danish Road Directorate, talks about “the basis” and “gimmicks” that needs to be used “cleverly”, like automatic cycling counters:

...What we've come to realize, what I've heard more and more is like none of the technology in itself can fix everything, it is the way we use the technology (C10)

A municipality officer working in the project on cycling highways juxtaposes ‘good’ solutions and ‘smart’ solutions:

We have all this kind of smart solutions, but sometimes it's not the smartest solution that's the best solution. (C16)

This attitude very much resonates with the way that the bicycle is framed in degrowth literatures and discussion on pro-innovation bias in urban planning: cycling planning is “boring” and, while there can be some improvements, it largely demands no exciting smart novelties to work.

Smartification of Cycling in Amsterdam

The Role of Cycling in Amsterdam Smart City and Smart Mobility Initiatives

Compared to Copenhagen, smart cycling innovation in Amsterdam plays a somewhat less significant role in branding Amsterdam as a smart city, and, similarly to Copenhagen, one would not be able to find a strong coherent narrative on the role of cycling in smart city initiatives. This can be at least partially explained by the decentralized nature of smart city initiatives and loose links of these initiatives to other roadmap and policy documents produced by the municipality (Raven et al., 2019). Amsterdam Smart City platform bears a distinctly decentralized character as citizens, entrepreneurs and civil servants register their initiatives on the website without much top-down steering (for a detailed analysis see Raven et al., 2018). Chief Technology Office (CTO) is an innovation team at the municipality of Amsterdam that collaborates with other departments and external parties in the sphere of innovation and smart technology. While they (co-)author and contribute to visions on smart mobility, they play a mediating and coordinating role in the field of collaborative smart initiatives and do not have an overarching vision of smart city that drives their actions.

Cycling is relatively underrepresented in official documents and platforms dedicated to smart mobility and smart city: for instance, the Metropolitan Region of Amsterdam plan for smart mobility 2018-2022 (MRA, 2017) includes 11 references to cycling, 34 references to cars and driving and 14 references to self-driving vehicles. While the difference these numbers is not significant, one has to remember that cycling makes for 48% of all trips in the city while the use of driverless vehicles is at this point still hypothetical. In 2020 only 2 out of 39 projects in the Mobility sector on Amsterdam Smart City Platform focused on cycling, in 2021 there are no cycling projects mentioned on the website (Amsterdam Smart City, n.d.). In the Smart Mobility Action Plan 2016-2018 (City of Amsterdam, 2016) there is some attention to the bicycle with 2 out of 24 projects explicitly focusing on cycling. In the more recent Programme Smart Mobility 2019-2025 (City of Amsterdam, 2019) only 1 out of 29 projects specifically focuses on cycling innovation. Both documents include mobility projects that may include cycling and mention cycling as a mobility mode that is already prioritized and should be prioritized more. Smart innovation, according to the two documents, should help create more space for cycling and walking in the city and also solve issues resulting from massive bike ownership rates, such as crowded bike parking spots and difficulty finding one's bike in the city depot after it was moved by the city for breaching parking regulations.

According to two interviewees from CTO office, the main reason for cycling to be not very prominent in the smart mobility policy and smart city projects is that it is taken for granted:

Maybe one of the reasons that it's not very prominent is that it's such an automatism for us to cycle... It's a great way of getting from A to B, and it's stuck in our culture. It's the natural thing to do. Also, I think if you're looking at, for example, mobility as a service, and the different options you offer to people, the bicycle will always be a very important option. ...So it's a fact of life and it's a fact of life that accommodates a lot of the things we want in the city. (A8)

Here, it's already pretty ubiquitous so there's not really a necessity... I think for other cities, it's a way of saying, "We want more bikes and we want it on all of our policy documents." For other cities this may be a way to pull bikes through (A11).

Also, some interviewees mention insufficient coordination between teams working on smart mobility and smart cities and teams busy with cycling policy and planning, both at the municipal and national level: "Those discussions are held in different conference centres. They still have to meet up." (A20, similar point made by A11, A24).

