

Review

Urban Transportation Concept and Sustainable Urban Mobility in Smart Cities: A Review

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Abstract: In order to create a sustainable future for the urban environment in s=Smart cities, it is necessary to develop a concept of urban transport, partially reduce the use of traditional transport, primarily cars, as well as the environmental pressure on society, which is essential to move to a sustainable urban future. In the latest discussions on the future of the urban transport system, the quality of the environment, and the possibility of its improvement are discussed, this issue became especially relevant with the onset of the pandemic, when the lockdowns were introduced. The problem of sustainable transport in urban areas has been recognized in academic studies, searching for appropriate models and solutions. The article presents the latest literature review and illustrates the newest trends with several examples. VOS Viewer software has been used to classify the different keywords, according to their co-citation, following clustering techniques. By analyzing the research conducted by other researchers, it has been possible to structure the ecosystem and trends in the Urban Transportation Concept, also mentioning likely future trends. Based on the literature analysis of the Sustainable Urban Transport, the authors of the study found that a large group of researchers deal with technical solutions and innovative business models, while the essential behavioral aspects are examined in less detail. Extensive literature analysis allowed the authors to select several solutions to achieve the transformation towards sustainable transportation in urban areas: new vehicle technologies and their environmental factors' analysis, geographic information systems, the analytic hierarchy process method, the time series analysis of road traffic accidents using multiplicative models, electrification and use of Friedman Analysis of Variance by Ranks, as well as innovations in sharing mobility.

Keywords: urban transportation concept; sustainable urban mobility; individual transport vehicles; smart mobility; car sharing; urban transportation models; low carbon transport means



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1. Introduction

The smart and sustainable development of cities and surrounding urban areas has become a topical and crucial issue, where one of the dominant questions is related to the transportation system ensuring smart and sustainable mobility. According to the United Nations, three million people move to cities from rural areas worldwide every week, and thus urban populations are expected to double by nearly 2050. Such growth of the urban population is raising questions about the ability of urban areas to absorb this migration in the coming decades with outsized housing, energy and traffic infrastructures and degrading air quality [1]. The development of sustainable and smart urban transportation solutions is associated with the sustainable development goals (SDGs) of the United Nations [2]. By approving the Agenda 2030, the United Nations has defined 17 Sustainable Development Goals to target the global sustainability challenges related to the poverty, inequality, and

environmental pollution. In 2015, SDGs were adopted by 193 countries of the United Nations, which have recognized that achieving these sustainability ambitions will require financial and non-financial efforts from policymakers, entrepreneurs, consumers, and society in general [3]. The progress achieved in the SDGs is monitored and annually evaluated by specifically defined indicators for each of the goals. The United Nations has emphasized that an efficient and well-designed transport system helps to improve the quality of life for society, as it provides access to education, health, and social care, work and business opportunities. In addition, an efficient and environmentally friendly transport system and transport vehicles reduce environmental pollution and climate change [4]. Although none of the goals directly mentions the development of sustainable transport and mobility, certain goals are closely related to it, such as Sustainable cities (Goal 11) Responsible consumption (Goal 12), Industry, innovation, and infrastructure (Goal 9), Decent work and economic growth (Goal 8). In addition, the promotion of sustainable transport is implicitly related to the following: Good health and well-being (Goal 3), Clean water and sanitation (Goal 6), Affordable and clean energy (Goal 7). Thus, in the 2030 Agenda, sustainable transport is mainstreamed across several targets, especially those related to food security, health, energy, economic growth, infrastructure, and cities and human settlements. In the context of the UN, it is also important to understand the regulatory framework set by countries and international organizations, as well as the proposed support instruments that promote the development of smart and sustainable transportation in urban areas, for instance, car sharing models, electric cars, light vehicles, and other environmentally friendly mobility options. It is undeniable that the development of these issues is influenced by changes in consumer needs, new technologies in various industries, and market offers. Most of the action plans of international organizations and governments have focused on improving the development and availability of public transport, as the proposed possibility of reducing transport emissions and creating other positive environmental effects.

