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To cite this article: Frauke Behrendt (2020) Mobility and data: cycling the utopian Internet of Things, *Mobilities*, 15:1, 81-105, DOI: [10.1080/17450101.2019.1698763](https://doi.org/10.1080/17450101.2019.1698763)

To link to this article: <https://doi.org/10.1080/17450101.2019.1698763>



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Published online: 21 Dec 2019.



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Mobility and data: cycling the utopian Internet of Things

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ABSTRACT

This article explores how cycling is currently considered in European policy documents related to transport aspects of the Internet of Things (IoT), what kind of representation of cycling can be imagined for utopian EC IoT policies documents, and how a combination of empirical policy analysis and a utopian approach could inform future policy and research. Debates around smart/intelligent/data mobilities and the IoT – including policy debates – tend to be dominated by motorized modes such as autonomous and networked cars. This article explores the implications of this for more sustainable and active modes such as cycling, both for current policies and for utopian thinking. It draws on literature concerned with utopian thinking, mobilities studies and critical data studies. The methodology combines a content analysis and a visual analysis of the EC policy documents with creating text and images for utopian future versions of these documents. The results show the heavy automotive focus of EC IoT policy documents and suggest an alternative bicycle-focussed IoT utopia. The conclusion facilitates a debate around utopian societies where smart cycling products, infrastructure, policy and funding facilitate sustainable, active and data-responsible mobility at scale. This challenges the current continuation of automobile cultures in smart mobility and IoT policy discourses, and the data and associated power asymmetries between cars and cycling that highlight the significance of this research.

ARTICLE HISTORY

Received 31 May 2019
Accepted 30 October 2019

KEYWORDS

Mobility; data; cycling;
Internet of Things; policy;
smart mobility; sustainable
transport

Introduction

Increasingly, only those modes of transport and mobility are ‘visible’ in the socio-economic context that have data at their heart, and they are often referred to as smart or intelligent. This forms part of the increasing number of objects in our lives that are connected and also produce, share and process data, aka The Internet of Things (IoT). While there is an emerging area of networked cycling practices (e.g. cycling apps, smart locks, shared networked bikes) and associated research, debates around smart/intelligent/data mobilities and the IoT – including policy debates – tend to be dominated by motorized modes such as autonomous and networked cars. This article explores the implications of this for more sustainable and active modes such as cycling, both for current policies and for utopian thinking.

Policymaking around mobilities is transformed by the discourse of IoT, and also by smart mobility discourses (Marsden and Reardon 2018) but active and non-motorized modes are often left out of these discussions. Current planning and policymaking will shape future mobilities, and if they largely focus on motorized transport, active and non-motorized transport will continue to be marginalised in the future. Some scholars argue for less technology, data and speed-heavy approaches to future mobilities in shifting from car to bicycle-based mobility systems (Popan 2019). This article suggests

a different critical direction: bringing active transport into the data-centred planning process; making cycling central to IoT debates and policies. Utopian thinking is important in this process, as to not just identify how marginalised active modes of transport are in current policy debates, but to also suggest alternative future policies where cycling takes centre stage in smart mobility and IoT discourses and the policy landscape, and also to highlight the sharp contrast to current state of affairs, and as provocation to the car-centric approaches of those engaging in these discourses and policies. The benefits of cycling-focussed mobility over automobile-focussed mobility have been discussed at length in the academic literature (e.g. Pucher and Buehler 2017; Fishman 2016), including positive impacts at individual and societal level on health, sociability, urban development, air pollution, CO2 emissions, energy, safety, congestion, etc.

Specifically, the article asks: How is cycling currently considered in European policy documents related to transport aspects of the Internet of Things (IoT)? What kind of representation of cycling can be imagined for utopian EC IoT policies documents? How could a combination of empirical policy analysis and a utopian approach inform future policy and research?

The first part of the article draws on the literature on utopian thinking, mobilities studies and critical data studies, next, the methodology explains the textual and visual analysis of the EC policy document and the creating of utopian future versions of these documents, followed by the results of these analyses. The conclusion discusses the results in light of the literature and makes recommendations for future policy and research.

Background

Levitas suggests that 'explicit alternative scenarios for the future are fundamental to any kind of democratic debate' and that 'utopian method involves both making explicit the kinds of society implied in existing politic programmes and constructing alternatives' (Levitas 2013, xviii). Following this invitation, this article draws on some of her thoughts around utopia as a method. In terms of creating alternative visions of the future, there is a danger of 'ceding the ground to engineers, economic forecasters, [...], global capitalist class and politicians with very short term perspectives' and 'our very silences shape utopias' (Levitas 2013, 217). This is very much the case in the EC policy documents this article focusses on, in terms of who gets to speak in them on who remains silent. This article is then an attempt to 'imagine alternative ways of life that would be ecologically and socially sustainable and enable deeper and wider human happiness than is now possible' (Levitas 2013, 198). The material proposed here can be understood as a 'provisional hypothesis about how society might be, offered as part of a dialogue, neither intending nor constituting a forecast' and moving 'between critique and reconstitution' (Levitas 2013, 198).

Utopian considerations and imagining of future mobilities has been part of policy and academic debates around transport and mobilities in a range of fields for decades. Contemporary examples of sustainable and smart utopias in relation to mobilities include Urry's (e.g. Urry 2016; Elliot and Urry 2010) who talks about the performative consequences of anticipated futures (Urry 2016, 2), and also highlights that smart city scenarios are particularly powerful in terms of their performativity (2016, 9). This is another reason why it is important to feature bicycles in anticipated IoT scenarios, following Urry's suggestion to 'use the future to question, unpack, invent what is going on and what can be done within the present' (Urry 2016, 8). Urry and Klein (Urry 2016; Klein 2014) warn of the 'dangers of catastrophism' in writing about climate-changed futures as they convey the impression that 'environmental catastrophe is inevitable, and nothing can be done'; this article aims to contribute to 'actively planning viable alternatives' (Urry 2016, 52) and to 'envisioning alternative futures from a place enabled by hope rather than risk, crisis and fear' (López-Galviz, Büscher, and Freudendal-Pedersen 2019).

The utopia developed in this article draws on two of the four scenarios of future mobilities Urry develops. One of them is 'Digital City' that sees a 'widespread substitution of physical movement of objects and people by many modes of digital communication and experience' and vehicles that

resemble “networked computers’ linked to many streams of data’ (Urry 2016, 142, 144), with connected cars as key example, but no discussion of bicycles. Active modes such as cycling are discussed as part of the low-carbon ‘liveable cities’ scenario (Urry 2016, 147 ff) where ‘[a]longside bicycles, other personal vehicles would be electronically integrated through information, payment systems and physical access and connecting with collective forms of transport.’ (Urry 2016, 147). Across the four scenarios presented, Urry considers the Digital City future to have significant momentum but is cautious that digital does not necessarily equal good, and the liveable cities scenario is considered less likely but more desirable. This article’s scenario draws on the Digital City in terms of the ‘smart technologies’ and the Liveable City in terms of the active mode of cycling, aiming to make a more likely scenario also more desirable.

Popan’s ‘Bicycle Utopias’ (2019), that, like this article, also draws on Levitas, starts off with a utopian description of a bicycle-focussed mobility system in 2050. He envisions that ‘[b]ig data as well as visualisations also helped considerably with effectively measuring and drawing attention to the enormous volume of space that cars occupied in cities’ (Popan 2019, 23). In a similar move, this article’s utopia analyses and creates visualisations that bring attention to how much space cars take up in contemporary graphic representations (and discourses) of the IoT.

Popan also discusses smart bicycles and cycling accessories as forming a key part of the transition to ‘his’ bicycle utopia (Popan 2019, e.g. 28 ff), for example in ‘attracting new cyclists’ (Popan 2019, 29). While he proposes that eventually, smart cycling will be replaced by simpler bicycle technologies again, in the move towards a slow-cycling future, this article suggests that smart cycling will remain a key element of cycling futures, and that is even instrumental for bicycles to feature significantly in future mobility scenarios. While Popan’s cycling utopia is a textual one, others have created visuals alongside textual descriptions (Tight et al. 2011), an approach also taken in this article. These scholarly cycling utopias sit alongside the rich history of utopia-related thinking and action in the non-academic cycling context (e.g. Critical Mass).

This article shares Timms, Tight, and Watling (2014) concerns with utopias in relation to sustainable mobilities but focusses specifically on cycling. The authors understand utopian methods as a key contribution to the ‘increasing amount of research interest in methods that imagine environmentally friendly futures’ (Timms, Tight, and Watling 2014, 79). Images or illustrations are an example of a static temporal form of utopias that are easy to grasp by the viewer, but as a downside can appear ‘overprescriptive’ or even as ‘authoritarian blueprints’ (2014, 83). While dynamic process utopias (often in narrative form) are more open, they run the risk of too many platitudes. This article’s analysis draws on both modes.

Another useful classification of utopian scenarios is to distinguish ‘images of utopia, images of dystopia, and images of dystopia avoidance’ (Timms, Tight, and Watling 2014, 87). Dystopia plays a key role in the use of utopian methods for transport/mobility in the context of sustainability, where utopias play the role of avoiding a dystopian future around climate catastrophe, providing suggestions for mitigation.

This article also works with ‘Smart Mobility’ (Büscher et al. 2012) perspectives that consider political, social and embodied aspects of mobile people and societies in the digital/data age. It contributes to emerging critical analysis of smart automobility that include Sheller’s examination of policy documents, media coverage and trade shows (Sheller 2007). More specifically, it draws on the concept of ‘Smart Velomobility’ that is concerned with networked practices, systems and technologies around cycling (Behrendt 2016a). It brings together attention to forms of cycling mobility (velomobility) with attention to smart/intelligent/code/data aspects of mobility. Smart velomobility considers how networked cycling practices and experiences fuse physical and digital aspects, including aspects of physical mobility, infrastructure, power relations, representations and everyday experiences and practices. This article combines smart velomobility with utopian thinking to extend the concept’s horizon from exploring the present (Behrendt 2016b) and past (Behrendt 2019) to also consider the future. Related research analyses how smart cycling futures are imagined on the websites of smart cycling innovations (Nikolaeva et al. 2019).