When cycling *is* mentioned on Smart City Amsterdam platform and in the visions (co-)produced by CTO, similarly to Copenhagen, smart cycling innovation is mobilized to serve the existing priorities in mobility policy such as the perceived scarcity of space in the city center, especially in the context of bike parking as well as congestion, especially at the regional level. Thus, for instance, one of the key reasons to bring together smart technology and cycling is that the city is "increasingly under pressure" and since the "space will not grow", the city needs to use the existing space and the existing infrastructure "smarter" (A3, similar point made by A6, A7, A8). According to the former manager of the Smart Mobility programme, while one of the means to do that is "discouraging cars", one can also consider how cycling could be differently organized, for example, through more bikesharing, and how the city can manage increasingly crowded bike lanes (A8). Interestingly, the interviewee repeatedly compares the bicycles to cars in that respect: how it is increasingly more accepted to share a car or not to own more than one car, whereas it is still normal to have more than one bike, and also that car parking is much more regulated than bike parking (A8). Those norms are probably hard to change as a bike "represents so much more" than a car: owning a bike is a strong element of in the Dutch cycling and having a few bikes and having freedom to park them almost anywhere have thus far been very important (A8). So, for the former manager of Smart Mobility programme this remains an open question whether the smart technology can change that cultural norm in the service of "smarter" use of infrastructure (A8). A somewhat similar doubt about the possibilities of technology is shared by another city official involved in smart city projects as part of CTO team:

The most obvious possibility is the decreasing space used by bikes through sharing, which is a mainstay of the smart narrative. ...It's a bit like the holy grail. What if we could all share our bikes then we would need less because of awful lot of bikes. At the end, if it still hasn't happened yet maybe it's not that important after all (A11, similar point made by A6).

Thus, similar to Copenhagen, we see that local policy priorities appear to shape engagement with technology. However, unlike in Copenhagen, there is some sort of friction between the aspiration to optimize the use of space with the help of smart technology and the local mobility culture. What is peculiar about the role of cycling in smart city visions in Amsterdam, compared to Copenhagen, is that cycling is framed as a source of problems to solve as well as a solution. A quote from the Smart Mobility Action Programme 2016-2018 sums it up:

The objective of encouraging cycling innovation is greater use of bicycles, fewer abandoned bicycles, less but smarter use of space (by parked bicycles, for example) and assisting with cycling traffic flows. (City of Amsterdam, 2016, p. 33, translated from Dutch by the author)

Similar to Copenhagen, actors across the board, both involved in smart city projects from the side of CTO office and from cycling policy and planning, brought up technosolutionism in the discussion as a trend that they observed and that, they believe, did not take hold in their city, at least not in the field of mobility they are involved in:

It's not only solutions coming from market or citizens but it's also the institutional departments trying to embrace smart mobility solutions for their problems and that's a fairly new development ... People are saying, "Okay, it's great, but it also needs to work for us." It's not something because IBM says it's a good idea then we just need to implement it. It needs to work for us (A11).

This CTO official compares this approach to the past experiences:

Two years ago, a report was made in which a consulting firm actually advised the city of Amsterdam, "Self-driving vehicles are coming...You need to really think hard about it...You need extra policemen and extra fences at crossings to educate the Amsterdamers that they should behave." Okay, this is the most ridiculous advice, this is turning the world around....Two years ago, this was perfectly feasible. I don't think any consulting firm would now consult in a way like that. (A11)

The former manager of Smart Mobility programme makes a similar observation that also echoes the idea of “flipping” technosolutionism articulated by the interviewees in Copenhagen:

We discovered that when we started that sometimes, for example, autonomous vehicles was regarded as a cool thing, and as a goal in itself, instead of a means through which to solve a problem. That's our new way of thinking: We have to look at area development ...What does certain area need in the broadest sense? How can we accommodate that, other than giving people parking spaces in the streets? (A8)

We thus see in Amsterdam a very similar to Copenhagen process of growing reflexivity and proactive approach in dealing with smart mobility technology.

The Rationales for Cycling Planners and Advocates to Engage in Smart Tech Projects

The analysis of interviews with cycling advocates and officials involved in cycling planning in Amsterdam suggests that, similar to their colleagues in Copenhagen, they engage with technology, smart mobility discourse and smart city agenda when it suits their goals. The “Long term cycling plan 2017-2022” (City of Amsterdam, 2017) mentions cycling innovation in the context of bike parking issues and shows interest in “cycling-friendly” innovations that aim to make cycling more comfortable, such as rain sensors at junctions that invoke a longer green signal for cyclists when it rains.