However, the COVID-19 pandemic has changed the behavior and preferences of transport users. The International 2020 Consumer Trends Chart reflects the changes brought about by the COVID-19 pandemic. The most important elements in the TOP 10 consumer trends of 2020 are adaptability and durability. Consumers have highlighted the need for safety and security, balanced time planning, thoughtful spending, and flexible solutions to reduce anxiety and worry. The COVID-19 pandemic has shifted priorities to personal safety and enhanced hygiene, the desire for comfort, which in turn changed consumption preferences from always available to experiences [5]. Researchers previously concluded that the need for safety and health encouraged transport users to distance themselves and choose individual means of vehicles instead of the public transport [6]. In comparison to 2020, the experts underline that: “consumers are putting their plans into motion, taking chances and seizing the moment” [5]. The pandemic has made consumers reconsider daily conveniences, preferring private transport and reducing the use of public transport, which has also had an impact on climate change and the environment. Air pollution, traffic congestion and parking are just some of the areas affecting the urban environment where the development of mobility is introducing new opportunities to promote the well-being of citizen [7]. The main determinants for the sustainable transport within urban areas can be characterized by low or zero emissions, smart technological solutions, and behavioral change of citizens–transport users [8]. Various smart technological solutions improve traffic organization and monitoring, safety of transport participants and users, as well as air and environmental quality monitoring at the level of sustainable urban planning and development. Likewise, new technologies offer solutions and platforms for improving accessibility, ensuring more efficient and user-centered mobility and using transport. The urban mobility is becoming autonomous, electric, connected and easy to use, taking into account the evolution of consumer needs and assuming the clean environment issues [9]. The current problem is that urban congestion is too high [10], the number of cars per person has increased and the population continues to grow [11]. The mentioned problems create

challenges in the urban transport system and promote the search for more efficient, smart and sustainable mobility development. Urban mobility is a crucial sector that cities need to address to accelerate their transition to climate neutrality and follow the European Green Deal transition. There is a need for mutual understanding and alignment of technical solutions with the identified needs of end-users and cities striving to achieve the climate neutrality mission goal. Developing an Urban Transportation Concept in a Smart city is an essential part of an innovative mobility and transport concept that must be agreed upon by all parties involved: technology providers and municipalities in cooperation with end users, residents and other stakeholders. Performance optimization, ease of use and maximum throughput can be highlighted as important tasks in this concept creation. This issue plays an important role in the examination of the Smart city concept which includes accessibility to new technologies (especially ICT or information and communications technologies) in cities as a key factor and cities' capability to use ICT technologies.

The development of new technologies together with citizens' use and access of them, as well as investments in research and development, personnel, training, and intangibles help to create a Smart city [12,13]. Hamamurad et al. defined the Smart city as a city that uses ICT, technology, and innovation with the aim of developing the city as a whole and improving the quality of life of its inhabitants, to promote the development of the economy, the sustainable environment and ensure effective urban management including smart mobility [14]. Dashkevych and Portnov emphasize a rather human-centric as techno-centric approach for the definition of Smart cities [15]. Anthopoulos believes that a modern Smart city should include attributes such as resources, transportation, urban infrastructure, living, government, economy, and coherency [16]. The creation and efficient usage of excellent infrastructure, including the urban mobility system, is central to the achievement of sustainable development goals. However, it also requires citizens to participate in local governance and innovation processes [17]. Tregua et al. defined a three-level Smart city structure: environment such as smart environment and smart mobility, social level: smart people, smart lifestyle and smart management and economy as a smart economy [18].

Some authors believe that business models in E-mobility can be divided into public, semi-public and private. The public basis is taxis, buses in the public transport system, car sharing with charging stations, street parking. Semi-public (private) is based on placement in residential or office buildings, with the company's car fleet colliding with police and ambulance transport, and logistics centers with trucks, delivery sprinters and parking lots. The important aspects of developing business models in E-mobility are external: legal regulations, user experience and internal: increasing revenue, sustainability and innovation. [19] Other authors propose to use the Unified Modeling Language (UML) for management purposes when solving ICT problems for electric light vehicles [20].

Smart cities focus on creating a more sustainable living environment that benefits everyone, regardless of their social background, following a holistic approach that greatly contributes to the transformation of mobility, interdisciplinary living laboratories can serve as a basis for the development of innovative and sustainable mobility solutions. [21] Urban transport models in Smart cities need to be examined how they enhance current public transport and freight transport services, introduce active mobility and micro-mobility, while adapting to deployment, adaptability, and shared implementation in cities. These models will also identify new challenges, for example in the areas of flexibility, privacy and resilience for future technological development. The European transport development planning initiatives indicate that the mobility is in the transition from the conventional ownership-based transport to the access-based transport [8]. In this transition, different car sharing models are essential especially in urban areas. Car sharing is exploiting the platform-based business models allowing car drivers to reach any distance in the city by not owning the car. The driver pays only for the journey time, or the distance traveled using the individual car available on the sharing platform [19]. The car sharing sector is forcing companies and municipalities to adapt to trends and change business models based on the principles of the sharing economy [20,21]. When improving mobility in