In terms of the data ecology around the IoT-facilitated mobility discussed in this article, the analysis also draws on Critical Data Studies that 'explore the unique cultural, ethical, and critical challenges posed by Big Data', understand 'data are a form of power' (Iliadis and Russo 2016, 1) and interrogate how data are 'doing' work in the world (Kitchin, Lauriault, and McArdle 2015). Critical Data Studies also ask 'where the cracks and seams, the spaces for resistance and alternatives, might be found' (Dalton, Taylor, and Thatcher 2016, 1) – a link to utopian methods. In their analysis of smart city dashboards, Kitchin et al. call for 'for a conceptual re-imaging of these projects as data assemblages – complex, politically infused, socio-technical systems that, rather than reflecting cities, actively frame and produce them' (Kitchin, Lauriault, and McArdle 2015, 6). In a similar vein, this article aims to consider how EC policy documents with their texts and visualisations actively frame and produce what we understand as the Internet of Things and the related data in the context of mobility (i.e. car-centric), and also to consider how utopian versions of these documents could help us imagine different socio-technical systems and actively re-frame and produce the Internet of Things as more sustainable and inclusive, specifically in terms of cycling. The increasing number of networked objects that form part of mobility experiences, politics and power also need to be understood as data assemblages so we can ask critical questions around these 'complex socio-technical systems infused with politics and context' (Kitchin, Lauriault, and McArdle 2015, 7).

Andrejevic (2014, 1675) discusses how big data 'is about finding new ways to use data to make predictions, and thus decisions, about everything from health care to policing, urban planning, financial planning, job screening, and educational admissions.' If big data is often used for predictions about the future, this article asks how we can relate them to utopian approaches. Following Boyd and Crawford (2012), we could understand the IoT automotive industry as 'Big data rich' and the area of IoT cycling as 'big data poor'. Asking for other forms of mobility to also join the big data era is of course a double-edged sword as it asks for more connected things – bicycles rather than cars – but keeps within the overall narrative of 'more data is better', thus showing the complexity of these issues, and the challenges around understanding these complex landscapes, and of imagining alternatives. This article goes down one such route, the route of creating a utopian bicycle-focused IoT mobility, rather than a non-networked and non-data velomobility. This fits in with Andrejevic observation that 'overcoming the digital divide means exacerbating the big data divide' (Andrejevic 2014, 1686).

The big data issues around smart mobility are also closely linked to issues of governance (Docherty, Marsden, and Anable 2018), indicating why it is important to work with policy documents, as this article does. The urgency of utopian methods in this area is even clearer when we consider how late and slow policy responses to counteracting automobility have been – underlining the urgency of 'thinking through how state action and public policy will need to change to take account of the implications of the transition to a "Smart Mobility" future' (Docherty, Marsden, and Anable 2018, 115). With the technology sector being the driving force, where the focus is more in selling 'smart' products than reducing mobility (Docherty, Marsden, and Anable 2018), it is important to also regard the smart mobility transition as a 'major policy opportunity' and to ask 'whose voices are heard in the Smart Mobility Debate?' (Marsden and Reardon 2018, 1, 8), something this article examines for EU policy documents by looking at keywords relevant to automobility and to cycling. These documents, and how they treat cars and bicycles, are important because 'no amount of smart technology (or big data) will overcome the need for good policy, planning and governance of the smart transition' (Docherty 2018, 23). While this is framed through the car vs bicycle lens in this article, the issues are of course broader, engaging with the role public value play in the smart mobility transition, where aims such as public health, active modes and open systems should be clearly articulated and as driving force for regulatory frameworks, standards, taxation, etc. – rather than policy support of smart mobility for the sake of innovation (Docherty 2018).

Data is central in this transition process: 'In the smart future, data is the knowledge upon which the power to control the marketplace is built' (Docherty, Marsden, and Anable 2018, 121), further highlighting the importance of creating alternative smart mobility utopias. This article shares

'concern[s] about information asymmetries' in a future 'where the aggregation of mobility services across different forms of transport is the proviso of a small number of powerful corporate interests' (Docherty, Marsden, and Anable 2018, 121) and asks what modes of transport will play key roles and how to challenge this. These 'industry concerns' link back to governance and policy as the mobility data aggregating firms who 'will have access to the crucial datasets underpinning the smart ecosystem – will be in a very powerful position to claim that they understand the preferences of their users better than anyone else, and that it is for public authorities to respond to these preferences' (Docherty, Marsden, and Anable 2018, 122). For example, '[t]he first quarter of 2016 was the first time ever in history that more cars than phones were newly connected to US mobile networks' (PricewaterhouseCoopers EU Services EEIG 2018, 48) – with associated data going to industry, not policy – while similar facts or figures about bicycles do not exist.

Methodology

The methodology comprises three elements: content analysis, visual analysis and a utopian approach. For all three, the article works with IoT policy documents published online by the European Commission that are relevant for Transport and Mobility, with a particular focus on cycling and cars. While choosing European Commission documents covers its 28 member countries, it represents a European and Western and perspective. The analysis covers January 2014 to June 2018, to ensure a sufficient number of documents, covering several years and inclusion of contemporary documents.

Some of the material analysed in this article is also included in a related but different study (Behrendt 2019) that covered a more diverse and larger number of documents to answer a different set of research questions. Here, a small sub-set of the material presented there is analysed in a new way, and in combination with new material.

While cycling policies are currently often dealt with at regional or city level, and at best at national level, there are efforts to more supra-national approaches, for example at European level (e.g. driven by the European Cycling Federation). IoT and other smart mobility-relevant frameworks, however, are not only dealt with at regional or city level but are firmly part of national and supra-national discourses and policymaking. This article's analysis is therefore situated at this level, considering European documents as an example of supra-national IoT discourse around contemporary and future mobilities.

This article focusses on a content analysis of these documents, rather than a systematic analysis of the stakeholders involved in the production of the documents and in related events, though some stakeholders are mentioned in the results section below.

On the primary Internet of Things website by the European Commission (European Commission 2018a), (1) the pages 'Reports and Studies' (European Commission 2018b) and (2) 'Reports and Studies about Investing on network and technologies' (European Commission 2018c) were reviewed and the document lists displayed were filtered for 'reports/study' type documents. From these 'filtered' lists, those documents that have IoT or Internet of Things in the title and/or sound like they might cover mobility/transport, or be broad enough in scope to do so, were selected, resulting in 10 items being selected for analysis (see Table 1). This includes a range of document types, from edited collection books to commissioned reports to short workshop reports, and diversity in terms of word length (see Table 1). Many of these documents are also included under the theme 'Digital Single Market' on the European Commission's website.

For the content analysis, this article 'measure[ed] the frequency and variety of messages' (Merriam and Tisdell 2016, 179), in combination with a qualitative element (summative content analysis) that is concerned with 'latent and more context depended meaning' (Schreier 2014, 173) and 'the evidence is provided in context, and by using words and examples from the text and its pictures rather than simple numbers' (Merriam and Tisdell 2016, 180) to understand how keywords are used in the documents. This was supported by a combination of NVIVO (analysis software for qualitative and



Table 1. Table with an overview of the documents and the detail of the keyword count analysis.

Document title	Publication year	URL	Bicycle	Cycling	Bike	Cyclist	Bicycle +Cycling +Bike +Cyclist	Car	Automotive	Vehicle	Car +Automotive +Vehicle	Transport	Mobility	Transport +Mobility	IoT/ Internet of Things	Number of pages
Digitising the Industry. Internet of Things. Connecting the Physical, Digital and Virtual Worlds	2016	https://ec.europa.eu/digital-single-market/en/news/digitising-industry-internet-things-connecting-physical-digital-and-virtual-worlds	1	0	0	0	1	20	5	62	87	53	119	172	2277	364
Building the Hyperconnected Society	2015	https://ec.europa.eu/digital-single-market/en/news/building-hyperconnected-society-iot-research-innovation-value-chains-ecosystems-and-markets	1	0	0	0	1	26	16	61	103	52	148	200	1679	331
Cross-cutting business models for IoT: Final report	2018	https://ec.europa.eu/digital-single-market/en/news/cross-cutting-business-models-internet-things-iot	1	0	0	0	1	311	37	76	424	60	116	176	1981	304
Cognitive Hyperconnected Digital Transformation. Internet of Things Intelligence Evolution	2017	https://ec.europa.eu/digital-single-market/en/news/digital-transformation-internet-things-intelligence-evolution	0	0	0	0	0	16	20	87	123	41	121	162	1786	338
Benchmark Study for Large Scale Pilots in the area of Internet of Things	2015	http://ec.europa.eu/digital-agenda/en/news/benchmark-study-large-scale-pilots-area-internet-things	0	0	11	0	11	25	0	41	66	59	40	99	189	116
Baseline Security Recommendations for IoT in the context of Critical Information Infrastructures	2017	https://ec.europa.eu/digital-single-market/en/news/baseline-security-recommendations-internet-things-context-critical-information-infrastructures	0	0	0	0	0	10	6	4	20	5	4	9	1134	103

(Continued)

Table 1. (Continued).

