Public Transport Systems and its Impact on Sustainable Smart Cities: A Systematic Review

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Abstract This article presents a systematic literature review that includes research papers published since 2015–2019, and addresses topics in the areas of on Public Transport Systems, Sustainability and Smart Cities. From 42 articles, 20 were documents that met the inclusion criteria and represented a diverse sample. This article also mapped 171 smart cities from 5 continents, where the transport system is most relevant. Although the results show a similar trend in terms of the close relationship between sustainability and public transport systems in terms of Information and Communication Technologies (ICT), it differs from one country to another in terms of the implementation indicators, policies and user behaviors. In light of the above, this research offers a contemporary view of the activities carried out under the theme and creates the basis for future action plans.

Keywords Public transport systems · Smart cities · Sustainability · Information and communication technologies · Urban mobility

1 Introduction

The concept of Smart City (SC) integrates the presence, application and use of ICTs as a complex system that allow citizens, business, transports, communication networks, services and utilities being interconnected to each other's. The mentioned situation allows efficiency in operations that improve the quality of life in public

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spaces, particularly with regard to urban mobility [1, 2]. This phenomenon is also facing challenges, mainly due to the population growth and climate changes. Thus, in recent years, governmental initiatives have focused on policies and programs to implement strategies and actions aimed to create sustainable urban environments, monitoring environmental impacts, economic growth and social inclusion [3].

Access to urban services are rapidly changing, as cycles of technological innovation are shorter, particularly regarding to the digitization and online communication systems that are advancing at a fast pace. Connectivity and big data have also allowed for a better evaluation of services and consequently an improvement in quality [4, 5].

In light of the above, this research lies down on a systematic literature review, which focuses on the challenges that urban mobility faces, specifically with regard to the public transport service. The previous option is justified by the relevance that this theme has for the citizens' lifestyle, especially those residing in SC [6, 7].

In the literature, the aspects related to public transport systems have been widely discussed; mainly from the point of view of the development of urban transport, with the sustainable panorama still being considered to a lesser extent [8]. As projects that involve both, urban transport and sustainability, are becoming more relevant, due to the pressure for better planning, greater sustainability and governance in transport, new approaches are also emerging. Therefore, this research, emphasizes those approaches that are integrating strategies developed by local authorities, which allow the development of more sustainable transportation alternatives. These alternatives tended to result in efficiency and system reliability, passenger comfort and the implementation of sustainability and safety policies [9].

Overall, this research tries to shed some light on the public transport systems by standing on the shoulders of those that have significantly contributed to the literature in this past 5 years. Additionally, our objective is to explain the development of the public transport system and its close connection with sustainability in SC. In particular on the development of innovative business models and the use of digital technologies that directly contributed to the economic growth, the protection of the environment and the health and safety of citizens.

The first section presents an overview of the 20 articles selected as well as data from 171 cities around the world addressed in the papers; following, we focus on the methodological process, which emphasized the inclusion and exclusion criteria; then, the results highlighted the review process and findings discussion; finally, the last section presented the conclusions and recommendations for future research.

2 An Overview

A great extent of mobility in urban areas is supported by public transport systems. However, in several cities the services offered by public transport still hold important inefficiencies as well as issues related with safety. Many systems are characterized with delays, long waiting times, embarkation and disembarkation procedures, etc. [10]. Therefore, major challenges remain to be addressed concerning the optimization of mobility through the implementation of efficient and effective urban transport services [6, 11].

According to Vanolo [12], transport systems represent a crucial factor in the structures of SC, by directly impacting in terms of sustainability, as a result of the use of ICTs and the access to citizen's data for offering emerging technologies and better services [3, 13]. This exchange of information will influence the relationship between transport companies and their stakeholders. Customer-centric services will be based on data from individual users and their needs, and this will allow, for example, real-time traffic management, increase in the frequency of public transport under specific timetable demands or during special events [6, 14].

