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A SYSTEMATIC OVERVIEW OF DECISION-MAKING ON PUBLIC TRANSPORT SYSTEMS USING BIBLIOMETRIC ANALYSIS ON VOSVIEWER

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From the perspectives of users, operators, and the community, decision making for public transportation is regarded as one of the most crucial characteristics to assess quality, ease and preferable. Studies on the decision-making for public transportation have been published. Comprehensive and quantitative investigations are lacking, nevertheless. Additionally, the Scopus database contains very few assessments of public transport integration. The current evaluation was carried out to provide scholars and practitioners with the most recent updates of papers on public transport and decision-making over the last 18 years (between 2005 and 2023), to allay their worries and address their inquiries about better public transport systems. The purpose of this bibliometric analysis and the overview is to encourage future research and collaboration by illuminating the idea of transport decision making studies, highlighting the paucity of relevant works, and providing a summary of the most productive nations, journals, and institutions in the field. A bibliometric analysis of the publications on public transportation and decision-making obtained from the Scopus database was carried out using the VOSviewer software. This allowed researchers to trace the historical and annual records of publications related to decision making covering the top countries, institutions, journals, most frequently used keywords, authors, citation network analysis, and most cited publications. The analysis's findings identify the indications and interesting issues spots as well as the publications' remarkable annual rise in decision-making on public transportation systems.

Keywords: Bibliometric, VOSviewer, Decision-Making, Public Transport, Literature Review, Transport

1.   Introduction

Public transportation refers to the services offered by municipalities or private businesses to guarantee that inhabitants are moved daily from one place to another following their needs and joys. Public transportation, which includes standard modes of transportation like the metro, tram, bus, etc., is typically highly recommended for reducing traffic congestion, providing a sustainable solution, to offer reducing air pollution, and creating energy efficiency, depending on the facilities offered in the city. Systems of urban public transportation are essential for promoting sustainable development goals in our communities (Mugion *et al.,* 2018; Şahin *et al.,* 2022). Public transportation has drawn attention since it is a green, environmentally friendly mode of transportation that benefits the environment, gives people who don't own automobiles a way to get around, and lessens the social divide (Özden and Şahin, 2020).

Three different methods are frequently used to evaluate the performance of transit services. One strategy is based on the perception or satisfaction of the transport users (Nathanail, 2008; Tyrinopoulos and Antoniou, 2008; Eboli and Mazzulla, 2011), in which the users score the various components of the transit service via a satisfaction survey. The second method involves determining the "efficiency" indicators using a variety of factors that are pertinent to the demand for and operation of the transit system, such as loading/ridership, travel time, travel distance, frequency, service duration, revenue, manpower, cost, accident data, fuel consumption, and emission (Badami and Haider, 2007; Lao and Liu, 2009). Users' opinions and efficiency metrics are included in the third technique (Sheth *et al.,* 2007), which combines the first two procedures. Hassan *et al.* (2013) analyzed the performance of the public transit system at two different granularity levels (system level and route level). They assessed the performance at the route level, which can be used to discover operational flaws or potential improvement areas at the system level and to give specific recommendations to improve the operation for some routes. Using a weighted scoring method for a multi-criteria evaluation process, the analysis level was determined.

High-quality public spaces must be present throughout the city, and any new construction must adhere to sustainable urban planning principles. All these factors must function within two crucial processes: a strong, community-centered, democratic sustainability framework for decision-making and vision-oriented, reformist thinking. The difficulty of altering the character of urban growth to a more ecological, sustainable paradigm is addressed in Kenworthy's (De Bruijn and Veeneman, 2009) list of 10 critical

responses: Infrastructure for walking, cycling, and public transportation is given priority over freeways and roads, with a focus on rail. The central city and its sub-centers are human centers that prioritize access and circulation by means of transportation other than the automobile, with the usage of cars and motorcycles being kept to a minimum.

From an environmental standpoint, Chen *et al.*, (2008) proposed a quantitative analysis of the costs and benefits of city compaction in the Chinese context, with a focus on "facilities availability, infrastructure efficiency, public transport, domestic energy and resource consumption, and environmental externalities. For the thorough decision-making process illustration, 45 major Chinese cities are chosen. Curtis and Scheurer (2010) attempted to implement policies that were based on how people choose between using public transportation versus a car when making travel arrangements. We contend that making accessibility measures widely available through visually appealing media can considerably improve understanding and advance a fruitful conversation about the future of urban shape and mobility.