Document title	Publication year	URL	Bicycle	Cycling	Bike	Cyclist	Bicycle +Cycling +Bike +Cyclist	Car	Automotive	Vehicle	Car +Automotive +Vehicle	Transport	Mobility	Transport +Mobility	IoT/ Internet	Number of pages
Standardisation to Support Digitisation. Report from the Workshop on Standardisation to Support Digitisation European Industry	2017	https://ec.europa.eu/digital-single-market/en/news/reporting-main-outcome-workshop-standardisation-support-digitising-european-industry	0	0	0	0	0	2	2	2	6	4	3	7	47	31
Definition of a Research and Innovation Policy Leveraging Cloud Computing and IoT Combination	2014	https://ec.europa.eu/digital-single-market/en/news/definition-research-and-innovation-policy-leveraging-cloud-computing-and-iot-combination	0	0	1	0	1	24	2	19	45	46	19	65	749	95
Study on emerging issues of data ownership, interoperability, (re-) usability and access to data, and liability	2018	https://ec.europa.eu/digital-single-market/en/news/study-emerging-issues-data-ownership-interoperability-re-usability-and-access-data-and	1	0	0	4	5	144	51	142	337	71	59	130	255	435
Which EU Internet of Things Large Scale Pilots? Consultation and Invitation for Commitment	2015	https://publications.europa.eu/en/publication-detail/-/publication/e58e6253-fc01-11e7-b8f5-01aa75ed71a1/language-en	0	0	0	0	0	0	0	0	0	0	4	4	23	13
Totals ->			3	0	12	4	20	578	139	494	1211	391	633	1024	8139	2130

mixed-method research, see (QSR International 2018)) and Excel (spreadsheet program and analysis tool, see (Microsoft 2018)). The following keywords that would reflect the focus of this article were selected so they could be used for easy discovery of relevant sections in the (often long) documents, and they were combined into four categories (a)-(d): (a) bicycle, cycling, bike, cyclist (b) car, automotive, vehicle, (c) IoT, Internet of Things, (d) transport, mobility. (a) and (b) keywords were included to reflect the focus of this article on these two forms of mobility, while (c) reflects the context considered, and (d) gives a broader idea of how frequent the wider themes of transport and/or mobility are discussed in the documents. While 'vehicle' in the mobilities literature could include bicycles, in policy documents such as the ones analysed here, they do not tend to be included in this umbrella term.

First, a 'word search query' was carried out for each key word individually, including stemmed words and plural forms (e.g. bikes, bicyclist, cars, vehicles) where relevant (excluding instances such as 'life-cycle' etc.). While many of these word counts were double-checked through manual analysis, the results may include a small number of keywords used in different contexts (e.g. mobility of data is key, motorcyclists, policy is the vehicle for). The word counts for keyword and document are presented in Table 1. The combined word count for each of the four categories (a)-(d) is also included in the same table.

Second, to review the keywords in their context, their occurrences were coded in NVIVO, and the contextual material found was compiled into one 'memo' for each of the 10 documents analysed (structured by keywords). An exception was made for keywords with more than 30 results in the same document, where a note on the number of occurrences (and key sections of the text, e.g. a section on 'smart transport and mobility') was made to inform the analysis. Third, based on reviewing the results from these first two steps, four documents were selected for detailed analysis. A limitation of this content analysis is that it did not analyse the stakeholders involved in detail to examine the making of EC policy.

The second element of the methodology is a visual analysis. To identify images in the documents that convey something about cars or bicycles in the context of IoT, all pages of the four documents selected for detailed analysis (see above) were reviewed with a focus on visual elements, such as visualisations, photos or images (rather than graphs of numerical data). Each of these visual elements was scrutinized to see if they include a direct or indirect visual reference to transport/mobility, and specifically to cars (or other road vehicles) or bicycles. A representative selection of these is analysed in detail.

The third element of the methodology is concerned with imagining future alternatives to the current policy situation, drawing on Levitas' utopian method as 'critical tool for exposing the limitations of current policy discourses about economic growth and ecological sustainability' (Levitas 2013, xi). In the 'architectural mode', the 'Imaginary Reconstitution of Society' involves "the institutional design and delineation of the good society" (Levitas 2013, xvii).

The article links policy document analysis and the utopian method by re-thinking the usual 'policy recommendations' often found at the end of academic papers as 'third way of thinking about utopia itself: the attempt not just to imagine, but to make, the world otherwise' (Levitas 2013, xiii). This is achieved through experimental mock-ups of illustrations of future policies that are included as figures and discussed in the article. They are 'concerned with the principles and institutions of a potential alternative world – yet one which needs to be treated as a hypothesis rather than a plan' and serve as an example of 'utopia as method [being] concerned with the potential institutions of a just, equitable and sustainable society' (Levitas 2013, xviii).

Results

Policy document analysis

The analysis of the 10 2014–2018 EC IoT policy documents that are relevant for Transport and Mobility, with a particular focus on cycling and cars, shows how differently keywords are used in

these documents. The results are presented in detail to evidence clearly just how stark the contrast between the treatment of cars and cycling is in these documents. [Table 1](#) gives an overview of the documents and the detail of the keyword counts.

This shows that 'bicycle', 'cycling', 'bike' or 'cyclist' is not mentioned once in four of the documents and a further four have only one mention. One document mentions cycling 5 times, and one document 11 times. The overall sum of mentions is 20. In contrast, 'car', 'automotive' or 'vehicle' is mentioned 1,211 times across the 10 documents, with nine documents mentioning them, and the highest count for an individual document being 424. Overall, 'car', 'automotive' or 'vehicle' is mentioned 20 times more often than 'bicycle', 'cycling', 'bike' or 'cyclist' (see also [Figure 1](#)).

Analysis of 2014 'definition of a research and innovation policy leveraging cloud computing and IoT combination' document

This article now moves on to analyse four of the 10 documents in more detail, starting with three documents that do not or hardly mention cycling, followed by one that does engage with it.

The 2014 document 'Definition of a Research and Innovation Policy Leveraging Cloud Computing and IoT Combination' mentions 'car', 'automotive' and 'vehicle' 45 times while 'bicycle', 'bikes', 'cycling' and 'cyclist' is only mentioned once, as follows: 'Transport sharing is another area where IoT is offering new opportunities in the smart transport environment: a growing number of European cities (of all sizes) are successfully experimenting shared bikes, shared cars, shared electric cars and their number is expected to grow in the coming years' (European Commission 2014, 46). The one cycling example is around shared mobility, while individual ownership is not discussed. Cars are referenced much more broadly (not just shared ownership) throughout the document. For example, it discusses 'opportunity-rich use cases such as connected vehicles, driverless cars and e-call' (European Commission 2014, 10).

An IoT definition that is used frequently in the document mentions cars as part of the definition: 'The Internet of Things enables objects sharing information with other objects/members in the network, recognizing events and changes so to react autonomously in an appropriate manner. The

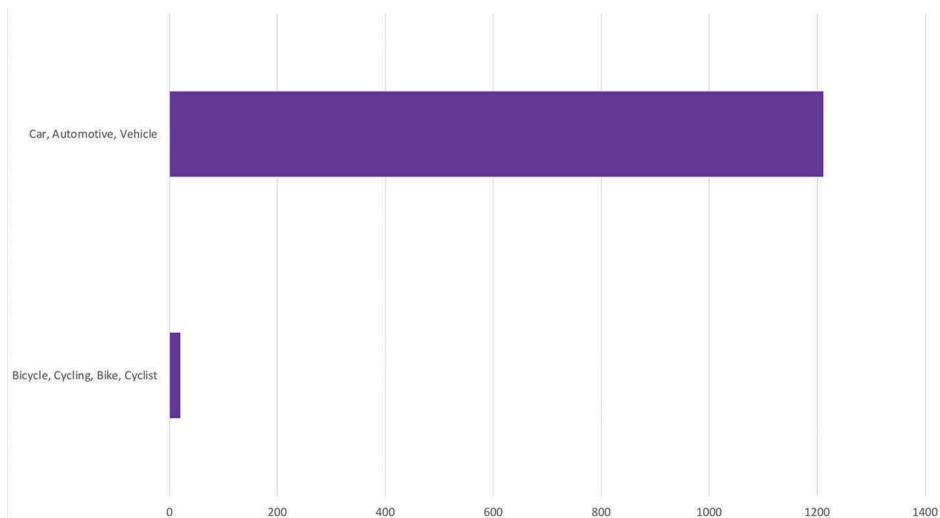


Figure 1. Comparing 'cars' and 'cycling' keyword count across the 10 documents.

IoT therefore builds on communication between things (machines, buildings, cars, animals, etc.) that leads to action and value creation' (European Commission 2014, 18).

Where the document discusses how 'the number of devices or "things" connected to networks will proliferate at 5–10 times the rate of personal computer installed', cars form again part of the examples used: "we are on the cusp of things (TVs, cars, livestock, machinery etc.) being connected" (European Commission 2014, 29). 'Connected Vehicles' are identified as one of the key use cases in another graphic on 'smart environments' (European Commission 2014, 43), and on several other occasions in the document, such as: 'Connected Vehicles (Vehicle-to-Vehicle) & driverless cars will attract particular attention from manufacturers, policy-makers, IT companies and investors' (European Commission 2014, 47). Two of the seven main use cases listed for 'smart manufacturing' in a graphic are about transport, and one is 'Connected Vehicles & Driverless Cars', the other is 'Airport Energy Management' (European Commission 2014, 46). One of the six short-term recommendations made in the report references 'consumer applications for personal wellness, public transportation, connected cars' as examples (European Commission 2014, 12, 78).

Analysis of 2017 'baseline security recommendations for IoT in the context of critical information infrastructures' document

More examples of using cars as a central element of the IoT definition and as a key example for IoT throughout can be found in the document 'Baseline Security Recommendations for IoT in the context of Critical Information Infrastructures' (2017). Despite the fact that three of the six 'vertical application areas of IoT' discussed in the document are transport-related (European Union Agency for Network and Information Security 2017, 12), the document does not include any mention of 'bicycle', 'cycling', 'bike' or 'cyclist'. Car, automotive and vehicle are used 20 times. This highlights the significance of transport for the IoT sector and the invisibility of cycling in this context.