Transport systems in urban areas involve environmental, social, economic and cultural concerns [8, 15]. Air pollution, traffic congestion, noise pollution, and loss of time in transfers, are some of the factors that affect the quality of life in cities, which, in addition to the impact on population health, also contribute to lost productivity and economic efficiency [16, 17]. For the European Commission [18], the economy of this continent loses about 100 billion euros annually due to traffic congestion as a source of pollution, accidents, productivity and efficiency in companies.

In environmental terms, the increase in population and access to improved purchasing power that allows the use of private cars as an essential element [19] has caused serious traffic problems, especially in large cities, which consequently increases pollution levels [6]. Staricco [20] estimates based on 27 European Union countries that 25% of greenhouse gases (GHG) emissions and more than 30% of the total energy consumed were due to the transport sector. When considering that more than 90% of the previous results come from non-renewable sources [15], several proposals for solutions have been considered in order to somehow reverse the negative impact that the use of private vehicles brings, such as the increase in the use of urban public services; bike path networks; shared transport services; etc. [21–23].

Although advanced economy countries are investing in the development of projects of public transport systems that focus on reducing environmental impacts, Roda et al. [15] mentions that the problem of emissions from vehicles with internal combustion engines is still relevant and caused mainly by the lack of capacity in public transport guaranteeing quality and comfort services, therefore stimulating the use of individual means of transport.

3 Research Methodology

This research draws on a systematic literature review (SLR). The SLR carried out in January 2020 focused on documents retrieved from the following electronic databases: SCOPUS and Web of Science (WoS). The documents ranged from 2015 to 2019, and the keywords used were: Sustainability, Smart Cities, Public Transport or Public Transportation, as shown in Table 1.

In the first phase 42 articles were identified, 24 from Scopus database and 18 from the Web of Science. The higher percentage of published articles ranged from 2017 to

Table 1 Literature review process

Keywords	"Smart cities" AND "sustainability" AND "public transport"
	"Smart cities" AND "sustainability" AND "public transportation"
Fields	Article title, Abstract, Keywords
Language	English
Source type	Journals and conferences
Document type	Articles and conference paper
Years	2015–2019

Table 2 Source and year of publication of articles identified

Year	"smart cities" AND "sustainability" AND "public transport"		"smart cities" AND "sustainability" AND "public transportation"		TOTAL
	SCOPUS	WoS	SCOPUS	WoS	
2015	2	0	1	1	4
2016	0	3	1	2	6
2017	3	2	4	3	12
2018	3	2	1	3	9
2019	5	2	4	0	11
TOTAL	13	9	11	9	42

2019, indicating that manuscripts based on the selected keywords are gaining greater interest in the scientific community. Table 2 shows the distribution list.

From the 42 papers identified in the first filtering criteria, 12 were duplicated, one was published in two different journals and, one document could not be accessed. From the remaining 28 articles, eight papers were partially related to the keywords, by using one or more of them only in the name of the Journal or Conference where they were published or in the name of participating institutions without any significant involvement in the investigation. Thus, 20 papers were selected, of which 6 correspond to articles published in conferences and 14 published in journals. Moreover, 43% of the journals are in Quartile 1 of the SCimargo Journal Rank (SJR). The SJR was considered ahead of Clarivate Analytics from Web of Science to calculate the reliability score since it is an open access search engine [24].

Figure 1 illustrates the process in a schematic way based on the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) technique, a transparent process based on the evaluation of random documents focused on reducing the margins of error in the selection of publications during systematic reviews [25]. To increase the validity and reliability of the paper, the activities corresponding to each of the stages that set up the PRISMA technique were distributed among the authors. After the second author has collected and analyzed the data according to the content analysis technique, the first author reviewed the entire

