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Cycling the Smart and Sustainable City: Analyzing EC Policy Documents on Internet of Things, Mobility and Transport, and Smart Cities

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Abstract: This article asks how cycling, a sustainable form of urban mobility, is discussed in the context of smart cities and the Internet of Things in European Commission (EC) policy documents, and how this compares to discussions around cars. Sustainable forms of transport, such as cycling, are a key issue for cities across the globe, including smart cities, while transport is increasingly becoming part of the Internet of Things (IoT). This article contributes to an understanding of how cars and bicycles are discussed in this context. To do so, 39 relevant EC policy documents (2014–2018) were identified and examined through keyword searches and rigorous document analysis. The results show how the vast majority of policy discussions in this area revolve around cars (including autonomous cars and smart vehicles), while cycling is hardly considered, with a strong affinity between IoT and cars. In addition, recent EC policy debates take place more around IoT than around Smart Cities, while sustainability is not considered much in the IoT context. The conclusion highlights the implications of sustainable urban modes of transport such as cycling being absent from IoT/smart debates, including lack of policy visibility and funding opportunities, underlining the significance of this research, and it also makes policy suggestions for addressing these issues and for future research.

Keywords: mobility; transport; smart cities; intelligent transportation systems (ITS); cycling; sustainable transport; Internet of Things (IoT); policy; data

1. Introduction

Sustainable forms of transport are a key issue for cities across the globe, including smart cities. Cycling is an important element of sustainable and urban transport. At the same time, transport plays a major role as part of the increasing number of objects that are connected and online—often referred to as the Internet of Things (IoT). 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" [1] (p. 48). Increasingly, only those modes of transport/mobility that are smart/intelligent/networked and engage with data are 'visible' in the socio-economic context—and this tends to be discussions of smart and autonomous cars for the most part. This provides new challenges for sustainable modes of transport such as cycling, and their visibility in the policy context, underlining the significance of this research.

It appears that the shift in conversations from sustainable cities to smart cities might have a parallel development around transport, where a shift in conversations from sustainable mobility to smart mobility can be observed. The purpose of this article is to provide a counterpoint to the dominant focus on autonomous and smart cars in policy discussions of smart mobility in (smart) cities. The article is concerned with mobility and transport in the smart/sustainable city and compares the dominant mode of transport—cars—with a more sustainable but much less dominant mode—cycling. The focus is on passenger transport, not freight. The perspective is international, as the material analyzed pertains to the 28 member-states of the European Union. While European Commission policy

documents also have some readership and influence beyond the EU, this results in a Western and European perspective.

A recent literature review of smart city literature from 1990 to 2017 has identified the Internet of Things as one of the two key technologies for smart cities, the other one being AI (Artificial Intelligence) [2]. The authors explain how "cities are facing several challenges in dealing with carbon emissions, energy consumption, traffic and aging infrastructure" and how smart cities technologies are used to meet these challenges [2] (p. 7). The article identifies five application areas of IoT in smart cities, the 'smart home' is the one most frequently discussed in the literature, followed by 'smart transport' as "the second most applied domain of IoT" [2] (p. 5). In discussing transport, this article therefore engages with a key application area for smart cities. The focus on IoT in the analysis of the policy documents is also informed by this.

The majority of research on 'smart', 'intelligent' and 'networked' transport and mobility is largely focused on automobility [3,4] and this includes techno-centric perspectives around 'Intelligent Transport' [5]. For example, one of the key current debates around mobility and transport, both in research and in policy, is around autonomous/smart/networked cars. This article contributes to showing how little these conversations are concerned with sustainability, and also how discussions around smart cities only play a minor part in those debates. This is shown by comparing how cars and cycling are discussed in European policy documents. This analysis draws on the tradition of critical research on automobility, a term introduced by Urry. Automobility "can be conceptualized as a self-organizing autopoietic, non- linear system that spreads world-wide, and includes cars, car-drivers, roads, petroleum supplies and many novel objects, technologies and signs" [6] (p. 27). This article explores how automobility continues in the context of 'smart' urban developments such as IoT-related city transport, and how this is evident in contemporary European policy documents.

Research on cycling has proliferated over the last decade [7,8], and the majority of this research considers the urban context, and often contributes to debates and around sustainable transport and mobility [8–10], especially for cities. At the same time, the vast majority of research on cycling is regarding it as an 'offline' mode of transport. However, a small number of publications focus on cycling as networked, smart or intelligent mode. This includes considerations of big data for cycling [11], cycling and IoT [12], monitoring fleets [13], discussions on integrating bicycles with connected vehicle programs [14], and conceptual approaches such as the 'Smart Velomobility' concept that considers the politics and practices of smart cycling [15].

The main aim of this article is to understand how cycling, a sustainable form of urban mobility, is discussed in the context of smart cities and the Internet of Things in European Commission (EC) policy documents, and how this compares to discussions around cars. For this, it first identifies which contemporary EC policy documents are relevant for understanding how cars and bicycles are discussed in the context of smart cities and the internet of things. The article then asks: How often do these documents mention keywords associated with this topic and how do mentions around bicycles and car in the context of smart cities and IoT compare? How do these patterns play out in examples from the documents?

2. Materials and Methods

This article focusses on analyzing policy documents that are published on the European Commission's website and that are relevant for Transport and Mobility and IoT in Smart Cities, with a particular focus on cycling and cars. The focus on the European Commission enables the analysis of policies that are relevant for 28 countries, but represents a Western and European perspective. All policy documents selected for this article are listed under 'Reports and Studies' on the European Commission's website. The time period covered is January 2014 to June 2018, to cover a period when all search terms were relevant, to include contemporary articles but also cover a period of four years, and to ensure a sufficient number of documents for analysis. Three themes relevant to this article—smart cities, transport and mobility, and internet of things—were used for the discovery of

documents. The procedure for compiling the archive of relevant documents under each of these themes for analysis is as follows (see also Figure 1).

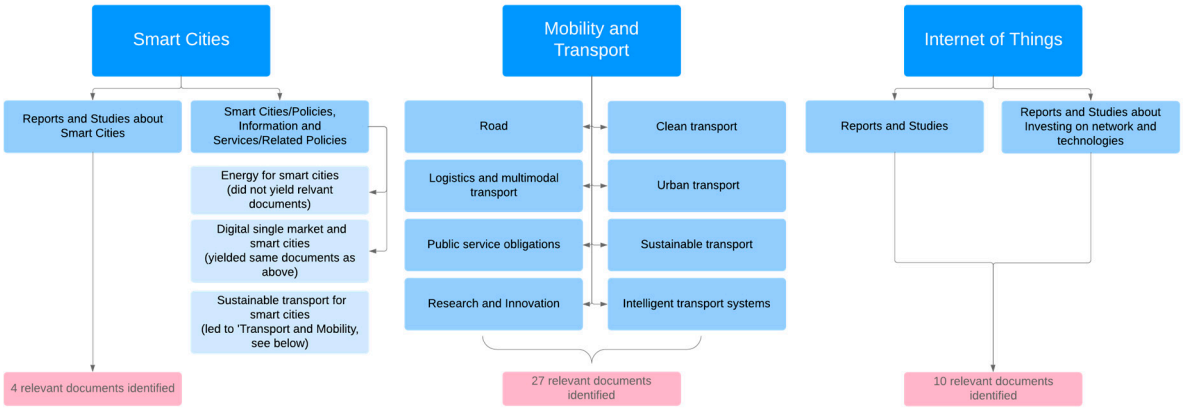

Figure 1. Diagram with the process for identifying relevant documents for analysis from the European Commission (EC)'s website through the themes Smart Cities, Mobility and Transport, Internet of Things.

For 'Smart Cities' there are two key entry points on the EC's website. The first is under 'Reports and Studies about Smart Cities' (note: this shows in the upper navigation as: European Commission/Strategy/Digital Single Market/Reports and studies, and in the right hand navigation as 'About Smart Cities') [16]. From the list of documents displayed, documents on energy, e-government, and others not relevant to this article were excluded. Smart cities, IoT, transport or mobility was mentioned in four documents and these were selected for analysis (see Table A2 'smart cities').

The second Smart City entry point on the EC's website is the 'Smart Cities' website (which shows in the top navigation as 'Policies, Information and Services', and in the upper navigation as: 'Home/EU regional and urban development/Topics/Cities and urban development/City initiatives/Smart cities') [17]. Under 'Related Policies', this website displays three links (rather than a list of actual policy documents). They are as follows: (1) 'Digital single market and smart cities' [18]—when filtering for 'reports and studies' this did not yield any documents not already discovered through other routes described here; (2) 'Energy for smart cities' [19]—page and documents excluded as not directly relevant for this article; (3) 'Sustainable transport for smart cities'—this links to the page 'Clean transport, Urban transport' [20], and clicking on 'Studies' to get to the associated policy documents, this takes users to a website [21] on the 'Mobility and Transport' page of the EC and its sub-category 'urban'—these are included in the search in the 'Mobility and Transport' page, as described next.

On the 'Mobility and Transport' page of the EC, the aim was to cover the widest range of documents possible. It was therefore decided to not limit the document search to 'urban' (as suggested under the smart city link above) but to search the entire list of 'Transport and Mobility' documents by going to the start page [22] and selecting menu item 'Facts and Funding' and then 'Studies on Transport Issues' [23]. From the long list of documents displayed, the following were excluded: those that are about inland waterways, maritime and air transport modes, rail, international relations. The initial longlist included those under the themes 'Road', 'Logistics and multimodal transport', 'Public service obligations', 'Research and Innovation', 'Clean transport', 'Urban transport', 'Sustainable transport' and 'Intelligent transport systems' (with the last three of particular importance to this this article). From this longlist, judging from the document titles, those reports were excluded that are about heavy goods transport and also documents concerned, for example with euro-vignette, driving time for truck drivers, electronic tolling (although there is an IoT element to this), internal market for haulers, commercial vehicles hired without drivers, alternative fuels. Documents where the title suggested that they might comment on 'smart, 'cycling', 'car' or 'urban' or 'sustainable' elements of transport were selected. This resulted in 27 documents (see Table A3 'Transport and Mobility').

From the key EC's website on the Internet of Things [24], (1) the link 'Reports and Studies' [25] and (2) the page 'Reports and Studies about Investing on network and technologies' [26] were investigated; and for both, the list of documents was filtered for 'reports/study' type documents. From the resulting lists, documents that have IoT, internet of things, smart cities, or transport in the title (or sound like they might cover one of these issues) were selected, resulting in 10 items (see Table A4 'Internet of Things').

Overall, the document search on the European Commission's website resulted in 39 documents (see Table A1), 27 for Mobility and Transport, 10 for IoT, and four for Smart Cities (two of which are also listed under Transport and Mobility, so do not count towards the overall number of documents). Amongst them, there is a large diversity of type of documents, from short workshop reports to commissioned reports to edited collection books. There is also diversity with regards to the word length of documents (see column in Tables A1–A4). Where several documents were part of a zip folder, only the main (summary) report was analyzed. It is worth noting that many of the themes and documents relevant to this article are presented under the broad umbrella of the 'Digital Single Market' on the EC's website.