The executive summary of the document mentions cars in its second sentence: 'IoT is an emerging concept comprising a wide ecosystem of interconnected services and devices, such as sensors, consumer products and everyday smart home objects, cars, and industrial and health components' (European Union Agency for Network and Information Security 2017, 7).

Analysis of 2018 'cross-cutting business models for IoT: final report' document

The document 'Cross-cutting business models for IoT: Final report' that was published in 2018, mentions 'car'/'automotive'/'vehicle' 424 times, the highest of all IoT documents analysed (PricewaterhouseCoopers EU Services EEIG 2018). 'Bicycle', 'cycling' or 'bike' is only mentioned once.

Cars are central to the report as one of three application areas covered: 'Smart Health, Smart Cars and Smart Energy'. This 'smart cars' application area includes a broad range of discussions and data, including considerations of (semi) autonomous cars and digital companies such as Google or Apple expanding into the automotive sector.

One interesting section discusses how cars interact with their environment, and how cycling does not feature in this conversation: 'Smart Cars also interact with their surroundings, connecting to other cars or public transport facilities, smart road infrastructures and smart traffic, all of which results in improved multi-modal mobility and reduced congestion' (PricewaterhouseCoopers EU Services EEIG 2018, 24). Bicycles are a key element of cars' 'surroundings' but are not mentioned at all. Similarly, the document mentions 'Examples in Smart Cars show cross-cutting intersections with Smart Cities (e.g. data on parking space usage) and Smart Energy (e.g. energy trading between households owning electric vehicles)' (PricewaterhouseCoopers EU Services EEIG 2018, 116), more examples of cars' surroundings that do not include considerations of cycling.

The one-time cycling is mentioned in the document, it is about shared mobility: 'Businesses like Uber and Lyft, as well as regional names like Zipcar and BlaBlaCar, are demonstrating the possibilities

where car ownership and the benefits of mobility are decoupled. Services such as OV-Fiets and Vélo-V offer flexible on-demand bicycle rentals for commuting within cities.’ (PricewaterhouseCoopers EU Services EEIG 2018, 106).

Analysis of 2015 ‘benchmark study for large scale pilots in the area of Internet of Things’ document – cycling features

The 2015 document titled ‘Benchmark Study for Large-Scale Pilots in the area of Internet of Things’ is the IoT document analysed that mentions cycling the most with 11 occurrences. At the heart of this document are 19 use cases that are intended to inform ‘future Large-Scale Pilots (LSPs) in the domain of the Internet of Things (IoT) to be included in the next Horizon 2020 work programme’ (Ackx et al. 2015, 7).

The first of the ‘top 5’ use cases is ‘Multi-modal mobility and smart road infrastructure’ (Ackx et al. 2015, 8). One of the eight ‘specific use cases’ discussed under this broader use case is ‘improve the last mile reachability by equipping public bikes with tracking devices and keyless bike locks to enable easy bike sharing’ (Ackx et al. 2015, 37).

When considering ‘entry barriers’ around this use case, the report mentions that last mile issues ‘can for example be mitigated by allowing public bike users to leave their bike behind on every street corner’ (Ackx et al. 2015, 39). When discussing the “attractiveness to users and providers” of this case study, the report explains that combining ‘verticals and integrat[ing] even more information into navigators (e.g. parking spot availability, road tolling, car and bike sharing, etc.) [...] has not yet been demonstrated’ (Ackx et al. 2015, 38). This use case also mentions ‘[p]ositioning vehicles and public bikes can be done by using GPS/Galileo devices’ (Ackx et al. 2015, 40), ‘[b]ike sharing solutions: companies that can provide keyless bike locks and bike tracking devices, e.g. Bitlock and Skylock’ (Ackx et al. 2015, 41), and ‘Bike sharing solutions: could seek value-added services via better integration with other means of transportation’ (Ackx et al. 2015, 42).

Visual analysis

This section analyses images from the four documents examined above; images that include direct or indirect references to road vehicles more broadly, and specifically cars or cycling. Some of the visuals used were created specifically for the documents while others are appropriated from other sources (see images/captions).

A figure on ‘Smart Transport – Main Use Cases’ from the 2014 document ‘Definition of a Research and Innovation Policy Leveraging Cloud Computing and IoT Combination’ (European Commission 2014) shows six different use cases (see Figure 2). Three of them refer to a specific type of mobility: flying. The other three are more generic, ‘Fleet Management’, ‘Freight Monitoring’, ‘Transport Sharing’, while none of them specifically references cars or cycling. The textual analysis (see above) has shown that the document heavily references cars, while cycling is only mentioned once. The implicit message of the figure used is therefore to cover motorized modes of transport in those use cases, while the ‘Transport Sharing’ one does mention cycling once in the text. The graphic does not include any representations of any specific mode of transport to illustrate its words or confirm the implicit meaning further.

The document ‘Baseline Security Recommendations for IoT in the context of Critical Information Infrastructures’ (European Union Agency for Network and Information Security 2017) includes two visuals that reference transport and mobility. A figure on the ‘IoT Pervasive Ecosystem’ (see Figure 3) shows a city context at its centre, including a truck, a car and a plane representing transport. The truck and car include a symbol for being connected



Figure 2. Figure from the 2014 document ‘Definition of a Research and Innovation Policy Leveraging Cloud Computing and IoT Combination’ (European Commission 2014, 45).

(red waves). A bicycle is not included. The symbols grouped in the circle around the centre do not specifically reference transport.

The figure ‘IoT high level reference model’ (see Figure 4) in the same document includes a section on ‘use cases’ on the right-hand side, with transport being one of them. The two graphics representing transport are a plane and a car, the latter displayed with the ‘connected’ symbol of curved waves. Again, no bicycles are included. This figure is also used on the cover of the document and therefore has a strong visual impact on readers. The visual analysis does not match the textual analysis for this document as the text references cycling while the visuals do not.

The document ‘Cross-cutting business models for IoT: Final report’ (PricewaterhouseCoopers EU Services EEIG 2018) includes 10 relevant figures. While the figure ‘The IoT market by 2020’ in the document includes a graph representing numerical data, a type of visual not usually included for this analysis, it does also include visuals on the left-hand side, which qualified it for inclusion (see Figure 5). One of the seven categories included is ‘Automotive’ and a visual of a car is included. No other type of transport or mobility is referenced in the text or the visuals.

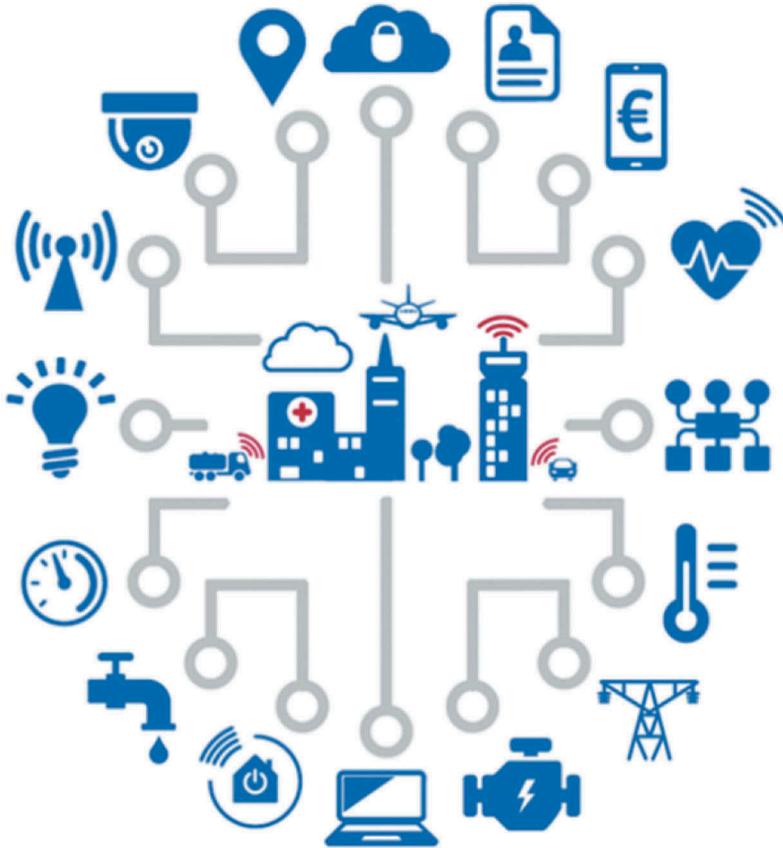


Figure 3. Figure from the document ‘Baseline Security Recommendations for IoT in the context of Critical Information Infrastructures’ (2017) (European Union Agency for Network and Information Security 2017, 18).

The figure ‘Cross-cutting business model opportunities for connected cars’ from the same document is focused entirely on cars as a mode of mobility. This includes fleet management, car rental, charging of electric cars and many others (see [Figure 6](#)).

This document’s ‘IoT reference model’ figure includes six visuals for the ‘application layer’ at the top, and one of them is a car (see [Figure 7](#)). The ‘physical layer’ at the bottom also has six visuals, including a truck and a train (a rare depiction of public transport). No bicycle is included.

Also, a ‘connected car’ is one of five ‘Examples of Connected Devices’ depicted in a figure in this document (see [Figure 8](#)).

The ‘IoT Ecosystem’ figure (see [Figure 9](#)) shows an ‘intelligent’ city, hospital, highway and factory with cars and trucks depicted in all four, and on the connecting roads. They are pervasive in the illustration, plus they have their dedicated section that highlights ‘automated car system’, ‘traffic cameras’ and several other elements of the ‘intelligent highway’. ‘Connected ambulances’ in the ‘hospital’ scenario are another reference to road transportation.

