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Bibliometric Analysis of Sustainable Public Transport Indicators: Trends of Global Research from 2000-2024

Ala Zuhier Keblawi[1,2], Mohd Rosli Mohd Hasan[3*], Khaled Ahmad Al-Sahili[4], Ahmad Farhan Mohd Sadullah[5], Samer Saeed Abdulhussein[6]

[1, 3] School of Civil Engineering, Universiti Sains Malaysia (Engineering Campus), 14300 Nibong Tebal, Penang, Malaysia
[2] Faculty of Engineering and Technology, Palestine Technical University (PTUK)- Kadoorie, Tulkarm, Palestine
[4] Civil and Architectural Engineering Department, An-Najah National University, Nablus P4110257, Palestine
[5] Vice Chancellor, Universiti Putra Malaysia, 43400 Serdang, Selangor Darul Ehsan, Malaysia
[6] Civil Engineering Department, College of Engineering, Mustansiriyah University, Baghdad 10071, Iraq

[*]E-mail: cerosli@usm.my

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Abstract

This article offers a bibliographic review of studies undertaken concerning sustainable public transport and the importance of sustainability indicators to the growth of the transport field. The study used a total of 430 Scopus-indexed articles published between the years 2000 and 2024 using the phrases "sustainable," "public transport," and "indicators." These articles were reviewed using the software packages VOSviewer and Biblioshiny. The article explores the contribution of the indicators towards the analysis and implementation of sustainable transport systems, and their added value and limitations. The findings of the article indicate that the leading country concerning the publication of articles is China, and the leading journal is Sustainability (Switzerland). The most used keywords are "indicators," followed by "transport," "sustainability," and "sustainable transport systems." The most used indicators are emissions, energy consumption, and accessibility, followed by user satisfaction and cost efficiency. These are used concerning the environmental, societal, and economic aspects of the sustainability of the transport systems. The leading nation studied herein is Italy, and there are various studies that highlight the progress of the intelligent and sustainable mobility systems of the Italian States.

Keywords: Bibliometric Analysis, Global Trends, Public Transportation, Sustainable Indicators

1. Introduction

"Sustainable development and sustainable transport have become a globally important issue due to the positive influence of sustainable development and sustainable transport on the environment, society, and the economy of the places where the programs are implemented" [1]. With the aim of enhancing sustainable development and sustainable transport and consequently decreasing the emission of carbon dioxide produced through the consumption of energy globally [2], the carbon dioxide emissions could be reduced through sustainable development and sustainable transport programs and practices since sustainable development and sustainable transport are beneficial to the environment and the community globally [3], [4], because the programs and practices are environmentally friendly and positive towards the environment and the community's well-being globally [5]. Worldwide, sustainable transportation projects' goal is to integrate multimodal urban transportation networks [6]. The original efforts aimed to replace diesel buses with compressed natural gas [7]. Furthermore, smart and shared mobility have risen as a modern substitute to traditional modes of transportation [8], as has active mobility through walking and bicycling [9]. However, the implementation of rapid transit systems improves the public transportation network's affordability with private automobiles [10]. One of the primary objectives for attractive public transportation services is to establish a sustainable public transportation system, which includes replacing traditional fleets with alternative vehicle technology [11].

The sustainability of a project is normally measured using quantifiable indicators, which largely affect the resultant analysis of the project's sustainability [12]. Different indicators have been used to analyze various modes of transporting people

and goods in different cities across the world [13], [14]. At first, different indicators for creating and analyzing sustainable modes of transporting people and goods were created and used in developed nations [15], [16]. The value of the indicator used differs among various nations depending on the nature of the nation and its citizens [17]. The use of the same indicators to analyze developing and developed nations might not be ideal [18], and therefore, the developing nations should work towards creating special indicators for sustainable transportation modes [19].

Nevertheless, a thorough understanding of the trends and scope of research work over the years related to the indices and indicators of public transport is not yet well addressed within the prevailing mass of literature. The issue addressed within the scope of the research work undertaken is that there is a lack of a formal data-driven bibliometric study that encompasses the body of literature related to the sustainable public transport indices and systems within the period of the last two decades (2000-2024). This paper aims to cover four primary research objectives: (1) to examine the publication trend of sustainable public transportation studies over the past few decades using the Scopus database, (2) to outline the list of the most prominent authors and publications determining paratransit studies within the literature, (3) to understand the trend of the level of research topics and issues of sustainable transports through bibliometric analysis using keywords (4) knowledge related to the sustainable public transports indicators.

This study aims to answer the following questions, to achieve the objectives:

RQ1. What are the trends and designs in global sustainable public transportation research over the past eras, as reflected in the Scopus database?

RQ2.Who are the most powerful contributors (authors, institutions, and countries), and what are the main themes in sustainable public transportation research?

RQ3. What are the most highly cited documents in the field, and what key themes do they address?

RQ4. What are the most common keywords and thematic collections in sustainable public transportation literature?

RQ5. What are the patterns of co-authorship and international collaboration in sustainable public transportation research?

RQ6. What are the key indicators commonly identified in the area of sustainable public transportation research?

With the above introduction and rationale, the paper is organized into the following sections: Section 2 introduces the data collection procedures and further explanations of the analysis procedure undertaken using the Publish or Perish software and the VOSviewer program, while Section 3 outlines the Solution Pathway Topic analysis and provides the data of the most frequently cited papers, authors, institutions, and publication Journals. Section 4 provides a review of the literature and presents future possible studies of the research that has yet to be explored, while Section 5 provides policy information and undertakes a response to the Solution Pathway Topic. Section 6 provides a conclusion of the paper and recounts its limitations.

2. Gaps and Research Significance

It became clear that study trends differ in how their findings are presented, both bibliometric and traditional research on the most recent studies relevant to the sustainability of public transportation were revealed. Some studies focus on specific aspects of sustainability, such as environmental pollution. [20]-[22], while others address the economic side of energy consumption [23]-[25]. Many studies also discuss accessibility to transportation facilities. [26]-[28]. Additionally, numerous studies explore sustainable transportation modes such as walking, cycling, or shared bicycles [29]-[31], as well as electric vehicles [32]-[34] and the substitution of public transport with trains [35]-[37]. Furthermore, many studies examine methods for measuring pollution and other indicators, such as spatial coverage [38]-[40] and user satisfaction [41]-[43]. However, only a few studies incorporate multiple indicators that address all aspects of sustainability [6], [19], [44]. Although many studies emphasize the impossibility of addressing one aspect of sustainability in isolation from the others, sustainability in public transportation is an integrated process. This is an important gap.

This study focuses on sustainable public transportation (SPT) to offer a thorough scientific evaluation to analyze research trends related to public transport indicators studies over the past decade have highlighted indicators of sustainable public transport, analyze the trends and evolution of research related to SPTI and systems from 2000 to 2024, based on academic publications in the engineering domain, provide insights into the geographical distribution of research on sustainable public transport, including key regions or countries contributing to the academic discourse, and uncover gaps and opportunities for future research in sustainable public transport indicators and systems with a focus on addressing existing challenges in urban mobility, sustainability, and transport services.

The novelty of the paper relies on the fact that using the bibliometric analysis for the first time about SPT as an effective tool to visualize research trends, maps relationships, analyzes data, and identifies emerging areas, helping to discover research points, predict scientific developments, and foster innovation.

3. Research Methodology

The choice of the Scopus database, managed by Elsevier, has been considered the primary source for the investigation of publications related to the topic of the research since the database is expansive and includes a wide range of publications. It is important to understand that the databases are continually updated and often lead to changes over time. The literature review undertaken has been within the time framework of 2000 to 2024. This review is presented within a descriptive framework and utilizes a quantitative approach that identifies potential trends for future studies. The large volume of research

publications that are distributed through various academic journals makes the task of determining the leading publications within the field very challenging. The adoption of advanced quantitative approaches for literature mapping and clustering facilitates the representation of complex research literature. Moreover, through bibliometric analysis, researchers are capable of identifying and demarcating research trends and analyzing the most up-to-date developments within a defined field.

3.1. Search Strategy

The keywords for the research were applied to obtain research resources from the Scopus database using the application of key terms of relevance [45]. After the data acquisition for the study, a bibliometric analysis procedure was applied using the VOSviewer software. The VOSviewer software is a computer program used for the visualization and bibliometric analysis of data using bibliometric plots and networks. The VOSViewer software has widely been used in bibliometric studies for the data mapping of scientific articles to identify characteristics and features of publications [46].

3.2. Data Collection, Cleaning, Harmonization, Visualization, and Analysis

The search using the keywords was performed a number of times to get a good database, leading to a total of 3,694 documents. During the screening stage, the initial documents were filtered to retain those that fulfilled the criteria of employing only the literature that cites all four key words presented from the search, and the final count of documents that attained the criteria stood at 768.

After the data collection of the article data, the data was exported using ". ris" and ".csv" file formats. The studies were reviewed using the title and abstract of the studies to ensure relevance to the study's topic. Studies that are not related to the topic are filtered out, and the final list consists of a total of 430 studies, not including the entire scope of the research topic. The apps of the VOSviewer are used thereafter to perform the functions of network visualization, visualizing redundancy, and density visualization. The data visualization used keywords that are written at least three times and filtered those that are not very important. This paper further continues the discussion of the thorough bibliometric analysis of the trends and contributions of radicalism and the use of digital technologies.

Using the Scopus database, a total of 430 papers that fulfilled the study criteria were sourced. The information sought and obtained using the database includes metadata of the papers, which are the authors' names, title, publication year, name of the journal, publisher, citations, links to the articles, and the URLs.

3.3. Tools

Two research tools are used to carry out the bibliometric analysis for the study. Biblioshiny is a web-based interactive R program that facilitates the use of bibliometrix to interpret the relationship of publications, authors, and various journals and keywords effortlessly and efficiently using bibliometrix software, and bibliometrix doesn't require any complex programming knowledge [47]. VOSviewer is a very useful tool for the visual representation of knowledge within a scientific field [46]. It proficiently develops and illustrates relationships within "network data" to demonstrate the structural progression of collaborations and other affiliations within a specific knowledge subject. [48]. VOSviewer is characterized by its ability to visually depict data and its effectiveness in analyzing extensive datasets. Fig.1 presents the methodology to choose related papers.