Perkes *et al.* (2013) examine the recent increase in the number of public bike-sharing programs. The act of using a fleet of bicycles that are readily available to the public on a shared basis for transportation is known as bike sharing. Analysis is provided by researchers from North America and Europe. The analysis is based on interviews with 12 European and 14 North American decision-makers, an assessment of 19 systems, and published data sources. In a study by Jain *et al.* (2014) to gather data for defining public preferences for these features of public transportation under four criteria to help people make better decisions, reliability, comfort, safety, and cost were identified based on a literature analysis and expert opinion. According to their findings, safety is the most crucial factor (36%) for persuading urban commuters to switch from private vehicles to public transportation, followed by dependability (27%) and cost (21%) and comfort (16%). The findings also revealed that 96% of commuters are eager to switch to public transportation if the aforementioned factors or services are taken into account in order to provide an effective system of public transportation.

A good way to address the energy and environmental issues related to the transportation industry is to encourage urban commuters to use public transportation. Public expectations and needs should be at the forefront of the policy-making process to improve public transportation, the preferred method of transportation for metropolitan commuters. Celik *et al.* (2014) researched to examine the characteristics of Istanbul's rail transit system, which includes metros, trams, light rail, and funiculars. In this paper, we provide a unique methodology for measuring customer satisfaction for Istanbul's rail transit system that combines statistical analysis, SERVQUAL, interval type-2 fuzzy sets, and VIKOR. Their method offers recommendations for future investments and can be adapted and applied to complicated decision-making problems that involve imperfect, ambiguous, or unreliable data.

To evaluate customer satisfaction with public transportation systems, some researchers, academicians, and authorities now use MCDM (Multi-Criteria Decision Making) as one of their primary decision-making methodologies (Celik *et al.,* 2014; Awasthi *et al.,* 2011). One of the most crucial systems of transportation, particularly in large, populated cities, is public transportation. Evaluation of public transportation systems is thus a strategic concern for both the corporate and public sectors.

For the evaluation of public transportation systems, Nasreddine and Eskandari (2017) proposed an integrated MCDM technique based on the Delphi method, group analytic hierarchy process (GAHP), and preference ranking organization method for enrichment of evaluations (PROMETHEE). The proposed model generated more precise and realistic results and provides suggestions for raising the standard of upcoming public transportation services. A sensitivity analysis is performed to look at how the decision-making problem is affected by the weights of the criteria. Ghorbanzadeh *et al.* (2018) used Mersin, a coastal city in southern Turkey with 1.7 million population, as a case study to contrast a study for travelers to use stakeholder groups as references. 40 users of the public transportation system, 40 non-users, and 17 experts were the three groups that were surveyed. Based on interval pairwise comparison matrices that included the entire judgements of all three groups, the IAHP (Interval Analytic Hierarchical Process) technique was able to reach a consensus preference rating for a future public transportation system between the three groups.

Fuzzy TOPSIS, fuzzy VIKOR, and fuzzy GRA were investigated by Awasthi *et al.* (2018) for the purpose of evaluating the sustainability of urban mobility initiatives. These methodologies are suitable multicriteria decision-making (MCDM) methodologies. The three projects that were taken into consideration were the construction of a new tramway in the Luxembourgian city center, service optimization on the city's current bus lines, and the construction of electric vehicle car-sharing stations. The study that is being proposed is one of the first to investigate the application of ideal solution-based multicriteria decision-making approaches for sustainability evaluation of urban transport projects under uncertainty.

Transportation networks are intricate sociotechnical systems, and the literature on their planning, which identifies courses of action from both public and private points of view, reflects this dual nature. On the one hand, it is evident from the social sciences literature that the majority of transportation-related

decisions are "wicked," meaning that because they are ill-defined, they cannot be solved using conventional engineering methods. On the other hand, since they must (or should) adhere to stringent technical and economic standards, transportation systems include a strong technical component that influences most of these decisions. Transportation planning is mostly discussed in the literature on transport engineering and economics as a methodical procedure based on the creation and evaluation of various possibilities (Cascetta *et al.,* 2015; Scott *et al.,* 2016; Nalmpantis *et al.,* 2019).

Public transportation and decision-making have been the subject of numerous articles, although they have all concentrated on specific and constrained aspects of transportation systems. Moreover, twenty-three review papers about the dependability of public transportation have only been published, according to the WOS database. This paper was written to illustrate the relationship between the transportation system and decision-making, call attention to the paucity of research in the area of transportation systems, and provide a summary of the most productive countries, journals, and organizations in the field of public transportation and decision-making publications. Also, to make it easier to acquire data for subsequent investigations, the terms related to decision-making that appeared the most frequently in earlier studies are included in the current work. Also, forecasts for upcoming trends in the field of transport system decision-making study were included in this report, along with some suggestions for further research.