urban areas, it is necessary to consider not only the well-being of citizens and changes that do not harm the environment but also the well-being of the economy, so that the improvements are also beneficial for businesses. Innovations in improving urban mobility through various apps, social networks and sharing platforms have impacted the economic attractiveness of cities and the satisfaction of citizens. Moreover, these innovations in transport solutions and smart technologies change the lifestyle and behavior of citizens toward more sustainable living [22]. In the scientific literature, citizens' connections with innovation and its sustainability aspects have not been sufficiently studied together, and the innovation gap has not been comprehensively examined from four perspectives: from business, municipalities, society and educational institutions (the Quadruple Helix model). The main purpose of this article is to identify concepts and models of the smart urban transport system from a managerial perspective, taking into account the main aspects that make up the system. The study proposes to structure and analyze the available academic literature by conducting an exhaustive academic study on urban transport. It is intended to identify new directions and possible solutions to the problem of sustainable urban mobility. The paper consists of an introduction, a description of the methodological framework of the research and a bibliometric analysis of the main keyword related to Smart cities and urban transportation and smart mobility from a managerial perspective and explanation of models of sustainable transportation in urban areas. This is followed by a discussion and conclusion.

2. Theoretical Conceptualization and Methodological Framework

2.1. Main Trends of Sustainable Transportation in Urban Area: Methodology Framework of the Research and Bibliometric Analysis

The theoretical basis of this study is related to concepts of sustainable urban mobility and its development discourses, assuming the managerial perspective, sharing business models and the individual transport user-centric approach. The analyses of NgramViewer shows the frequency of occurrence of main keywords in the google books corpus (Figure 1). The main highlights of the NgramViewer's analyses allow us to provide a comparison of the frequency of mentions of interrelated keywords in publications in the selected period and, accordingly, indicate less researched issues, and the ones with a high relevance [23].

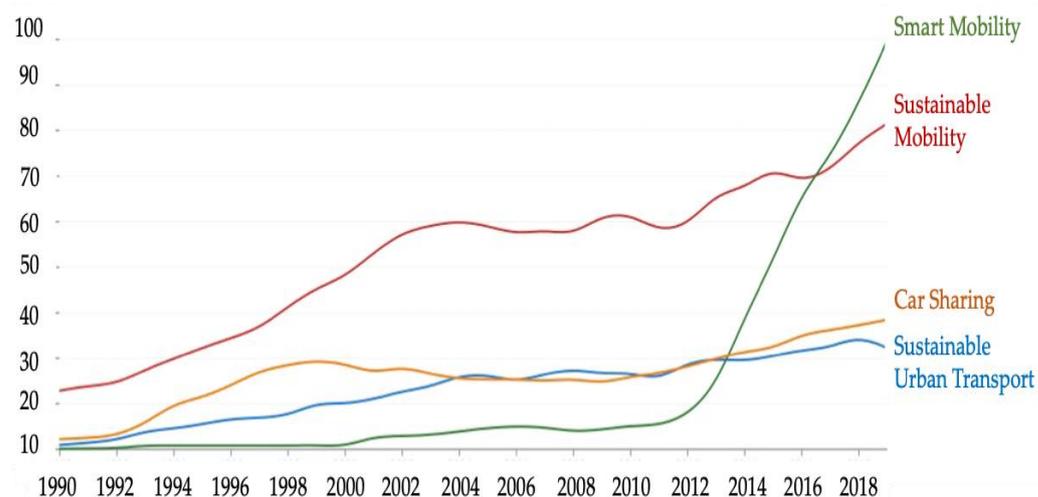


Figure 1. The frequency of using keywords “Sustainable Urban transport”, “Car Sharing”, “Sustainable Mobility” and “Smart Mobility”, which was created by the authors with NgramViewer.

The number of publications on smart mobility has increased rapidly in the last 10 years. In addition, NgramViewer confirms that sustainable mobility is a constantly increasing issue in publications for the last 30 years. On the other hand, the issues of sustainable transport related to urban areas are relatively less published. A similar frequency of publications is also about car sharing, which is an essential trend for sustainable mobility

in urban areas. Within the framework of this study, a systematic literature selection and analysis were carried out. Publications were selected in the SCOPUS database by two attempts or using two search strings. To define the criteria and keywords for the selection of the literature in each of the search strings, the initial pre-selection and analyses of the literature were undertaken. This approach allowed the authors to verify the research scope and gaps, and identify research categories and related concepts. The selection criteria of both search strings derive from the defined research framework and limitations. These criteria also show the focus of the research and indicate the need for exploring the interrelation of particular concepts or keywords within the scientific literature. The literature analysis conducted in this study was based on a methodological framework to ensure internal validity, construct validity, and reliability throughout the study. The internal validity was achieved by conducting an initial literature review to define the research scope, gaps, problems, relevance, and related concepts. In addition, these questions were further analyzed, and the conclusions were verified in the content analysis using such tools as NgramViewer and VOSviewer. This content analysis provided an opportunity to identify previous discussions and research findings of the academic community and allowed their interpretation in the context of this study and the results revealed. The construct validity was ensured accurately and based on the previously performed initial definition of the research framework. In this study, qualitative analysis methods are used, accurately making records, and reflecting the steps of the analysis under the defined research framework. When defining the most appropriate keywords for the literature selection and analysis of related concepts, nine different search strings of selection criteria were initially tested. Seven out of nine search strings were considered as not appropriate for the further literature review as the number of selected publications in each string was either too large up to 4000 literature sources or not significant—less than 50 and even 10 sources. Accordingly, two search strings with the most suitable keywords and the number of selected publications between 500 and 2000 were selected for analysis. The search criteria and keywords used for the first search string are “urban transportation”, “smart city” and “management” and accordingly 1136 publications were selected. The search criteria and keywords used for the second search string are as follows—“urban mobility”, “car” and “sustainable transport” and accordingly 580 publications were selected. The traceability of these keywords and further verification using VOSviewer content analysis confirms the construct validity.