The ‘vertical sectors’ table (see [Figure 10](#)) includes a column on ‘manufacturers of motor vehicle, trailers and semitrailers’ which includes the logos of the brands Scania, Volvo and BMW. In the column ‘transportation and storage’, ‘CycloSafe’ is included, a Belgium smart system for tracking bicycles. Interestingly, this figure has been replicated from another EC IoT document, namely ‘Benchmark Study for Large Scale Pilots in the area of Internet of Things’

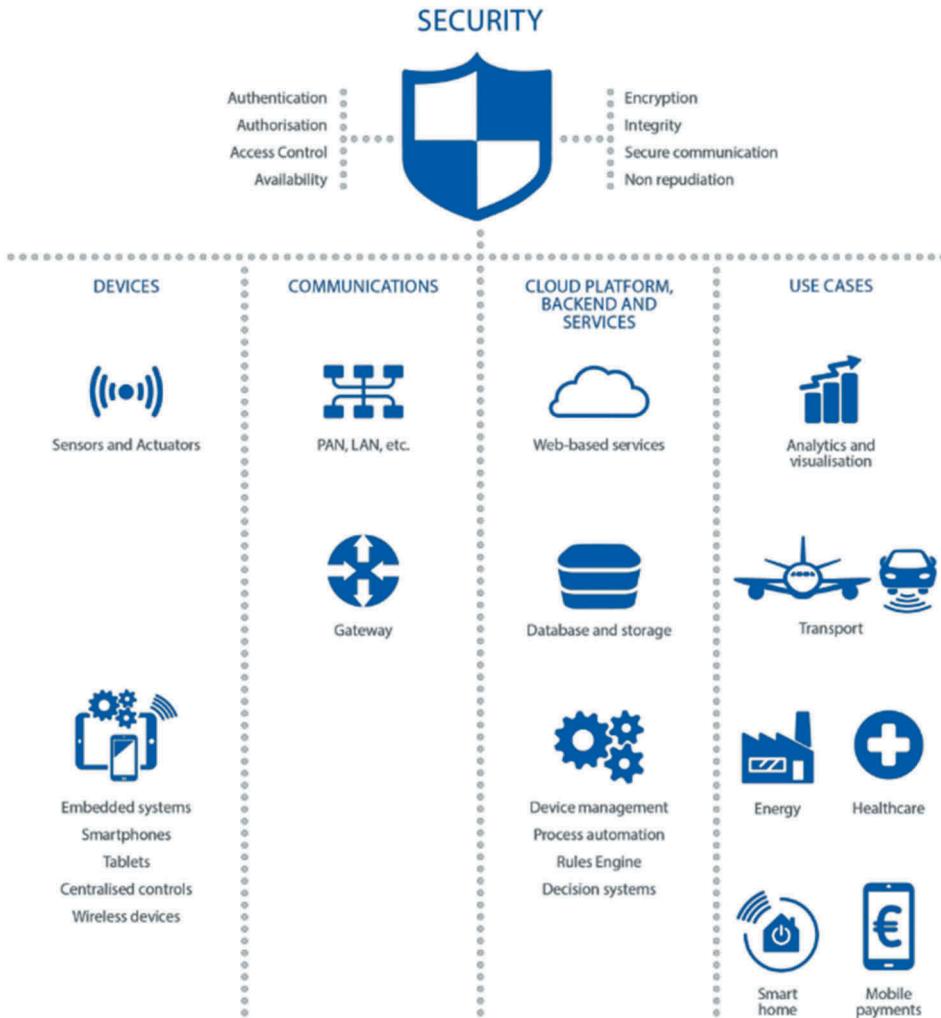


Figure 4. Figure from the document ‘Baseline Security Recommendations for IoT in the context of Critical Information Infrastructures’ (2017) (European Union Agency for Network and Information Security 2017, 25).

(Ackx et al. 2015, 21), showing how some illustrations circulate across multiple policy documents.

The figure ‘Sizing IoT market opportunities in the Unites States’ shows ‘150 million unconnected passenger vehicles’ as one of the six areas (see Figure 11). For one of the other areas, the ‘83.1 million millennials in the US’, the visual OF two people and a bicycle are used, with the arrow indicating this is representing bike-sharing.

The ‘illustration of big data streams generated by connected cars’ (see Figure 12) shows a range of car-related and lorry/truck-related situations, including interactions with other vehicles and contexts, but none of these include bicycles (or pedestrians or any depictions of humans).

The ‘overview of security challenges for connected cars’ (see Figure 13) does not feature any humans or bicycles in the illustrations. Car and computer symbols are used alongside a target symbol.

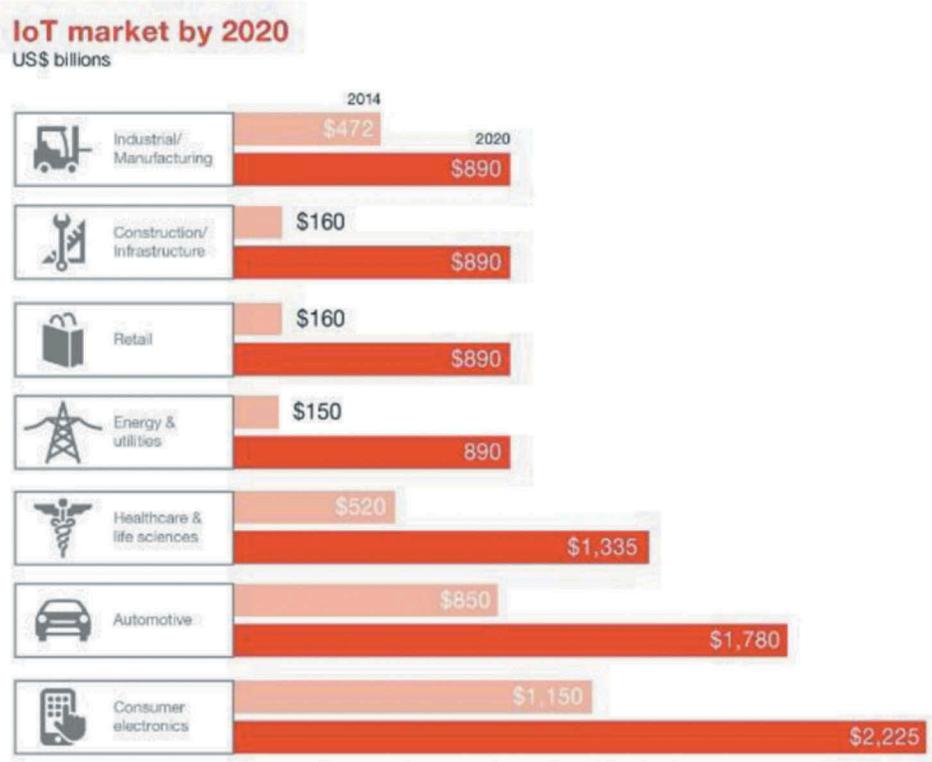


Figure 5. Figure from the document 'Cross-cutting business models for IoT: Final report' (PricewaterhouseCoopers EU Services EEG 2018, 23).

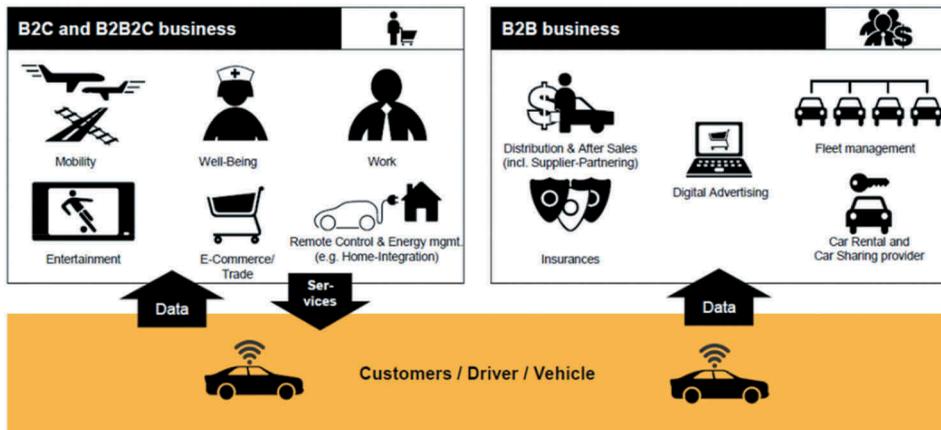


Figure 6. Figure from the document 'Cross-cutting business models for IoT: Final report' (PricewaterhouseCoopers EU Services EEG 2018, 27).

The figure 'attack vectors for connected cars' (see Figure 14) shows a car at the centre and annotations of car elements surround it. None of these allude to interaction with other road users such as cyclists. Across the 10 figures that reference transport and mobility in this document (PricewaterhouseCoopers EU Services EEG 2018), two included reference to cycling. The textual

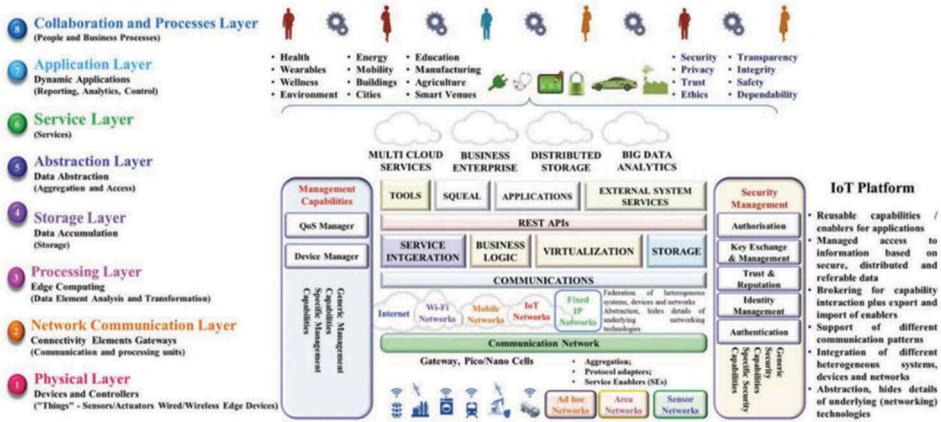


Figure 7. Figure from the document ‘Cross-cutting business models for IoT: Final report’ (PricewaterhouseCoopers EU Services EEIG 2018, 33).