2.   Method of Bibliometric Analysis

This review was established, and bibliometric analysis was used to achieve its goals. VOSviewer is a bibliometric analysis and bibliographic map specialist program. In order to describe current research trends connected to transport on decision-making and give researchers a clear picture to aid them in future study and collaboration, the required data from the gathered documents were extracted and summarized using the software.
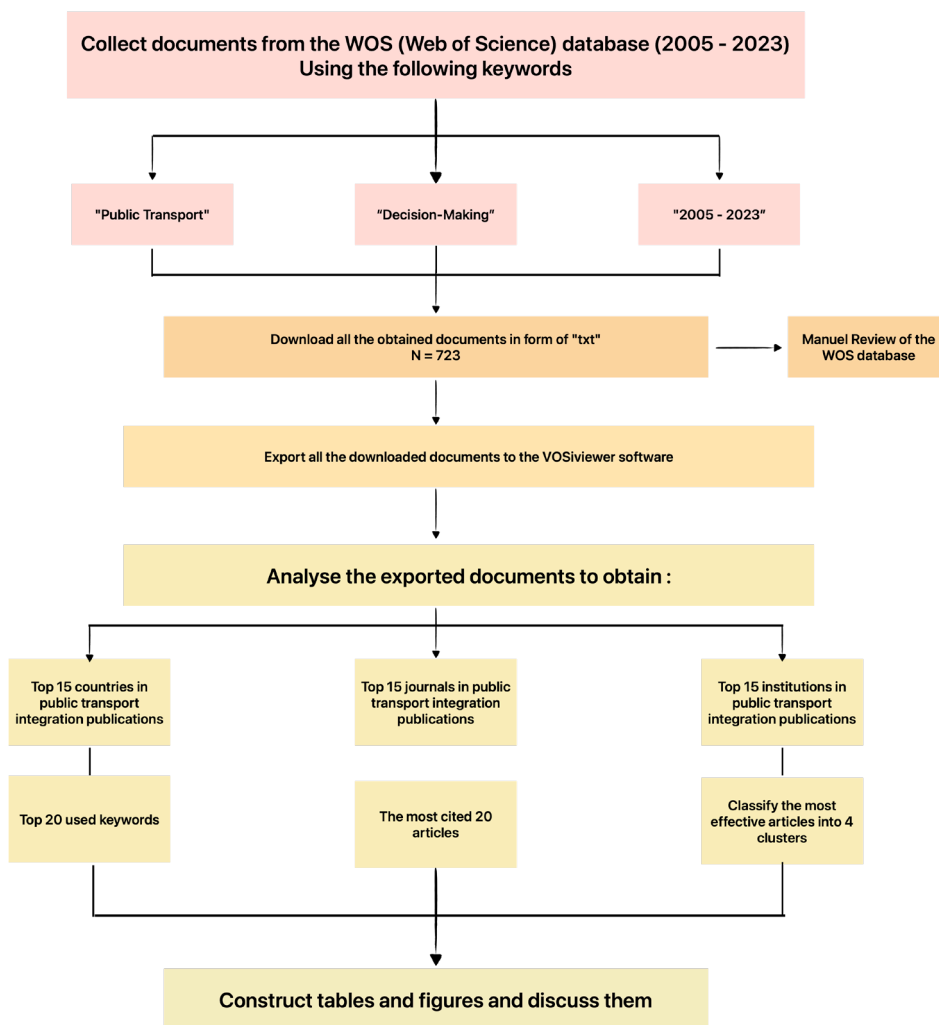

Figure 1. Bibliometric review structure methodology chart

To accomplish the objectives of the current review, five steps were established, as indicated in Figure 1. Using the WOS database's basic search feature and the keywords "Decision-making" AND "Public Transport" along with a year range of "2005-2023," documents were gathered in the first phase. The collection of documents took place on April 6, 2023. The WOS database states that 723 documents were downloaded and obtained for phase 2 analysis. Furthermore, using the first associated author address from phase 2 and the WOS website, a manual evaluation of the nation's publication output was done. Phase 3 involved exporting the obtained documents to the VOSviewer program in order to highlight the paucity of research and pinpoint the top 15 countries, journals, and organizations for publishing on public transportation decision-making. Phase 3 additionally identified the top 20 most-used search terms and the top 20 most-cited academic articles. However, in order to identify literary trends, the most significant papers were compiled based on document citation. The 137 documents that were cited more than nine times by the VOSviewer program which will be covered in depth in Section 3.5. In the final stage, the generated tables and bibliographic maps were examined and discussed.