This bibliometric protocol describes the data collection procedure for analyzing sustainable public transportation indicators using the Scopus database. It details the search parameters, the time period (2000–2024), and the filtering procedure. In the end, 768 records were found, of which 338 were eliminated for being irrelevant (e.g., medical research, non-English publications). The final number of articles that are pertinent to the analysis topic was 430. The multiple stages for the bibliometric protocol are shown in Fig. 1:

- The study's focus is on Sustainable Public Transport Indicators, and its scope is clearly defined to include English-language articles published between 2000 and 2024.
- Keywords & Search String: To make sure the search was accurate and focused within the Scopus database, a thorough search was carried out using particular keywords like "Sustainable Public Transport," "Indicators," and related terms like "Public Transport Systems" and "Transport Services."
- Data Extraction: Using the Scopus database, on December 14, 2024, only those that matched the search parameters were extracted.
- Identification and Screening: 768 relevant records were found at first; additional screening was necessary to make sure they were related to the examination.
- Removal of Records: 338 records were eliminated during screening. These documents were either not in English or had nothing to do with the subject (medical research, for example).
  Final Inclusion for Analysis: 430 articles were kept and added to the bibliometric analysis after the irrelevant records were eliminated. These papers served as the study's foundation, enabling a thorough analysis of sustainable public transportation metrics.

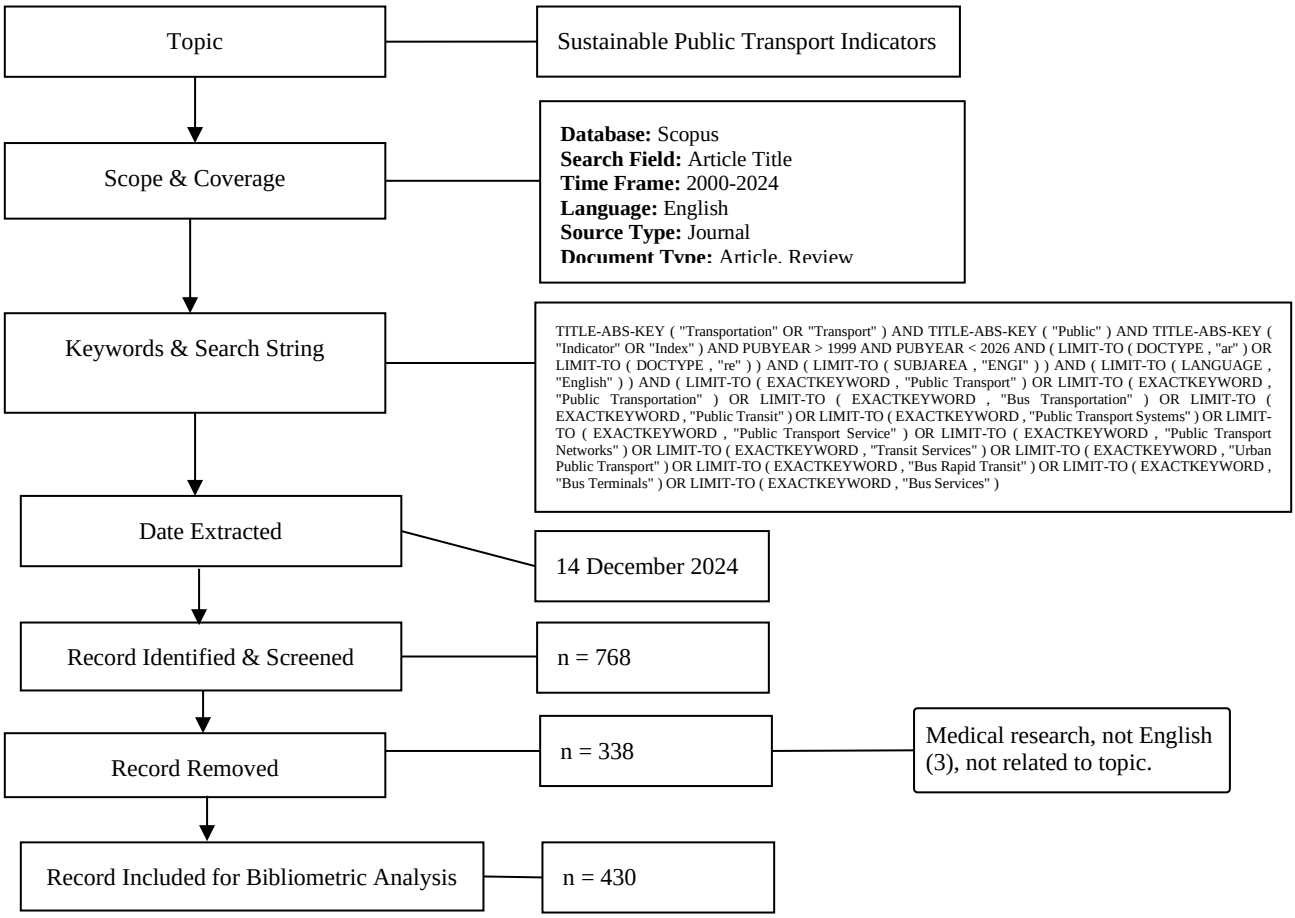

Figure 1. Methodology framework to choose papers.

Table 1. Papers profile.

Timespan	No. of sources	No. of documents	Type of doc.		Average citations per doc	Total citation	No. of references	No. of authors	Single-authored docs	International co-authorships %
			article	review						
2001	2	2	2	0	14.5	29	20	2	2	0
2002	3	3	3	0	95.33	286	104	5	2	33.33
2003	1	1	1	0	73	73	21	1	1	0
2004	3	3	3	0	54	162	57	13	0	0
2005	2	2	2	0	307.5	615	68	3	1	0
2006	3	3	3	0	151.3	454	78	8	0	0
2007	2	2	2	0	30.5	61	20	5	0	50
2008	1	1	1	0	20	20	26	1	1	0
2009	1	1	1	0	55	55	56	3	0	0
2010	3	3	3	0	39	117	60	8	1	0
2011	9	9	8	1	34	306	186	30	0	22.22
2012	5	5	5	0	17.6	88	126	12	1	0
2013	7	7	5	2	27.86	195	266	19	1	28.57
2014	5	6	6	0	22.33	134	221	14	3	0
2015	10	10	9	1	60.9	609	465	32	1	20
2016	8	9	9	0	56.44	508	438	27	3	11.11
2017	22	25	24	1	33	825	1285	75	1	24
2018	18	21	20	1	39.86	837	970	79	1	19.05
2019	25	38	38	0	23.24	883	1685	118	2	26.32
2020	30	44	41	3	29.5	1298	2694	138	3	18.18
2021	32	46	46	0	16.8	773	2994	158	1	23.91
2022	39	55	53	2	10.15	558	3166	209	4	32.73
2023	32	48	46	2	4.08	196	2678	178	3	25
2024	55	86	82	4	1.33	114	4979	353	2	37.21
ALL	**184**	**430**	**413**	**17**	**21.39**	**9198**	**21865**	**1374**	**34**	**25.58**

4. Results

4.1. Trends in Publication

The total number of publications for all years (2000 – 2024) was 430 documents published by 184 sources (journals), as presented in Table 1. Among them, 413 articles and only 17 reviews were published with a total citation of 9198 times, 21865 cited references, and 1374 contributing authors. There were 34 single-authored documents and 25.58% international co-authorships. The highest number of publications was found in 2024 (n= 55 documents), while the lowest number (n= 1 document) was shared in three years (2003, 2008, and 2009) (Fig. 2). However, the average number of citations per document was noticed for 2005 and 2006 (307.5 and 151.3 times, respectively) (Fig. 3). The highest number of total citations was noticed for 2020 (n= 1298 times). More details are shown in Table 1. The most frequent topic in publications was "public transport", while the least frequent were "key performance indicators" and "indicators", as seen in Fig. 4

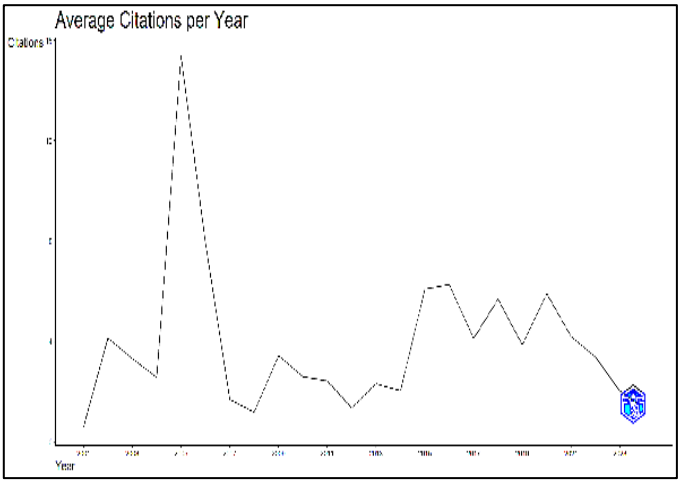

Figure 2. Annual scientific production.

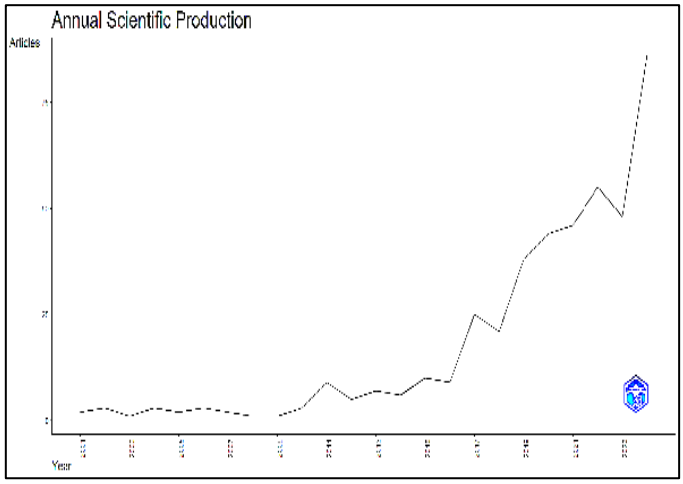

Figure 3. Average citation per year.