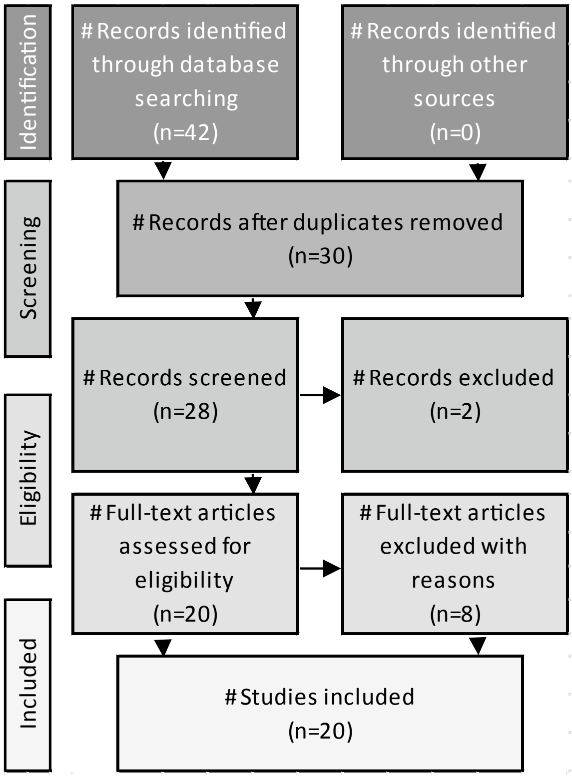

Fig. 1 Filtering process based on the PRISMA model

methodological process, the three authors were subsequently involved in the review process, in particular regarding with methodology. Once the process was finished, the triangulation of perspective was initiated in order to evaluate and interpret the data obtained in the 20 articles selected. Several aspects were discussed that would allow the categorization of the specific actions identified in the work, and, in case of disagreement, it was necessary to analyze the evidence more deeply and try to bring about the discrepancy as recommended by Stake [26].

4 Results and Discussion

4.1 Geographical Location

The information and geographical distribution on a global scale, representing the 171 cities retrieved from the reading of the selected articles are shown in Fig. 2. Based on this, it is possible to identify, in the first place, the localities that in the last 5 years have been investing in the areas of sustainability and public transport. The three most

Fig. 2 Geographic distribution of SC considered in the literature review

relevant regions in this type of initiatives are Europe, Australia and North America; nevertheless, the European Union effort is remarkable, mainly Italy and Spain that add up to 75% of the 89 cities belonging to that continent. In the case of Australia, 27 cities were mentioned in 3 of the selected articles and in North America, 67% of the 21 cities mentioned in 4 articles belong to the United States, and 7 cities to Canada.

On the other hand, the regions of Asia, Latin America and Africa included a smaller number of SC compared to the rest of the world. In Asia, the most representative countries regarding the application of sustainable policies in the public transport service in SC are China and India with four cities each. Latin America and Africa is represented in most cases only by capital cities, with the exception of two countries in Latin America and two in Africa that consider alternative cities: León and Guadalajara in Mexico, São Paulo and Rio de Janeiro in Brazil, Johannesburg in South Africa and Minna in Nigeria. Figure 3 presents the information on the 171 cities included in the 20 studies analyzed.

4.2 Specific Actions

The analysis of the selected papers aimed at identifying projects and practices concerning public transport systems in the context of SC. To this end, the papers were read in full and each project addressed in the text was attributed a classification. The coding process was iterative, and the classifications attributed were revised and refined throughout the process. The projects and cases concerning public transport systems were assigned to the proposed classification groups according to its characteristics and the degree of similarity with other projects in each group. A total of 7 distinct categories were identified and characterized with the purpose of highlighting the relationship between public transport systems and their impact on the sustainability of SC.