3.   Results and Discussions

3.1. Historical and Geographical Trends

From 2005 to 6 April 2023, 723 documents about public transportation and decision making were published, according to the WOS database. The annual publication's historical patterns and the total number of citations from 2005 to 2023 are shown in Figures 2 and 3. Figure 2 shows that the number of annual publications increased throughout the course of the previous 15 years from 2005 to 2008 and then straight forward till 2011. The number of publications remained largely unchanged; it began to rise in 2011 and then increased more rapidly in each of the following years: 2014, 2016, 2019 and 2021. Over the past 15 years, the annual publishing of public transport and decision making has increased. In addition, the publication's annual citations climbed with occasional peaks and valleys between 2005 and 2018, then decreased in 2009 and 2010, before starting to increase again. This is to be expected since it takes some time for academic papers to have a discernible impact because it takes time for other people to read new research, pay attention to them, and use them as references in other works. As a result, research that has been published recently typically has fewer citations.
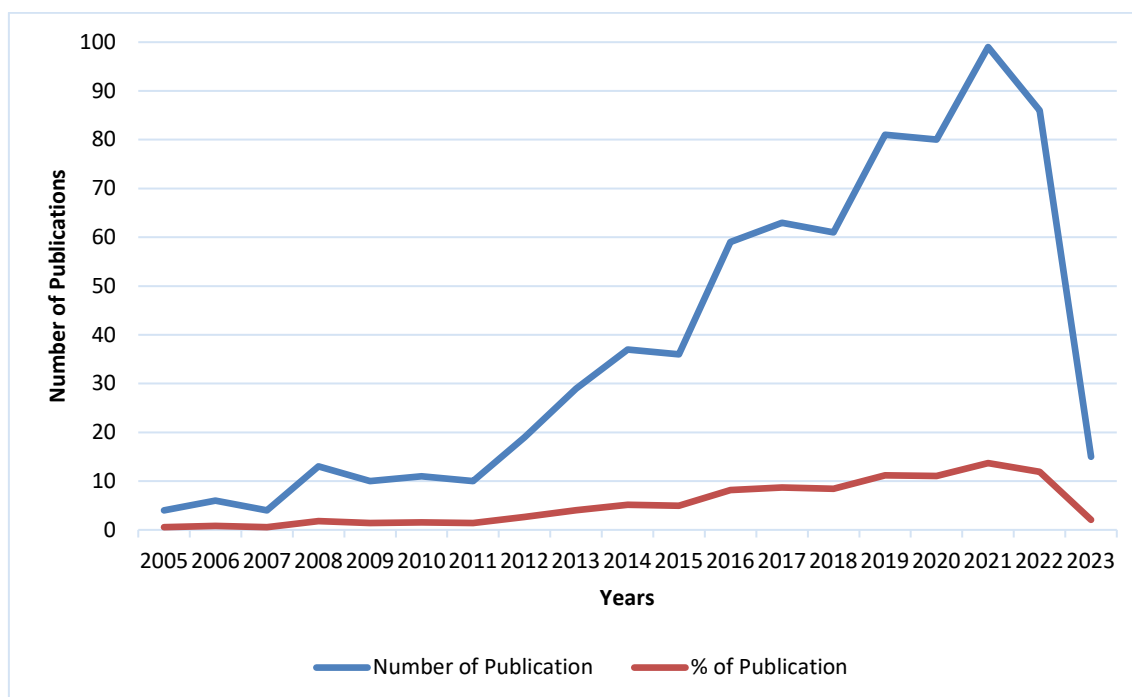

Figure 2. Total publications from 2005 to 2023, according to the Web of Science (WOS) database
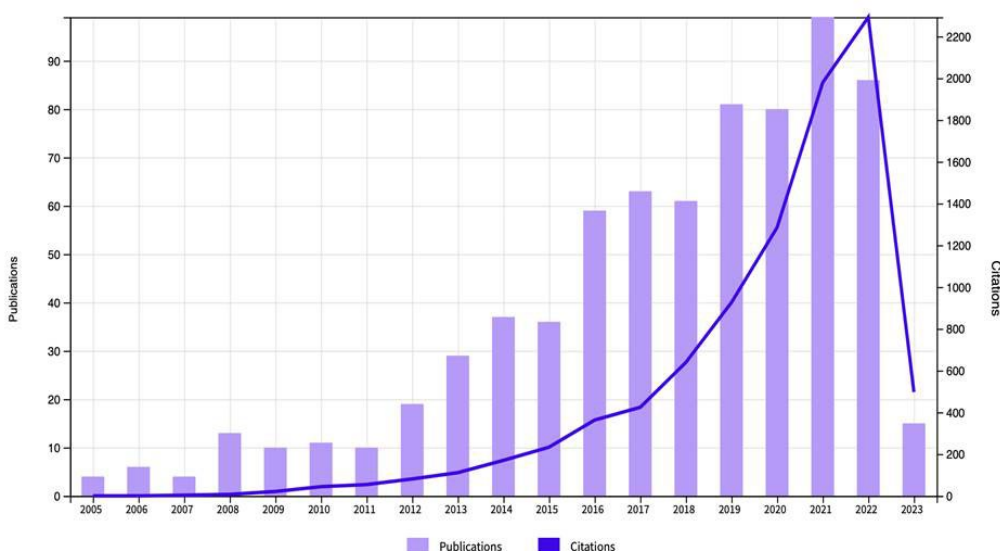
Figure 3. Citation totals from 2005 through 2023 based on the Web of Science (WOS) database