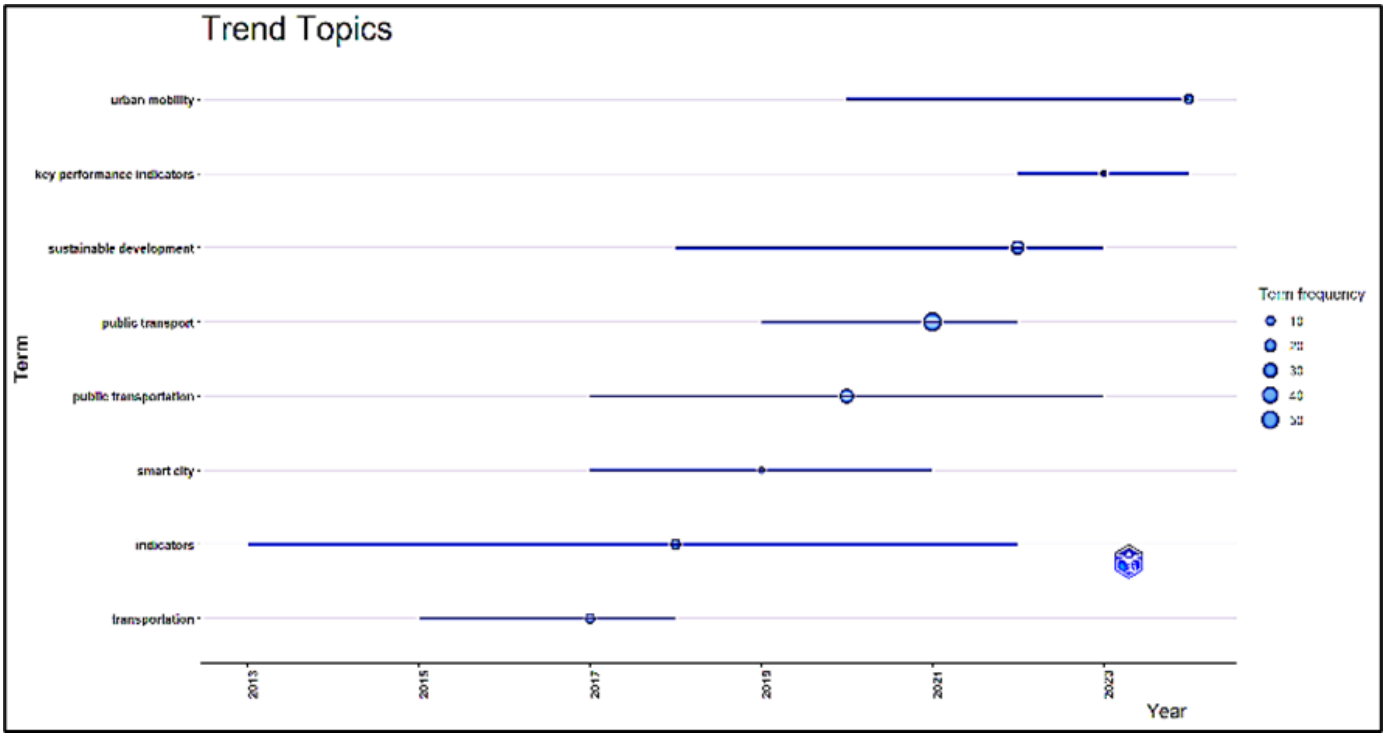

Figure 4. Trend topics.

4.2. Contributing Author

Among the 1374 contributing authors, 25 had at least 3 published documents, as shown in Table 2. Three authors contributed 4 documents, while the remaining authors contributed 3 documents. Of them, Sun, C had the highest number of citations (n= 285 times).

Table 2. Top contributing authors with a minimum of 3 published documents.

Contributing author	Documents	Citations
Alonso, A	4	160
Cavallaro, F	4	130
Wang, Y	4	96
Bruzzone, F	3	114
Chen, Y	3	76
Cyril, A	3	4
De Gruyter, C	3	120
George, V	3	4
Grindlay, AL	3	12
Haghshenas, H	3	229
Ignaccolo, M	3	72
Jasti, PC	3	33
Liu, Q	3	12
Monzón, A	3	158
Mulangi, RH	3	4
Nesmachnow, S	3	30
Nocera, S	3	114
Ochoa-Covarrubias,	3	12
Shi, J	3	47
Sun, C	3	285
Tahmasbi, B	3	170
Ušpalytė-R	3	14
Weng, J	3	54
Xu, J	3	20
Zhao, X	3	221

4.3. Contributing Country

There were 80 different countries contributing to the published documents. Among them, there were 18 countries with a minimum of 10 documents, as presented in Table 3. China had the highest number of publications (n= 58 documents), while Lithuania had the lowest number (n= 10 documents). The USA had the highest number of citations (n= 1472 times). The network visualization of the contributing countries is shown in Fig. 5. The world map of the scientific production and collaboration between countries is shown in Fig. 6 and Fig.7. The corresponding author's country, including single-country production and multiple-country production, is shown in Fig. 8.

The majority of sustainable transportation research and projects have been focused in Europe, with 186 research projects, where numerous nations have made notable advancements in this area. Notable nations that represent a wide range of European countries are Italy, Spain, the United Kingdom, Poland, Germany, Greece, Sweden, the Netherlands, Portugal, and Lithuania. There has been a significant amount of research conducted in Asia after Europe, with 130 research studies, with nations like China, India, Iran, Japan, and Malaysia actively promoting sustainable mobility solutions. North America, led by the United States and Canada, with 62 research projects, has also made a substantial contribution, particularly in the areas of policy and technical advancements. Last but not least, while less so than in Europe and Asia, Australia, representing Oceania, has also taken part in sustainable transportation initiatives.

Table 3. The top contributing country with a minimum of 10 published documents.

Contributing country	Documents	Citations
China	58	1046
United States	41	1472
Italy	35	1032
Spain	33	658
India	30	330
United Kingdom	29	651
Australia	24	969
Canada	21	753
Iran	20	502
Poland	20	272
Germany	13	292
Greece	12	129
Sweden	12	729
Japan	11	236
Malaysia	11	71
Netherlands	11	380
Portugal	11	217
Lithuania	10	57

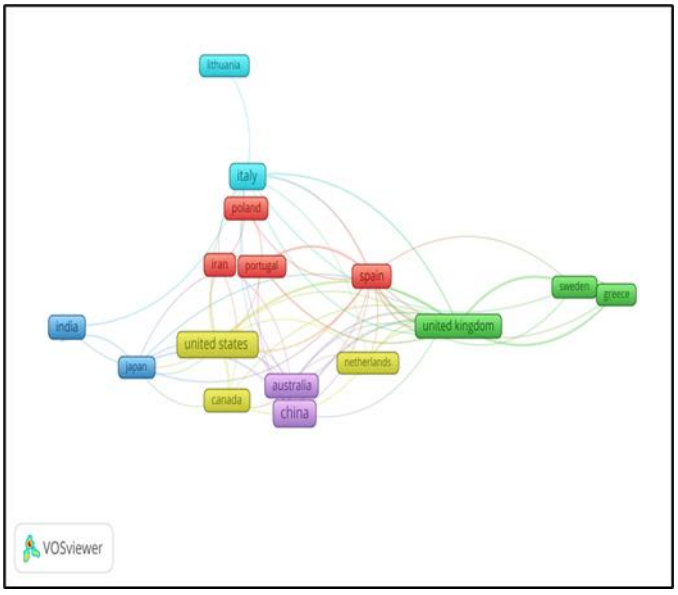

Figure 5. The network visualization of the contributing countries.

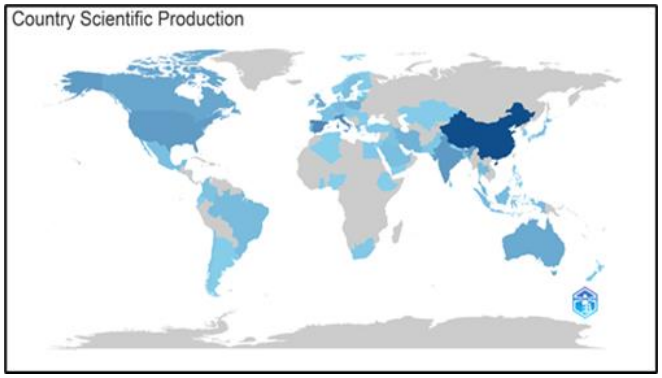

Figure 6. Country scientific production/ Dark color more publications.

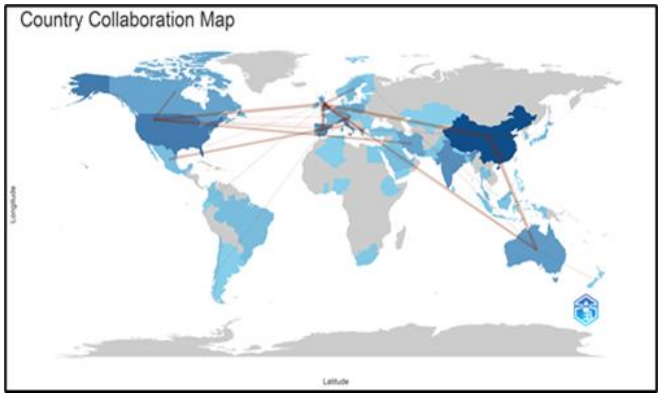

Figure 7. Country collaboration map.

Citations peaked around 2020, coinciding with the global emphasis on sustainable infrastructure and urban resilience after the COVID-19 pandemic, which heightened interest in mobility, public health, and green transportation systems.

National policies that prioritize sustainable mobility, such as the "New Urbanization Plan" and the "14th Five-Year Plan for Urban Transport," as well as increased institutional funding and research incentives in the areas of green and smart transportation, are discussed in relation to China's growing publication volume.