Transport Policies. With the application of policies in SC, it is increasingly common to notice changes in the social behavior of citizens regarding the sustainable use of resources [9]. The implementation of transport policies is associated to the strategy

AUSTRALIA	USA - Atlanta	ESP - Castellón Plana	GBR - London	NLD - Amsterdam
AUS - Adelaide	USA - Austin	ESP - Ciudad Real	GBR - Milton keynes	NLD - Rotterdam
AUS - Boroondara	USA - Boston	ESP - Córdoba	ITA - Ancona	POL - Warsaw
AUS - Cambridge	USA - Denver	ESP - Getafe	ITA - Bari	PRT - Porto
AUS - Chittering	USA - Fort Worth	ESP - Gijón	ITA - Bologna	SWE - Stockholm
AUS - Dumbleyung	USA - Los Angeles	ESP - Huelva	ITA - Bolzano	SWE - Västerås
AUS - Gingin	USA - Miami	ESP - Huesca	ITA - Brescia	TUR - Istanbul
AUS - Gr. Melbourne	USA - Minneapolis	ESP - Jaén	ITA - Cagliari	**ASIA**
AUS - Hornsby	USA - Nebraska	ESP - Logroño	ITA - Campobasso	ARE - Dubai
AUS - Joondalup	USA - New York	ESP - Lugo	ITA - Catania	CHN - Beijing
AUS - Kent	USA - Portland	ESP - Madrid	ITA - Catanzaro	CHN - Hong Kong
AUS - Ku-ring-gai	USA - San Diego	ESP - Majadahonda	ITA - Firenze	CHN - Shanghai
AUS - Lane Cove	USA - San Francisco	ESP - Málaga	ITA - Florence	CHN - Shenzhen
AUS - Lower Eyre P.	USA - Washington DC	ESP - Móstoles	ITA - Frosinone	IDN - Semarang
AUS - Mallala	**LATIN AMERICA**	ESP - Motril	ITA - Genova	IND - Almaty
AUS - Manningham	ARG - Buenos Aires	ESP - Murcia	ITA - Lecce	IND - Delhi
AUS - Melbourne	BRA - Rio de Janeiro	ESP - Oviedo	ITA - Messina	IND - Kampala
AUS - Mosman	BRA - Sao Paulo	ESP - P. de Mallorca	ITA - Milan	IND - Mumbai
AUS - Narrogin	CHL - Santiago	ESP - Paterna	ITA - Napoli	JPN - Tokyo
AUS - Nedlands	COL - Bogota	ESP - R. Vaciamadrid	ITA - Palermo	KOR - Seoul
AUS - Nillumbik	ECU - Quito	ESP - Salamanca	ITA - Piacenza	MYS - Kajang
AUS - Peppermint Gr.	MEX - Guadalajara	ESP - S. C. Laguna	ITA - Potenza	MYS - Singapore
AUS - Pittwater	MEX - Leon	ESP - St C. del Vallés	ITA - R. Calabria	PHL - Makati
AUS - Sydney	MEX - Mexico City	ESP - Santander	ITA - Rimini	RUS - Moscow
AUS - Wandering	PER - Lima	ESP - S. de Compostela	ITA - Rome	RUS - St Petersburg
AUS - Wickepin	**EUROPE**	ESP - Segovia	ITA - Salerno	SAL - Makkah
AUS - Willoughby	AUT - Vienna	ESP - Sevilla	ITA - Silver Coast	TWN - Taipei
AUS - Woodanilling	CHE - Zurich	ESP - Tarragona	ITA - Teramo	VNM - Haiphong
NORTH AMERICA	DEU - Berlin	ESP - Toledo	ITA - Terni	**AFRICA**
CAN - Montreal	DEU - Frankfurt	ESP - Valencia	ITA - Torino	KEN - Nairobi
CAN - Saint-Augustin	DEU - Munich	ESP - Valladolid	ITA - Treviso	ZAF - Johannesburg
CAN - Shawinigan	DEU - Solingen	ESP - Vitoria-Gasteiz	ITA - Turin	JOR - Amman
CAN - Surrey	DNK - Copenhagen	ESP - Zaragoza	ITA - Udine	NGA - Minna
CAN - Toronto	ESP - Alcobendas	FIN - Helsinki	IRL - Dublin	
CAN - Vancouver	ESP - Alicante	FRA - Paris	LUX - Luxembourg	
CAN - Vaughan	ESP - Barcelona	GBR - Edinburgh	LVA - Riga	

Fig. 3 Smart cities considered in the systematic review

in the management of sustainable conditions that integrate ICT in the infrastructure of the city, creating viable solutions regarding the mobility of citizens through public services [27, 28].