In addition, the reliability was ensured by adopting the principle of triangulation in the selection of data and literature sources, comparing the scientific discussion of the academic community, strategic directions and perspectives of strategic and policy planning documents, as well as analyzing views, cases and approaches of the industry representatives and practitioners. The conclusions gained were discussed within the focus group discussions. The content analysis was performed using VOSviewer (version 1.6.18). VOSviewer uses the metadata of selected publications of the SCOPUS database and performs an extensive bibliographic analysis. The content analyses of the first search stream indicate four main clusters or groups (Figure 2).

In Figure 2, each of the colors demonstrates one cluster of interrelated keywords or phrases. The size of letters for each keyword or phrase differs, and a larger size indicates that the specific keywords or phrases appeared in the publications more often compared to the others and, accordingly, dominate the particular cluster. The red cluster indicates the relevance of the topic of the sustainable transport and related issues such as sustainable city, sustainable development, and sustainable urban development [24], sustainable transport, sustainable mobility and sustainable urban mobility [25], sustainable freight [26], the climate change due to emissions or CO₂ [27,28], and stakeholders [29,30]. The yellow cluster indicates the relevance of the development trends in the means of transport, particularly, the transition from fossil fuels to electric means of transport [31,32], considering the use of light vehicles and change of the lifestyle of transport users to greener preferences [33]. The blue cluster indicates the relevance of smart solutions using data analyses, intelligent transport management systems [34] and digital technologies introduced within the trans-

port system [35,36]. It can be seen that this direction has not been sufficiently explored. The green cluster indicates the issues related to the traffic safety, the road infrastructure and multi-modality. In addition, smart and digital solutions using deep learning, artificial intelligence and automatization [37,38]. The content analyses of the second search stream using keywords “urban mobility”, “car” and “sustainable transport” are visualized in Figure 3 using the VOSviewer’s network visualization chart. These clusters highlighted already in the first search stream indicated issues.

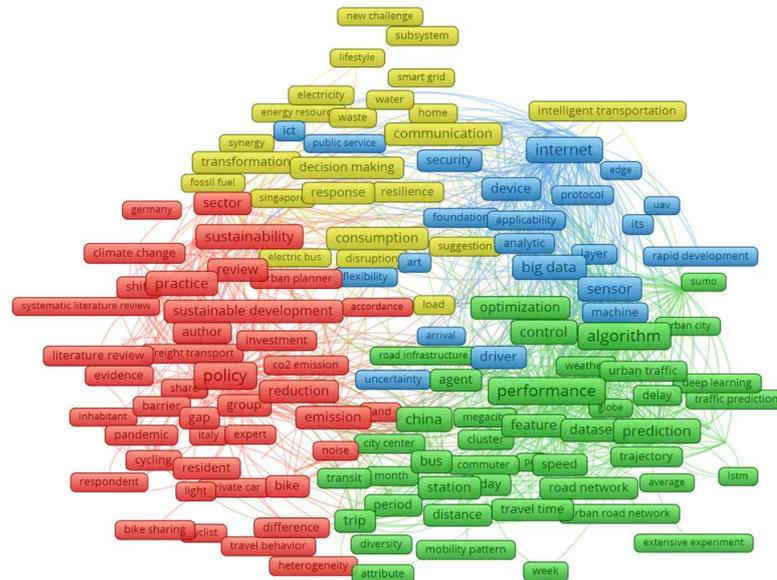


Figure 2. The network visualization of co-occurrence of keywords “urban transportation”, “smart city” and “management” was created by the authors with VOSviewer.