The overall number of papers on public transport and decision-making research includes contributions from more than 100 nations. The 15 most productive nations in the public transportation and decision-making study were included in Table 2 according to the number of publications. By 13,69 % of all publications over the previous 18 years, China maintained its top spot in the field of research on public transportation and decision-making. England ranked in first place with a total publishing rate of 8,71 % in the literature on the decision-making and public transportation, followed by Australia, Turkey, and Netherlands with respective publication rates of 8,02 %, 6,09 %, and 5,95 %. In addition, more than thirty publications each came from the USA, Germany, Spain, and Hungary. Based on a review of the WOS database and VOSviewer software, the top 15 nations contributed to more than 81,74 % of all publications and more than 95 % of all citations between 2005 and 6 April 2023.

Table 1. Distribution of VOSviewer's Top 15 Global Leaders from 2005 to 2023

COUNTRIES	TP	TC	TLS	TP%
China	99	1293	7247	**13,69**
England	63	1174	8921	**8,71**
Australia	58	1347	4694	**8,02**
Turkey	44	932	5052	**6,09**
Netherlands	43	960	5620	**5,95**
USA	43	741	5503	**5,95**
Germany	36	723	4257	**4,98**
Spain	35	331	3486	**4,84**
Hungary	31	541	4568	**4,29**
India	29	316	2654	**4,01**
Italy	26	134	2348	**3,60**
Sweden	23	200	2004	**3,18**
Poland	22	114	732	**3,04**
Brazil	21	91	1005	**2,90**
New Zealand	18	174	2153	**2,49**

The vast populations in nations like China, India, Brazil, and the United States as well as the notable population growth in the member states of the European Union, as shown in Fig. 4, are driving a lot of interest in research on public transportation and decision-making. On the other side, based on the first linked author address provided by the WOS database, 723 publications were manually evaluated (one by one) to determine how many publications were created annually for each country. The WOS website and VOSviewer program were unable to pinpoint the precise amount of publications for each nation each year, thus this inquiry was conducted. Table 2 displays the publication distribution for the top 5 leading counties from 2005 to 2023. Table 2 demonstrates that most countries continued to experience an increase in the

number of paper publications, with China and England leading the way. This is because integration-related research articles are becoming more widely dispersed geographically as a result.
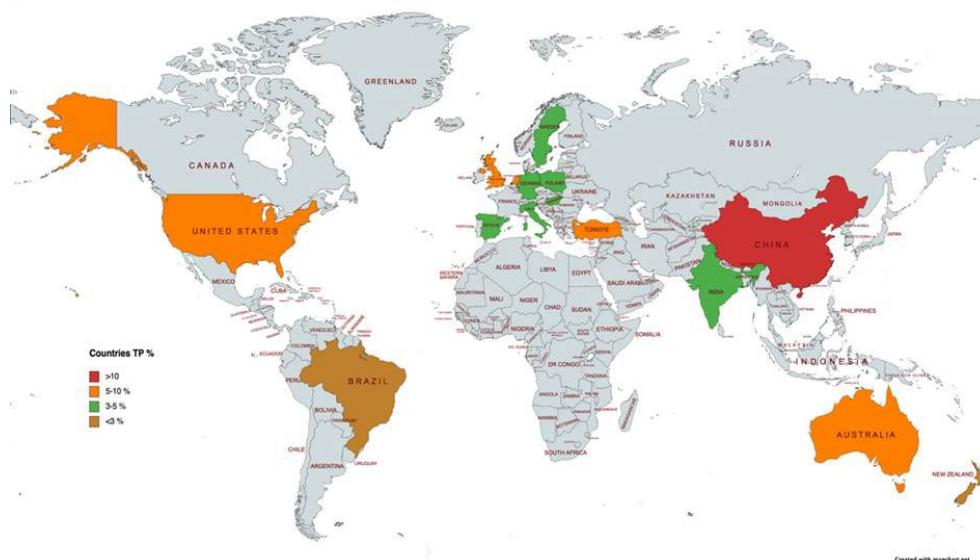

Figure 4. Top ten top nations from 2005 to 2023, in order

Table 2. The top 5 most significant contributors, together with the number of publications they produce annually