Figure 8. Figure from the document ‘Cross-cutting business models for IoT: Final report’ (PricewaterhouseCoopers EU Services EEIG 2018, 34).

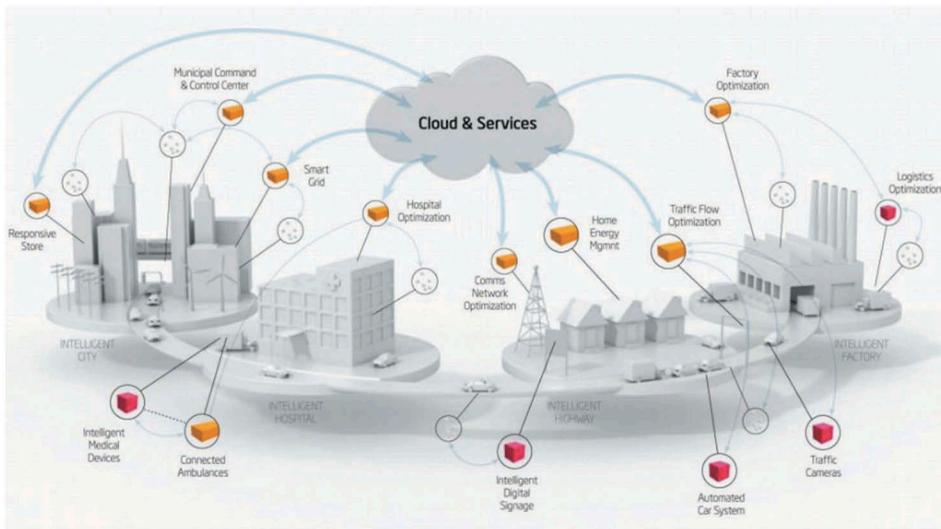


Figure 9. Figure from the document ‘Cross-cutting business models for IoT: Final report’ (PricewaterhouseCoopers EU Services EEIG 2018, 40).

analysis of this document showed that cycling was mentioned once, so there is consistency across text and visuals.

Other than Figure 10 that was also included in one of the other documents analysed, the fourth document (Ackx et al. 2015) does not include any illustrations that reference transport or mobility,

Vertical sectors							
Agriculture and fishing	Mining and quarrying	Manufacturing	Manufacturer of motor vehicles, trailers and semi-trailers	Electricity, gas and water supply	Construction	Wholesale and retail trade	Transportation and storage
							
Accommodation and food service activities	Financial and insurance activities	Real estate activities	Professional, scientific and technical activities	Public administration and defence	Education	Human health and social work activities	Arts, entertainment and recreation
							

Figure 10. Figure from the document ‘Cross-cutting business models for IoT: Final report’ (PricewaterhouseCoopers EU Services EEIG 2018, 47).



Figure 11. Figure from the document ‘Cross-cutting business models for IoT: Final report’ (PricewaterhouseCoopers EU Services EEIG 2018, 68).

but this document also does not contain many figures overall. This again shows consistency across text and visuals.

Across these 13 images that reference transport or mobility in some way, two include bicycles, and they are both part of the one document out of the three that mentions cycling in the text once.

Big Data streams from connected cars.

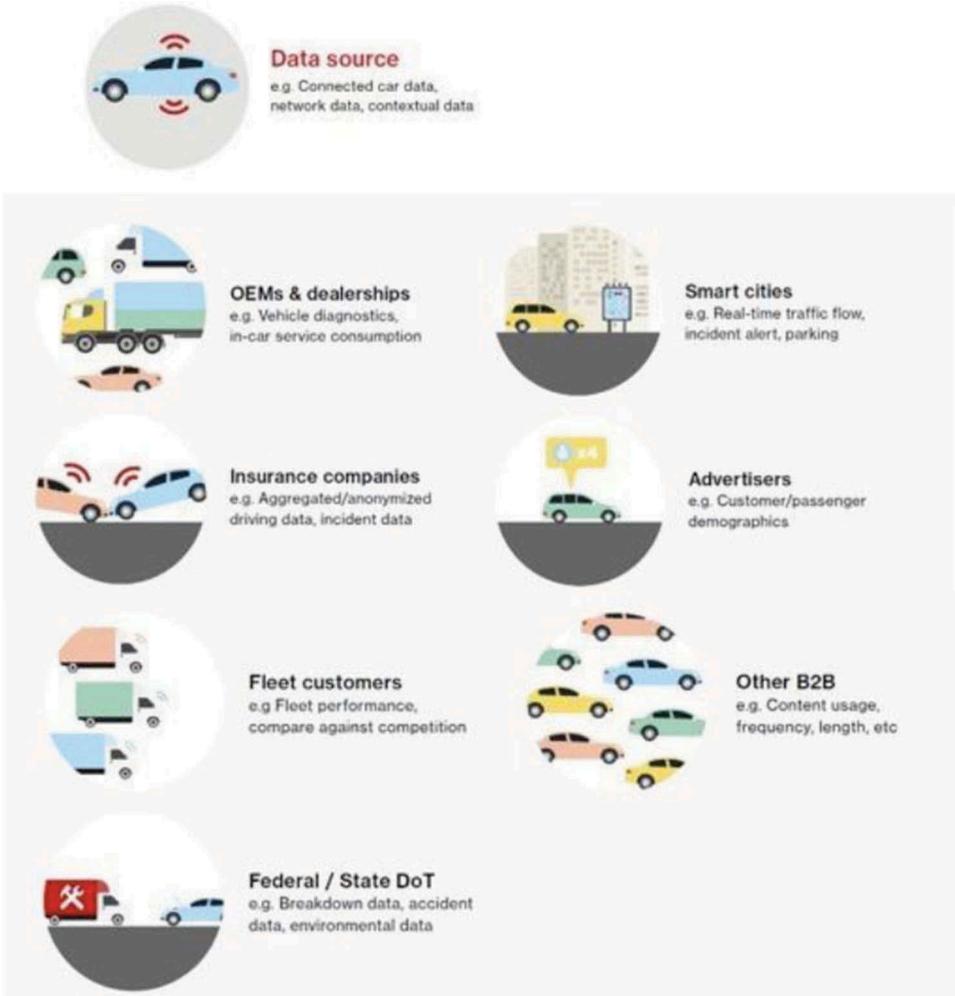


Figure 12. Figure from the document 'Cross-cutting business models for IoT: Final report' (PricewaterhouseCoopers EU Services EEIG 2018, 116).

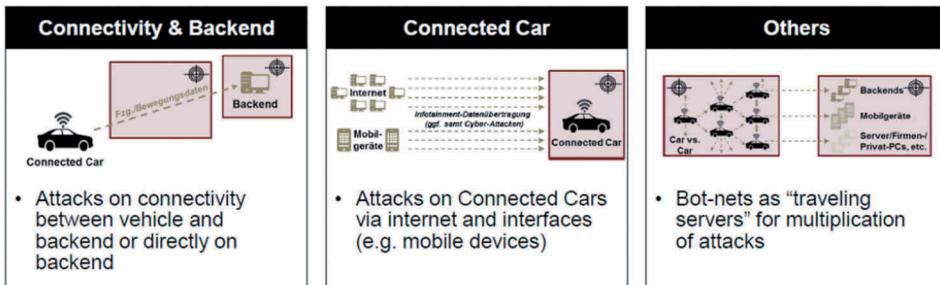


Figure 13. Figure from the document 'Cross-cutting business models for IoT: Final report' (PricewaterhouseCoopers EU Services EEIG 2018, 147).

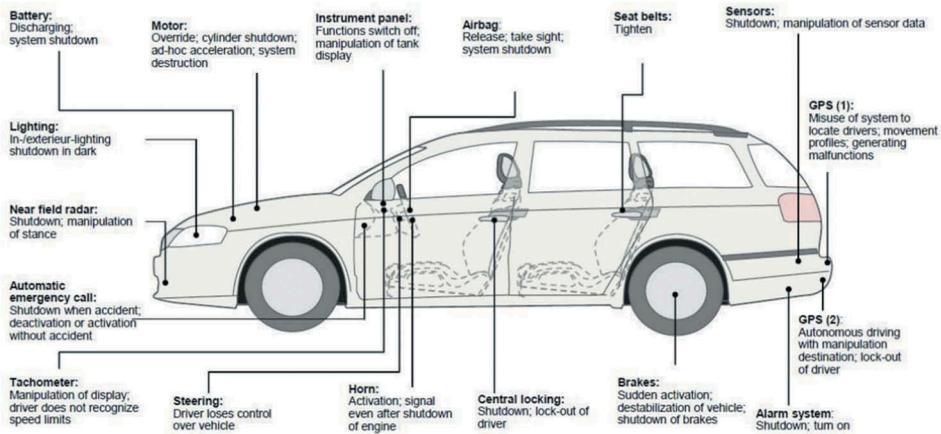


Figure 14. Figure from the document ‘Cross-cutting business models for IoT: Final report’ (PricewaterhouseCoopers EU Services EEIG 2018, 147).