This archive of 39 documents was then analyzed using a combination of NVIVO (analysis software for qualitative and mixed-method research, see [27]) and Excel (spreadsheet program and analysis tool, see [28]) as follows (see also Figure 2). A list of keywords was compiled to reflect the focus of this article, organized into six categories (a)–(f). They are: (a) bicycle, cycling, bike, cyclist (b) car, automotive, vehicle, (c) Smart City, Smart Cities, (d) IoT, Internet of Things, (e) transport, mobility, and (f) sustainability. In the first step of the analysis, a 'word search query' was conducted across all documents, for one key word at the time. Plural forms and stemmed words of keywords were included (e.g., bikes, cars, vehicles, bicyclist, sustainable) where possible (e.g., not possible for cycling, as it includes 'life-cycle' etc.). Even though bicycles can be understood as vehicle, the common use of the word does not include vehicles, and this is also the case in the documents analyzed. It is worth noting that Smart City and IoT applications in the area of transport and mobility are often labelled as Intelligent Transport Systems (ITS), and the term is part of several document titles too. It has been captured through the search for 'transport' as part of the analysis. The number of times a keyword occurred in each document is captured in Tables A1–A4 (see Appendix A) that were generated in Excel. The tables are organized by publication year, and within each year of publication in no particular order (note that publication dates are taken as published on the EC's website, which might differ to dates included in reports). Please note that these results include a very small number of uses of keywords in different contexts, (e.g., Policy is the vehicle for, Mobility of data is key, motorcyclists . . .), though for key documents and words, this has been double checked through manual analysis. Formulas were included in the tables to generate a combined count for the keywords grouped under (a), (b) and (e) for each document, and to generate overall sums of keywords used across documents. For some of the keyword analysis, outliers were removed, that is the document with the highest number of mentions was excluded in order to remove distortions of averages (e.g., where one document had a very high word count, but all others a very low one). It is clearly indicated in the results where outliers were removed.

In a second step, the actual content found for key words was compiled into documents. For the 'IoT' and 'Smart City' documents, all items coded at all keywords were copied into one 'memo' per document. This resulted in a memo for each document, organized by the keywords, showing all occurrences and its context in the relevant document. For the 'Transport' documents, the (a) keywords (i.e., bicycle, cycling, bike and cyclist) found in each document were viewed with 'Coding Context' set to 'Broad' to show the context around the word, and all occurrences and their context were then copied into a memo linked to the original document. This results in a memo for each document, organized by the (a) keywords (rather than all keywords, due to time and space constraints), showing all occurrences and its context in the relevant document. Occurrences of the key words in references were not included. Where there were more than 30 results for a key word in a document, the results were not copied in the memo, instead a note was made on the number of occurrences in the document. In addition,

where there was a section of the document largely dedicated to one keyword (e.g., a section on 'smart transport and mobility' in a chapter), this was not copied entirely, but it was flagged as key area for detailed analysis. Overall, this resulted in 146 pages of 'memo' text, a selection of which is analyzed in detail below. Notes were taken throughout to aid the analysis.

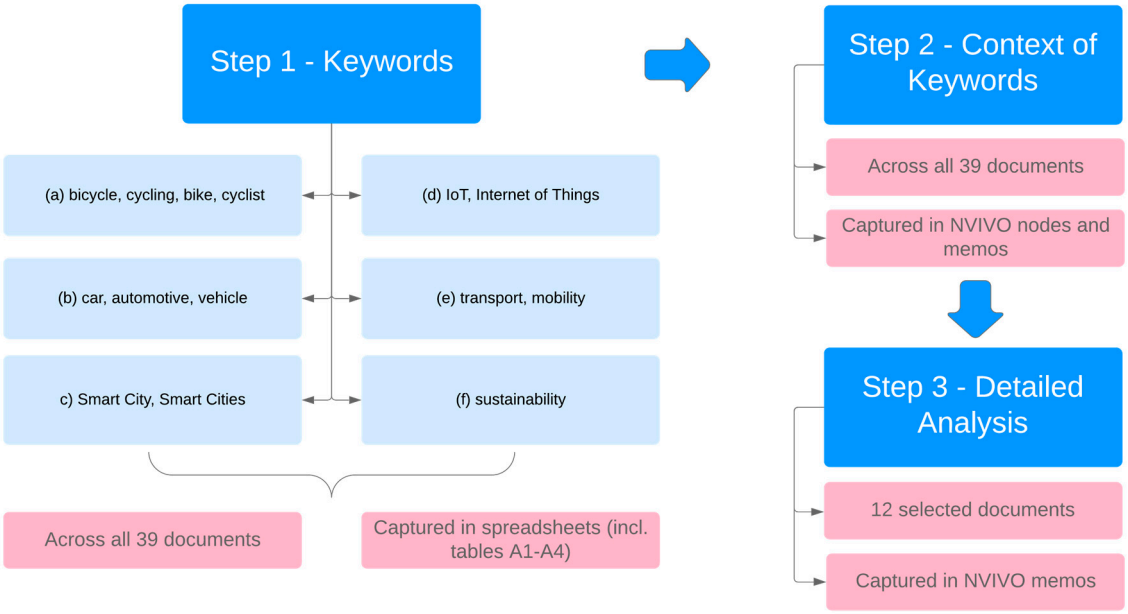

Figure 2. Diagram of the three-step process for analyzing the documents.

In a third step, based on the analysis of the data from the Tables A1–A4 and step 2, 12 documents were selected for detailed analysis. Overall, 6,424 pages of documents were analyzed. This 'Materials and Methods' section has shown which contemporary EC policy documents are relevant for understanding how cars and bicycles are discussed in the context of smart cities and the internet of things.

3. Results

The first (Section 3.1) and second (Section 3.2) section of the results focus on how often the selected documents mention the keywords (grouped as follows)—(a) bicycle, cycling, bike, cyclist (b) car, automotive, vehicle (c) Smart City, Smart Cities (d) IoT, Internet of Things, (e) transport, mobility, and (f) sustainability—and what we can observe from the results. These overview results are captured in Tables A1–A4 (see Appendix A). Drawing on these figures, these sections also explore how mentions of bicycles and cars compare in the context of smart cities and IoT. The third section (Section 3.3) of the results contains a more detailed analysis of twelve documents to show how these patterns play out in examples from the documents.

3.1. Keyword Analysis across all Documents

This section highlights key findings from analyzing all documents selected for this article (full details are listed in Table A1 (see Appendix A)).

'Bicycle', 'cycling', 'bike' or 'cyclist' is not mentioned once in 19 of the documents and a further five have only one mention. Eleven documents mention it between four and 85 times, and one document 873 times. The overall sum of mentions is 1186, and minus the outlier with the most mentions, the figure is 313. Two documents do not mention 'car', 'automotive' or 'vehicle', 16 documents mention it up to 100 times, 18 documents mention it between 100 and 1000 times, and three documents between 1000 and 3000 times. The overall sum of mentions is 12,022, when deducting the outlier with the most mentions (2455), the figure comes to 9567. Comparing the overall mentions (minus one outlier) for

'bicycle', 'cycling', 'bike' or 'cyclist' of 313 and for 'car', 'automotive' or 'vehicle' of 9567, shows a stark difference in the coverage these modes receive in the selected EC documents, with more than 30 times as many mentions of the 'car' than of the more sustainable 'bicycle' (see Figure 3).

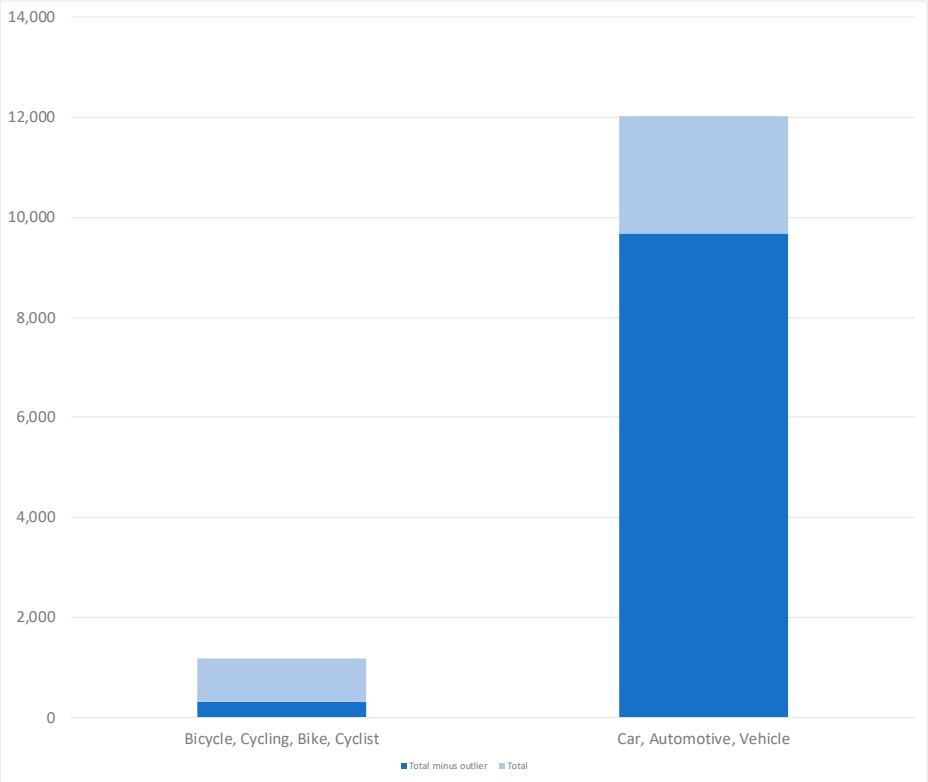

Figure 3. Comparing 'cars' and 'cycling': selected keyword count across the 39 documents (outlier document with most mentions in light blue).

'Smart City' or 'Smart cities' is not mentioned in 23 documents, and five documents mention it only once. The overall number of mentions is 317, and minus the outlier of the document with the most mentions (98) it is 219. The relatively large number of documents with no mentions, and the overall low number of mentions is surprising since the documents were discovered through 'Smart City' pathways on the EC's website.

'IoT' or 'Internet of Things' is not mentioned in 23 documents, eight mention it in double figures, three in triple figures and five mention it between 1134 and 2277 times. Overall, it is mentioned 10,216 times, and minus the outlier with the most mentions 7939.

'Sustainability' is not mentioned at all in nine documents, 11 mention it up to ten times, nine between ten and 20 times, nine documents mention it between 20 and 70 times, and one document 246 times. The latter document is about sustainable financing of public transport, so more about economic sustainability than social and ecologic sustainability. The overall figure is 742 mentions of 'sustainability', and minus the outlier with the most mentions it is 496.

