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Review

Car-Sharing Systems in Smart Cities: A Review of the Most Important Issues Related to the Functioning of the Systems in Light of the Scientific Research

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Abstract: Currently, short-term car rental services (car-sharing) are a solution that is an alternative to individual motorization, which can be used in cities. With the level of sophistication of the relevant systems, there are more and more problems with their proper functioning. However, to understand the essence of some of the problems or properly introduce a new system to the market, it is important to understand how the systems work and the main relationships between the factors affecting car-sharing. This work aims to comprehensively present the most important aspects related to the functioning of car-sharing in light of the current research, as a form of compendium of knowledge about car-sharing. A review of the literature indicates that the leading areas of research in the field of car-sharing are seven topics related to the origin and history of services, the analysis of the functioning of the services market and criteria affecting the development of the relevant systems, the management of vehicle systems and location, issues related to the sustainable development of transport, IT systems, electromobility in car-sharing, and service optimization and modeling. A detailed analysis of the work carried out in this area allowed for the identification of 15 leading factors influencing car-sharing. This article supports the implementation and improvement of car-sharing services. In addition, it supports researchers during literature reviews and the search for a coherent list of the factors influencing car-sharing.

Keywords: car-sharing services; car-sharing systems; car-sharing functioning; car-sharing operation; shared mobility; mobility management; smart cities; sustainable development

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1. Introduction

Modern cities are developing at a very fast pace. Currently, 55% of the world's population lives in urban areas, and statistics indicate that this proportion is expected to increase to 68% by 2050 [1]. The phenomena of globalization and urbanization as well as the gradual shift of the population from rural areas are projected to add another 2.5 billion people to urban areas [2]. This type of increase will be particularly noticeable in cities with a population of less than 1 million [1], making the issue important both for small urban centers and for large agglomerations. The dynamic development of urban centers, apart from several advantages, is associated with many problems, including difficulties with one of the key factors of their economic development—transport and the elementary need of society, which is mobility [3]. Increasing the number of people staying in cities and at the same time meeting the related growing transport needs, regarding the fastest possible movement at any given time, is one of the challenges that urban transport managers face.

An attempt to reduce the phenomenon of increased traffic volume is also one of the aspects to be eliminated by the implementation of a sustainable transport development policy. According to its assumptions, modern transport should effectively meet the needs of society, be economically efficient, and at the same time have a positive impact on the environment, public health, economy, and urban planning [4]. Therefore, based on the guidelines of sustainable transport policy, the duties of cities include [5–8].

- striving to eliminate the negative impact of the automotive industry on the environment and society by limiting the emission of harmful substances, increased noise, and vibrations;
- increasing the accessibility of transport;
- introducing changes in the structure of urban travel to increase its effectiveness and efficiency;
- striving to improve the quality of life of residents;
- striving to improve the image of the city due to economic, investment, and tourism aspects.

The changing transport needs of society and the requirements for the implementation of a sustainable transport policy for urban transport systems have led to the need to look for various types of transport solutions that will be able to affect their efficiency. One of the trends in this area is the promotion of the idea of "new mobility", i.e., a concept that, compared to classical mobility (understood as the entirety of communication behaviors being undertaken to meet transport needs [9]), combines the idea of moving [10] with the use of modern technologies [11]. To meet the guidelines of this new mobility, smart cities should meet basic requirements, such as

- providing all citizens with mobility opportunities that give access to key travel destinations and services [12];
- improving the efficiency and cost-effectiveness of transporting people and goods [12];
- reducing air and noise pollution, energy consumption, and greenhouse gas emissions [13];
- improving security [13];
- increasing the attractiveness and quality of the urban environment for the benefit of residents, the economy, and the community [14].