The most common symbols and visuals included in the 13 figures are of cars, followed by other ground-based motorised modes such as trucks.

Results of utopia research

Drawing on Levitas work, this final results section presents visual and textual mock-ups of a smart velomobile utopia that provides a counterpoint to the current focus on networked cars as shown above. Rather than understanding ‘intelligent transport’ as a continuation of automobile cultures, this allows a more radical re-imagining of future networked mobilities. A future where ‘smart’ cycling is at the heart of digital innovation, the Internet of Things and mainstream mobilities. A utopia where research, funding and policy are informed by a deep understanding of the importance of the physical movement, infrastructure, power relations, representations as well as everyday practices and experiences of networked cycling practices, systems and technologies. For example, EU policies around transport and the Internet of Things would mainly cover cycling, with cars hardly mentioned, reversing the current reality. Using utopia as a creative method, this section produces visual and textual representations of smart velomobile utopias.

A utopian policy document on ‘Definition of a Research and Innovation Policy Leveraging Cloud Computing and IoT Combination’ would include several use cases around cycling, for example ‘Connected Bicycles’ and ‘Energy Management for electrically assisted bicycles and other active modes such as e-scooters’. The executive summary that discusses the most attractive IoT business opportunities would discuss the collaboration between IoT companies and the cycling manufacturers, cycling accessories, cycling infrastructure and cycling service providers. The strategic policy recommendations of the document would reference ‘consumer applications for active personal mobility and connected bicycles’ as examples and ensure cycling is covered as a key example for transport whenever mentioned in the policy recommendations.

A utopian version of the document ‘Baseline Security Recommendations for IoT in the context of Critical Information Infrastructures’ would make cycling central in the three transport-related ‘vertical application areas of IoT’ (out of six overall). One would be ‘Smart Cities, Active and Public Transport’, one would be ‘Smart Bicycles’ and one would be ‘Smart Active Mobility Infrastructure’ – letting cycling take center stage in IoT policy conversations, while giving less space to conversations around cars and other less sustainable forms of transport. Also, the second sentence of the executive summary of the document would mention cycling: ‘IoT is an emerging concept comprising a wide

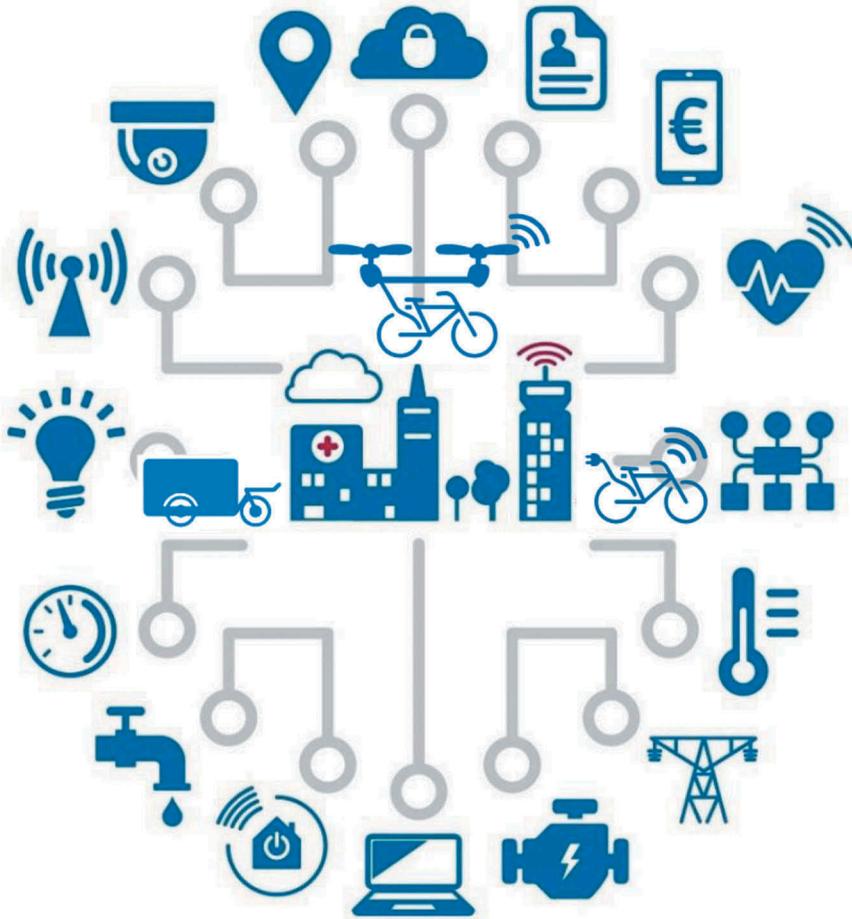


Figure 15. Utopian IoT Pervasive Ecosystem. Author's adaptation of a figure from the document 'Baseline Security Recommendations for IoT in the context of Critical Information Infrastructures' (European Union Agency for Network and Information Security 2017, 18).

ecosystem of interconnected services and devices, such as sensors, consumer products and everyday smart home objects, bicycles, and industrial and health components'.

A visualization of the IoT pervasive ecosystem in such a document would include symbols of connected cycling at its heart (see Figure 15), including networked cargo bikes and e-bikes as well as a flying drone bike. This figure would also be included on the cover of the utopian document.

A utopian version of the document 'Cross-cutting business models for IoT: Final report' would include a word count for 'Bicycle', 'cycling' or 'bike' that would be at least as high as the one for 'car'/ 'automotive'/ 'vehicle'. The report would cover three key application areas, and one of them would be 'smart bicycles', and it would include a broad range of discussions and data, including considerations of collaborations between the cycling sector and digital companies such as Google or Apple expanding into this sector. The collection, use and sharing of data would be regulated to ensure user's rights alongside commercial interests.

Discussions on how smart bicycles interact with their environment would include considerations of several other modes of transport: 'Smart Bicycles also interact with their surroundings, connecting to other bicycles, cars, e-scooters or public transport, smart road infrastructures and traffic, all of which will result in improved multi-modal mobility and reduced congestion'. The document would

IoT market by 2025

US\$ billions

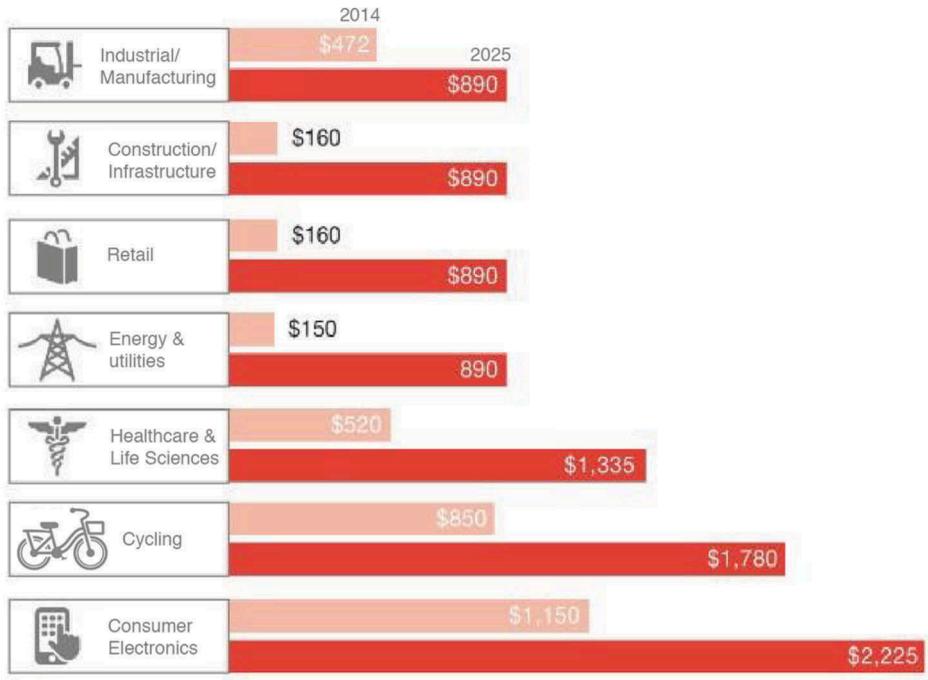


Figure 16. The utopian IoT Market by 2025. Author’s adaptation of a figure from the document ‘Cross-cutting business models for IoT: Final report’ (PricewaterhouseCoopers EU Services EEIG 2018, 23).

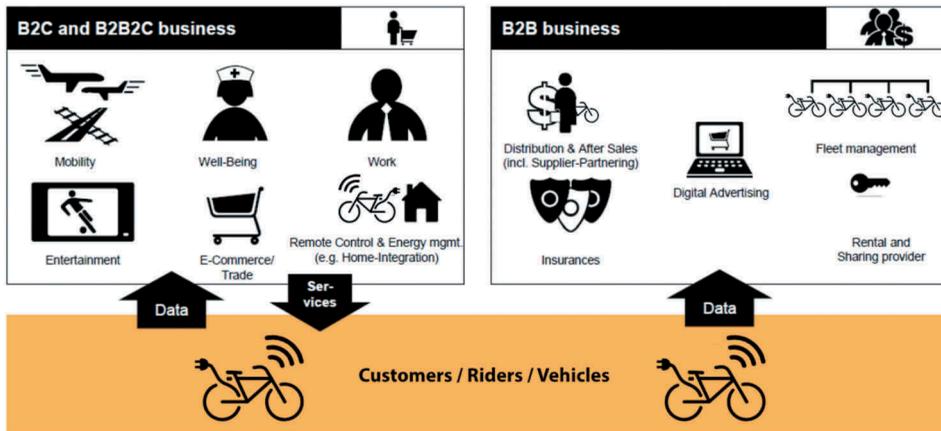


Figure 17. Utopian Cross-cutting business models for connected bicycles. Author’s adaptation of a figure from the document ‘Cross-cutting business models for IoT: Final report’ (PricewaterhouseCoopers EU Services EEIG 2018, 27).