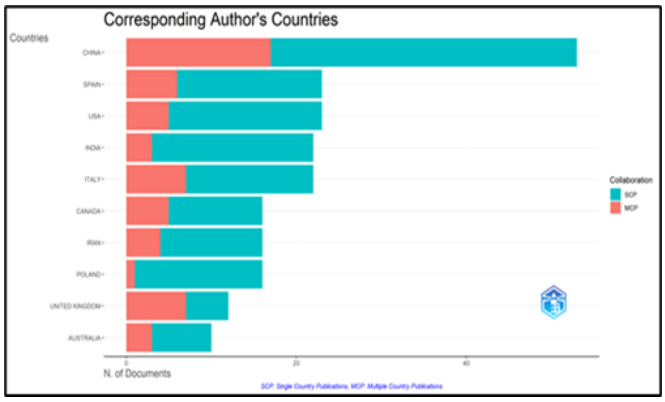

Figure 8. The corresponding author's country.

4.4. Contributing (Source) Journal

There were 184 sources (journals) that contributed to the published documents. Among them, 19 journals had a minimum of 5 published documents, as summarized in Table 4. Sustainability (Switzerland) journal had the highest number (n= 72 documents), while the lowest number was shared by 5 journals (n= 5 documents each). The Sustainability journal had the highest number of citations (n= 1126 times), while the Energies journal had the lowest number (n= 32 times).

The h-index of the top contributing journals is shown in Fig. 9. The highest index (h-index= 19) was for the Sustainability (Switzerland) journal, while the lowest index (h-index= 5) was shared by 3 journals.

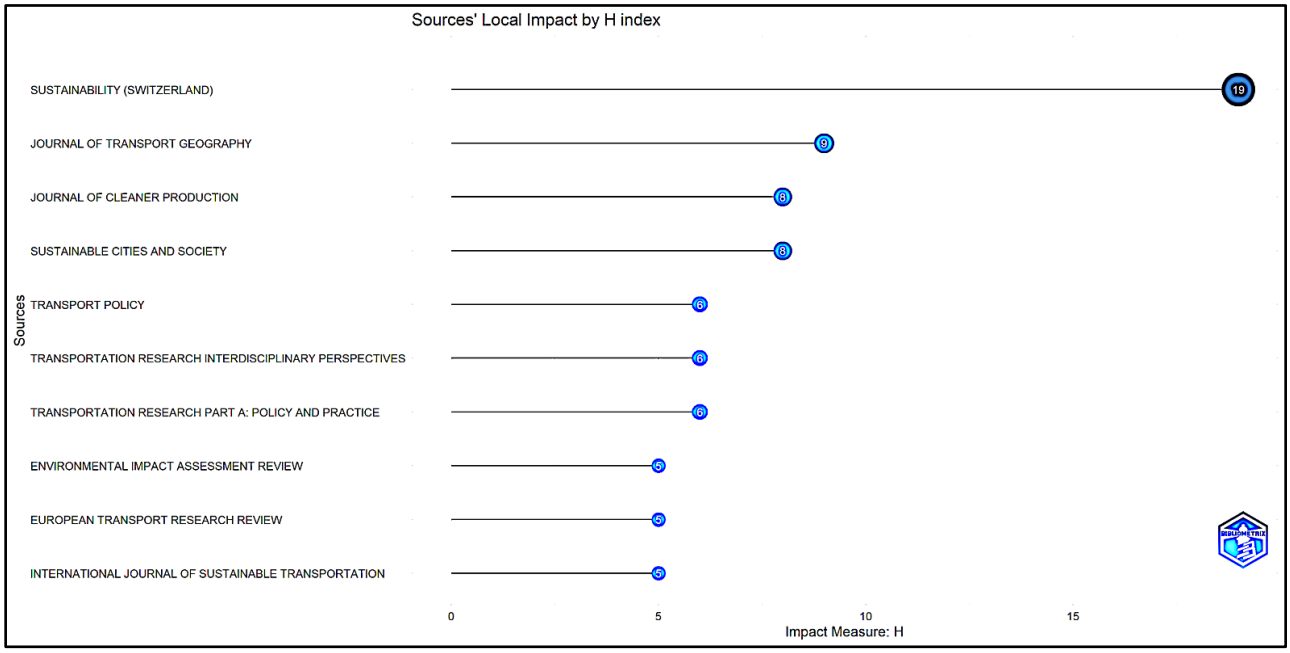

Figure 9. The h-index of the top contributing journals.

Table 4. Top contributing source with a minimum of 5.

Contributing Journal	Documents	Citations
Sustainability (Switzerland)	72	1126
Journal of Transport Geography	12	509
Journal of Cleaner Production	11	415
Sustainable Cities and Society	9	395
Science of The Total Environment	8	142
Transport Policy	8	461
Transportation Research Record	8	93
Case Studies on Transport Policy	7	94
International Journal of Sustainable Transportation	7	55
ISPRS International Journal of Geo-Information	7	157
Transportation Research Interdisciplinary Perspectives	7	117
Transportation Research Part A: Policy and Practice	7	696
European Transport Research Review	6	270
Transport	6	53
Cities	5	114
Energies	5	32
Environmental Impact Assessment Review	5	91
Journal of Transport and Health	5	164
Journal of Urban Planning and Development	5	240

4.5. Terms Used in Publication

Among 12036 terms used in titles and abstracts, there were 19 terms with a minimum frequency of 100 times as presented in Table 5. The most frequent term was “indicator” with 297 times frequency, while the least frequent term was “factor” with 106 times frequency. The co-authors' network is shown in Fig. 10.

Table 5. Terms with a minimum of 100 times used in the publication.

Term	Occurrences	Term	Occurrences
Indicator	297	Level	141
Study	259	Data	137
City	223	Impact	133
Analysis	215	Transport	123
Model	160	Research	119
Area	152	Service	119
Sustainability	145	Use	112
Development	143	Transportation	111
Public transport	143	Factor	106

4.6. Keywords Used in Publications

A total of 1449 authors’ keywords were extracted from the publications. Of them, there were 14 keywords with a frequency of at least 10 times, as presented in Table 6. The most frequent keyword was “public transport” (n= 56 times), while the least frequent was shared by 3 keywords (built environment, transportation, and urban transport) with 10 times each. The co-occurrence network is shown in Fig. 11.

Table 6. Keywords with a frequency of at least 10 times.

Keyword	Citations
Public Transport	56
Sustainability	52
Accessibility	27
Public Transportation	26
Sustainable Development	24
Sustainable Mobility	22
Sustainable Transportation	17
Urban Planning	17
Sustainable Transport	14
Indicators	11
Urban Mobility	11
Built Environment	10
Transportation	10
Urban Transport	10

Additionally, the study observed a shift in research focus over time, reflecting socioeconomic developments. Initially, keywords such as “natural resources,” “automobile,” “accidents,” “consumption,” and "planning" for the environment were predominant. However, as time progressed, the focus shifted to keywords such as “sustainability,” “public transport,” “shared-mode,” and “infrastructure.” In the later stages, the keywords that gained prominence included “customer satisfaction,” “economic development,” “urban planning,” “real-world development,” “efficiency,” and “health.” Fig.12 illustrates keywords over the years, and Fig.13 presents the trend in public transport topics.

The temporal evolution of key terms and themes related to sustainable public transportation indicators from 2000 to 2024 is illustrated in Fig. 13. A direct sustainability indicator or a related research concept related to public transportation systems is represented by each term (e.g., public transport, carbon dioxide, user satisfaction, and urban planning). While the bubble size indicates the frequency of term usage, thereby indicating its relative importance or popularity in scholarly discourse, the horizontal bars display the span of years during which the terms were most actively used in published research.

For instance, long-term relevance as core indicators is indicated by the sustained research interest in terms such as "public transport", "transportation infrastructure", and "carbon dioxide". A shift toward social and technological sustainability dimensions is suggested by the more recent emphasis on "customer satisfaction", "decision support systems", and "urban planning". The growing interest in environmental management systems and regional planning is reflected in the expansion of policy-level indicators. Research themes are categorized in this thematic map, which is presented in Fig.14, according to development (density) and relevance (centrality): "Decision

making," "urban transportation," and "sustainable development" are recognized as motor themes (highly developed and central to the field). The terms "urban transport," "public transport," and "sustainability" emerge as fundamental (though underdeveloped) themes. The themes "air quality," "urban area," and "article" are niche (well-developed but of limited relevance).

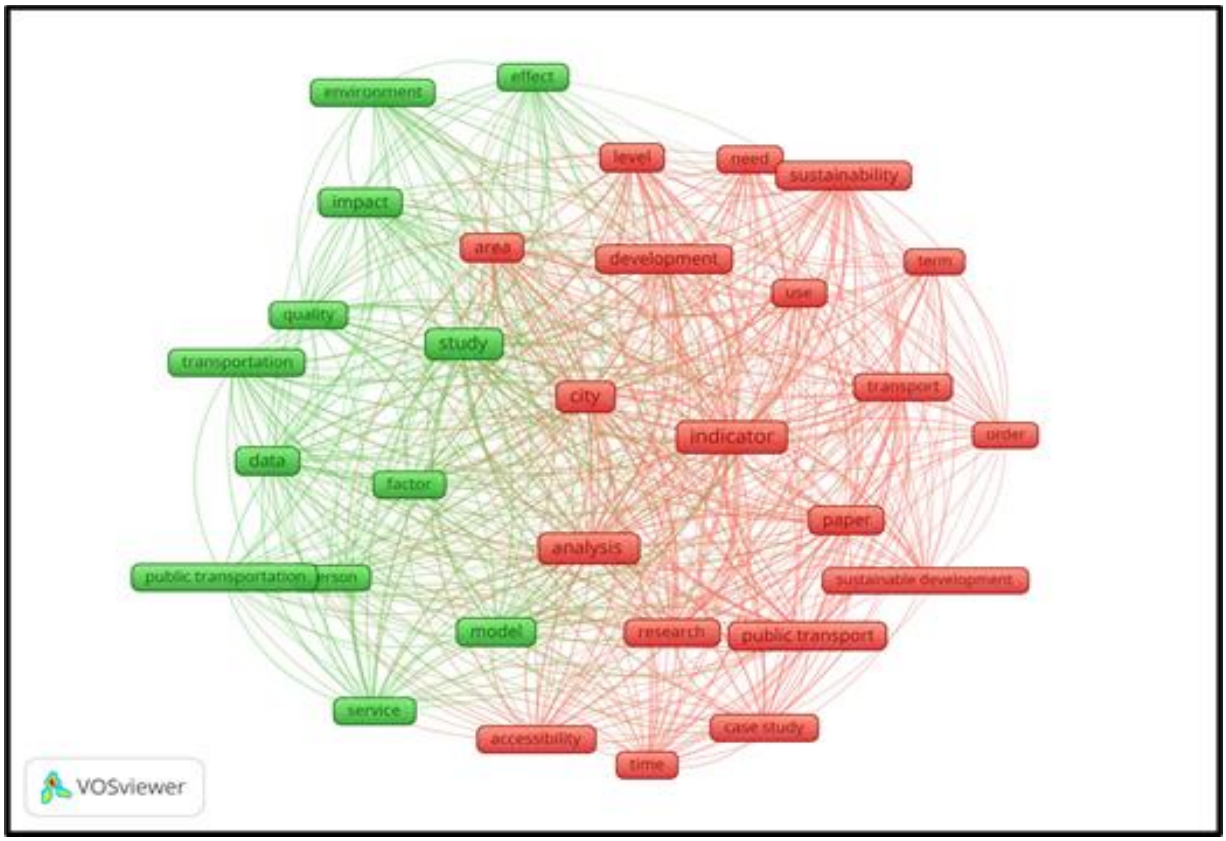

Figure 10. The co-authors network.