Within new mobility, many different forms of transport are offered. These include, among others, all services that offer shared mobility services [15]. These services derive from the trend of the sharing/shared economy, according to which, through publicly available cooperation platforms (websites and mobile applications), it is possible to temporarily use goods or services provided by several different people [15]. Companies offering services in the digital matching economy, in addition to using online systems, also rely on three main assumptions, which include [16]

- ensuring the greatest possible time flexibility in terms of the availability of the full range of services for the user;
- having a rating system for users, aimed at increasing trust in the user's offer;
- relying primarily on rented, shared, or loaned resources.

The sharing economy was created due to the need to reduce consumerism while increasing the availability of certain goods or services [17]. Its main feature is to ensure access to goods or services without the need to own them [17]. Based on these assumptions, the concept is often referred to as "access beyond ownership" [18]. The sharing economy aims to combat excessive consumerism and eliminate social inequalities and economic barriers, while building social capital and creating satisfaction with the possibility of using a given good or service, without the need to purchase it [18]. The result of the sharing economy is an increase in market efficiency with a reduction in waste [18].

The first references to the sharing economy In the literature date back to 1978 [19]. However, this concept gained its greatest popularity in 2008, in connection with the prevailing economic crisis [20]. The concept was based on the provision of goods for free, but, by concerning all business models, it began to take a paid form [21]. Usually, sharing in the framework of the sharing economy means the possibility of using given services or goods for a short time [21].

Currently, due to the need to balance the functioning of various aspects of the business sector, the concept of the sharing economy is used concerning various types of activities. In the case of urban transport systems, the concept of the shared economy means the concept of shared mobility, which is understood as an opportunity [22]:

- renting passenger cars, bicycles, kick-scooters, or scooters made available by organized operators for users, at their disposal for a short period (colloquially referred to as "rental of vehicles for minutes");
- renting someone's car by making it available through dedicated Internet platforms, associating people who want to rent a vehicle for a short period with vehicle owners;
- taking advantage of trip sharing by using a mobile application that connects people who want to travel with available drivers;
- taking advantage of trip sharing by using a mobile application that connects a person wishing to travel with other people who are oriented to travel in the same direction and available drivers.

Among all the offered forms of shared mobility, car-sharing services are one of the most affordable in terms of convenience and autonomy [23]. Car-sharing services are systems that allow the rental of a car for a short period via a website or mobile application. Every year, car-sharing systems are gaining more and more popularity. Since car-sharing services are one of the synonyms of smart cities [24,25], it is particularly important to define both the problems and factors that are essential for their proper functioning in modern cities. The purpose of this work is to indicate the most important aspects related to car-sharing operation in light of the current research. The research methodology is a comprehensive review of the literature on issues related to the aspects affecting proper car-sharing functioning.

This article lists the main research areas related to the functioning of car-sharing, indicates the leading factors affecting the correct operation of the related systems, and discusses the historical approach to car-sharing services, the principles of service operation, and the elements that make up the related systems. It also focuses on the detail of the leading problems of such systems. This article is a support for practitioners dealing with the subject of car-sharing, such as operators or municipal management, and a compendium of knowledge for researchers and people interested in shared mobility services.

The article is divided into four sections. The first section presents the general background of the current state of transport, which led to the implementation of car-sharing services. The second section shows the research methodology. The third section refers to the main part of the article. It presents the issues of car-sharing functioning in light of the global research and contains a historical outline of the functioning of car-sharing, the current statistics of the systems in world markets, and the principle of the service operation types of such systems and their business models. In addition, it also refers to the main aspects affecting car-sharing functioning, by taking into account the problems encountered during the implementation and operation of such systems in cities. The last section is a summary of the work, which includes final remarks and some possible implementations.

2. Research Methodology

To be able to develop a knowledge base of the most important issues related to the functioning of car-sharing considering scientific research, it was decided to conduct a literature review. The tasks of the literature analysis were to determine the research query, indicate keywords, specify the database to which the search refers to, indicate whether literature reviews are filling the research gap of the query to which an article refers, specify what type of documents are in the database, and specify the criteria inclusions and exclusions, including detailed analysis, synthesis of documents, and an indication of results [26].