Figure 18. Utopian Examples of Connected Devices. Author’s adaptation of a figure from the document ‘Cross-cutting business models for IoT: Final report’ (PricewaterhouseCoopers EU Services EEIG 2018, 34).

mention how “‘Smart Cycling’ has cross-cutting intersections with Smart Cities (e.g. data on bike parking space usage) and Smart Energy (e.g. energy trading between households/businesses owning electrically-assisted bicycles)”.

Figures for this utopian document would feature bicycles in IoT Market figures (see [Figure 16](#)), figures on cross-cutting business models for connected bicycles (see [Figure 17](#)), and as an example of connected devices (see [Figure 18](#)), and across other figures.

A utopian ‘Benchmark Study for Large Scale Pilots in the area of Internet of Things’ document would make cycling central to several of the 19 uses cases that inform which ‘future Large-Scale Pilots (LSPs) in the domain of the Internet of Things (IoT) will be funded in the future’. For example, the first ‘top 5’ use cases ‘Multi-modal mobility and smart road infrastructure’ would make cycling infrastructure and its interoperability with other sustainable modes such as public transport, and with key urban infrastructure, key. While the current policy document includes several references to cycling and smart cycling, the utopian version would let this take centre stage throughout the document.

Discussion and conclusion

This article’s focus on policy documents is one way of ‘futures thinking’ as ‘a major way of bringing the state and civil society back in from the cold’ (Urry 2016, 191). This discussion and conclusion considers how the combination of policy analysis and utopian methods worked in the mobilities context and how they could be understood as ‘critical tool for exposing the limitations of current policy discourses’ (Levitas 2013) around intelligent transport and autonomous cars, facilitating debate around an imaginary society where smart cycling products, infrastructure, policy and funding facilitate sustainable, active and data-responsible mobility at scale.

The analysis of the EC policy documents involved looking for existing examples of cycling in the context of the IoT, something that resonates with Levitas’ archaeological mode that involves ‘piecing together the images of the good society that are embedded in political programmes’ (Levitas 2013, 153). This yielded a rather small number of results, while cars were covered at length, as the detailed analysis evidenced. Mainly, the utopian element of this article has worked in an architectural mode, ‘imagining a reconstructed world’ in an attempt to ‘figure (and figure out) the absent presence’ as ‘part of a dialogue, neither intending nor constituting a forecast’ (Levitas 2013, 197, 198). A limitation of this article is that there is little engagement with Levitas’ ontological mode, with both the original and the utopian texts and images being very ‘thing’ and technology-heavy, and engaging less with people, something that could be developed in future research. While the utopian element of this article’s analysis retains the technology-first approach that the ‘original’ car-centric policy documents adopt, it is of course only one element of envisioning future cycling-focussed smart mobility scenarios. They need to sit alongside a strong envisioning of the social, economic and political elements, something that is only hinted at in this article, due to space restrictions. This should also include social justice considerations of cycling (Duarte 2016; Médard de Chardon 2019; Stehlin 2019).

The IoT policy documents reviewed for the article propose networked, smart and autonomous cars as the key solution in the transition towards future and more sustainable mobilities. The alternative scenario developed in this article instead proposes to move the focus from cars to bicycles, while retaining the move towards smart and networked mobilities. This is a different proposition to Popan’s (2019) who presents a desirable slow bicycle utopia that eventually abandons smart technologies alongside the imperatives of growth and speed.

This article challenges the association often made as cycling being a sustainable but non-smart mode of mobility, while automobility is associated with smart but less sustainable mobilities. It argues that as part of a transition away from automobility and towards more sustainable mobilities, cycling plays a key role, but so do smart technologies, drawing on Urry’s (2016) ‘Digital Cities’ and ‘Liveable City’ scenarios. Combining both could be an important factor in moving towards more

sustainable mobility futures. This does not mean that all cycling needs to be smart (offline and traditional approaches will sit alongside smart ones), but that cycling will play a key role in smart mobility policies, economies and futures – and this article’s utopia gives a small taste of this.

The IoT cycling utopia developed here would be more benevolent, sustainable and just than current automobile IoT scenarios for two reasons: First, because it would be centred around cycling, rather than automobility, thus bringing to the fore all the beneficial impacts of increasing cycling; and second, because the data element would develop within a policy context that favours a just approach to personal and aggregated data rather than facilitating industry-driven data practices that benefit companies rather than society and individuals (Spinney and Lin 2018). To develop the first part of this argument, this article drew on mobility literature, for the second part it drew on data justice research.

The utopia developed in this article therefore represents a step towards a socially and ecologically sustainable future, but it will require significant changes to the way smart technologies and data are developed and used (for future consideration), not just a shift of use from car to bicycle.

The bicycle-centred utopia proposed in this article can also be understood as a dystopia-avoidance type of utopia (Timms, Tight, and Watling 2014, 84–85). The visualizations created for this article speak to Timms concern that ‘whilst there is a large amount of interest shown in the academic transport literature in creating images of environmentally sustainable futures (typically through backcasting exercises), these images frequently reduce to numerical targets such as reductions in CO2 emissions or energy usage’ (Timms, Tight, and Watling 2014, 90). The visualisations include some diversity of bicycles (low-step, cross-bar, electrically assisted, flying, cargo) but do not cover the full variety of bicycles (e.g. child seats, three-wheeled, recumbent). Other active modes of personal mobility such as scooters are not included due to this article’s focus on bicycles. Social context has not been added to these vehicle-centric illustrations to retain the character of the illustrations as found in the current policy documents. This is something that would be prudent to develop in future research (see also below), especially since utopian policymaking should depart from technology-centric approaches to mobility and pay much more attention to the social context and work with diverse perspectives.

Transnational policy papers are influential in terms of influencing the visibility and invisibility of certain types of mobility over others, with the associated politics, power and funding. For the smart mobility transition, there is still scope to influence how it develops, and there is a crucial role for policy and governments in shaping this (Marsden and Reardon 2018; Docherty 2018). This paper explores how utopian methods can help provide a counterpoint to the current focus on ‘networked cars’ in discussion of intelligent transport and smart mobility. It also challenges the current continuation of automobile cultures in intelligent/smart/data/IoT policy discourses. Increasingly, only those modes of transport/mobility that have data at their heart (i.e. are smart/intelligent) are ‘visible’ in the socio-economic context, underlining the significance of this research as a ‘lack of data is an[...] indication of power’ (Iliadis and Russo 2016, 1). The IoT scenarios in the EC policy documents that referenced transport and mobility have an overwhelming focus on automobility, suggesting that the key future mobility data available will be car-centric – perpetuating, and even further increasing existing data inequalities, such as those between cycling and driving. This contributes to Critical Data Studies’ understanding of data ‘as a form of power’ (Iliadis and Russo 2016, 1) and indicates how this could play out in a smart mobilities future. The empirical analysis has ‘track[ed] the ways in which data are generated, curated, and how they permeate and exert power on all manner of forms of life’, specifically how this is the case for mobility data in EU policy documents (Iliadis and Russo 2016, 2). Amongst others, this includes considerations of what kind of data is held – e.g. car rather than bicycle data – or who holds mobility data – e.g. corporations rather than governments. This article understands IoT mobility futures as data assemblages that ‘actively frame and produce’ cities (Kitchin, Lauriault, and McArdle 2015, 6). This acknowledges the active role of mobility data in contemporary and future smart cities, and how different these car-centred assemblages are compared to bicycle-centred ones. The way IoT data are discussed in policy documents actively producing meaning, ‘produce and shape the world’ (Kitchin, Lauriault, and McArdle 2015, 20). This article proposes a utopian society where cycling is ‘big data rich’ (Boyd and Crawford 2012), which stays within the industry and policy drive towards the further datafication of society. This article draws on both mobility justice (Sheller

2018) and data justice (Taylor 2017) to argue that being data-poor increases the risk of cycling becoming invisible in policy and industry discourses. Proposing a data-rich cycling utopia would therefore contribute to 'fairness in the way people are made visible, represented and treated as a result of their production of digital data' (Taylor 2017, 1) while doing so with utopian mobility methods helps us in 'actively seeking mobility justice [so] can we protect our common futures' (Sheller 2018: 171).

Future research in this area could expand the utopia development of the IoT and smart mobility futures by (a) developing the sketched-out scenarios presented here in more detail, (b) by considering more specific local, national and global context, rather than quite generic scenarios, (c) going beyond the Western focus, (d) involving more collaborative, crowd-sourcing and bottom-up methodologies, or by (e) working with a diverse range of stakeholders. In general, research would benefit from ensuring sustainable and active modes such as cycling are considered in all work on smart mobilities and on transport in the context of the IoT.

Policy recommendations echo these concerns around future research and more specifically ask for more inclusion of non-car mobilities, especially active and sustainable modes such as cycling across all types of policy documents and other formats such as workshops and events. This should also include (a) involving industry stakeholders that engage with cycling, not just those that engage with automotive, (b) letting a diverse range of stakeholders and mobilities take centre stage and (c) ensuring that textual and visual representations of 'future scenarios' are less car-centric and more inclusive of cycling.

Overall, this article hopes that both research and policy may increasingly embrace more utopian ways of engaging with smart mobility futures, counter-acting the current marginalisation of particular mobilities in dominant IoT and car-centric visions of future mobilities, instead developing more radical ways of addressing unsustainable mobilities, including a focus on active modes.

Acknowledgments

The research for this article was partially funded by the AHRC grant AH/S004475/1 'Creative and Industry Approaches to Mobility in the Age of the Internet of Things, Blockchain and Data (CIAM)'.

Disclosure statement

No potential conflict of interest was reported by the author.

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