Bike parking, especially around train stations is high on national transport policy agenda and very much so in Amsterdam. A representative of Transport Authority Amsterdam, a collaboration of 15 municipalities in the sphere of mobility, explains why they began investigating the possibilities of innovative solutions:

The most important thing was, we’re going to work on innovations to optimize these parking facilities. And that can be putting more racks in the same space, but we thought, why not try to use one bicycle that is standing for 24 or 36 hours doing nothing, letting these bicycles fly in, fly out more often. And that could solve a lot. So for us that maybe [is] the golden egg, the holy grail. We’re in search of the holy grail. (A2, similar point made by A6)

This priority stems directly from the Administrative Agreement on Bike Parking at train stations, signed by the national government, local bodies, including Transport Authority Amsterdam, and interest organisations such as Cyclists’ Union in 2016. The goal of the Agreement and thus of this search for the “holy grail” is combatting the challenge of scarcity of bike parking at train stations and high costs of continuing to build extra facilities by, for instance, more efficient use of the existing infrastructure.

Investigating “smarter” way of using parking space at and around train stations is also related to broader goals of maintaining accessibility of the city and a modal shift – encouraging the switch from driving to using a bike-train combination (A6, A2). Apart from this very prominent policy goal, the interviewees also mention crowdedness on bike lanes, stress of cycling and improving cycling comfort as important policy objectives that can be supported by innovation (A3, A6). At the regional level, the issue of congestion and modal switch to an e-bike plays a role: the initiative Bike Coalition SmartCity (in Dutch: Fietscoalitie SmartCity) which is the only cycling initiative in Amsterdam that by its very name establishes a connection to the smart city discourse, was co-

financed by the national anti-congestion policy “Optimising Use” (“Beter Benutten” in Dutch) and investigated how to improve experience of (e-)biking between the municipality of Zaanstad and Amsterdam (A7). We thus see again, much like in Copenhagen, the close connection of policy goals and the interest in innovation. While that does not exclude the possibility of presence of pro-innovation bias and tech push, it does show that the interest in smart innovation takes very different paths in terms of areas of application in the two cities and is thus very much context specific.

Where we do see some indication of a pro-innovation bias and tech push is in how less prominent reasons to engage in smart cycling innovation are articulated. They include the momentum for smart technology in the mobility discussion, positive public attitudes towards technology and financial stimuli to use innovation by their top managers (A2, A7, A22). Also, similarly to Copenhagen, there is a feeling of mild concern about technosolutionism and possible dangers of smart mobility discourse centered on (self-driving) cars:

We should in any case be careful that we do not consider everything from the perspective of a self-driving car. The city is more than traffic...It should keep being about interaction between people and not between machines (A22, also A20)

Cycling doesn't need to be smarter, but if it doesn't become part of the picture it will be forgotten...car will prevail. (A19)

How is Smart-ness Understood in the Context of Cycling Projects in Amsterdam?

Most interviewees emphasize that the innovation does not need to be tech-heavy or “smart” in the sense of the application of ICT or IoT technologies (A2, A3, A6). Smart innovation can be useful, if it aligns with the policy goals, can make cycling easier and safer but it is not essential (A18, also A22). Interviewees questioned the very notion of smartness and the notion of innovation, pointing out that some solutions that are not driven or facilitated by a new technology can be important, such as a bicycle street⁶, new designs for intersections, bike sharing and bike leasing (A2, A3, A4). Much like in Copenhagen, there is an attachment to the simplicity of the bike, its “low-tech” nature, freedom and autonomy that it offers, resonating with the celebration of the bicycle by the degrowth literature.

What is nice about cycling is that it is so accessible...All the apps et cetera – I don't really see it happening, and, I think that's also not what we [the city of Amsterdam] want. The bike is so free and easy...You don't want to sit with a phone on your bike. ...You have to keep that freedom a bit like it is. (A6)

⁶ A street on which bicycles get prioritized.

It's important to hold down a bit on the idea of innovations solving everything for biking. Because the bike, it's a really basic thing. It's just iron with a little chain on it. And that's also the strength of this... If you make it less simple, it might be even people don't use the bike, because it's not easy and simple anymore. So, I think the strength is that it's so simple, but still you can experiment and do innovations with it. (A2)

Also like in Copenhagen, the bicycle itself (and cycling planning perhaps, by extension) came up in the interviews as the embodiment of smartness: "Bicycle is the smartest thing that we have in Amsterdam and we should not lose it." (A4). All these quotes suggest not just the pride in the local cycling culture but also the resistance to the imposed tech-driven visions of the urban mobility future and the relentless search for novelty.