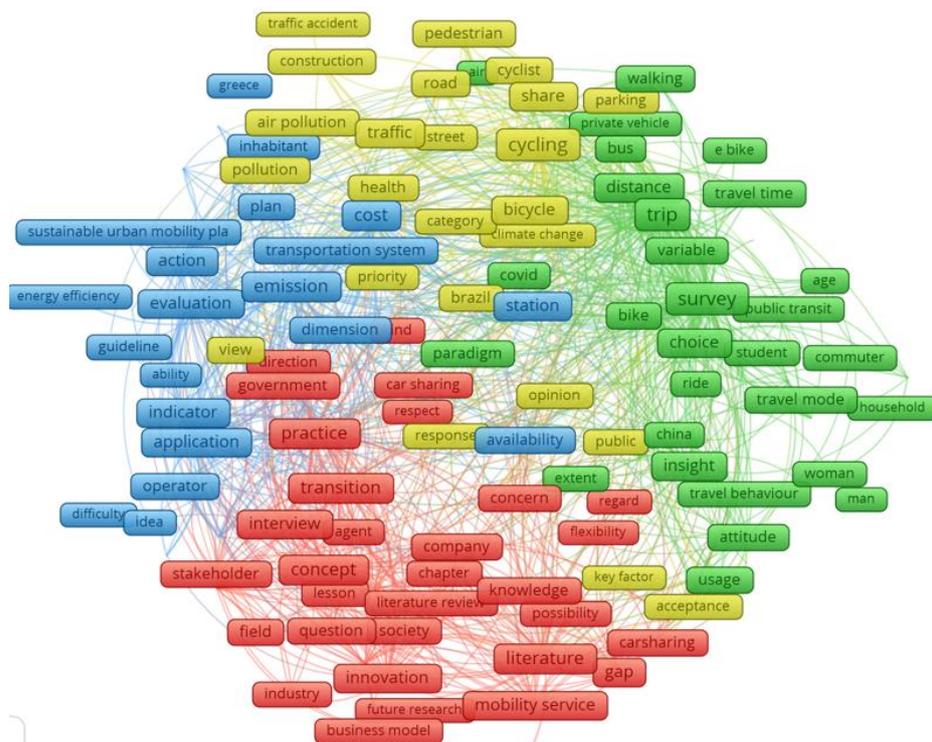


Figure 3. The network visualization of co-occurrence of keywords “urban mobility”, “car” and “sustainable transport” was created by the authors with VOSviewer.

One of the clusters (blue) represents the environmental and climate change issues concerning the transport system. The second cluster (yellow) indicates the importance of various means of transport relevant to the sustainable transportation system, such as cycling, and car sharing, and their impact on the environment and climate change. The third cluster (green) is the user behavior and preferences regarding mobility and transport. The fourth cluster (red) stresses the importance of stakeholder cooperation and the ecosystem approach, the development of innovations, and new business models in the transport and mobility industry. In this context, car sharing has been widely discussed among researchers. According to the bibliometric data of the SCOPUS database, the most published authors on this topic are presented in the Table 1.

Table 1. The authors with the largest number of publications on “urban transportation”, “urban mobility” and “sustainable transport” in the bibliometric analysis.

1st Search Stream Authors	Number of Publications	2nd Search Stream Authors	Number of Publications
Zhu W.	6	Campisi T.	5
Fang Y.	5	Canitez F.	5
Garau C.	5	Marletto G.	5
Ignaccolo, M.	5	Oviedo D.	5
Iwan S.	5	Awasthi, A.	4
Lv, Y	5	Bakogiannis, E.	4
Yang, Z.	5	Givoni, M.	4
Bellini, E.	4	Mladenovic', M.	4
Bhuiyan, M.	4	Yigitcanlar, T.	4

Geographically, the largest number of publications within the first search stream is from countries such as China, America, Italy, India, the United Kingdom, Poland, and Germany. Within the second search stream, scholars represent countries such as Italy, the United Kingdom, Germany, Spain, America, Brazil, and Australia. The authors have performed the analysis of the papers mentioned in the search of 252 authors with the largest number of publications on “urban transportation”, “urban mobility” and “sustainable transport” in the bibliometric analysis. The results of the analysis are presented in the Table 2.

Table 2. Main research areas and the authors with the largest number of publications in “urban transport”, “urban mobility” and “sustainable transport” studies.

Main Field of Studies within the Research Domain	The Authors of Publications and Information Sources
- Social and behavioral issues within transportation and the transformation agenda	Lu et al. [39]; Campisi et al. [40]; Torrissi et al. [41]; Annunziata et al. [42]; Davidich et al. [43]; Xiong et al. [44]; Patel et al. [45]; Campisi et al. [46]; Guzman et al. [47]; Torrissi et al. [48]
- Transformation and transportation management system: approaches, concepts and models	Annunziata et al. [42]; Xiong et al. [44]; Yang et al. [49]; Campisi et al. [50]; Torrissi et al. [51]; Lv et al. [52]; Cocone et al. [53]; Torrissi et al. [54]; Bellini et al. [55]; Bellini et al. [56]; Sabogal-Cardona et al. [57]; Charradi et al. [58]; Campisi et al. [59]; Campisi, Ignaccolo et al. [60];
- Usage of digital solutions and artificial intelligence for transportation issues	Xiong et al. [44]; Lv et al. [52]; Zhu et al. [61]; Bellini et al. [62]; Campisi et al. [63]; Bedoya-Maya et al. [64]; Russo et al. [65]; Mavlutova et al. [66];
- Environmental awareness and the assessment of its impact on urban transportation and other related concepts	Yuan et al. [67]; Severino et al. [68]; Madziel et al. [69]; Yang et al. [70]; Lu et al. [71]; Oviedo et al. [72]; Balleto et al. [73]