Among the various forms of literature reviews, the focus was on the methodology that considers the state of the art and the integration method [26], which considers the different views of researchers of short-term car rentals. The literature review was performed based on the methodology of Booth et al. and was composed of the following five steps [27]:

(1) determining the purpose of the literature review;
(2) fully searching for and retrieving the literature;
(3) extracting and evaluating the collected evidence;

(4) synthesizing and analyzing the results;
(5) sharing the results.

In the first step, the aim of the study was defined as a literature analysis on car-sharing and the identification of the existing literature gap, which this article intends to fill. The scope of the study was defined by a broad review of documents available on car-sharing in the publicly available scientific database Scopus. The Scopus database was chosen because it is a leading scientific database that is widely used for systematic literature reviews [28]. The Boolean functions were used to search for individual volumes in the database. Such functions provide the possibility of thorough logical analysis to ensure the sense and truthfulness of the statements searched for during literature reviews [29]. In the first stage, the term "car-sharing" was searched for in the titles, abstracts, and keywords contained in the Scopus database of documents. The focus was on works written in English. The author's own name was excluded from the search to avoid citing her research. The detailed search formula is as follows (1):

$$\boldsymbol{FS = D_{TIT\ ABS\ KEY} = (car - sharing) AND\ !E_{AN} = (TURO\acute{N}) = 1666\ documents} \quad (1)$$

where:

FS is the first search;
$\boldsymbol{D_{TIT\ ABS\ KEY}}$ is the documents including "car-sharing" in titles, abstracts, and keywords;
$\boldsymbol{E_{AN}}$ is exclusion of the name of the author of this article.

In total, 1666 results were obtained. These included scientific articles, literature reviews, and chapters in monographs. The obtained results were analyzed in detail. This number is so large because the word "car-sharing" is used in many different senses in various scientific disciplines. The results showed that car-sharing services are presented by researchers in a very multi-criteria manner, but no work that would constitute a compendium of knowledge about the most important issues affecting the functioning of car-sharing was found. Therefore, in the next step, a search was made for works that would focus on aspects related to the functioning and operation of car-sharing services as well as related aspects. The detailed search formula is as follows (2):

$$\begin{aligned} \boldsymbol{SS = D_{TIT\ ABS\ KEY}} &= \boldsymbol{(aspects)\ OR\ D_{TIT\ ABS\ KEY} = (functioning)\ OR\ D_{TIT\ ABS\ KEY}} \\ &= \boldsymbol{(operation)\ AND\ D_{TIT\ ABS\ KEY} = (car - sharing) AND\ !E_{AN} = (TURO\acute{N})} \\ &= \boldsymbol{198\ documents} \end{aligned} \quad (2)$$

where:

SS is the second search;
$\boldsymbol{D_{TIT\ ABS\ KEY}}$ is documents including "aspects", "functioning", "operation", and "car-sharing" in titles, abstracts, and keywords.

The second stage of the search allowed for obtaining 198 results. A detailed analysis of the obtained documents, however, indicated works that referred to car-sharing only superficially, e.g., as one of the keywords, and the research did not directly refer to this form of mobility. Therefore, in the next search, the scope was limited, as shown in Formula (3):

$$\begin{aligned} \boldsymbol{TS = D_{TIT\ ABS\ KEY}} &= \boldsymbol{(aspects)\ OR\ D_{TIT\ ABS\ KEY} = (functioning)\ OR\ D_{TIT\ ABS\ KEY}} \\ &= \boldsymbol{(operation)\ AND\ D_{TIT\ ABS}\ = (car - sharing) AND\ !E_{AN} = (TURO\acute{N})} \\ &= \boldsymbol{60\ documents} \end{aligned} \quad (3)$$

where:

TS is the third search.