The highest mentioned combined count is 'transport' and 'mobility' with 14,803 mentions; they appear in all but one document. This is not surprising, given that both terms are widely used and umbrella terms. All (combined) word counts are summarized in Figure 4.

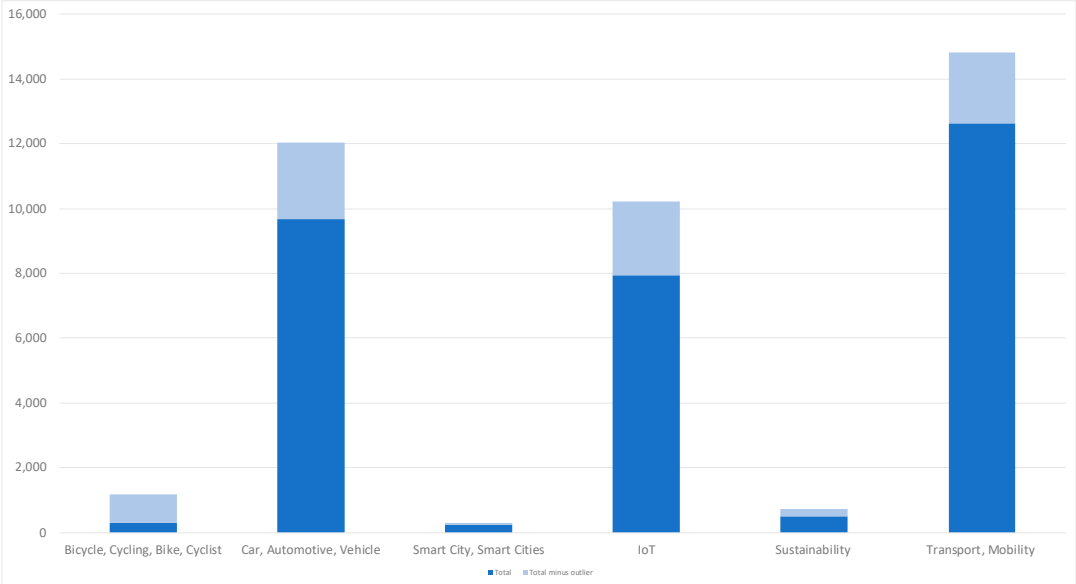

Figure 4. Keyword count across the 39 documents (outlier document with most mentions in light blue).

3.2. *Keyword Analysis for 'Smart Cities', 'Internet of Things', and 'Mobility and Transport' Documents*

In addition to the analysis across all documents above, a separate analysis was carried out for each of the three topics under which the documents were listed on the EC's website, such as 'Smart Cities', 'Internet of Things' and 'Mobility and Transport', see Tables A2–A4 (in the Appendix A). As part of this, documents for detailed analysis were also selected.

Table A2 on 'Smart Cities' includes only four documents, and three of them are very short (under ten pages). None of the documents mention 'smart cities'/'smart city' (an interesting irony) or 'sustainability'. None of them mention 'bicycle', 'bike', 'cycling' or 'cyclist' either. Three documents mention 'car' and 'vehicle', 'transport' and 'mobility'. Two of the documents mention 'IoT'. One of the four documents is entirely dedicated to cars. One document does not mention any of the keywords, but this document is a short website description of a workshop. From this list, two documents was selected for further analysis [29]. All word counts are summarized in Figure 5.

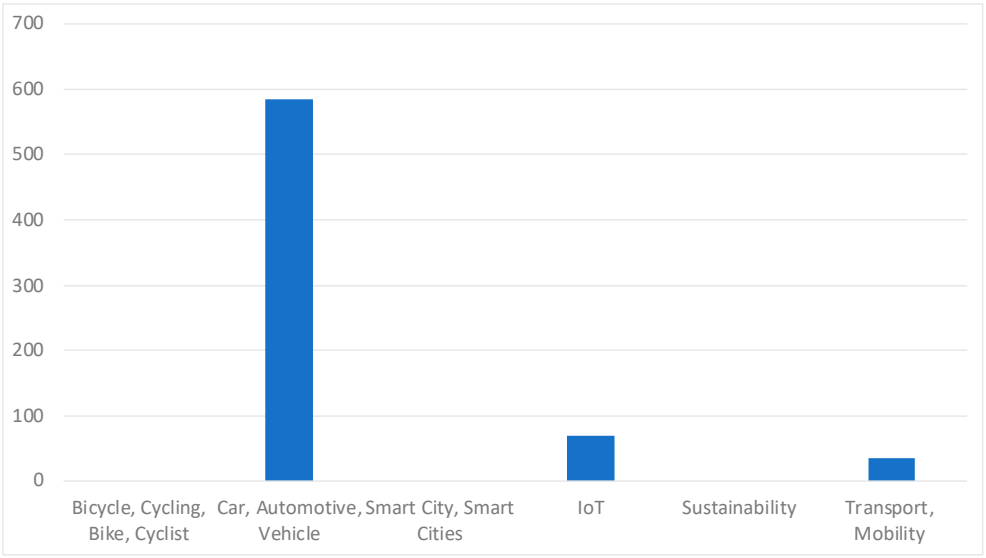

Figure 5. Keyword count across the 4 'Smart Cities' documents (outliers not separated due to low number of documents).

Table A3 covers the 'Transport and Mobility' documents (see Appendix A), and Figure 6 summarizes key findings. 'IoT' is mentioned in only five of the 27 documents, with the largest number of mentions (54) in [29], a document that does not mention 'bicycle', 'cycling', 'bike' or 'cyclist, and has a clear focus on cars. 'Smart City' is mentioned in seven documents, but this includes five documents where it is only mentioned once and one with three mentions. Across all Transport and Mobility documents, it is mentioned 21 times. The document where it is mentioned most (13) is selected for further analysis [30]. Thirteen of the 27 documents do not mention 'bicycle', 'cycling', 'bike' or 'cyclist' at all, that is half the documents. This includes seven documents that mention 'sustainability'. The overall sum of 'bicycle', 'cycling', 'bike' and 'cyclist' mentioned across all 27 Transport and Mobility documents—minus the outlier mentioned next—is 292. One document is a clear outlier in terms of mentioning 'bicycle', 'cycling', 'bike' and 'cyclist' — with a joint 873 occurrences; it is a report dedicated to walking and cycling [31], the only one found for this analysis that does so. This document does not mention 'IoT'/'Internet of Things' once, and 'Smart City'/'Cities' only once. This is therefore an example of how little IoT and Smart City are discussed in the context of cycling, and the quite stark division between policy documents engaging with cycling, and those engaging with IoT/Smart elements—and cars. The overall sum of 'car', 'automotive' and 'vehicle' mentioned across all 27 Transport and Mobility documents—minus the outlier with the most mentions of them (to mirror the cycling analysis)—is 8347. This illustrates how often cars are discussed in the context of transport and mobility. When comparing to the cycling figures above, this shows a strong disparity in how often these two modes are mentioned in the selected European Commission Policy documents on Transport and Mobility. One document [30] has relatively high counts for 'IoT' (17) 'Smart City/ies' (13) and mentions 'bicycle', 'cycling', 'bike' or 'cyclist' several times (14), and the only document on the list that scores across these key areas. It is therefore selected for further analysis.

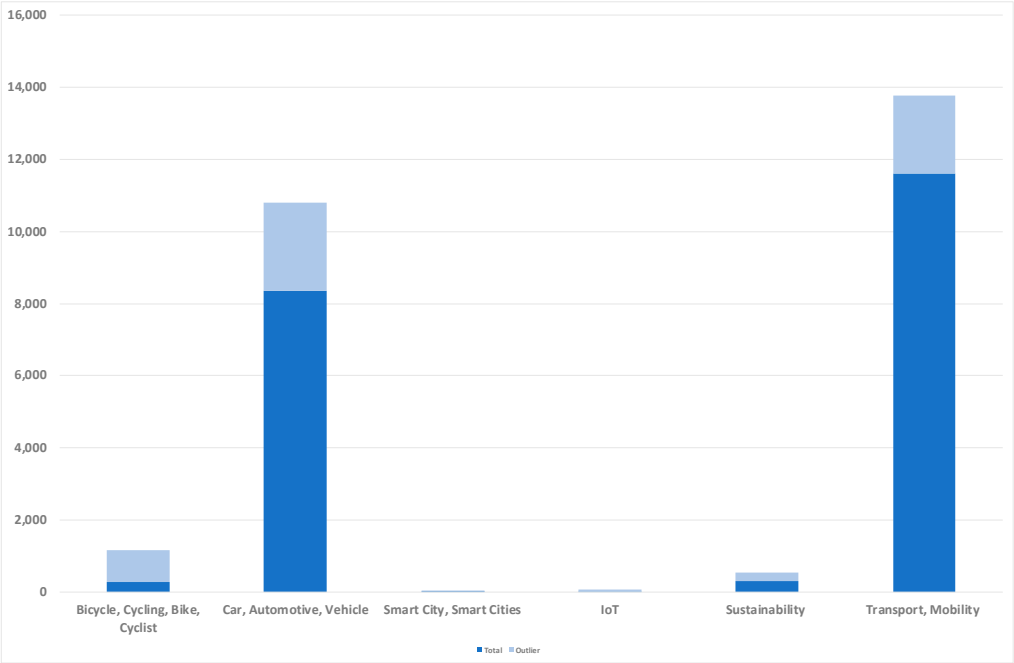

Figure 6. Keyword count across the 27 'Transport and Mobility' documents (outlier document with most mentions in light blue).

Table A4 (see Appendix A) shows the keyword analysis of 'Internet of Things' documents. It shows that four of the ten documents on IoT do not mention 'bicycle', 'cycling', 'bike' or 'cyclist' once, and four further ones have only one mention across the three words. With 11 mentions, [32] has the highest count and this document is therefore selected for further analysis. 'Smart City/ies' is mentioned in all but one document, with four documents having quite a large number of mentions

(between 34 and 98) [1,33–35]. This illustrates the close link between Smart City and IoT discourses. All documents mention 'sustainability' and 'transport'/'mobility', showing that these areas are important for IoT discussions. One document [1] has a particularly high number of mentions for 'car'/'automotive'/'vehicle' (424) and for 'IoT' (1981). The title and content of the report show it is not about cars, but the IoT. It is selected for further analysis as it shows how cars are frequently used as key IoT examples. These word counts are summarized in Figure 7.