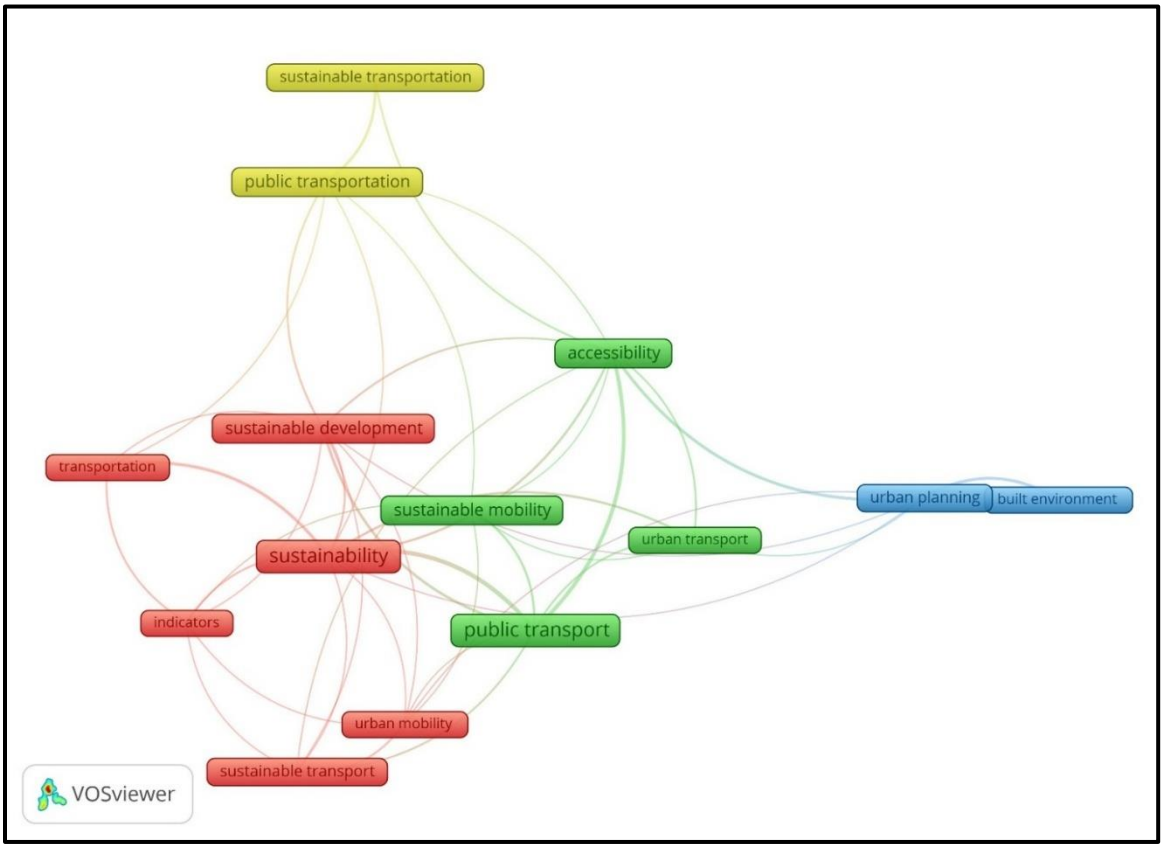

Figure 11. The co-occurrence network.

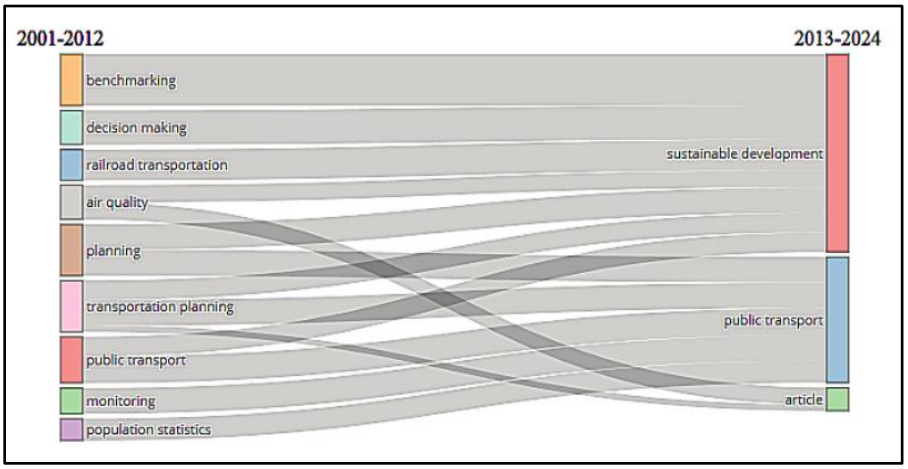

Figure 12. Keywords plus findings.

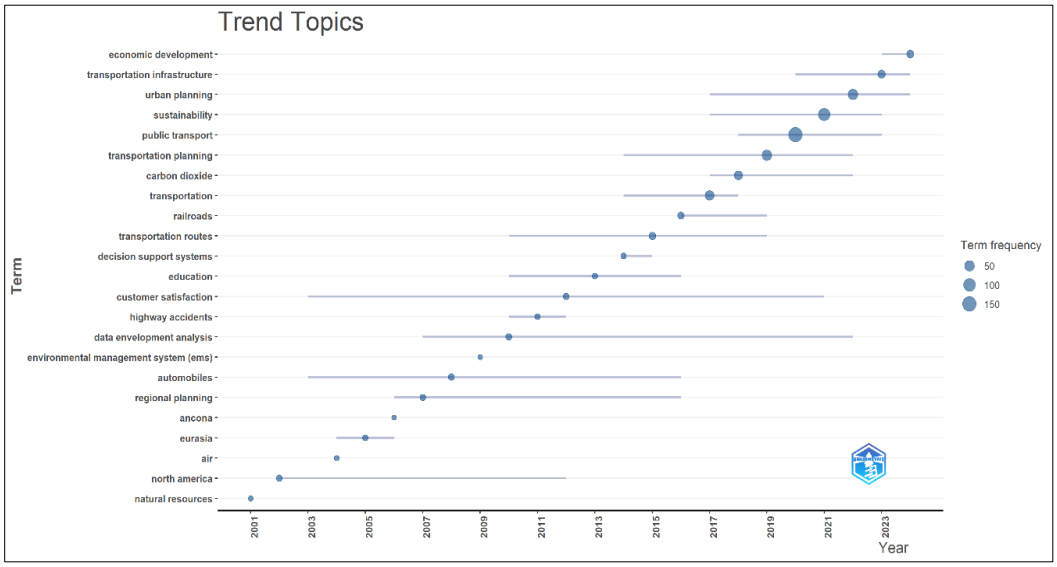

Figure 13. The trend topic of public transport.

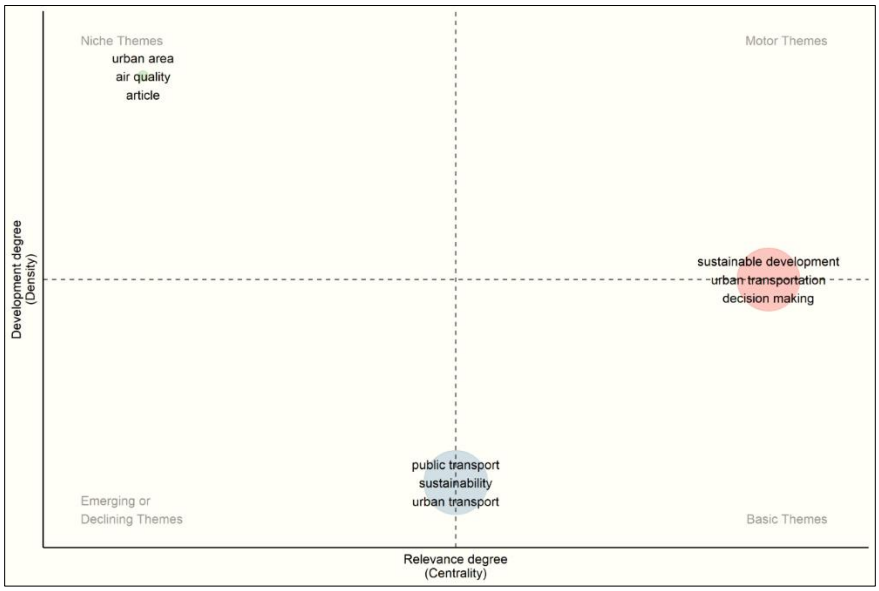

Figure 14. Thematic map.

4.7. Published Documents

A total of 430 documents were published from 2000 to 2024. Of them, there were 22 documents with a minimum of 100 citations as presented in Table 7. The most cited document was "Vredin Johansson (2006)" (n= 453 times cited), while the least cited document was "Kwok (2004)" (n= 1062 times cited).

Table 7. Top cited documents with a minimum of 100 citations.