Publications	Years	CHINA	ENGLAND	AUSTRALIA	TURKEY	ENGLAND
4	2005	0	0	1	0	0
6	2006	0	1	1	0	0
4	2007	0	0	1	0	1
13	2008	1	0	2	0	0
10	2009	3	1	0	0	2
11	2010	2	1	1	0	0
10	2011	0	0	2	0	3
19	2012	2	1	1	0	0
29	2013	5	1	3	1	1
37	2014	4	2	0	3	1
36	2015	5	1	4	2	3
59	2016	4	4	10	2	1
63	2017	2	5	5	3	7
61	2018	6	7	5	5	3
81	2019	11	6	4	3	5
80	2020	18	7	3	9	7
99	2021	14	13	6	11	8
86	2022	21	8	8	4	1
15	2023	1	5	1	1	0
Total		99	63	58	44	43

3.2. Key Journals in Decision Making-Related Research

The fact that the 723 papers were published in 169 conference or symposium proceedings which were indexed in WoS, shows the breadth of interest in the study field of integration in public transport. This phase investigated the top 15 journals and proceedings that had published the most research on decision-making during the previous 18 years (from 2005 to 2023). Table 3 lists those journals in rank order based on the total number of papers and citations they have received about decision-making and public transportation.

The Sustainability Journal, which has published 48 articles in total on the decision-making and public transportation and had 477 total citations over the previous 18 years, is at the top of the list of all journals (from 2005 to 2023). The Journal of Transport Policy, however, has the best reputation in terms of citations. Additionally, the majority of publications published on decision making-related TLS (Total Link Strength) are in Sustainability Journal. Also, the Transportation Research Part A Policy and Practice journal, which ranks third in terms of publications, has the highest percentage in terms of both publication count and total citations. According to the VOSviewer, the top 15 journals' relationships on their networks

can be observed in Figure 5. The most striking aspect of this circumstance is that the all most respected journals have contributed the decision making-related public transport research as the most.

Table 3. Top 15 most prestigious publications for research on decision-making from 2005 to 2023

JOURNALS	TP	TC	TLS
Sustainability Switzerland	48	477	1234
Transport Policy	21	500	757
Transportation Research Part A Policy And Practice	19	453	631
Transportation Research Record	17	81	257
Public Transport	15	161	269
Case Studies on Transport Policy	13	110	277
Journal of Transport Geography	12	313	301
Transportation Research Part F	10	174	325
Sustainable Cities and Society	10	202	186
Transportation	8	279	369
Research in Transportation Economy	8	44	73
Journal of Advanced Transportation	7	78	113
Applied Sciences-Basel	6	71	264
Research in Transportation Business	6	61	226
Energies	6	41	113

Figure 5. From 2005 through 2023, the top 15 journals for research in decision-making

3.3. Key Institutions in Decision Making-Related Research

The nations shown in Fig. 6 are shown in Table 4 together with the top 15 institutional decision-makers in public transport research for the previous 18 years (from 2005 to 2023) in order of the number of publications on integration. With the exception of Vilnius Gediminas Tech University from Lithuania, Zilina University from Slovakia, Monash Technology Institute from Israel, and Southeast University from

Bangladesh, most of them are from the top 15 leading countries with the most publishing years, as shown in Figure 7. The largest producer of integration-related research among the numerous institutions tracked in this analysis is Budapest Univ. Tech. & Econ in Hungary, with the largest publications share of (28), while Delft Tech. Univ. in Netherlands has the largest share of citations (553) from 2005 to 2023, also is the second-best provider, with 20 publications. Other top-15 institutions contribute with more than five publications apiece, although top leading nations and institutions including Hungary, Netherlands, England and Australia have excellent citation records.

Table 4. From 2005 to 2023, the top 15 organizations conducting research on decision making