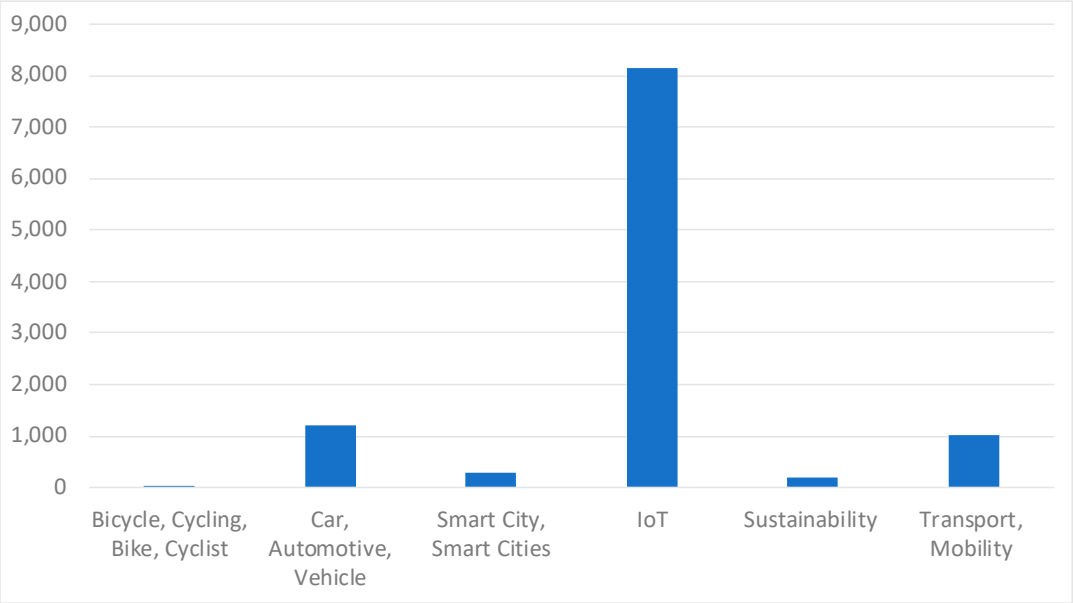

Figure 7. Keyword count across the 10 'Internet of Things' documents (note: outliers not separated due to low number of documents).

3.3. Document Analysis

These results sub-section explores how the patterns identified through the keyword analysis play out in examples from the documents. The first two documents are listed under both 'Smart Cities' and 'Mobility and Transport' on the EC website; their analysis is followed by six 'Mobility and Transport' documents, and then four 'Internet of Things' documents. Older documents are followed by newer ones in each of these areas.

3.3.1. 'Smart City' and 'Mobility and Transport' 2016 Document

The 2016 document titled 'Cyber Security and Resilience of smart cars. Good practices and recommendations' was selected for analysis due to a high number of 'Car/vehicle/automobile' and 54 IoT mentions. A first example is the document explaining the acronym "V2X" (Vehicle to Everything) as including notions of: "Vehicle-to-Vehicle communications", "Vehicle-to-Infrastructure communications" and "Vehicle-to-Pedestrian communications" [29] (pp. 13, 63) while bicycles or bikes are not mentioned. This is an example of not including the sustainable mode of cycling when thinking through the security implications of smart cars.

The second example is, how under the heading "EU Policy Context", the documents explains: "the EU Commission launched the AIOTI15 Alliance in 2015, in order to enhance the dialogue between actors of the Internet of Things (IoT)" and that one "AIOTI workgroup is specifically dedicated to Smart Mobility, which includes IoT use cases pertaining to the car industry" [29] (p. 10). This quote shows how smart mobility is equated with the automotive industry in the document, and how cars are the most prominent example of IoT given around transport—both patterns are also found in many of the other documents analyzed.

3.3.2. 'Smart City' and 'Mobility and Transport' 2018 Document

This short report of a 2018 workshop that "aimed at getting the views of stakeholders around the conditions for data sharing in the context of Cooperative, Connected and Automated Mobility (CCAM)" shows clearly how 'mobility' is conflated with 'automobility' in many EC policy documents, as all presenters and presentations are car-centric. Some are from non-automotive sectors (e.g., insurance, data), but where presentations are online, they imply cars. There are no cycling presentations/presenters or presentations that mentioned bicycles. There is one photo of a bicycle as title photo of one presentation (Mobivia) but no text about it. In the same presentation, an infographic includes a bicycle for 'now' but not for 'future' (slide 3). The report document does not mention 'bicycle', 'bike', 'cycling', 'cyclist', 'IoT', 'sustainability', 'smart city' or 'smart cities', but the word 'data' is used several times around the smart and networked aspects. 'Car' is used five times and 'vehicle' three times. This document is another indication of how little bicycles are considered in the context of smart/intelligent transport/mobility conversations, where data, IoT and other technical approaches are discussed, and how little the urban context of non-car users and sustainability are considered.

3.3.3. 'Mobility and Transport' 2014 Document

After looking at two documents that were listed under 'Smart Cities' and 'Mobility and Transport' on the EC website, this analysis now moves to six documents that are listed under 'Mobility and Transport', starting with a 2014 document titled 'Study on the benefits resulting from the installation of Event Data Recorders' that mentions 'cycling' eight times and sustainability once while it does not mention smart cities or IoT. It is noteworthy that the 'European Cyclists' Federation' is one of the stakeholders consulted [36] (p. 194). What is interesting about this document, is that cyclists are mentioned in relation to 'smart' devices that log specific transport data. This is mainly around collisions between motor vehicles and what is termed 'vulnerable road users' such as pedestrians and cyclists, with worries that "after a collision with a pedestrian or a cyclist the vehicle will be driven from the scene (e.g., for repair or to clear the road) before the data is downloaded" (p. 42), and recommendation for "an additional 'standstill' trigger for heavy vehicles [. . .] in order to maximize the chances of recording data from collisions [. . . with] a pedestrian, cyclist or motorcyclist" (p. 65) as well as a vulnerable road user "triggering algorithm that could be used in addition to current triggers" [36] (p. 71). In addition, the "recommendations for cars": include "defining adequate triggering requirements for pedestrian and cyclist collisions" [36] (p. 100).

3.3.4. 'Mobility and Transport' 2016 Document

The 2016 'Study on the Deployment of C-ITS in Europe' does not mention Smart Cities or IoT, while sustainability is mentioned 13 times. It has 1342 mentions of cars and ten mentions of cycling, for example.: "Many of the C-ITS services deployed in the scenarios aim to improve safety and reduce both the frequency and severity of accidents," a large proportion of which "affect vulnerable road users" [37] (p. 38). The study includes services that "aim [. . .] to protect pedestrians and cyclists" [37] (p. 38) and "this may be achieved [. . .] in the case of cyclists, via communication with a C-ITS device fitted on the bike" [37] (p. 183). This is interesting as the fitting of a smart device on a bicycle is proposed (even if in the annex).

3.3.5. 'Mobility and Transport' 2017 Document 1

The 2017 document titled 'Towards a Single and Innovative European Transport System SINTRAS' mentions 'bicycle', 'cycling', 'bike' or 'cyclist' 14 times. This includes a footnote that references a document that includes "bicycle crossings" in its considerations on automated driving [30] (p. 32) and a paragraph that laments the lack of integration between modes of transport in the move towards Mobility as a Service (MaaS), around ticketing "rail is rarely integrated with public transport nor with bicycle sharing schemes". Furthermore, the document explains the importance of integration

and smart services in order to "strengthen the sustainable modes of transport" such as "rail, public transport and new shared mobility services (e.g., bike-sharing, car-sharing, car-pooling, etc.)" [30] (p. 87). This is also echoed later in the document, where "[n]ew mobility services, such as car-, ride or bike-sharing, are barely integrated in MMITS" (Multi-Modal Information and Ticketing Systems)—and this is identified as major barrier [30] (p. 189). The document observes that "[c]ar- and bike-sharing, ride-sharing, car-pooling, and parking lot-sharing are new services that become increasingly popular and successful in urban areas in the EU" and goes on to discuss how important it is to capture more data and make it more interoperable between modes and countries [30] (p. 189).

One of the first focus areas of the document is "connected driving and automation of transport" [30] (p. 23). While the text is almost exclusively about connected and automated driving, a figure summarizing projected developments in this focus area includes "Transition phase. Interaction with walking and cycling" as one of the technology-focused solutions needed [30] (p. 29). This is then picked up in the text as follows: "Interactions in urban areas between connected and automated vehicles and pedestrians and cyclists will stretch the technological limits", and interestingly directly followed by the question: "The key question is, how public safety is ensured without discouraging technical innovations?" [30] (p. 30). This question frames bicycles as a potential threat to innovation around connected vehicles, rather than as an innovation opportunity in itself (see also pp. 27, 168). The barrier "road safety concerns" mentions that "all road users", including cyclists, will be affected, and while "safety improvements are a powerful argument for the deployment of C-ITS and Automation", also "new types of road safety issues might arise" (pp. 27, 168). This phrasing again suggests cycling as potential barrier to innovation. The document states potentially needed physical separation between modes as barrier too (p. 165). However, the document correctly observes that "the role of cyclists and pedestrians in the deployment of C-ITS and Automation is not clear" (p. 168) and also suggest that non-industry stakeholders such as cyclists should be included in future work—a positive comment, but quite buried in the document (p. 38).

The other four focus areas of the document do not cover cycling, even though three of the themes would suggest so: infrastructure, smart mobility services (which includes "smart city" considerations, see p. 10), standardization and interoperability. Overall, all mentions of 'bicycle', 'cycling' and 'bike' in this document were around shared or public bike schemes, not about individually owned bicycles, while the term 'cyclist' was used is a more generic way.

Smart Cities are considered in focus area 3, and largely around freight logistics [30] (pp. 10, 79, 84, 154, 191). They are also considered in focus area 4, where "number of smart cities" is mentioned in a table on costs and benefits (p. 116) and in another table on KPIs [30] (p. 125, see also p. 127).

Where examples for IoT or Internet of Things are given, they do not include cycling, for example "Internet of Things (IoT) technologies (e.g., vehicle to infrastructure connectivity)" (p. 53), "Industry 4.0 and the Internet of Things (IoT) will dramatically affect how transport service providers of all sizes operate [...], transportation management services, warehouse management systems, and other aspects of logistics" (p. 112) and "freight and logistics where data availability is being strongly affected by the growth of the Internet of Things" [30] (p. 163).

3.3.6. 'Mobility and Transport' 2017 Document 2

The 2017 document 'Study on Urban Vehicle Access Regulations' (UVAR) is one of the few transport/mobility documents that focus on 'urban'—the smart city context—as we can see from the title. It has a high count of 'car', 'automotive' and 'vehicle' (964) but also 34 mentions of 'cycling' [38]. Out of the latter, only one occurs in the main body of the text [38] (pp. 1–39); the rest occur in the annexes (pp. 40–186). One of the summary recommendations is: "Planning the use of revenues from a UVAR scheme for measures to improve sustainable mobility options like public transport, walking and cycling" [38] (p. 33, see also p. 103). This cost argument is also made elsewhere: "After the initial setup, costs and operational costs are taken into account, UVARs schemes can generate significant revenues for improving sustainable mobility options like public transport, walking and cycling" [38]

(p. 101). A key argument of the document is that UVAR should be considered in conjunction with other measures, for example those around cycling [38] (pp. 85–86, 86, 99, 100).