Based on the final search, 60 documents were obtained, which covered aspects of the functioning and operability of car-sharing in light of the scientific research. A detailed analysis of the articles (synthesis) made it possible to identify seven main research areas related to the functioning of car-sharing, which include

(1) origin and history of services;
(2) analysis of the functioning of the services market and criteria affecting the development of systems;
(3) management of vehicle systems and location;
(4) issues related to the sustainable development of transport;
(5) IT systems;
(6) electromobility in car-sharing;
(7) service optimization and modeling.

The following chapter of this work refers in detail to the indicated research areas, indicating the main issues affecting the functioning of car-sharing. The works selected at the search stage served as the basis for further supplementing the literature with references to works that were cited in the indicated publications as a broader scope of the analyzed material.

3. Functioning of Car-Sharing—Main Issues in Light of the Scientific Research

3.1. Historical Outline of Car-Sharing and Current State

The popularity of car-sharing systems has increased in recent years. Although the implemented services may seem very modern, the first historical references to car-sharing date back to 1948 [30]. At that time, one of the housing cooperatives in Zurich, Switzerland, called "Sefage" (German: Selbstfahrergemeinschaft), offered its clients the option of the short-term rental of vans with van space for short periods during removals [30]. Subsequent initiatives gradually appeared as tests in European countries in the 1970s. Usually, however, these were short-term practices, initially based on making several vehicles available to users, which emerged as a test or due to the lack of sufficient funds to purchase a vehicle for ownership. At the end of the 1980s, more and more successful car-sharing initiatives began to appear in Europe—the literature indicated that about 200 car-sharing organizations [31] were operating in 450 European cities, e.g., in Germany, Austria, Switzerland, Italy, Great Britain, the Netherlands, Sweden, Norway, and Denmark [32]. A list of selected car-sharing systems operating in Europe through the end of the 1990s is presented in Table 1.

Table 1. List of selected car-sharing systems operating in Europe in 1948–1999.

Established Year	Country	City	System	Fleet Size	Reference
1948	Switzerland	Zurych	Sefage	N/A	[33]
1971	France	Montpellier	Procotip	35	[33]
1973	Netherlands	Amsterdam	Witkar	35	[33]
1977	Great Britain	Suffolk	Share-a-Car Service	N/A	[33]
1983	Sweden	Örebro	Vivalla Bil	5	[33]
1987	Switzerland	N/A	ATG Auto Teilet Genossenschaft	N/A	[33]
1987	Switzerland	N/A	ShareCom	N/A	[33]
1988	Germany	Berlin	StadtAuto Berlin	300	[33]
1993	Germany	Monachium, Frankfurt	Lufthansa Airlines car-sharing	N/A	[33]
1993	Switzerland	Zurych	CarShare—Swissair	N/A	[33]
1997	Switzerland	N/A	Mobility Carsharing Switzerland	1200	[33]
1997	France	N/A	Praxitele	N/A	[33]
1997	Germany	N/A	Volkswagen car-sharing	N/A	[33]
1999	France	La Rochelle	Liselec	50	[33]

N/A—specific data not available.

In the case of the American market, the first car-sharing systems appeared much later than their European competitors. The first practice was observed in 1983 [32]. Although the beginnings of car-sharing systems in North America began 35 years later than in the European market, the systems met with greater popularity [32]. A list of selected car-sharing systems that were in operation in North America until the late 1990s is shown in Table 2.

Table 2. List of selected car-sharing systems operating in North America in 1983–1999.

Established Year	Country	City	System	Fleet Size	Reference
1983	United States	West Lafayette	Mobility Enterprise	N/A	[33]
1983	United States	San Francisco	Short-Term Auto Rental (STAR)	N/A	[32]
1994	Canada	Quebec City	Auto-Com	34	[33]
1995	Canada	Montreal	CommunAuto	32	[31]
1997	Canada	British Columbia	Cooperative Auto Network (CAN)	14	[33]
1997	United States	San Francisco	City CarShare	8	[34]
1997	Canada	Victoria	Victoria Car-Share Co-Op	5	[33]
1997	United States	Rutledge	Dancing Rabbit Vehicle Cooperative (DRVC)	3	[32]
1998	Canada	Toronto	AutoShare–Car Sharing Network	8	[33]
1998	United States	Boulder	CarShare Cooperative	1	[34]
1998	United States	Portland	CarSharing Portland	11	[34]
1998	United States	Olympia	Olympia Car Coop	1	[32]
1999	United States	Corvallis	Motor Pool Co-O	N/A	[31]
1999	United States	Chicago	ShareCarGo!	12–14	[32]