Organization	TP	TC	TLS	Country
Budapest Univ. Tech. & Econ	28	490	1244	Hungary
Delft Tech. Univ.	20	553	750	Netherlands
UCL	13	216	811	England
Melbourne Univ.	13	470	414	Australlia
Auckland Univ	12	155	851	Australlia
Vilnus Gediminas Tech. Univ	12	115	196	Lithuania
National Defence Univ.	11	301	1201	Turkey
Zilina Univ.	10	11	13	Slovakia
Sydney Univ.	9	126	338	Australlia
Monash Univ.	8	84	1051	Australlia
Israel Tech. Inst.	8	96	908	Israel
Leeds Univ.	8	271	639	England
Yıldız Tech. Univ.	8	261	470	Turkey
Southeast Univ.	8	156	337	Bangladesh
Southampton Univ.	7	82	987	England
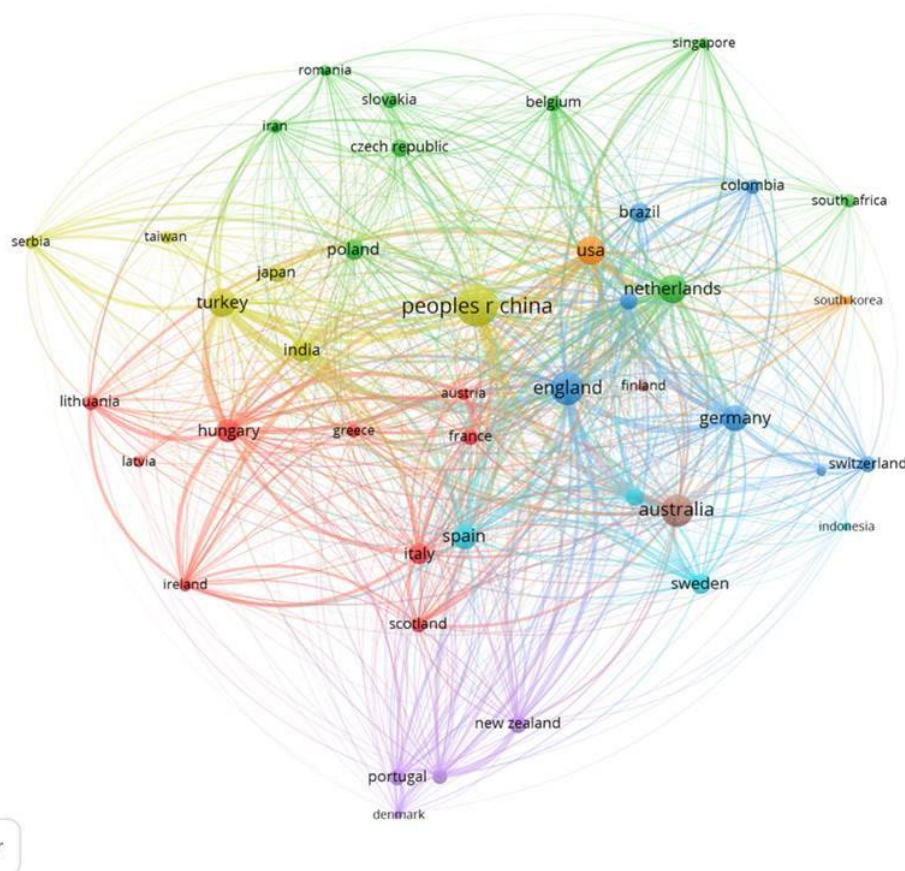
Figure 6. Top 15 leading countries by time in decision making-related research from 2005 to 2023
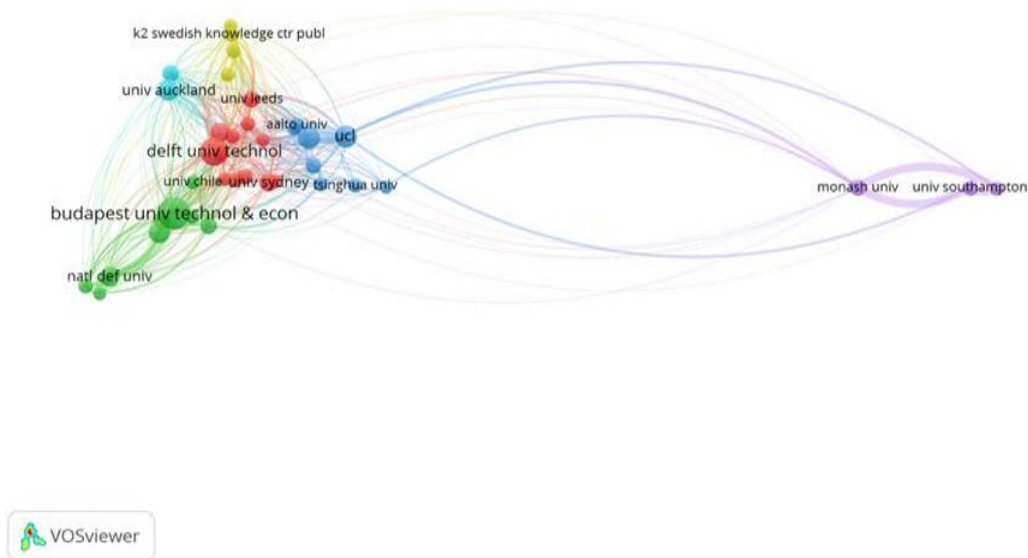
Figure 7. Top 15 leading organizations by year in decision making-related research from 2005 to 2023

3.4. Keywords' Characteristics

A total of 3325 keywords, or an average of 5 keywords per article, are provided by the 723 articles that were chosen. 3325 keywords were divided into two categories to prevent the issue of duplication, and Table 5 shows the corresponding frequencies of these groups. Only 186 separate keywords — or 5,42 % of all keywords—appear more than once. Besides, the top used keyword was "public transport" (222 times), and "decision making" (61 times) was the second top keyword used, other keywords with more than 20 times appearances include "model" (65 times), "accessibility" (50 times), "AHP" (28 times), "impact" (39 times), "systems" and "mobility" (36 times), "sustainability" (34 times), ''quality'' (30 times), "service quality" (25 times), "transport" (45 times), "performance", and "systems" (25 times), "framework" and "transit" (24 times), "city" (26 times), and lastly ''behavior'', ''public transportation'' and "transportation" has been used equally for 30, 29 and 27 respectively.