The document explains that there is a large variety of UVAR schemes, but that objectives typically aim "to address environmental or congestion problems", "to improv[e] the physical environment (livability, well-being) in cities, increase[e] safety for pedestrians and cyclists as well as enabling the prioritization of public transport and soft modes (i.e., walking and cycling)" [38] (p. 138, see also p. 139). Positive effects of UVARs include: "lower health-care expenditure may occur because of improved local air quality and increasing attractiveness for active mobility like walking and cycling is an example of indirect or co-benefits of a UVARs scheme strategy" and also "public transit volumes or the conversion of road capacities to other transport modes (e.g., cycling) that may also produce local public health benefits" [38] (p. 142). When discussing the data required to measure success, examples of the data required include cycling data [38] (p. 158).

'Smart City' or 'Smart Cities', 'IoT' or 'Internet of Things', are not mentioned in the document at all. This is surprising as the topic of the report would lend itself to such solutions around the monitoring of vehicle access. 'Sustainability' is mentioned three times, twice around monitoring [38] (p. 143, p. 156) and once in a reference.

3.3.7. 'Mobility and Transport' 2017 Document 3

The 2017 document 'Support study on data collection and analysis of active modes use and infrastructure in Europe' focusses on walking and cycling [31]. Not surprisingly, since it is the only document dedicated to cycling (and walking) found through this article's methodology, it is the document that has by far the most mentions of 'bicycle', 'cycling', 'bike' and 'cyclist' (873). 'Car', 'automotive' and 'vehicle' are mentioned 37 times. 'Smart city/ies' is only used once (but this is in a reference), and 'Internet of Things'/'IoT' is not mentioned at all. 'Sustainability' is mentioned 15 times, most of which are when mentioning institution, council or project names and only three discuss "calculation method for sustainable urban mobility", integrating active modes in the "urban environment as part of sustainable urban mobility indicators", or evaluating "progress towards sustainable mobility" [31] (p. 71, p. 94).

The analysis of this document shows how the conversation around active modes such as walking and cycling are not integrated with conversations around the internet of Things—while those are strongly integrated with conversations around cars, as we can see from the other documents analyzed. However, this document does talk about big data and crowdsourcing, providing some link to 'smart' conversations. The document is not featured under 'Digital Single Market' or 'IoT' on the EC website, only under 'Mobility and Transport'. While several of the car-centric transport/mobility documents are also listed under IoT/Digital Single market.

3.3.8. 'Mobility and Transport' 2018 Document

The 2018 document 'Preparatory work for an EU road safety strategy 2020–2030' talks about cyclists in the context of "vulnerable road user" and associated deaths (see e.g., p. 9). The dominant theme around cycling is the use of helmets and one of ten "Key road safety performance indicators" identified is "Proportion of a) motorcyclists, b) moped users and c) pedal cyclists with correct use of a protective helmet" [39] (p. 13, see also pp. 25, 31, 54, 78, 79, 80, 96, 118, 119). The document also repeatedly talks about the positive effects of limiting speeds to 30km/h in mixed mode areas, and separating cycling infrastructure in higher speed areas [39] (e.g., pp. 22, 40–41, 61, 116).

In terms of smart or intelligent technologies in the context of cycling, the document mentions mainly vehicle-based technologies that could reduce casualties, such as "crash avoidance and active safety technologies" and an "integrated approach to vehicle safety, linking preventive, crash protection and post-crash approaches into cooperative systems for drivers, passengers and vulnerable road users as well as vehicle and road network safety systems" [39] (p. 66).

Under "Safety management of automation and the path to driverless vehicles", tests for "new safety functions of automated vehicles [. . .] would take into account high-risk scenarios for occupants and interactions with cyclists, pedestrians and powered two wheelers" (p. 70). Under "cooperative, connected and automated vehicles", the "recommendations for EU action" include: "Adopt the proposed package proposed by the Commission for the revision of the General Safety Regulation and Pedestrian Safety Regulation with special priority and urgency being given to:

- voluntary overridable intelligent speed adaptation in motor vehicles
- automated emergency braking for pedestrians and cyclists
- improvements to frontal and side impact crash protection tests
- improvements to pedestrian crash protection tests
- HGV standards to improve driver vision and vulnerable road user protection
- measures to reduce driver distraction and impairment
- lane keeping assist
- event data recorders" [39] (p. 71, see also p. 68,117).

Overall, it is promising that cycling is considered several times throughout this important document, and is included in discussions of autonomous cars. However, intelligent/smart technologies are not discussed for bicycles themselves, only for cars and trucks while helmet use is the dominant theme and recommendation around cycling.

3.3.9. 'IoT' 2014 Document

After analyzing six 'Mobility and Transport' document, this analysis now moves on to the analysis of four IoT documents. The first is the 2014 document 'Definition of a Research and Innovation Policy Leveraging Cloud Computing and IoT Combination' that talks about "opportunity-rich use cases such as connected vehicles, driverless cars and e-call" [40] (p. 10). The company who wrote the report for the EC mentions cars as part of its IoT definition that features heavily throughout the document: "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 IoT therefore builds on communication between things (machines, buildings, cars, animals, etc.) that leads to action and value creation" [40] (p. 18).

Later on, cars are again listed as key example when talking about "the number of devices or 'things' connected to networks will proliferate at 5–10 times the rate of personal computer installed" where the authors continue to say that "we are on the cusp of things (TVs, cars, livestock, machinery etc.) being connected because they can on the basis that the full benefit from this will become apparent in the future" [40] (p. 29). In a graphic about "Smart Manufacturing—Main Use Cases (2014 vs. 2020)" one of seven listed is "Connected Vehicles & Driverless Cars" (another one is transport related—"Airport Energy Management") [40] (p. 46) and under "Smart Environments in detail: Main Use Cases in 2014 and 2020", "Connected Vehicles" are listed as one of the largest use cases [40] (p. 43). Connected vehicles are identified as key future IoT area several times in the document, for example: "Connected Vehicles (Vehicle-to-Vehicle) & driverless cars will attract particular attention from manufacturers, policy-makers, IT companies and investors" [40] (p. 47).

The document contains six short-term recommendations, and two of them mention transport or cars. One recommendation is that "[t]he EC should implement Large Scale Pilot (LSPs), or other innovation actions, in the most relevant emerging IoT markets, prioritizing energy, transport, manufacturing and public sector emerging markets, possibly within integrated end user domains such as environmental monitoring, smart cities and smart homes" [40] (pp. 13, 78). Another recommendation references "consumer applications for personal wellness, public transportation, connected cars" as examples [40] (p. 12, p. 78).

'Car', 'automotive' and 'vehicle' is mentioned 45 times in the document, 'smart city/ies' seven times, 'transport' and 'mobility' 65 times and 'sustainability' six times (all in an economic context).

'Bicycle', 'bikes', 'cycling' and 'cyclist' is mentioned only once in the document: "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" [40] (p. 46). This is an example of the use of cycling as an example of shared mobility, in a document about IoT.

3.3.10. 'IoT' 2015 Document

Cycling is discussed several times around one of the key use cases in the 2015 document titled 'Benchmark Study for Large Scale Pilots in the area of Internet of Things'. This document discusses and scores 19 uses cases 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" (p. 7). "Multi-modal mobility and smart road infrastructure" is identified as the first of the "top five" use cases [32] (p. 8). Under this larger use case, eight more "specific use cases" are listed and one of them is "improve the last mile reachability by equipping public bikes with tracking devices and keyless bike locks to enable easy bike sharing" [32] (p. 37). Considering the "attractiveness to users and providers" around this case study, the document 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" [32] (p. 38). When discussing "entry barriers" around this use case, the document mentions that last mile issues "can for example be mitigated by allowing public bike users to leave their bike behind on every street corner" [32] (p. 39). Furthermore, the use case includes "[p]ositioning vehicles and public bikes can be done by using GPS/Galileo devices" (p. 40), "[b]ike sharing solutions: companies that can provide keyless bike locks and bike tracking devices, for example, Bitlock and Skylock" (p. 41), and "Bike sharing solutions: could seek value-added services via better integration with other means of transportation" [32] (p. 42), overall covering many of the analysis aspects of the use case.

'Smart City/ies' are mentioned 20 times in the document, but only where examples are mentioned, largely in tables. There is no discussion of it in the main text. The document discusses the sustainability of case studies, in terms of technology becoming obsolete (p. 107) and in asking the demonstrators to "to elaborate on guarantees for sustainability" (p. 9, p. 35), and once in relation to agriculture [32] (p. 46). However 'sustainability' is not mentioned in relation to 'smart city/ies', 'cycling', 'cars' or 'transport'. As the whole document is concerned with IoT, this is not analyzed separately here.

3.3.11. 'IoT' 2017 Document'

This 2017 document titled 'Baseline Security Recommendations for IoT in the context of Critical Information Infrastructures' has instances of cars being part of the definition of IoT and of the car acting as main example for the IoT. For example, the second sentence of the executive summary of the report states: "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" [41] (p. 7). This report covers six "vertical application areas of IoT", and three of them have to do with transport [41] (p. 12) but bicycles are not part of these. This shows the significance of transport for the IoT sector, and the documents serves as an example of an IoT report where transport is so central, and how it does not include any mention of 'bicycle', 'cycling', 'bike' or 'cyclist' (see Table A1).

3.3.12. 'IoT' 2018 Document

The 2018 document 'Cross-cutting business models for IoT: Final report' has a particularly high number of mentions for 'car'/'automotive'/'vehicle' (424) and for 'IoT' (1,981) [1] and is analyzed here to illustrate how cars are frequently used as key IoT examples.

This document contains an example of car and bicycle examples sitting right next to each other in two subsequent sentences: "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." [1] (p. 106). However, this is the only time 'bicycle', 'cycling', 'bike' or 'cyclist' are used in the entire document. 'Car', 'automotive' and 'vehicle' on the other hand are used 424 times.

The document covers "three application areas: Smart Health, Smart Cars and Smart Energy"—putting cars right at the heart of the report. The description of the application area "smart cars" covers a wider range of data, discussions of companies such as Apple or Google expanding into automotive, and considerations of (semi) autonomous cars. When talking to issues outside the car itself, the text includes: "examples are given in the wider sense of mobility, namely in terms of public transportation, car sharing or vehicle management" (p. 24) and "[s]mart 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" [1] (p. 24). Cycling is not mentioned in relation to these anywhere in the document, it can be assumed that they have not been considered as part of this wording, even though bicycles are clearly part of "a wider sense of mobility" and cars' "surroundings".

The car application area also mentions a clear link to smart cities: "these areas will also, of course, influence the design of Smart Cities and how they will operate in the future" (p. 24). The people interviewed for the report, were representing the "smart car" application area, and not other mobility areas. The document mentions 'smart city' and 'smart cities' 49 times, mainly when mentioning examples and pilots (e.g., p. 113, p. 196 ff.), but also as IoT key area [1] (e.g., p. 158).