Table 2 shows the main field of studies for the paradigm change to achieve sustainability goals in Smart cities' urban transportation through the transformation process. The previous studies show that most of the authors deal with solving specific transport management problems, while existing approaches, concepts and models are discussed, analyzed and evaluated [50–52]. However, there is no single umbrella approach or model suitable for research, as most studies only cover a specific area of urban transportation (while some focus on regional aspects of the problem) [39,49,57].

Based on the analysis carried out, the authors of this study have found that a large group of researchers are dealing with a social problem while very important behavioral aspects are analysed in less detail with one or two exceptions (e.g., Lu et al. [42]); moreover, it should be emphasized that the social aspects discussed in the mentioned research works are applicable to specific regions, therefore cultural, regional, geographical and economic differences are possible and conclusions cannot be generalized [40,41].

Another important area is infrastructural problems and their solutions—this was also emphasized in the framework of social issues and similar conclusions could be drawn—the infrastructural problems considered and solved in the mentioned research works cover a specific region, so potentially cultural, regional, geographical and economic differences can lead to the need make corrections in findings [53,54,56].

The next field is related the need to use advanced tools and technologies, including artificial intelligence, to solve data-related problems and consider elements of uncertainty [63–65].

In the analyzed publications, the discussion of environmental awareness and impact on the environment in the context of urban transport is rare [68,69].

2.2. Main Trends of Sustainable Transportation in Smart Cities: Modeling Framework

The problem discussed above covering the issues of sustainable transportation in urban areas is also recognized by academic research looking for appropriate models and solutions. The following part of the study is going to illustrate the trends with essential examples. It is worth considering that the major part of the studies supports a new paradigm—the sustainable transformation encouraging the development of a better and more sustainable future of Smart cities, where the promotion of the pro-environmental behavior of individuals is extremely important. Extensive literature analysis allows the authors to select several solutions to achieve the transformation toward sustainable transportation in Smart cities. Some of the solutions are going to be discussed below. Nabiyeva and Wheeler assume that Geographic Information Systems (GIS) could be considered as a multipurpose computer-based tool that provides a sophisticated ability to model, to map and to analyze data on different spatial layers that could be useful to support the sustainable development goals [74]. Similar ideas are expressed by other authors [75–77]. Kopelias et al. underline the importance of global efforts on climate change and new vehicle technologies, while their study is an extensive review of the research devoted to the environmental and noise impacts predicted by the application of new kinds of vehicles on the road traffic [78]. As a result of the study 11 factors are categorized based on whether they are related to the vehicle, the road network, or the user of the road network and vehicle, and what is their environmental impact. The discussion about the autonomous vehicles and their environmental impact and role towards sustainability is further discussed in the scientific literature [79–81]. Adrian and Fantana consider the Analytic Hierarchy Process (AHP) method essential for solving transport and logistics problems. It is worth considering that the AHP algorithm is useful for a wide range of problems including the issues of urban sustainability, and therefore it could be applied in further studies [82]. As suggested by the authors mentioned above it is necessary to prepare a comparison matrix for several criteria and alternatives, to calculate the consequences, and to generate the performance matrix to model and to determine the best alternative. The mathematical algorithm of this model is described by Saaty [83]. On the other hand, a local real-time Hazard Reporting System (HaReS) with combined detection methods may model the reduced negative effects of environmental conditions, such as adverse weather conditions (e.g., fog and heavy rain)