In recent years, government entities belonging to the European Union have prioritized the implementation of sustainable transport policies through encouraging the use of low-emission vehicles, active travel (cyclists and pedestrians), public transport and/or shared mobility; establishing a cost-benefit balance and contributing significantly to the reduction of pollution levels based on initiatives, such as using smaller vehicles or the adequacy of the offer according to the demand in rotating schedules [5, 6, 29].

The application of transport policies requires an adequate, flexible and compatible infrastructure with the challenges that the emerging SC demand. Thus, the public transport must be accessible, efficient, safe, comfortable and ecologically viable. But, at the same time, it must maintain adequate levels of service quality and be accessible to all economic sectors of the society [27, 30].

It is clear that urban mobility is largely influenced by public and private policies [29]; therefore, both sectors must work in synergy to integrate technological tools as part of smart services between conventional and intelligent transport systems. For instance, Bus Rapid Transit (BRT) and ridesharing schemes, where passengers are matched to spare seats in private car journeys [29, 31]. The latter is a controversial alternative, because it is considered an unfair competitor because it directly affects individual public transport services (taxis). For that reason, in several regions, legal efforts have been made to try to ban the existence of services such as UBER, Cabify, etc. [29].

This integration is defined by Roda et al. [15] from a technological and sustainable point of view, considering three types of infrastructure: (1) an intermodal system of sustainable mobility, (2) an energy infrastructure based on renewal sources for vehicle fleets and, (3) an ICT structure based on Internet of Things (IoT), Open Data, sensors, information security management and Geographic Information Systems (GIS).

Planned Communities. The close link between citizens and technology define the concept of SC development, since emerging technologies need to integrate and respond to the needs and habits of citizens in order to effectively improve urban sustainability [3]. The planning or regeneration of urban centers that incorporate ICT is committed to creating attractive environments based on sustainable development [32]. As a result, cities around the world rely on action plans to assess specific conditions for the proper use of their resources in sustainable terms.

In Italy, the ITACA Protocol is mainly used to support specific policies to promote sustainable construction [33], and places the accessibility of public transport as one of the main criteria in terms of the quality of the location for the design and development of urban enterprises sustainable [32]. Likewise, the ELAN project applied in cities in Slovenia, Belgium, Croatia, Czech Republic and Portugal, aims to improve the perception of cities and the quality of life by changing the behavior of mobility while the shared use of cars and improving the public transport service infrastructure through real-time data transmission [11, 28]. On the other hand, some cities in Spain rely on the Sustainable Urban Mobility Plans (SUMP), which provides multiple views of sustainable mobility when evaluated by various criteria that aim to improve the general infrastructure and service of a given location [17].

Behaviors. The applicability of ICT in public services has developed behavioral changes in citizens of SC [34]. According to Sunstein [35], some cities provide a set of personalized and persuasive interventions, in order to encourage individuals to choose public transport over their private vehicles. For example, in Durham, North Carolina, citizens were provided with personalized route maps and their options for commuting between home and work in various types of vehicles, considering that less availability of public transport is associated with greater concentration of private vehicles [3]. In Enschede, the Netherlands, an application was developed that encourages people to take different routes, in order to avoid using private vehicles and prefer the use of public transport, cycling or walking [34]. Variations between the use of public and private transport were also linked to the capacity of data transmission over broadband. Yigitcanlar and Kamruzzaman [36] research highlights the negative relationship between Internet access, sustainable travel patterns and remote work, resulting from the decrease in the use of public transport and the considerable increase in the use of private transport, possibly the cause of the fragmentation of work activities.