There are also three occurrences where smart cities and transport are mentioned in the same breath:

- "Smart Cities, with optimized transportation networks, will improve work–life balance." (p. 82)
- "Beyond individual vehicles, analytics are at the heart of making traffic systems more efficient. IBM has an entire division working on intelligent transportation solutions to predict and manage traffic in Smart Cities." (p. 114)
- "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)." [1] (p. 116)

The first of them is mode agnostic, and the other two are car-centric (with the assumption that IBM is not working on solving bicycle traffic—showing how cars are also often implicit, not just explicit in the documents).

'Sustainability' is mentioned 19 times; around business models (p. 61), as domain for IoT hardware (p. 99, p. 197), around examples (p. 102), around open source software (p. 125) and in two references [1]. No proximity between the use of 'sustainability' in the document with 'smart city/ies' or with 'transport' was observed. The document is about IoT, so this keyword is not analyzed separately.

4. Discussion and Conclusions

This article analyses policy documents that are published on the European Commission's website and that are relevant for 'Transport and Mobility' and 'IoT' in 'Smart Cities', aiming to compare the treatment of cycling and cars. The results show that across the 39 relevant 2014–2018 EC policy documents, cars are discussed very frequently, while cycling is hardly mentioned (9567 vs. 313, see Sections 2 and 3 for details on calculations, e.g., outliers). In addition, there is a strong affinity between cars and 'IoT'/'Smart Cities', while there is hardly any considerations of cycling with regards to 'IoT'/'Smart Cities'.

The results illustrate that discussing smart mobility with a strong focus on cars without mentioning cycling at all is a common theme in many documents [29,36,42]. Across most documents, mobility is equated with the automotive industry and 'mobility' is conflated with 'automobility'. A common theme for IoT discussion is to use cars as examples and use cases of IoT [1,40] and definitions [41]

and there is only one document where cycling is mentioned as part of a IoT case study (e.g., GPS tracking and smart locks) [32]. Discussions about connected and autonomous vehicles in relation to collisions (and their recording) with cyclists are another theme where cycling is mentioned. This is an important conversation about making vehicles 'smarter' to avoid cyclists' injuries and deaths, but it lacks a consideration of 'smarter' bicycles [36,39].

On the rare occasion that cycling is mentioned in the context of IoT or smart elements of transport, largely shared or public bike schemes are noted (e.g., [30,32]), whereas discussions of cars include primarily individual and only some shared use. This includes documents [1,30,38] that mention shared bikes, but not a 'smart' element of this and documents [32,40] that mention shared bikes in the 'smart' context. In terms of discussing individual bikes as 'smart', there is only one example, in an annex [37]. A question posed in one document [30] frames bicycles as a potential threat to innovation around connected vehicles, rather than as an innovation opportunity in itself—which is how 'smart cars' are framed.

The one document dedicated to cycling (and walking) does not mention 'IoT' or 'Smart Cities', though it discusses data. This serves as an example of how little IoT and Smart City are discussed in the context of cycling, and the quite stark division between policy documents engaging with cycling, and those engaging with IoT/Smart elements—and cars. This finding from policy documents links in with how cycling is treated in the majority of academic literature on cycling, where it is also largely regarded as an 'offline' mode of transport [8,10] and with those academic visions of smarter and greener mobility that are also often very car-focused [3–5], and with IoT-related work such as a recent article on smart cities and IoT that also uses car-centric examples around transport: "IoT can be used in transport to: provide an intelligent parking, create new routing services, ensure an intelligent tracking of vehicles, improve security level through the use of road sensors or RFID" [2] (p. 5). This shows how automobility, the "self-organizing autopoietic, non- linear system that spreads world-wide, and includes cars, car-drivers, roads, petroleum supplies and many novel objects, technologies and signs" [6] (p. 27) extends into the 'smart' age and this paper contributes to the critical literature on automobility, especially to the emerging mobility studies work on 'smart' mobilities [43,44]. Furthermore, it contributes to research on digital culture, where 'smart' and 'IoT' elements are discussed (e.g., [45]), but transport and mobility are rarely considered.

Most (23) documents contain no mentions of 'Smart Cities', and the overall low number of mentions (219) is surprising since all documents selected were discovered through 'Smart City' pathways on the EC's website. While 23 documents also do not mention 'IoT', across all documents, it is mentioned much more frequently (7939 times) than 'Smart Cities'. This shows that recent EC policy debates are taking place more around 'IoT' than around 'Smart Cities'. 'Sustainability' is mentioned in most documents (30) and mentioned 556 times, showing that while sustainability is part of the debates, it is not central. From this article's analysis, it seems that as part of policy discussions shifting from 'sustainable' to 'smart', for example around cities and around transport, an increase in conversations around the Internet of Things can be observed. The framing of conversations—for example, around autonomous/smart cars—around IoT rather than smart/sustainable cities seems to facilitate a focus on the 'thing'—the car—and the technologies behind and in it, and very little consideration about the context cars operates in, such as the urban environment. It also seems that the attention to 'new' 'smart' modes of transport takes away attention from traditional sustainable modes such as cycling. There also seems to be little discussion around sustainability in documents dedicated to the Internet of Things—this is important and concerning, because IoT is a major policy focus area with associated funding, and also a key economic growth area. While research on smart cities has considered cycling [15], sustainable mobility [46] and smart mobility [47] and the IoT [2], this paper's contribution is to consider these topics together, and to do so with a policy perspective, something that has not been a focus in the literature on smart cities.

With its focus on EC policy documents, this paper has an international perspective, but one that is limited to a Western and European viewpoint. This study worked with a content analysis of secondary

sources, and associated limitations include that those documents are there to create representations of particular views; this can also be seen from the type of actors (research, third sector, policy, industry) involved in producing the documents. A further limitation is the relatively short time period analyzed.

The results show how urgently more research on cycling in the smart and IoT context is needed to further develop emerging work in academia [15,48], the industry [49,50] and in the third sector [51], in order to build up a more substantial area of research that sits alongside the current car-centric perspectives, an area of research this paper contributes to. Other future research in this area could include a consideration of H2020-funded projects, an analysis that goes beyond an EU/Western perspective, a focus on policy documents of specific countries or cities, an analysis of a more diverse range of policy documents, an analysis of academic publications in the same areas, an analysis of industry documents, and a comparison of these different document types.

This discussion of the results provides a counterpoint to the current focus on 'autonomous cars' in discussion of smart urban mobility. Comparing cars to cycling provides a critical challenge to the current continuation of automobile [6] cultures in policy documents. This is significant as increasingly only those modes of transport/mobility that are smart/intelligent and engage with data are 'visible' in the socio-economic and policy context. This provides new challenges for sustainable modes of transport such as cycling. If they are not discussed in the context of smart technologies such as IoT, they lack policy visibility and are less likely to receive associated funding. In terms of policy recommendations, this paper therefore suggests that sustainable modes of transport such as cycling should be included more consistently and centrally in policy documents concerning the Internet of Things, smart cities, connected vehicles and (smart) transport. This could include involving cycling stakeholders (as recommended in [30]) or creating cycling use cases [32], rules on having to consider cycling and other sustainable modes of transport alongside car and vehicle considerations, creating more reports and projects dedicated to 'smart' cycling and 'smart' sustainable transport, and of course, shifting funding to facilitate these measures.

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Appendix A

Table A1. All European Commission documents analyzed for this article. Columns with bold numbers indicate sums of previous columns (as indicated in the header). The Bottom row with bold numbers includes figures for total sums of all rows above.

Document Title	Publication Year	URL	Bicycle	Cycling	Bike	Cyclist	Bicycle+Cycling+Bike+Cyclist	Car	Automotive	Vehicle	Car+Automotve+Vehicle	Smart City/Cities	Transport	Mobility	Transport+Mobility	Sustainability	IoT+Internet of Things	Number of Pages	Also Listed in Tables
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**	7	46	19	**65**	6	749	95	IoT
Study on the benefits resulting from the installation of Event Data Recorders	2014	https://ec.europa.eu/transport/sites/transport/files/docs/study_edr_2014.pdf	0	0	0	8	**8**	171	5	1014	**1190**	0	44	7	**51**	1	0	224	Transport and Mobility
To develop and validate a European passenger transport information and booking system across transport modes	2014	https://ec.europa.eu/transport/sites/transport/files/themes/its/studies/doc/20140812-july9thversion-awtfinalreport.pdf	1	0	3	0	**4**	187	0	141	**328**	3	1042	148	**1190**	12	6	339	Transport and Mobility
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	0	4	**4**	1	23	13	IoT
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**	20	59	40	**99**	18	189	116	IoT
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**	70	52	148	**200**	46	1679	331	IoT
ITS Action Plan	2015	https://ec.europa.eu/transport/sites/transport/files/themes/its/studies/doc/2014-07-its-action-plan-d5-action-b.pdf	0	0	0	0	**0**	18	2	35	**55**	0	39	6	**45**	1	0	137	Transport and Mobility
Study on passenger transport by taxi, hire car with driver and ridesharing in the EU Final Report	2016	https://ec.europa.eu/transport/sites/transport/files/2016-09-26-pax-transport-taxi-hirecar-w-driver-ridesharing-final-report.pdf	0	0	1	0	**1**	697	0	259	**956**	0	558	49	**607**	1	0	173	Transport and Mobility

Table A1. *Cont.*

Document Title	Publication Year	URL	Bicycle	Cycling	Bike	Cyclist	Bicycle+Cycling+Bike+Cyclist	Car	Automotive	Vehicle	Car+Automotve+Vehicle	Smart City/Cities	Transport	Mobility	Transport+Mobility	Sustainability	IoT+Internet of Things	Number of Pages	Also Listed in Tables
Comprehensive Study on Passenger Transport by Coach in Europe	2016	https://ec.europa.eu/transport/sites/transport/files/modes/road/studies/doc/2016-04-passenger-transport-by-coach-in-europe.pdf	3	0	1	0	**4**	30	0	230	**260**	0	1248	93	**1341**	7	0	372	Transport and Mobility
Study on the Deployment of C-ITS in Europe	2016	https://ec.europa.eu/transport/sites/transport/files/2016-c-its-deployment-study-final-report.pdf	0	0	1	9	**10**	222	32	1088	**1342**	0	351	84	**435**	13	0	218	Transport and Mobility
Study on ITS Directive, Priority Action A: The Provision of EU-wide Multimodal Travel Information Services	2016	https://ec.europa.eu/transport/sites/transport/files/themes/its/consultations/doc/2015-its-mmtips/consultation-report.pdf	5	24	32	1	**62**	117	1	96	**214**	1	901	38	**939**	22	0	276	Transport and Mobility
Study on economic and financial effects of the implementation of regulation 1370/2007 on public passenger transport services	2016	https://ec.europa.eu/transport/sites/transport/files/themes/pso/studies/doc/2016-02-effects-implementation-regulation-1370-2007-public-pax-transport-services.pdf	4	13	3	0	**20**	152	0	632	**784**	0	2145	38	**2183**	23	0	444	Transport and Mobility
Cyber Security and Resilience of smart cars. Good practices and recommendations	2016	https://ec.europa.eu/digital-single-market/en/news/cyber-security-and-resilience-smart-cars-good-practices-and-recommendations	0	0	0	0	**0**	328	49	190	**567**	0	20	24	**44**	0	54	84	Transport and Mobility, Smart Cities
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**	98	53	119	**172**	45	2277	364	IoT
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**	8	4	3	**7**	2	47	31	IoT
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**	8	5	4	**9**	2	1134	103	IoT
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**	34	41	121	**162**	46	1786	338	IoT