and storms [84]. Popescu [85] believes that the time series analysis of road traffic accidents using multiplicative ARIMA models and the attractive features of the Box–Jenkins approach provide an adequate description of the data and are useful in modeling and forecasting of road traffic injuries. Meanwhile, such data analyses and modeling contribute to the planning and management of a more sustainable urban transport system, indirectly changing patterns to use transport and mobility services in a more environmentally friendly and sustainable way. The authors of the current paper are convinced that ARIMA models used to predict future values based on past values could serve as an appropriate tool for modeling new patterns of the mobility of citizens using various types of vehicles. In the first step it is necessary to apply differencing to capture the moving trend (lag-1 differencing, while parameter d determines how many times to apply lag-1 differencing) and seasonality (seasonal differencing). In the second step it is necessary to fit the ARIMA model to the difference series. Further discussion regarding emerging transportation technologies could not be continued disregarding such issues as new transport systems and behavioral changes [86]. The European Life project, called DYNAMAP, has been devoted to model a real image of the noise generated by the vehicular traffic in urban and suburban areas, developing a dynamic acoustic map based on a limited number of low-cost permanent noise monitoring stations. The developed methodology allows drawing conclusions of how to improve traffic planning in a large urban environment [87]. Zhang and Fujimori are developing the idea that the electrification could be seen as an attractive solution for reducing the negative environmental impact of the transportation. The authors performed scenario replications to show the role of transport electrification in the climate change mitigation and concluded that the transport electrification as an independent component is not contributing to the reduction of the negative environmental impact while swapping to electrified vehicles under the shared socioeconomic path allows achieving better results in terms of the low-carbon transition [88]. Marvin et al. are addressing the same problem as mentioned above by discussing the evidence-based methods developed to escalate the effectiveness of traffic management through the transformation of infrastructure facilities and control systems. The research focuses on the analysis of difficult areas of road networks in a medium-sized city and creates basics for substantial improvements in traffic flow parameters and, consequently, sinking the negative environmental impact [89]. Zhang et al. underline some sustainable redevelopment factors such as the location, the support of local governments, the allocation of investment costs, and underline huge differences between rural and urban areas in this extent [90]. Another significant contribution of those authors is the description of the methodology applicable to solve further urban sustainability issues and could be applied in the coming research papers. The evaluation of the factors mentioned by Zhang et al. is based on the methodology—Friedman Analysis of Variance by Ranks. If the results determined by application of above-mentioned methodology show that at least one treatment is significantly different from another, a multiple comparison test is necessary to identify which treatments are significantly different usually at $p < 0.05$ level. This methodology could be applicable for the modeling of urban transport sustainability issues and will be considered in the coming research papers. Flexible and practical approaches were described by Iacobucci, Bruno and Schmöcker to improve the performance of shared autonomous electric vehicles including smart charging using dynamic electricity prices which are designed to be scalable and a simple integrated optimization system [91]. The model optimizes both real-time relocation and vehicle charging based on dynamic electricity price signals. Similar solutions and discussions of the operation of shared autonomous electric vehicles can be found in several studies [92–94]. Inland waterway transport is considered to be the least energy-intensive transport mode among the other modes of transport in a comprehensive transport system in connection with being environmentally friendly in terms of energy efficiency, gas emissions and noise [94–97]. A few examples mentioned above, on the one hand, demonstrate topicality of the problem both for academic research and practice, and on the other hand, show that the problem could be discussed from different perspectives—for example, new technologies and users'

behavior, traffic management and transformation of infrastructure facilities—due to its complexity and interdisciplinary as well as from a sustainability dimension. Valdemars et al. emphasize the importance of responsible change in the behavior of vehicle drivers to promote ecological and safe driving, save time, and thereby promote sustainable consumption and socio-economic development. We can agree with these researchers that not only ecological driving, but also transport safety is an undervalued factor contributing to sustainability. Transport safety is important as it affects the potential costs of social care and health for both individuals—accident victims, and rescue and support services. According to Valdemars et al. families that have lost family members in traffic accidents, faced a decline in income and living standards in their households [98].

3. Discussion and Conclusions

There are usually discussed and analyzed problems regarding the future of the transport system, the quality of the environment and the possibilities for improving this quality. The authors have found out that most of the studies so far have analyzed the impact of new technologies on economic development, the availability of these new technologies is considered an essential element, mainly analyzing their impact on economic development without taking into account the aspect of sustainable development [9,14].

However, the authors agree with the second stream of research that defines two factors representing an important aspect in the ICT sector, namely the use of these new technologies and the ICT capability from inhabitants and governance perspective in this field [13,15,16].

Creation of a sustainable urban future in the cities requires a partial reduction in the use of conventional transport means, especially cars, as well as environmental pressure on society, which is essential to ensure the successful transition to a sustainable urban future. This opinion could be found in the wide range of research papers [96–98].

Sharing economy is seen as a potential way to reduce the environmental impact and costs of using products, to assess the socioeconomic impact, while increasing the availability of the products. The authors of the current study agree with the opinion presented and discussed in [21,99–101]. The authors of the study believe that collaborative consumption and sharing have ushered in an unprecedented breakthrough in the field of transport. It should be emphasized that joint mobility, autonomous mobility, and other forms of mobility impact the way how people move [102,103]. After the COVID-19 pandemic, there is a growing demand for various micromobility services: low-speed, short-distance, short-term and on-demand.

Along with the long-time popular bike rental and bike sharing, today there are stations with driverless or free-floating vehicles such as shared scooters, including stationary electric scooters and moped-type scooters. Further discussion could be followed in the number of research papers [104,105].