Document	Citations	Document	Citations
Vredin (2006)	453	Tahmasbi (2019)	117
Jeon (2005)	378	Le Vine (2019)	113
Yang (2015)	240	Allen (2020)	112
Richardson (2005)	237	Su (2010)	110
Black (2002)	178	Alonso (2015)	109
Zhao (2020)	175	Kennedy (2002)	108
Onat (2016)	134	Groppi (2018)	107
Benenson (2011)	133	Bruzzone (2021)	106
Pakusch (2018)	131	Pinna (2017)	104
Munshi (2016)	130	Lättman (2016)	104
Melo (2017)	122	Kwok (2004)	102

4.8 Cited Authors

There were 31584 authors cited in the published documents. Of them, there were 31 cited authors with a minimum of 50 citations. Among the top 10 cited authors presented in Table 8, the most cited author was "Cervero R." (n= 176 times cited), while the least cited author was "Bertolini L." (n= 72 times cited). The co-authorship network is shown in Fig. 15.

Table 8. Cited authors with a minimum of 50 citations.

Cited author	Citations	Cited author	Citations
Cervero R.	176	Ewing R.	87

Litman T.	159	Liu Y.	87
Banister D.	110	Wang J.	80
Wang Y.	106	Van Wee B.	77
Zhang Y.	93	Bertolini L.	72
Currie G.	91		

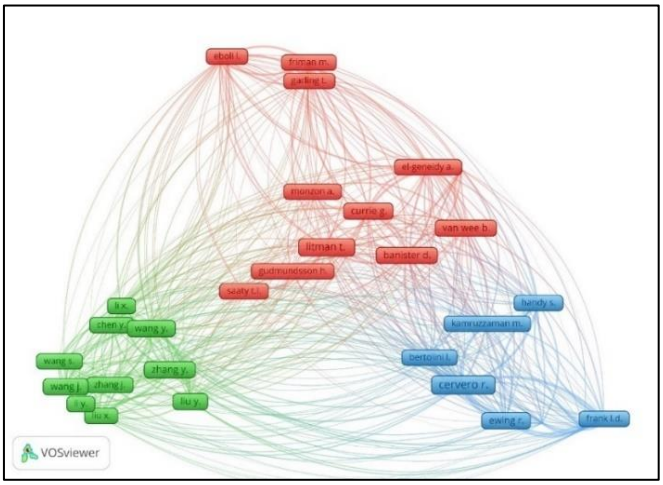

Figure 15. The cited co-authorship network.

4.9 Cited References

There were 21560 references cited in the published documents. Of these, 23 references were cited a minimum of 5 times, summarized in Table 9. The reference by Banister D. was the most cited (n= 11 times cited), while multiple references (n= 14 references) shared a minimum of 5 times cited.

Table 9. References with a minimum of 5 times cited.

Cited Reference	Citations
Banister D., The Sustainable Mobility Paradigm, Transp. Policy, 15, pp. 73-80, (2008)	11
Reisi M., Aye L., Rajabifard A., Ngo T., Transport Sustainability Index: Melbourne Case Study, Ecological Indicators, 43, pp. 288-296, (2014)	7
Banister D., The Sustainable Mobility Paradigm, Transport Policy, 15, 2, pp. 73-80, (2008)	6
Calthorpe, P., The Next American Metropolis: Ecology, Community, and the American Dream, (1993)	6
Geurs K.T., Van Wee B., Accessibility Evaluation of Land-Use and Transport Strategies: Review and Research Directions, J. Transp. Geogr, 12, pp. 127-140, (2004)	6
Haghshenas H., Vaziri M., Urban Sustainable Transportation Indicators for Global Comparison, Ecol. Indic, 15, pp. 115-121, (2012)	6
Haghshenas H., Vaziri M., Urban Sustainable Transportation Indicators for Global Comparison, Ecological Indicators, 15, 1, pp. 115-121, (2012)	6
Lucas K., Transport and Social Exclusion: Where Are We Now? Transport Policy, 20, pp. 105-113, (2012)	6
Miller P., De Barros A.G., Kattan L., Wirasinghe S.C., Public Transportation and Sustainability: A Review, Ksce J. Civ. Eng, 20, pp. 1076-1083, (2016)	6
Alonso A., Monzon A., Cascajo R., Comparative Analysis of Passenger Transport Sustainability in European Cities, Ecological Indicators, 48, pp. 578-592, (2015)	5
Black, W.R., Sustainable Transportation: Problems and Solutions, (2010)	5
Cervero R., Kockelman K., Travel Demand and the 3ds: Density, Diversity, and Design, Transportation Research Part D: Transport and Environment, 2, 3, pp. 199-219, (1997)	5
De Gruyter C., Currie G., Rose G., Sustainability Measures of Urban Public Transport in Cities: A World Review and Focus On The Asia/Middle East Region, Sustainability, 9, (2017)	5
Ewing R., Cervero R., Travel and The Built Environment: A Meta-Analysis, Journal of The American Planning Association, 76, 3, pp. 265-294, (2010)	5
Geurs K.T., Van Wee B., Accessibility Evaluation of Land-Use and Transport Strategies: Review and Research Directions, Journal of Transport Geography, 12, 2, pp. 127-140, (2004)	5
Geurs K.T., Van Wee B., Accessibility Evaluation of Land-Use and Transport Strategies: Review and Research Directions, Journal of Transport Geography, 12, pp. 127-140, (2004)	5
Hansen W.G., How Accessibility Shapes Land Use, Journal of The American Institute of Planners, 25, 2, pp. 73-76, (1959)	5
Litman T., Burwell D., Issues in Sustainable Transportation, Int. J. Glob. Environ. Issues, 6, pp. 331-347, (2006)	5
Newman P., Kenworthy J., Sustainability and Cities: Overcoming Automobile Dependence, (1999)	5
Pinna F., Masala F., Garau C., Urban Policies and Mobility Trends in Italian Smart Cities, Sustainability, 9, (2017)	5
Pojani D., Stead D., Sustainable Urban Transport in The Developing World: Beyond Megacities, Sustainability, 7, pp. 7784-7805, (2015)	5
Redman L., Friman M., Garling T., Hartig T., Quality Attributes of Public Transport That Attract Car Users: A Research Review, Transport Policy, 25, pp. 119-127, (2013)	5
Transforming Our World: The 2030 Agenda for Sustainable Development, (2015)	5

4.10 Cited Sources

A total of 8,712 sources were cited across the reviewed publications. Of these, 221 sources received at least 10 citations. Table 10 presents the top-cited sources, limited to those with a minimum of 100 citations. The most cited source

was Journal of Transport Geography (n=645), while Energy Policy was the least cited among this group (n=121). A network visualization of the source citations is illustrated in Fig. 16.

Table 10. The top-cited sources with a minimum of 100 citations.

Cited source	Citations
Journal of Transport Geography	645
Sustainability	505
Transport Policy	492
Transportation Research Part A: Policy and Practice	340
Journal of Cleaner Production	331
Transportation Research Record	267
Transportation Research Part D: Transport and Environment	248
Cities	204
Transportation	195
Transport Reviews	132
Energy Policy	121

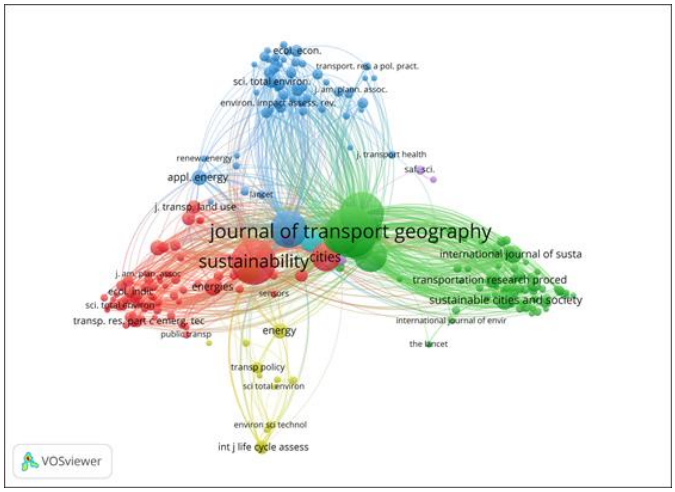

Figure 16. The network visualization for the top-cited sources with a minimum of 100 citations.

4.11. A Comprehensive Summary of the Top 15 Cited Documents

Table 11 provides a comprehensive summary of 15 studies on sustainable transportation, organized by authors, country of authors, country of research, and type of research method. These studies cover various geographical areas, including North America (Canada and the United States), Europe (Italy, Sweden, and the United Kingdom), Asia (China, Hong Kong, and India), and Australia. This global view highlights the importance of sustainable transportation research and its applicability across different urban and regional contexts.

As illustrated in Table 11, the scope of the study is categorized into two approaches: theoretical and practical. Theoretical studies are centered around theory and metrics of sustainable transportation, with the involvement of the environment, economics, and the community. The practical approach, however, focuses on the applications using GIS analysis, surveys, and simulation studies that tackle the aspects of accessibility, emissions, and functionality. The specific studies also demonstrate the variety of focuses of the research. Studies accomplished in Italy and Sweden demonstrate the aspects of user attitude, security of public transport, and the choice of mode of transport [36], [49]-[54]. Several studies also demonstrate the benefits of combining the operations of transporting passengers and freight. These studies include the merging of the various transport systems for enhanced first and last-mile operations. This is illustrated and addressed by Bruzzone et al. [36]. Melo and Baptista [55], for example, present the idea of changing normal delivery vans to the use of cargo bikes in cities. This reduces costs and the emission of CO_2 into the atmosphere tremendously. The issue of planning and policy also emerges as important. The authors of various studies direct the emphasis towards the importance of combining the knowledge of academe, the industry, and the government towards the formulation of strategies and policies that work. This is aptly addressed and illustrated by the study of Zhao et al. [56], emphasizing the importance of overall strategies that will lead to achieving the targets of sustainability. Nevertheless, the aspect of accessibility and equity also emerges. This is attributed to the fact that there are inconsistencies and inequalities related to the provision of transportation and public facilities, which disproportionately affect the poor. This is phenomenally observed and advocated by the study of Tahmasbi et al. [57], pointing towards inclusive development strategies. The positive changes that will be brought about through technological advancements, such as autonomous cars and energy storage systems, are both environmentally beneficial and face unique challenges. The work of Pakusch et al. [58] investigates mobility preferences related to autonomous cars and suggests that it could result in the "more extensive use of cars" than has been believed. Groppi et al. [51] investigated battery and hydrogen technologies and suggested that the importance of these technologies "cannot be overstated, since the mitigation of CO2 emissions and the improvement of energy independence are two of the key drivers of the commitment of the European Union and other governments towards sustainable development and a low-carbon future."