From a historical point of view, car-sharing reached Asian countries last. Sources in the literature indicate that the first car-sharing initiatives appeared in Asian countries in the late 1990s [29]. A list of selected car-sharing companies in Asia is presented in Table 3.

Table 3. List of selected car-sharing systems operating in Asia in 1997–1999.

Established Year	Country	City	System	Fleet Size	Reference
1997	Singapore	Upper Bukit Timah	NTUC INCOME Car Cooperative	4	[34]
1998	Japan	Motegi	Intelligent Community Vehicle System (ICVS)	N/A	[34]
1999	Japan	Tokio	Crayon	35	[34]
1999	Japan	Tokio	Inagi EV-Car Sharing	50	[34]

The first car-sharing systems were often test projects that ended their operation after a few years. However, a significant and, above all, more sustainable development of car-sharing began in 2000, when players providing typical business services of short-term vehicle rentals appeared on the market. At that time, world leaders such as Zipcar and Flexcar in the United States and City Car Club (now Enterprise Car Club) in Great Britain began their operations [34].

3.2. Car-Sharing—Current State

In the following years, car-sharing became an increasingly popular idea. In 2008, in Europe, services began to be offered by operators that had previously provided classic car rental services, such as Hertz [35]. Among the players offering car-sharing services, well-known car manufacturers also appeared. For example, the Car2Go system established by the Daimler company [35] inaugurated its services.

In 2009, car-sharing service systems were available to users in 14 European countries [35]. In subsequent years, the development of car-sharing systems resulted in a significant increase in the interest in such systems in Asia and North America. The data on the development of one-way car-sharing systems presented in the report "Innovative Mobility Carsharing Outlook: Carsharing Market Overview, Analysis, and Trends, Winter 2016" show that in 2014 car-sharing systems operated in 33 countries around the world, covering approximately 4.8 million users and 104,000 available cars [36].

The decisive development of the car-sharing market is visible in the years 2014–2018 [37]. Despite the earlier domination of the popularity of the systems in the European market, the most intense increase in the number of registered users of car-sharing systems and the number of rented vehicles was recorded in the Asian market [37].

Currently, car-sharing is developing at a very fast pace, and services are no longer available only in large cities. Operators also offer their services in selected rural centers [38]. In addition, these services are offered not only by dedicated operators but also by peer-to-peer systems. Revenue in the car-sharing segment is projected to reach USD 13.55bn in 2023. In the car-sharing segment, the number of users is expected to amount to 62.1 m users by 2027 [39]. Despite the occurrence of the COVID-19 pandemic and the initial limitation of the functioning of car-sharing systems in 2020 through lockdowns or restrictions implemented by authorities around the world, car-sharing services have survived on the market [40]. In many cities around the world, car-sharing has become an alternative to public transport, which was often completely suspended due to the propagation of the virus [40]. What is more, car-sharing service providers have implemented many business practices to limit the spread of the virus, including activities related to the safety and security of users [41]. With proper business practices, the services market is constantly evolving, and user penetration is 0.7% in 2023 and is expected to hit 0.8% by 2027 [39]. Such results indicate how strongly car-sharing services have developed in relation to the first historical initiatives. Research shows that the intensive development of car-sharing was influenced by issues such as ecology, infrastructure, a proper system management, and technological development. From the point of view of ecology, the issues affecting the popularity of carsharing were mainly related to the introduction of various types of environmental fees for entering cities or specific urban zones [42] and parking fees [42] as well as electromobility development [42]. From the point of view of infrastructure, the issues were traffic volume [43], the development of infrastructure in the form of bus lanes (especially those that are available for car-sharing [44]), the number of parking spaces dedicated to electric vehicles or the number of P&R parking lots [45], the urban street network structure including privileges for car-sharing vehicles [46], and the quality and quantity of the public transportation [46]. From the point of view of management, the issues are, for example, the spatial and functional integration of car-sharing systems with other means of public transport [47], the financial benefits related to the use of car-sharing [44], and the diversity of the vehicle fleets used by car-sharing systems [48].