Another model of behavior identified in SC while using public transport is the connection of citizens with their cities, although the research by Belanche et al. [23] indicates that being connected to a city is not enough to generate a certain behavior, this emotional bond can come to positively influence the affective-evaluative perceptions of urban services, such as the use of public transport. On the other hand, Vierling and Schmuelling [29] presents a different point of view to that of users and focuses on changing the behavior of drivers when facing new technologies incorporated into more recent bus models. The BOB project applied to the city of Solingen in Germany, aims to develop an information system based on a training program that allows drivers to read the vehicle parameters effectively and adapt to the new demands required to offer quality services.

Transport Sharing. The advancements of urban mobility faithfully follow the emergence and application of ICT to urban centers, placing them in appropriate positions to promote changes that suit citizens' needs. However, current mobility systems, especially public transport services, still remain unsustainable [6]. In recent years, several research works have emerged regarding the variety of innovative and sustainable business models that allow individuals to share their mobility using technology. According with Roda et al. [15] these initiatives could contribute to the re-planning of public transport systems and, in the long term, contribute to the reduction of the motorization rate, which, in addition to the environmental advantages, these measures would allow citizens to benefit from the reduction of space occupied by private vehicles and the economic advantages when preferring the use of alternative mobility systems.

In particular, bicycle sharing systems (BSS) are attributed several advantages in the urban context. Firstly, it promotes the reduction of emissions by largely replacing any other type of motorized transport, including public transport [37], likewise, the use of these systems promotes the health benefits of citizens while the number of calories burned with each use [38]. On the other hand, car sharing services are gaining more space in urban mobility in SC. For Pinna et al. [5], the recent and rapid evolution of this service in recent years is due to the inclusion of the service through fleets of electric cars. Although it is considered as a complementary option and not as an alternative, the personalized service compared to traditional public transport plays an important factor in choosing as a means of transport.

Integrated Services. These services offer great benefits for the environment, directly impacting the CO_2 reduction of large cities. Intermodality is recognized as an integral part of improvements in public transport [17], not only focused on the means of transportation themselves, but on the infrastructure that offers a comprehensive transport service, therefore, pedestrian paths, mobility platforms, columns of mobility. recharging for electric vehicles, bike lanes and e-buses, are considered as part of this sector [15].

Indicators. In the same way that several protocols have been applied for the management of public transport services, the use of evaluation indicators is frequently being used for the management of SC. Table 3 summarizes the indicators used by several

Table 3 Indicators found in the literature review

Authors	Indicators
Abdullahi et al. [39]	Promoting public transportation facilities.
	Increase population density especially around public transportation nodes
Mozos-Blanco et al. [17]	Public transport
	Cycling
	Intermodality
	Accessibility
	Air and noise pollution
	Public participation
	Indicators
Pinna et al. [5]	Public transport
	Cycle lanes
	Bike sharing
	Car sharing
Sharma and Agrawal [7]	Km of high capacity public transport system per 100,000 Population (h)
	Km of light passenger transport system per 100,000 population (l)
	Annual number of public transport trips per capita (p)
	Percentage of commuters using a travel mode to work other than a personal vehicle
	Km of bicycle paths and lanes per 100,000 population (b)
	Greenhouse Gas (GHG) Emissions in tonnes per capita
	Noise Pollution
Shmelev and Schmeleva [40]	Number of underground stations per million inhabitants
	CO_2 emissions per person per year (tonnes)
	Citizens walking, cycling or taking public transport to work (%)
Vassileva et al. [41]	Transport performance in public transport
	Energy demand in public transport
	CO_2 emissions in public transport
	Cost of a monthly ticket for transport
Wu et al. [42]	Provide a variety of transportation choices

authors and which only correspond directly to those concerning urban mobility, specifically to public transport systems.