The work of Benenson et al. [59] suggests that the "preferences of consumers and travelers play a key role in the adoption of sustainable mobility practices."

Additionally, the work of Alonso et al [60]. suggests that "public transport is more sustainable than cars."

Lastly, environmental factors and policies play a key role in the issue of mobility and the strategies that are applied. Pinna et al. [52] suggest that "the Italian cities today show a considerable degree of advancement toward smart mobility. The work of Munshi [61] suggests that the "urban environment shapes commuting behavior and that a convenient and sustainable way of reaching a shopping center and a well-designed shopping center itself are key factors that attract people into the shopping center and influence people's

Table 11. Overall summary of 15 studies on sustainable transportation.

Author	Country of research	Indicators	The main finding
Bruzzone et al. [36]	The study observes two case studies: **Northern Lagoon of Venice, Italy**: Exclusive transport challenges arise from its geographical and infrastructural constraints. **Municipality of Velenje, Slovenia:** This region offers contrasting transport dynamics compared to Venice.	**Operational Performance**: Metrics such as travel time, distance travelled, and cost efficiency. **Environmental Performance:** Indicators like energy consumption, Air pollution, emissions reduction, and environmental impact. **Social Performance**: Factors including accessibility, user satisfaction, cost, and social acceptance.	The results specify that mixing passenger and freight transport can reduce travel distances and externalities, showing potential for improved FLM operations. However, the study emphasizes the need for innovations in the regulatory context to implement these integrated solutions effectively in scenarios.
Zhao et al. [56]	**Australia and China** are the countries of the authors, but it is a review paper.	**Environment:** Environmental Impact, New Fuels for Vehicles. **Economic:** Supply Chain and Logistics Management, Transport Strategic Planning. **Social:** Involvement of Stakeholders, Travel Behavior, Bicycle, and Public Transport. **Operational Performance:** Sustainable Transport Indicators and Performance Models, Sustainable Transport Policy	The study concluded that while significant progress has been made in sustainable transport research, there is a need for more holistic and integrative approaches to achieve long-term sustainability goals. Enhanced collaboration between academia, industry, and policymakers is vital for driving impactful solutions in this field.
Allen et al. [50]	**Milan, Italy**	**Environment** **Cleanliness**: Hygiene and cleanliness of the transport vehicles and facilities, which directly impact environmental sustainability by promoting eco-friendly practices. **Economic** **Reliability**: Consistency and punctuality of the transport service, influencing economic efficiency and resource optimization. **Added-Value Services**: Extra services, such as Wi-Fi, which can contribute to the economic value of the service. **Social** **Safety**: Passengers' insights into personal security during the journey are crucial for social well-being. **Comfort**: Physical comfort experienced by passengers, which affects the social acceptability and user satisfaction of the service.	The study emphasizes the importance of managing critical incidents effectively and prioritizing key service quality attributes like reliability and safety to enhance passenger satisfaction and loyalty in public transport systems. These findings provide actionable insights for policymakers and transport operators aiming to improve public transport services.
Tahmasbi et al. [57]	**Isfahan, Iran**. Specifically, it evaluates the accessibility equity of Kowsar retail chain stores.	**Environment** **Multimodal Accessibility:** Assessment of accessibility for various transportation modes, such as walking, cycling, and public transit, which often contributes to reducing environmental impact by promoting sustainable transportation options. **Economic** **Vertical Equity** (Income-Based): Analysis of accessibility disparities among different income groups, focusing on the economic implications of access to public facilities for low-income populations.	The findings designate that under current conditions, low-income populations in Isfahan are less advantaged in terms of accessibility to Kowsar retail chain stores compared to other groups. Also, the study suggests that future development plans may worsen these concerns if equity considerations are not adequately addressed.

		Gini Coefficient: Utilization of the Gini index to quantify inequality, including the economic disparities in facility distribution. **Social** **Horizontal Equity:** Evaluation of equal access to public facilities among the general population, focusing on social fairness and inclusivity. **Vertical Equity (Income-Based):** Also, relevant here, as it examines the social implications of inequity among income groups.	
Le vine and Polak [62]	The research was conducted **in London, United Kingdom**, focusing on the early-stage impacts of a free-floating carsharing (FFCS) service in the city.	**Car Ownership Impact**: Assessment of whether FFCS usage has led users to forgo purchasing a car, dispose of an existing car, or sell a car shortly. **Frequency of Service Use**: Analysis of frequency of FFCS usage correlates with changes in car ownership decisions. **Socio-Demographic Characteristics**: Examination of user talents such as education, income levels, and their association with car ownership impacts.	The findings show that 37% of users stated that FFCS influenced their car ownership choices, with the majority deciding not to acquire a car they otherwise would have bought. Higher-income and educated users were more likely to preserve their existing car ownership levels.
Groppi et al. [51]	**Portuguese island, Portugal**	**Energy Costs:** Analysis of the financial implications of energy storage systems, and potential reduction in energy costs for small islands. **Carbon Dioxide Emissions:** Evaluation of the reduction of CO_2 emissions resulting from increased renewable energy usage facilitated. **Security of Supply**: Assessment of the reliability and stability of energy supply through the adoption of energy storage technologies. **System Stability:** Examination of the overall stability and flexibility of the island's energy system when including battery and hydrogen storage options.	The findings suggest that implementing energy storage systems, such as batteries and hydrogen storage, can significantly enhance the energy independence of small islands by improving system stability, reducing carbon emissions, and lowering energy costs.
Pakusch et al. [58]	**Germany**	**Travel Mode Preferences:** Valuation of participants' choices between conventional private cars, fully automated private cars, and other modes of transport. **Ownership Models**: Examination of whether participants prefer owning a private vehicle or shared mobility solutions in the context of autonomous driving. **Perceived Advantages of Autonomous Vehicles**: Evaluation of factors such as increased comfort, improved quality of travel time, and suitability associated with autonomous vehicles. **Potential Increase in Vehicle Usage:** Analysis of whether the availability of autonomous driving features might lead to an increase in the frequency or distance of car travel among users.	The findings suggest that private cars, conventional or automated, will remain the preferred travel mode. Also, the shift to shared mobility may not happen as predictably, and the expediency of autonomous vehicles might increase car usage.
Pinna et al. [52]	The research focuses on **Italy**, analyzing a sample of twenty-two Italian cities	**Evolution of Public Transportation Systems**: Analysis of changes and	The findings suggest that the development in smart mobility varies among Italian cities, with some

	over three successive time periods: 2005, 2010, and 2015	improvements in public transport services over the specified periods. **Implementation of Smart Mobility Projects:** Evaluation of the adoption and effectiveness of smart mobility initiatives, such as digital ticketing, real-time information systems, and sustainable transport modes. **Financial Investments:** Assessment of European and national funding allocated to smart mobility projects and their impact on service growth. **Compliance with EU Guidelines:** Examination of how Italian cities have aligned their urban mobility policies with European Union directives aimed at promoting sustainable and smart transportation.	viewing substantial advancements in public and smart transportation systems, while others lag behind.
Melo and Baptista, [55]	**Porto, Portugal** The research was conducted in Porto, Portugal, focusing on the potential integration of electric cargo bikes into the city's urban logistics system.	**Traffic Performance:** Evaluation of how replacing conventional vans with cargo bikes affects traffic flow, congestion, and overall network efficiency. **Environmental Impact**: Assessment of Well-to-Wheel (WTW) energy consumption and CO_2 emissions to determine the environmental benefits of using electric cargo bikes. **Operational Efficiency**: Analysis of the operational costs, including transportation and emission costs during driving and idling, as well as labor costs, to evaluate the economic feasibility for logistics operators.	The findings show electric cargo bikes could replace up to 10% of conventional vans within 2 km, preserving network effectiveness. And reduce CO_2 emissions by up to 73%, or about 746 kg. Moreover, yielding up to a 25% reduction in external costs.
Onat et al. [63]	The research does not focus on a specific country but rather presents a generalized framework applicable to various contexts.	**Environmental Indicators:** Greenhouse Gas Emissions, Energy Consumption, Resource Depletion. **Economic Indicators:** Cost of Ownership, Market Penetration Rates, and Infrastructure Investment. **Social Indicators:** Job Creation, Public Acceptance, Health Impacts.	The study provided a complete view of the sustainability implications of electric vehicles, considering the dynamic and consistent nature of these factors.
Munshi [61]	**Rajkot, India** The research was conducted in Rajkot, India, focusing on the relationship between the built environment and commuters' mode choice within the city.	**Population Density:** The number of people per area and its effect on transportation selection. **Land Use Mix:** The diversity of land uses (residential, commercial, industrial) and its influence on commuting choices. **Proximity to Public Transit:** The distance from homes or workplaces to transit facilities and its impact on public transit use. **Street Connectivity**: is the availability of routes in the urban grid, which affects walking, cycling, or driving convenience. **Availability of Parking:** The ease of finding parking spaces and its effect on private vehicle use.	The findings propose that, amongst the built environment measures, population density has significant effects on all mode choices.
Lättman et al. [53]	**Sweden** The research was conducted in Sweden, utilizing survey data to assess individuals' perceived accessibility to	The study examines key indicators of perceived accessibility in public transport: **Quality of Public Transport:** Subjective ratings on trip planning, comfort, and safety, and their effect on perceived accessibility.	The findings propose that public transport safety, frequency, and quality improve supposed accessibility, endorsing social inclusion. Moreover, highlights the