3.3. Car-Sharing—Principle of Operation, Management, and Business Models

As part of car-sharing services, vehicles are made available to individual users—usually, people aged 18 to 21—by operators within a given urban transport system. The use of vehicles is possible for a fee. A vehicle can be rented individually, via websites, and/or by using mobile applications. The vehicle rental process is automated and does not require contact with a customer service office, which, among other things, results in much lower costs for running this type of service compared to classic car rentals [49]. In addition, these systems are available to potential users 24/7 [49]. A detailed comparison of the classic car rental and car-sharing systems is presented in Table 4.

Table 4. Comparison of the classic car rental and car-sharing systems.

Feature	Car-Sharing	Classic Car Rental
Rental time	any	daily, monthly, yearly, etc.
Availability	around the clock	during working hours of the customer service office
Vehicle rental process	fully automated	requires contact, e.g., to collect vehicle keys
Differentiation of vehicles	small—usually one, a maximum of several models	large—usually a full range of vehicle classes
Parking comfort	separate dedicated parking spaces in city centers	dedicated places, usually near airports or stations and car rental customer service points

With the development of the market availability of car-sharing systems, the services have seen many business solutions. From the organizational point of view, there are three main types of car-sharing services [49]:

- organized car-sharing—services offered by organized enterprises acting as system operators;
- peer-to-peer car-sharing—car-sharing services offered via organized platforms where individual vehicle owners can share their vehicle with other users for a fee;
- own/neighborhood car-sharing—services offered by individual vehicle owners on their own, most often around their place of residence.

From the point of view of organized car-sharing, the first vehicles, following the example of classic car rentals, were available only to customers in specific places, e.g., special zones or car parks [50]. They also had to be returned to the same location [50]. This type of solution, however, involved the need to always reach one rental point and then reach the same point to return the vehicle—which was a major limitation for the user because it interfered with their freedom of movement.

Subsequently, with the development of technology and the increase in popularity, organized car-sharing systems began to be more and more available to customers. Currently, four main types can be distinguished. They are the main types of business models and include

- stationary/classic (round-trip car-sharing, round-trip station-based, and back-to-base car-sharing)—when the vehicle is rented and always returned to the same location, a dedicated parking space [49];
- zone car-sharing (round-trip home-zone-based)—when the vehicle is rented and returned to the specific operating zones of the operator of a given system in a city [49];
- one-way, station-based car-sharing—when the vehicle is rented at a point, e.g., point A, and returned at another point, e.g., point B, while being limited to rental points established by the system operator [50],
- free-floating car-sharing—when the vehicle is rented and returned anywhere in the city, within the entire area of the car-sharing system [51].

Currently, the most popular form of car-sharing is sharing vehicles in free-floating systems.

3.4. Operational Issues of Car-Sharing in Smart Cities

Based on the literature review and the indicated seven areas of research on the functioning of car-sharing systems, the leading factors that affect car-sharing systems in the world can be demonstrated. For example, Shaheen and Cohen, based on expert research, showed the main areas affecting the international development of car-sharing services, specifying economic, technical, legal, and transport criteria [37]. In addition, they also indicated the main motivations for users to use the services, which included the reduction in costs incurred for travel, convenient vehicle locations, and dedicated parking spaces [37]. Extensive research on the criteria that may affect car-sharing services was also undertaken by many other authors. In their works, they showed, among other aspects, that