Conclusions

1. Smart cities and cycling: "flipping technosolutionism"?

Both in Copenhagen and Amsterdam the smartification of cycling appears to be driven by specific local policy priorities with Copenhagen focusing on increasing time savings as part of their climate change mitigation policy and Amsterdam on grappling with the pressures on existing space and infrastructure. Technosolutionism and technology push are present, but according to interviewees in both cities, have lost some ground in urban policy and planning in recent years. Even for city officers whose mandate is to work on "smart" solutions, technology appeared to be a complementary tool, and increasingly so as they acknowledge that after a "hype" around smart technology, they have become more critical and pro-active in dealing with it. It is possible, however, that it may be easier for these successful, almost iconic cycling cities to show that pro-active approach and mobilise local, grounded knowledge in solving challenges than it would be for other cities or even other policy areas. Further research could look into these dynamics in other cities and in other policy contexts.

2. Does the bicycle need to become smarter?

Cycling appears to be an interesting case for studying smart cities as it challenges the main presumptions of technosolutionist discourses and pro-innovation bias in urban planning. In both Copenhagen and Amsterdam there is some hesitation about the necessity to smartify cycling, at least beyond what the pressing policy goals may demand. In fact, where technosolutionism and technology push manifest strongest – it is in the concern that the future of mobility is smart and the bicycle might need to catch up in order to survive and thrive. In both cities interviewees highlighted the change in policy discourse around "smart city" as a shift from a *techno-centric smart city* to a *people-centric city that uses technology* to make people – their safety, comfort and well-being –

more central. The analysis of the smartification of cycling allows us to uncover the tensions between these visions, the uncertainties about the future and the importance of the choices of policy-makers in the present. Future research would gain more even insight into these processes from setting these tensions in the context of policies on motorised traffic.

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Appendix 1

Interviewees

Code of the interviewee	Organisation
Copenhagen case study	
C1	City of Copenhagen
C2	City of Copenhagen
C3	Danish Road Directorate
C4	Danish Road Directorate
C5	Copenhagen Solutions Lab (City of Copenhagen)
C6	City of Copenhagen
C7	Donkey Republic
C8	Donkey Republic
C9	ITS-Teknik
C10	Danish Road Directorate
C11	City of Copenhagen
C12	Danish Cycling Embassy, formerly City of Copenhagen
C13	COWI
C14	Danish Road Directorate
C15	Danish Technical University
C16	City of Copenhagen
C17	City of Copenhagen
C18	City of Copenhagen
C19	City of Copenhagen,
C20	Gehl Architects
C21	Loenderslootgroep
C22	Loenderslootgroep

C23	Technolution
C24	Ramboll
Amsterdam case study	
A1	Transport Authority Amsterdam
A2	Transport Authority Amsterdam
A3	Municipality of Amsterdam
A4	BYCS
A5	BYCS
A6	Municipality of Amsterdam
A7	Fietscoalitie Smart City (Cycling coalition Smart City)
A8	Amsterdam Smart City
A9	Fietscoalitie Smart City (Cycling coalition Smart City)
A10	Fietscoalitie Smart City (Cycling coalition Smart City)
A11	Municipality of Amsterdam
A12	Chief Technology Office (CTO), Municipality of Amsterdam
A13	Chief Technology Office (CTO), Municipality of Amsterdam
A14	Cyclists' Union Amsterdam
A15	Cyclists' Union Amsterdam
A16	Cyclists' Union Amsterdam
A17	Municipality of Amsterdam
A18	Ministry of Infrastructure and Water Management
A19	Bike Citizens
A20	Directorate-General for Public Works and Water Management
A21	Cyclists' Union National office
A22	CROW Knowledge Platform
A23	Breda University of Applied Sciences

A24	Breda University of Applied Sciences
A25	Municipality of Amsterdam
A26	Municipality of Amsterdam
A27	Ministry of Infrastructure and Water Management
A28	Ministry of Infrastructure and Water Management
A29	Ministry of Infrastructure and Water Management
A30	The Province of North Holland
A31	Transport Authority Amsterdam
A32	The Netherlands Institute for Transport Policy Analysis
A33	The Netherlands Institute for Transport Policy Analysis