Table A1. *Cont.*

Document Title	Publication Year	URL	Bicycle	Cycling	Bike	Cyclist	Bicycle+Cycling+Bike+Cyclist	Car	Automotive	Vehicle	Car+Automotve+Vehicle	Smart City/Cities	Transport	Mobility	Transport+Mobility	Sustainability	IoT+Internet of Things	Number of Pages	Also Listed in Tables
Together for smart, age friendly homes and neighbourhoods: shaping a European Reference Framework	2017	https://ec.europa.eu/digital-single-market/en/news/together-smart-age-friendly-homes-and-neighbourhoods-shaping-european-reference-framework	0	0	0	0	**0**	0	0	0	**0**	0	0	0	**0**	0	0	3	Smart Cities
Synopsis Report Consultation on the 'Building a European Data Economy' Initiative	2017	https://ec.europa.eu/digital-single-market/en/news/synopsis-report-public-consultation-building-european-data-economy	0	0	0	0	**0**	1	4	4	**9**	0	1	0	**1**	0	15	9	Smart Cities
Updating EU combined transport data. Final report	2017	https://publications.europa.eu/en/publication-detail/-/publication/c5b643b4-9e78-11e7-b92d-01aa75ed71a1/language-en	0	0	0	0	**0**	0	0	2	**2**	0	99	2	**101**	0	0	16	Transport and Mobility
An Overview of the EU Road Transport Market in 2015	2017	https://ec.europa.eu/transport/sites/transport/files/mobility-package-overview-of-the-eu-road-transport-market-in-2015.pdf	0	0	0	0	**0**	1	0	35	**36**	0	104	2	**106**	0	0	18	Transport and Mobility
Access to In-vehicle Data and Resources	2017	https://ec.europa.eu/transport/sites/transport/files/2017-05-access-to-in-vehicle-data-and-resources.pdf	0	0	0	0	**0**	249	60	2146	**2455**	1	63	53	**116**	3	2	259	Transport and Mobility
AWT (All Ways Travelling). Phase 2 - Proofs of Concept (PoCs)	2017	https://ec.europa.eu/transport/sites/transport/files/docs/2017-awt-phase-2.pdf	0	0	0	0	**0**	4	0	3	**7**	1	230	18	**248**	5	0	84	Transport and Mobility
Consultations and related analysis in the framework of impact assessment for the amendment of Combined Transport Directive	2017	https://publications.europa.eu/en/publication-detail/-/publication/37e91145-e14a-11e7-9749-01aa75ed71a1	0	0	0	0	**0**	1	0	28	**29**	0	747	3	**750**	6	0	120	Transport and Mobility
Support study on data collection and analysis of active modes use and infrastructure in Europe	2017	https://ec.europa.eu/transport/sites/transport/files/cowi_active_modes_final_report.zip	34	736	52	51	**873**	23	0	14	**37**	1	116	168	**284**	15	0	144	Transport and Mobility
Support study for an Impact Assessment for the revision of Regulation (EC) No 1073/2009 on access to the international market for coach and bus services	2017	https://ec.europa.eu/transport/sites/transport/files/studies/2017-12-support-study-ia-revision-access-intl-market-bus-coach.pdf	0	0	0	0	**0**	62	0	105	**167**	0	775	21	**796**	15	0	359	Transport and Mobility

Table A1. *Cont.*

Document Title	Publication Year	URL	Bicycle	Cycling	Bike	Cyclist	Bicycle+Cycling+Bike+Cyclist	Car	Automotive	Vehicle	Car+Automotve+Vehicle	Smart City/Cities	Transport	Mobility	Transport+Mobility	Sustainability	IoT+Internet of Things	Number of Pages	Also Listed in Tables
Final Report. Study on urban logistics. The integrated perspective.	2017	http://ec.europa.eu/transport/sites/transport/files/2018-urban-logistics-study-the-integrated-perspective.zip	1	0	4	2	**7**	51	0	53	**104**	0	99	48	**147**	16	0	33	Transport and Mobility
Study on a Pilot project: Making the EU transport sector attractive to future generations	2017	https://ec.europa.eu/transport/sites/transport/files/2017-06-study-attractiveness.zip	0	0	0	0	**0**	0	0	5	**5**	1	539	35	**574**	16	0	126	Transport and Mobility
Study on urban mobility – Assessing and improving the accessibility of urban areas	2017	https://ec.europa.eu/transport/sites/transport/files/2017-03-study-on-urban-mobility-assessing-and-improving-the-accessibility-of-urban-areas.zip	3	10	10	1	**24**	51	0	49	**100**	0	316	84	**400**	45	0	80	Transport and Mobility
Study on Urban Vehicle Access Regulations	2017	https://ec.europa.eu/transport/sites/transport/files/uvar_final_report_august_28.pdf	0	17	1	16	**34**	56	1	907	**964**	0	416	344	**760**	3	0	189	Transport and Mobility
Towards a Single and Innovative European Transport System SINTRAS	2017	https://ec.europa.eu/transport/themes/research/studies/research_en	2	1	4	7	**14**	36	0	323	**359**	13	1025	180	**1205**	67	17	206	Transport and Mobility
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**	2	71	59	**130**	15	255	435	IoT
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**	49	60	116	**176**	19	1981	304	IoT
Connected and automated mobility in Europe (CAM)	2018	https://ec.europa.eu/digital-single-market/en/connected-and-automated-mobility-europe	0	0	0	0	**0**	2	8	12	**22**	0	4	19	**23**	0	2	4	Transport and Mobility
Study regarding measures fostering the implementation of the smart tachograph	2018	https://publications.europa.eu/en/publication-detail/-/publication/3012c99b-49c6-11e8-be1d-01aa75ed71a1/language-en	0	0	0	0	**0**	1	0	179	**180**	0	111	5	**116**	0	0	50	Transport and Mobility
Gathering additional data on EU combined transport	2018	https://publications.europa.eu/en/publication-detail/-/publication/e58e6253-fc01-11e7-b8f5-01aa75ed71a1/language-en	0	0	0	0	**0**	0	0	3	**3**	0	128	2	**130**	0	0	51	Transport and Mobility
Preparatory work for an EU road safety strategy	2018	https://publications.europa.eu/en/publication-detail/-/publication/bd17c6de-6549-11e8-ab9c-01aa75ed71a1/language-en	24	20	4	37	**85**	165	6	295	**466**	0	149	69	**218**	28	0	122	Transport and Mobility

Table A1. *Cont.*

Document Title	Publication Year	URL	Bicycle	Cycling	Bike	Cyclist	Bicycle+Cycling+Bike+Cyclist	Car	Automotive	Vehicle	Car+Automotve+Vehicle	Smart City/Cities	Transport	Mobility	Transport+Mobility	Sustainability	IoT+Internet of Things	Number of Pages	Also Listed in Tables
Pilot project study on innovative ways of sustainably financing public transport	2018	https://publications.europa.eu/en/publication-detail/-/publication/f3815f44-5fc8-11e8-ab9c-01aa75ed71a1/language-en	4	6	9	1	**20**	59	1	102	**162**	0	700	257	**957**	246	0	150	Transport and Mobility
Workshop "Towards a harmonised deployment of Cooperative, Connected and Automated Mobility (CCAM): Data"	2018	https://ec.europa.eu/digital-single-market/en/news/workshop-towards-harmonised-deployment-cooperative-connected-and-automated-mobility-ccam-data-0	0	0	0	0	**0**	5	0	3	**8**	0	1	11	**12**	0	0	4	Transport and Mobility, Smart Cities
Totals ->			**60**	**827**	**137**	**137**	**1186**	**3267**	**308**	**8447**	**12022**	**317**	**12362**	**2441**	**14803**	**742**	**10216**	**6424**	

Table A2. 'Smart Cities' European Commission documents analyzed for this article. Columns with bold numbers indicate sums of previous columns (as indicated in the header). The Bottom row with bold numbers includes figures for total sums of all rows above.

Document Name	Publication Year	URL	Bicycle	Cycling	Bike	Cyclist	Bicycle+Cycling+Bike+Cyclist	Car	Automotive	Vehicle	Car+Automotve+Vehicle	Smart City/Cities	Transport	Mobility	Transport+Mobility	Sustainability	IoT/Internet of Things	Pages	Notes
Cyber Security and Resilience of smart cars. Good practices and recommendations	2016	https://ec.europa.eu/digital-single-market/en/news/cyber-security-and-resilience-smart-cars-good-practices-and-recommendations	0	0	0	0	**0**	328	49	190	**567**	0	20	24	**44**	0	54	84	already analysed as part of transport
Synopsis Report Consultation on the 'Building a European Data Economy' Initiative	2017	https://ec.europa.eu/digital-single-market/en/news/synopsis-report-public-consultation-building-european-data-economy	0	0	0	0	**0**	1	4	4	**9**	0	1	0	**1**	0	15	9	Also listed under Digital Single Market

Table A2. *Cont*

Document Name	Publication Year	URL	Bicycle	Cycling	Bike	Cyclist	Bicycle+Cycling+Bike+Cyclist	Car	Automotive	Vehicle	Car+Automotve+Vehicle	Smart City/Cities	Transport	Mobility	Transport+Mobility	Sustainability	IoT/Internet of Things	Pages	Notes
Together for smart, age friendly homes and neighbourhoods: shaping a European Reference Framework	2017	https://ec.europa.eu/digital-single-market/en/news/together-smart-age-friendly-homes-and-neighbourhoods-shaping-european-reference-framework	0	0	0	0	**0**	0	0	0	**0**	0	0	0	**0**	0	0	3	Also listed under Digital Single Market
Workshop "Towards a harmonised deployment of Cooperative, Connected and Automated Mobility (CCAM): Data"	2018	https://ec.europa.eu/digital-single-market/en/news/workshop-towards-harmonised-deployment-cooperative-connected-and-automated-mobility-ccam-data-0	0	0	0	0	**0**	5	0	3	**8**	0	1	11	**12**	0	0	4	already analysed as part of transport
Totals ->			**0**	**0**	**0**	**0**	**0**	**334**	**53**	**197**	**584**	**0**	**22**	**35**	**57**	**0**	**69**	**100**	**4**

Table A3. 'Mobility and Transport' European Commission documents analyzed for this article. Columns with bold numbers indicate sums of previous columns (as indicated in the header). The Bottom row with bold numbers includes figures for total sums of all rows above.