- atmospheric factors and weather forecasts increase the demand for car-sharing services in a city by approx. 10% compared to all rentals (on rainy days or when the weather conditions suddenly change to unfavorable, there is an increase in interest in car-sharing services) [52];
- vehicles from round-trip car-sharing systems are usually used for short trips or entertainment and occasionally for shopping and trips [53];
- users of free-floating systems are mainly young people and childless [54];
- free-floating users are more willing to resign from traveling by own car, due to the high availability of vehicles, compared to users using other forms of car-sharing or public transport [52];
- usually, users of car-sharing systems are people with secondary or higher education and above-average earnings, who come from small families [9];

- the most convenient distance at which the vehicle should be from the person wishing to rent it is between 400 and 500 m, and ideally this distance does not exceed 1 km [52];
- the day with the lowest number of uses is Monday [52];
- modernization of the vehicle fleet by operators has a positive effect on increasing the use of system services [44];
- car-sharing services are mostly used by men [55];
- services are more popular in densely built-up areas as well as among people who use public transport daily [55];
- electric vehicles are chosen by users for distances up to 24 km [56];
- travel in electric vehicles is concentrated mainly around city centers, while travel in vehicles with hybrid engines is more dispersed throughout a city [56];
- station-based car-sharing services are the most frequently used form when traveling "one-way" to the airport, to the areas around train stations, or to work [57];
- car-sharing services fill the gap in places with a reduced availability of public transport [57];
- when implementing car-sharing services, public–private partnerships, the development of local systems development policies, and the provision of packages of joint services, e.g., discounts for people using public transport, are particularly important, which may increase the popularity of such systems [47].

International research grants were also devoted to car-sharing services. These include, for example, the MOMO car-sharing project (More Options for Energy Efficient Mobility through Car-Sharing) implemented in 2008–2011 [58]. The project aimed to increase awareness of the use of car-sharing services. As a result of the project, the key barriers that may be faced by people wishing to implement services in cities and success factors were demonstrated [59,60]—these were referred to when constructing a list of criteria affecting the popularity of car-sharing, such as infrastructure, ecology, and management issues. In addition, the project also proposed guidelines for creating business plans for potential car-sharing operators. However, the specific costs that may be incurred by the operators were not indicated, and the solutions proposed in the guidelines are not in line with current market trends (due to the significant development of new technologies since 2011) [61]. The latest project implemented under the HORIZON2020 Program is the STARS project (Shared mobility opporTunities And challenges foR European cities) implemented in 2017–2020. As part of the project, the business models of the car-sharing services provided in Europe were analyzed [61]. The project aimed to develop recommendations for cities for the implementation of cost-effective service systems [61]. The main recommendations included aspects such as [62]

- needing to adapt the type of system to the requirements of a given area;
- creating local policies for the development of shared mobility services;
- investing in municipal MaaS systems or needing to develop local parking policies.

In the literature, there were also many studies on the proper management of car-sharing systems. Most of these works were focused on fleet management and their appropriate location as well as parking issues. For example, Millard-Ball et al. stated that every car-sharing vehicle replaces 14.9 private cars [63]. In turn, Shaheen, Sperling, and Wagner noted that most cars carry one person and are used for less than 1 h a day [64]. Another area of research on car-sharing services is the issue of sustainable development and the impact of such services on society, the economy, and the environment. In other studies, attempts were made to assess the impact of car-sharing on the behavior and mobility habits of users [57,65]. At that time, it was noticed that groups using vehicles of users should be appropriately organized [65] and the quality of services should be improved by reducing the need to carry out formalities during the rental process and striving to automate services through the appropriate use of the opportunities offered by IT systems [57,65].