	public transport and its implications for social inclusion.	**Frequency of Travel**: How often people use public transport and its correlation with perceived accessibility. **Safety Perceptions:** The feelings of safety while using public transport and its impact on perceived accessibility. **Demographic Factors:** Age's influence on accessibility, revealing that elderly people and those in their mid-thirties feel less accessible for daily activities via public transport.	role of individual perceptions in transport planning to ensure public systems support comprehensive societies.
Yang et al. [64]	**China**, Specifically analyzing the Beijing Subway system.	The study examines key indicators of urban rail transit networks, including: **Topological Properties:** Analyzing the network structure, like node degree distribution, to instrument resilience. **Node Importance:** Creating a weighted index to evaluate individual stations' significance and categorize critical hubs. **Network Performance Under Disruptions:** Pretending failures and embattled attacks to evaluate the network's efficiency and connectivity under disturbances.	The findings expose that the Beijing Subway is a scale-free network, resilient to random failures but vulnerable to targeted attacks on key stations. The study identifies critical nodes to improve the robustness of urban rail transit systems.
Alonso et al. [60]	The research covers a proportional analysis across **23 European cities**, aiming to benchmark the sustainability of their urban passenger transport systems (France/Paris, United Kingdom, London, Spain, Madrid, Barcelona, Valencia, Murcia, Seville, Bilbao, Asturias, Malaga, Majorca, Gran Canaria, Cadiz, Saragossa, Gipuzkoa, Tarragona, Granada, Pamplona, Girona, Corunna, Leon, Sweden, Stockholm, Netherlands, Amsterdam)	**Environmental Indicators:** Energy Consumption, Air Quality, and Greenhouse Gas Emissions, **Economic Indicators:** Affordability of Public Transport, Investment in Infrastructure, and Operational Efficiency. **Social Indicators:** Accessibility and Coverage of Public Transport, Equity in Transport Services, and User Satisfaction.	The study determined that a multidimensional method for sustainable indicators is vital for sustainable urban passenger transport. It highlighted the need for policies personalized to specific city situations to address challenges and improve strengths.
Benenson et al. [59]	The research focuses on the Tel Aviv metropolitan area in **Israel**, examining accessibility differences between public transport and private cars.	The study examines key indicators of accessibility, including: **Travel Time:** Measurement of travel times for public and private systems to destinations in the metropolitan area. **Accessibility Levels:** Assessment of how easily residents reach services and important services using several transport modes. **Mode Comparison**: Comparison of accessibility via public transport and private cars.	The findings display major gaps between car and public accessibility, with private cars providing much higher levels than public transport. This difference highlights the need for policy changes to enhance public transport for reasonable and sustainable urban mobility.

5. Discussion

This research achieved a bibliometric analysis covering almost two decades of studies on sustainable public transportation. The aim was to identify the bibliometric features of the chosen 430 articles to analyze research trends concerning public transport indicators. The findings indicated substantial impacts regarding authors, countries, and institutions. China was identified as a prominent country in sustainable public transportation

indicators research. Among the citations, the USA stood out as a key contributor.

According to a bibliometric study, the examination of sustainable public transportation in terms of indicators and techniques has significantly advanced the field. The amount and quality of publications during the previous 20 years were examined using data taken from the Scopus database. The global trends in sustainable public transportation metrics are being reported for the first time in this study. The highest number of publications was found in 2024 (n= 55 documents); furthermore, the highest number of total citations was noticed for 2020 (n= 1298 times). Regions that prioritize sustainable public transport as a significant focus in their urban planning and emphasize creative goals in their primary transport initiatives include China, the United Nations, Italy, and Spain, respectively. Roughly speaking, most countries with significant contributions to publications are developed nations. According to the total publication criteria, 80 different countries contributed to the published documents, and European countries, with 186 research papers, are the most productive countries.

It was discovered that the most frequent term that was used is "indicator" with a frequency of 297 times. Additionally, China had the highest number of publications (n= 58 documents). Finally, the USA had the highest number of citations (n= 1472 times). Engineering stands as the foremost discipline for research. This domain has a symbiotic link with other relevant fields, including social sciences, economics, and environmental sciences. The keywords that have garnered the most attention in the field of this research are "public transport", "sustainability", and "accessibility". The publication journal that falls under the category of Sustainability has taken the foremost position, with a total of 72 publications, while the most cited source was "Journal of Transport Geography" (n= 645 times cited).

Related to Indicators, the minimum number of indicators employed in the most often cited research was two, predominantly concentrating on emissions, whereas the maximum utilized was 17 indicators. Many studies have focused on diverse aspects of sustainability, with a large concentration on the environment and emissions. The economic aspect has focused on fuel use, maintenance, and operating costs, while also placing considerable importance on the safety, security, and affordability index within the economic framework. Accessibility is the most used sustainability indicator.

Overall, the framework of the evaluation of the current study includes widely used indicators that are categorized into four groups of indices of environment, economic, social, and policy. The indices are related to the strategies of the various countries, the differing intensity and natures of which depend upon the geographical position, development status, prevailing public transport, and the public policies of the various nations. The trends of the various European nations showed similarities between the indices used for the reduction of emissions. The USA and Canada focused more on the aspects of user satisfaction and equity. The indices of land use and congestion alleviation are given more importance by India and Malaysia. This confirms that the selected indices are related to the requirements of the various nations to address the concerns and build a sustainable system.

The conclusions drawn from the study demonstrate that the identified indicators are valid and supported by basic sustainable theories of transportation. The Environmental Theories Extension Cloud Theory, Sustainability Theory, and Environmental Economics are the most appropriate frameworks for the environmental domain. The Behavioral Decision Theory (BDT), System Dynamics Theory, and Economic Efficiency Theory are the important basic theoretical foundations of the economics of sustainability. The identified indicators of the social domain are supported by the Equity Theory, Social Cognitive Theory, and Theory of Planned Behavior (TPB).

6. Conclusion and Limitations

This paper applied the method of bibliometric analysis to examine international studies related to sustainable transport indicators, shedding light on publication trends, authors, and research institutions. The paper revealed the emergence of a steady trend of interest over the past ten years, reflecting the relevance of sustainable public transport indicators. The steady interest trend reflects the convergence of environmental concerns within the framework of transportation planning and the gradual alignment of international policies towards sustainable development. The paper illustrates the growing level of academic interest directed towards sustainable transport studies. The paper also suggests that there is a requirement for further research within specific realms of the studied field.

The trend topics analysis revealed the emergence of interest within the literature of advanced sustainable public transport indicators. Although the study identifies a gap, the first limitation is the geographical scope of the overwhelming body of research, which remains largely focused within the scope of large cities within developed countries. This could be considered a limitation, since the practicality and relevance within rural and developing areas of such sustainable practices are not measurable and might not be culturally accepted. The second limitation of the study that is identified concerns the scope of the prevailing empirical studies, which are largely focused within the characteristics of specific developed countries such as Western European States, the Unites States of America, the United States of America, and Australia. This could be considered a limitation since the scope of such studies might be less sustainable within other national contexts and conditions. These geographical and regional limitations highlight the importance of future studies that could consider a broader scope than the aforementioned geographical locations and related sustainable issues, since these locations are not appropriately addressed within the current sustainable scope of each.

Moreover, it is imperative to note that there is one major weakness of this method. The results of this work rely on the synthesis of scientific research conducted in a situation where the differences in the field of mobility culture, environmental

characteristics, socioeconomic processes, and traveling behavior are significantly high. These are contextual shifts that can have a significant impact on the findings and conclusions made based on the research. Although the bibliometric method has been seen to be an effective means of mapping trends in research, it lacks the deep qualitative understanding of the case studies or regional variations. Nevertheless, it provides a good pointer to the most commonly visited and indexed research, which can be studied in detail, to come up with meaningful results. This issue should be addressed by future research employing such empirical methods as stakeholder analysis, expert interviews, and surveys in specific regions to complement bibliometric data to make the research practical and provide a deeper insight. Besides, the bibliometric method depends on the articles that have been indexed by Scopus, and this could disqualify significant documents in other databases. In addition, although the study outlines key trends, the data analysis in terms of case studies needs to be more qualitative and able to present the findings in particular metropolitan regions. Another drawback of this research is that it mainly concentrates on public transportation in the context of the different governance structures, which portray different trends. This may overlook other or informal systems of mobility which are prevalent in most developing nations. Additional study would extend the guidelines of public transportation in general and offer a more detailed evaluation of the options of public transportation in unstable and developing regions. Improved alignment of indicators with national strategies can increase the operational value and policy-based significance of the research undertaken by researchers, as they can better understand the needs of urban areas and transportation systems that are sustainable.

7. Recommendations for Future Research

In general, the given bibliometric review is the first full-fledged analysis of sustainable public transportation indicators. In line with the identified shortcomings and constraints, it is proposed to conduct the following studies:

- Exploring New Indicators: Despite the popularity of environmental, economic, and social indicators, future research can address the use of new emerging factors, including active mobility, high-tech transportation, self-driving cars, and mobility as a service (MaaS).
- As another point, the paper has highlighted the unequal focus of different nations on the sustainability measures, based on their needs (e.g., the emissions in Europe, the satisfaction among the users in the USA). The next phase of research can be about the manner in which different countries and areas generalize their indicators to suit their local urban context, infrastructure, and rules. This can involve a closer case study and comparison between developed and developing nations.
- Evaluation of Developing Countries: As many significant contributions to the publications are made by the developing countries, a deeper analysis should provide an additional review of the public transportation systems in these countries. This can involve specific studies on the issues and opportunities of sustainability in countries with high urban population dynamics, poor infrastructure, and financial constraints.
- Defence optimization models in sustainable public transport.

In researching these avenues of the study, future research work can contribute to the development of sustainable public transport frameworks and facilitate the development of more efficient, egalitarian, and environmentally sustainable systems across the world.

Declaration of Competing Interest

The authors confirm that neither the manuscript nor any parts of its content are currently under consideration or published in another journal. All authors have approved the manuscript and agree with its submission to the Journal. The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Author contribution

Ala Keblawi, Khaled Al-Sahili, and Ahmad Ferhan were responsible for writing the original draft, investigation, and analysis.

Mohd Rosli chose methodology, checked references and databases, conducted validation, and Data curation.

Samer Saeed discussed the results and contributed to the final manuscript.

Data Availability

Data will be made available on request.

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