Document Title	Publication Year	URL	Bicycle	Cycling	Bike	Cyclist	Bicycle+Cycling+Bike+Cyclist	Car	Automotive	Vehicle	Car+Automotve+Vehicle	Smart City/Cities	Transport	Mobility	Transport+Mobility	Sustainability	IoT/Internet of Things	Number of Pages
Workshop "Towards a harmonised deployment of Cooperative, Connected and Automated Mobility (CCAM): Data"	2018	https://ec.europa.eu/digital-single-market/en/news/workshop-towards-harmonised-deployment-cooperative-connected-and-automated-mobility-ccam-data-0	0	0	0	0	**0**	5	0	3	**8**	0	1	11	**12**	0	0	4
Study regarding measures fostering the implementation of the smart tachograph	2018	https://publications.europa.eu/en/publication-detail/-/publication/3012c99b-49c6-11e8-be1d-01aa75ed71a1/language-en	0	0	0	0	**0**	1	0	179	**180**	0	111	5	**116**	0	0	50
Final Report. Study on urban logistics. The integrated perspective.	2017	http://ec.europa.eu/transport/sites/transport/files/2018-urban-logistics-study-the-integrated-perspective.zip	1	0	4	2	**7**	51	0	53	**104**	0	99	48	**147**	16	0	33

Table A3. *Cont.*

Document Title	Publication Year	URL	Bicycle	Cycling	Bike	Cyclist	Bicycle+Cycling+Bike+Cyclist	Car	Automotive	Vehicle	Car+Automotve+Vehicle	Smart City/Cities	Transport	Mobility	Transport+Mobility	Sustainability	IoT/Internet of Things	Number of Pages
Preparatory work for an EU road safety strategy	2018	https://publications.europa.eu/en/publication-detail/-/publication/bd17c6de-6549-11e8-ab9c-01aa75ed71a1/language-en	24	20	4	37	**85**	165	6	295	**466**	0	149	69	**218**	28	0	122
Pilot project study on innovative ways of sustainably financing public transport	2018	https://publications.europa.eu/en/publication-detail/-/publication/f3815f44-5fc8-11e8-ab9c-01aa75ed71a1/language-en	4	6	9	0	**19**	59	1	102	**162**	0	700	257	**957**	246	0	150
Gathering additional data on EU combined transport	2018	https://publications.europa.eu/en/publication-detail/-/publication/e58e6253-fc01-11e7-b8f5-01aa75ed71a1/language-en	0	0	0	0	**0**	0	0	3	**3**	0	128	2	**130**	0	0	51
Connected and automated mobility in Europe (CAM)	2018	https://ec.europa.eu/digital-single-market/en/connected-and-automated-mobility-europe	0	0	0	0	**0**	2	8	12	**22**	0	4	19	**23**	0	2	4
Updating EU combined transport data. Final report	2017	https://publications.europa.eu/en/publication-detail/-/publication/c5b643b4-9e78-11e7-b92d-01aa75ed71a1/language-en	0	0	0	0	**0**	0	0	2	**2**	0	99	2	**101**	0	0	16
Towards a Single and Innovative European Transport System SINTRAS	2017	https://ec.europa.eu/transport/themes/research/studies/research_en	2	1	4	7	**14**	36	0	323	**359**	13	1025	180	**1205**	67	17	206
Support study for an Impact Assessment for the revision of Regulation (EC) No 1073/2009 on access to the international market for coach and bus services	2017	https://ec.europa.eu/transport/sites/transport/files/studies/2017-12-support-study-ia-revision-access-intl-market-bus-coach.pdf	0	0	0	0	**0**	62	0	105	**167**	0	775	21	**796**	15	0	359
Study on urban mobility – Assessing and improving the accessibility of urban areas	2017	https://ec.europa.eu/transport/sites/transport/files/2017-03-study-on-urban-mobility-assessing-and-improving-the-accessibility-of-urban-areas.zip	3	10	10	1	**24**	51	0	49	**100**	0	316	84	**400**	45	0	80
Study on Urban Vehicle Access Regulations	2017	https://ec.europa.eu/transport/sites/transport/files/uvar_final_report_august_28.pdf	0	17	1	16	**34**	56	1	907	**964**	0	416	344	**760**	3	0	189
An Overview of the EU Road Transport Market in 2015	2017	https://ec.europa.eu/transport/sites/transport/files/mobility-package-overview-of-the-eu-road-transport-market-in-2015.pdf	0	0	0	0	**0**	1	0	35	**36**	0	104	2	**106**	0	0	18
Study on a Pilot project: Making the EU transport sector attractive to future generations	2017	https://ec.europa.eu/transport/sites/transport/files/2017-06-study-attractiveness.zip	0	0	0	0	**0**	0	0	5	**5**	1	539	35	**574**	16	0	126
Support study on data collection and analysis of active modes use and infrastructure in Europe	2017	https://ec.europa.eu/transport/sites/transport/files/cowi_active_modes_final_report.zip	34	736	52	51	**873**	23	0	14	**37**	1	116	168	**284**	15	0	144

Table A3. *Cont.*

Document Title	Publication Year	URL	Bicycle	Cycling	Bike	Cyclist	Bicycle+Cycling+Bike+Cyclist	Car	Automotive	Vehicle	Car+Automotve+Vehicle	Smart City/Cities	Transport	Mobility	Transport+Mobility	Sustainability	IoT/Internet of Things	Number of Pages
Consultations and related analysis in the framework of impact assessment for the amendment of Combined Transport Directive	2017	https://publications.europa.eu/en/publication-detail/-/publication/37e91145-e14a-11e7-9749-01aa75ed71a1	0	0	0	0	**0**	1	0	28	**29**	0	747	3	**750**	6	0	120
Access to In-vehicle Data and Resources	2017	https://ec.europa.eu/transport/sites/transport/files/2017-05-access-to-in-vehicle-data-and-resources.pdf	0	0	0	0	**0**	249	60	2146	**2455**	1	63	53	**116**	3	2	259
AWT (All Ways Travelling). Phase 2 - Proofs of Concept (PoCs)	2017	https://ec.europa.eu/transport/sites/transport/files/docs/2017-awt-phase-2.pdf	0	0	0	0	**0**	4	0	3	**7**	1	230	18	**248**	5	0	84
Study on the Deployment of C-ITS in Europe	2016	https://ec.europa.eu/transport/sites/transport/files/2016-c-its-deployment-study-final-report.pdf	0	0	1	9	**10**	222	32	1088	**1342**	0	351	84	**435**	13	0	218
Study on passenger transport by taxi, hire car with driver and ridesharing in the EU Final Report	2016	https://ec.europa.eu/transport/sites/transport/files/2016-09-26-pax-transport-taxi-hirecar-w-driver-ridesharing-final-report.pdf	0	0	1	0	**1**	697	0	259	**956**	0	558	49	**607**	1	0	173
Study on ITS Directive, Priority Action A: The Provision of EU-wide Multimodal Travel Information Services	2016	https://ec.europa.eu/transport/sites/transport/files/themes/its/consultations/doc/2015-its-mmtips/consultation-report.pdf	5	24	32	1	**62**	117	1	96	**214**	1	901	38	**939**	22	0	276
Study on economic and financial effects of the implementation of regulation 1370/2007 on public passenger transport services	2016	https://ec.europa.eu/transport/sites/transport/files/themes/pso/studies/doc/2016-02-effects-implementation-regulation-1370-2007-public-pax-transport-services.pdf	4	13	3	0	**20**	152	0	632	**784**	0	2145	38	**2183**	23	0	444
Cyber Security and Resilience of smart cars. Good practices and recommendations	2016	https://ec.europa.eu/digital-single-market/en/news/cyber-security-and-resilience-smart-cars-good-practices-and-recommendations	0	0	0	0	**0**	328	49	190	**567**	0	20	24	**44**	0	54	84
Comprehensive Study on Passenger Transport by Coach in Europe	2016	https://ec.europa.eu/transport/sites/transport/files/modes/road/studies/doc/2016-04-passenger-transport-by-coach-in-europe.pdf	3	0	1	0	**4**	30	0	230	**260**	0	1248	93	**1341**	7	0	372
To develop and validate a European passenger transport information and booking system across transport modes	2014	https://ec.europa.eu/transport/sites/transport/files/themes/its/studies/doc/20140812-july9thversion-awtfinalreport.pdf	1	0	3	0	**4**	187	0	141	**328**	3	1042	148	**1190**	12	6	339

Table A3. *Cont.*

Document Title	Publication Year	URL	Bicycle	Cycling	Bike	Cyclist	Bicycle+Cycling+Bike+Cyclist	Car	Automotive	Vehicle	Car+Automotve+Vehicle	Smart City/Cities	Transport	Mobility	Transport+Mobility	Sustainability	IoT/Internet of Things	Number of Pages
Study on the benefits resulting from the installation of Event Data Recorders	2014	https://ec.europa.eu/transport/sites/transport/files/docs/study_edr_2014.pdf	0	0	0	8	**8**	171	5	1014	**1190**	0	44	7	**51**	1	0	224
ITS Action Plan	2015	https://ec.europa.eu/transport/sites/transport/files/themes/its/studies/doc/2014-07-its-action-plan-d5-action-b.pdf	0	0	0	0	**0**	18	2	35	**55**	0	39	6	**45**	1	0	137
Totals ->			**81**	**827**	**125**	**132**	**1165**	**2688**	**165**	**7949**	**10802**	**21**	**11970**	**1808**	**13778**	**542**	**81**	**4282**

Table A4. 'Internet of Things' European Commission documents analyzed for this article. Columns with bold numbers indicate sums of previous columns (as indicated in the header). The Bottom row with bold numbers includes figures for total sums of all rows above.

Document Title	Publication Year	URL	Bicycle	Cycling	Bike	Cyclist	Bicycle+Cycling+Bike+Cyclist	Car	Automotive	Vehicle	Car+Automotive+Vehicle	Smart City/Cities	Transport	Mobility	Transport+Mobility	Sustainability	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**	98	53	119	**172**	45	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**	70	52	148	**200**	46	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**	49	60	116	**176**	19	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**	34	41	121	**162**	46	1786	338

Table A4. *Cont*

Document Title	Publication Year	URL	Bicycle	Cycling	Bike	Cyclist	Bicycle+Cycling+Bike+Cyclist	Car	Automotive	Vehicle	Car+Automotive+Vehicle	Smart City/Cities	Transport	Mobility	Transport+Mobility	Sustainability	IoT/Internet of Things	Number of Pages
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**	20	59	40	**99**	18	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**	8	5	4	**9**	2	1134	103
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**	8	4	3	**7**	2	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**	7	46	19	**65**	6	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**	2	71	59	**130**	15	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	0	4	**4**	1	23	13
Totals ->			**3**	**0**	**12**	**4**	**20**	**578**	**139**	**494**	**1211**	**296**	**391**	**633**	**1024**	**200**	**8139**	**2130**

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