From the point of view of modeling transport systems, car-sharing services were also subjected to analysis using multi-criteria decision support. For example, in [66], the

authors used the AHP method and derived data from the geographic information system (GIS) that was received from the system operator to identify potential future base stations of a car-sharing system operating in Shanghai. The authors relied on four main criteria, which included [66] potential users, demand for trips, destinations, and distance. This was based on 15 proposed evaluation indicators. The result of the investigation was to determine the type of station along with the number of parking spaces, between three and five, depending on the location in the city. In another work, based on the AHP method, the authors determined the profitability of the creation and maintenance of car-sharing stations in two districts in Shanghai [67]. The obtained results allowed to determine what actions the EVCARD operator should focus on to ensure the most efficient functioning of their system. Similar research, also based on the AHP method, was conducted in the French city of La Rochelle [68]. Apart from the indicated examples, no research studies were identified that would refer to the use of other types of multi-criteria decision support methods at the planning and implementing stages of car-sharing services. In addition, it was pointed out that most of the research on the location of charging stations or the appropriate relocation of vehicles is related to the optimization of car-sharing systems already existing on the market, rather than on any aspects of their implementation. It was also noted that the works relating to the modeling of systems are mainly based on the performance of simulations for the various types of data received from operators or traffic measurements. These data are mostly simulated, as they are computerized. Pagany, Camargo, and Dorne emphasized in their work [69] that case studies must be preceded by research that characterizes the detailed data or behavior patterns for a specific area.

4. Final Remarks

Car-sharing services are one of the alternative forms of mobility. Considering current trends, system development forecasts, and efforts to limit individual motorization in cities, car-sharing services may become a leading form of transport in cities. Particularly friendly to the development of car-sharing systems may be smart cities, which, thanks to the use of information and communication technologies to ensure the best possible interactivity and efficiency of urban infrastructure and its components, can offer residents properly functioning and accessible systems, while reducing many transport problems, for example, the social exclusion of transportation [70].

The conducted literature review showed that car-sharing systems have developed significantly in recent years. The leading factors of their development were the entertainment, infrastructure, and management aspects as well as the development of new technologies. However, for the systems to function better, it is important to take into account the many often-conflicting factors.

Therefore, for car-sharing operators or city authorities who want to implement or improve their car-sharing systems, it is recommended to pay attention to

- ensuring adequate (increased) availability of the fleet in bad weather conditions;
- properly considering the type of system that should be used around a given city, by considering the conflicting preferences for the use of round-trip versus free-floating car-sharing;
- applying an appropriate tariff of charges (by minute or kilometer);
- planning appropriate car-sharing zones that will make it possible to deploy one car-sharing vehicle per 1 square km of the zone's operating area, which will ensure high demand for services;
- introducing special benefits for using services on Mondays, e.g., additional credits for travel or the possibility of using a higher-class vehicle;
- making an appropriate selection of the vehicle fleet for the needs of the local community, by considering the availability of the infrastructure for electromobility;
- introducing special programs to promote the use of car-sharing by women to increase their interest in these services;
- striving to integrate car-sharing with public transport;

- providing special car-sharing zones near train stations, airports, and main communication points.

The fulfillment of the above criteria has a chance to translate into a better adaptation of car-sharing services for the needs of users and urban areas, which may have a positive impact on the development of the relevant systems and elimination of one of the problems of common mobility, i.e., the use of individual cars by drivers.

The conducted literature analysis showed that in terms of the functioning of car-sharing, researchers currently focus mainly on seven research areas, which include the origin of services, the analysis of the functioning of the services market and criteria affecting the development of the relevant systems, the management of vehicle systems and location, issues related to the sustainable development of transport, IT systems, electromobility in car-sharing, and service optimization and modeling. This is an important clue for researchers looking for new research gaps in the field of car-sharing.

In summary, through the analysis of the literature, the aim of the work was achieved in the form of indicating the most important aspects related to car-sharing in light of the current research. This work is a compilation of the existing knowledge about car-sharing and is a support for practitioners dealing with the subject of car-sharing, such as operators or municipal management, and a compendium of knowledge for researchers and people interested in shared mobility services.

The main research limitation of this work is the thematic limitation to only one database containing scientific works. In subsequent works, the author plans to carry out a literature review based on a larger number of databases and to compare the results.

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