In addition, nowadays, authors generally pay more attention to one-way electric vehicle car-sharing systems for their mobility in order to achieve a balance between the cost of the vehicle, the movement of personnel and the quality of the services offered. A clustering method was used, including station clustering, operations optimization and personnel flow or propose an incentive-based boundedly rational dynamic user equilibrium (IBR-DUE) model [106,107] Another group of researchers looked at the electric vehicle fleet displacement management sharing system from the company from an operational efficiency perspective by setting up a tow bar to minimize vehicle movement costs for the ride-sharing company by involving users through an innovative IT application [108]. Automation electrification, and shared mobility are considered to be three revolutions in the passenger transport sector, resulting in improved efficiency, reduced costs, and CO₂ emissions. Cargo operators are also considering the possibility of integrating these three revolutions, especially those operating in urban environments, rather than long freight transportation. The freight transportation and delivery systems in urban areas require a sufficient number of freight suppliers, a sufficient number of parcels, a sufficient number of charging stations (for electric freight transport), and the ability of consumers to receive

their parcel package that interlink them directly with a consumer and their mobility [109]. The urban transportation system is changing with population growth and the diversity of sharing business models that serve various and wider segments of society. In the transport sector, shared transport has a positive impact on the environment by reducing the number of kilometers driven. Sharing services is shifting the behavior of people and transport users by changing the need to own a car as a necessity for mobility to reach a certain destination. Due to this fact the authors of the study were able to determine that both social and behavioral aspects are being considered within the existing research [42,43,49], while social problems and potential solutions are more often found within the current discussion, nevertheless, behavioral aspects are considered important but less studied. Furthermore, the sharing of light vehicles, for instance, sharing of bikes or scooters can reduce the necessity to use motorized transport and thus reduces the use of petroleum products and minimizes gas emissions [110]. An alternative solution might be development within inland waterway transport [94]. To sum up, one can note that the sustainability issue in the domain of urban transportation and Smart cities is being broadly discussed in the scientific literature in the last years, while some of the theoretical and practical (modeling tools and approaches) solutions are proposed and could be developed further to contribute to the achievement of the goals. Exploring concepts and global trends in the urban mobility-related literature, it can be concluded that in the last 10 years there has been rapid development in this area. In literature, various new solutions and concepts appear, such as the sharing economy, ride and car sharing, low-carbon or smart transport, and others. Moreover, the authors are able to state that some topics are of particular relevance and importance within the rapidly developing research area (for example, discussions regarding the transformation and transportation management system: approaches, concepts and models) while others are assumed being a cornerstone to achieve the challenging sustainability goals are less covered (for example, environmental awareness and impact evaluation in the context of project implementation in the domain of transportation) [111–113]. The review of the analyzed literature allows one to identify the most popular areas of research as well as the areas that have not yet been addressed by researchers as “sustainable urban transport” and “car sharing”. Gaps have been identified by reviewing the obtained academic papers and their relationship with the clusters. On the other hand, in the inclusion of social and behavioral aspects, a greater understanding of stakeholders should be encouraged for sustainability purposes.

Having exhaustively explored all analyzed scientific literature, potential research for further development can be proposed. The analysis of the theoretical concepts and models in the domain of urban transportation and Smart cities demonstrates the topicality of the issue and its importance. Sustainable urban transportation helps to achieve the UN Sustainable Development Goals and supports the transformation processes to more sustainable economic development, green-thinking society and Smart cities. On the other hand, it is worth considering that the huge number of concepts and their wide spectrum do not contribute to a sufficient level of understanding and system thinking. Therefore, there is an urgent necessity to provide a systematic overview resulting in a general concept allowing one to see the connections between the UN Sustainable Development Goals (including the sub-goals), theoretical concepts as elaborated above and practical applications (concepts or models) to be used as decision-making tools and KPI to control the process of transformation towards sustainable development, it is valuable to rely on a KPI-based evaluation system covering the environment, energy, mobility, ICT, population, economy and governance in general [114,115].

The urban transport system in Smart cities should focus not only on users but on all citizens, and should focus on developing citizen-friendly business models and innovations, applying the principles of the Quadruple Helix model, while taking into account business, municipalities and universities which should support citizens by promoting their innovation activities towards sustainability [116,117].

The authors intend to continue the development of such a systematic concept, while they strongly believe that the current review paper contributes to the creation and development of the concept and provides added value for further research. Policymakers and transport planners need to reconsider the development possibilities of efficient and sustainable mobility using individual means of transport, for instance promoting the development of different car or bike and ride sharing businesses or social models, and the use of light vehicles. This in turn may require the development of green corridors in cities and the promotion of new preferences to citizens, like, walking and bike-riding instead of cars, especially in the short distances. The promotion of citizens' preferences is necessary, by studying the wishes and needs of citizens from the perspective of user behavior, as the literature review revealed that they are not taken into account when fully developing new Urban Transportation Models.

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