The indicators above are the result of several analysis and case studies applied to different cities around the world. Abdullahi et al. [39] presents a series of indicators resulting from the application of geographic information systems and radar remote sensing technology and synthetic aperture radar (SAR) data that analyzes the urban sustainability of the city of Kajang in Malaysia, these indicators are defined in three categories: density, mixed and intensity; the latter considered as the main parameter to determine the degree of compaction of an urban area making it more sustainable, and this category includes the two specific indicators referring to public transport services, mentioned by the author. On the other hand, the 7 indicators mentioned by Mozos-Blanco [17] are part of the Sustainable Urban Mobolity Plans (SUMP) mentioned in the "planned communities" section, indicators selected from a total of 15 and used in the evaluation of the general mobility plan applied to 38 cities in Spain.

In the case of Italy, 22 cities were selected to be evaluated using the indicators presented by Pinna [5] who, in addition to the general criteria shown in Table 3, collected data on the density of the bus network per square kilometer; the demand for public transport for passengers per year; the density of cycle paths for every 100 km^2 and for every ten thousand inhabitants; and, the density of bicycle stations by the number of stations per 100 km^2 and per ten thousand inhabitants. Sharma and Agrawal [7] use a convenience sample of 30 SC in order to assess transport and environmental pollution parameters from public data. Shmelev and Schmeleva [40] are based on the results obtained through a multiple criteria approach using 20 indicators applied to 57 cities, of which three referred directly to public transport services. Vassielela [41] focuses on Sweden with the application of 4 indicators in public transport that considers the impact of enabling technology on energy efficiency indicators; finally, Wu et al. [42] considers the city of Zurich in Switzerland to apply one of the ten indicators that assesses the smart growth of the city and that is related to the public transport services of this location.

Data. The data transfer is one of the essential elements in SC. The public transport systems of these urban centers are opportunely considering the opinion of users when planning and creating technological tools that contribute to improving services through the analysis and exchange of information regarding traffic reports, transportation schedules, travel preferences and online ticket purchase platforms [43]. These initiatives allow users to understand the selection of a particular type of transport, as long as access to data related to habits and preferences, as well as specific objectives and needs is allowed. On the other hand, the citizens´ feedback on improving services are essential for the development of an efficient and sustainable city [6].

Currently, the use of social networks has facilitated the sharing of information between users and public transport providers, which allows a more effective interaction and allows taking advantage of collaborative data technologies such as crowdsourcing [44]. In the University of Nebraska Omaha (UNO) for example, pressure from the student community contributed to the creation of a public and sustainable mobility plan within the campus through algorithms that models and identifies potential areas for optimizing traffic routes, relieves tension of the user and reduces the carbon footprint by reducing CO_2 emissions by avoiding the use of private cars within campuses [45].

5 Conclusions

This paper gathers relevant insights from the literature on public transport systems and its sustainable impact in 171 cities around the world. This paper evidences that the research developed in the last five years has focused on ICT applications in urban mobility services and its influence on the quality of life of people living in SC.

The improvement of transport systems in those locations has basically depended on seven applications: transport policies; planned communities; evaluation of citizens behavior regarding to the use of public transport systems; transport sharing and integrated mobility; transport indicators and the analysis of data collected through ICT. The results also focused on the application of indicators, which showed a comprehensive approach by involving sectors not only related to public transport but also various factors that interfere with the environmental impact of SC. Those indicators are such as the development of public policies, territorial planning and the increase in citizens' awareness of environmental issues [7, 17].

This research is based on a systematic review of the literature considering documents published in two of the main databases; therefore, only secondary data were used. Since this paper addresses a relatively recent theme, the object of study was limited to an exploratory methodology through the identification of areas of investigation and application of several projects, for this reason, there was no calculation of publications bias.

Nonetheless, the results suggest that the relationship between the increase in terms of public transport usage and the decrease in the use of private cars was considered as one of the most significant results with significant environmental impact in SC. However, little is known about the advantages of specific type of public transport, such as railway infrastructure or fleets of electric buses. Therefore, it is intended that future research will emphasize even more specific links with regard to environmental variations and sustainable impacts when using electric public transports in cities that significantly involve the use of ICT in their operations.

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