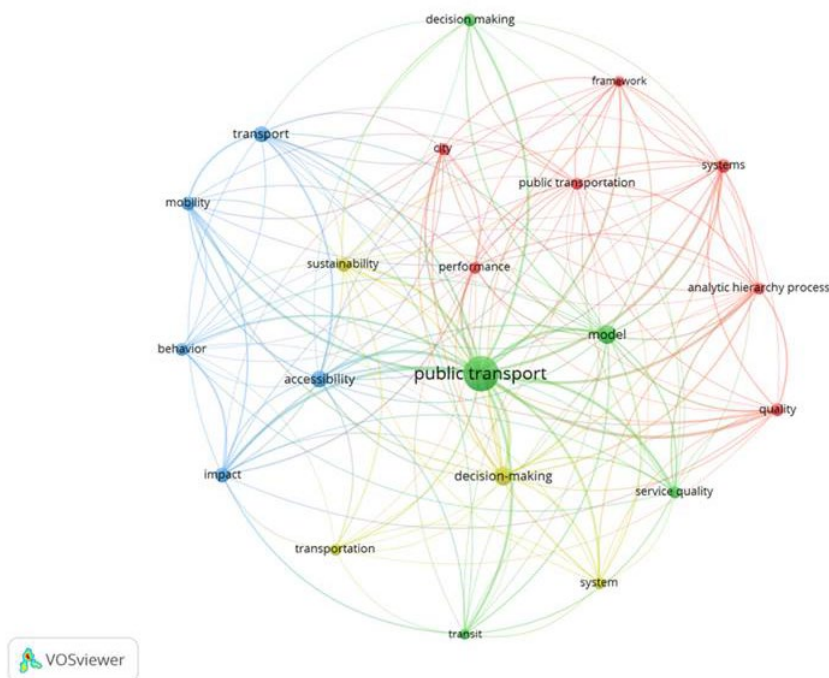*Figure 8.* Top 20 keywords in decision-making-related research from 2005 to 2023

Table 5. Top 20 used keywords and their frequencies

Keywords	Frequency	TLS
Public transport	222	282
Decision Making	61	94
Model	65	89
Accessibility	50	69
Analytic Hierarchy Process	28	65
Impact	39	64
Systems	36	59
Mobility	36	58
Sustainability	34	56
Quality	30	55
Service quality	25	48
Transport	45	48
Performance	25	44
Systems	25	44
Framework	24	41
Transit	24	40
City	26	39
Behavior	30	32
Public transportation	27	32
Transportation	29	28

3.5. Quantitative Content Analysis

Table 6 shows the most cited articles related to the topic of decision-making in public transport what can attract car users to shift to use public transport with the integrated systems and what should be the changes employed to encourage public transport use, building the network for the public transport systems and its impact on passengers' perception, service integration of whole system.

Table 6. Top 20 most cited publications in decision making-related research from 2005 to MAR 2023

Publication	TP	Citation	TLS
Deluba, Szabolcs	21	442	3531
Moslem, Sarbast	16	412	3289
Alkharabsheh, Ahmad	6	79	1849
Haghani, Milad	7	388	1389
Sarvi, Majid	7	388	1389
Lenne, Michael G.	5	77	1122
Salmon, Paul M.	5	77	1122
Stanton, Neville A.	5	77	1122
Beanland, Vanessa	5	52	1038
Esztergar-Kiss, Domokos	5	56	995
Deveci, Muhammet	8	298	391
Pamucar, Dragan	5	89	337
Ceder, Avishai (Avi)	6	41	320
Liu, Tao	5	52	313
Cats, Oded	6	273	124

3.6. Future Trends of Public Transport and Decision-Making Publications

Numerous earlier studies have used a constrained methodology to pinpoint problems with public transportation. Recent discoveries by researchers that the majority of public transportation problems are connected, either directly or indirectly, have forced them to devise fresh methods for contemporary research and coin the term "decision-making" which encompasses and assesses the majority of public transportation problems. As was previously noted, a strongly trending period from 2005 to the 6th of April 2023 had 723 documents published in the WOS database.

The rise in publications and citations was one of the variables that influenced the authors of the current work to predict an increase in publications on public transportation and decision-making over the following five years. Additionally, this inquiry has shown a lack of conceptualization in the areas of investigating the procedures and network, evaluating transportation information, and other public

transportation-related characteristics. On the other hand, sustainable modes, accessibility, impacts, and the public transportation system were the main topics of publications on public transportation and decision-making. The categorization has made clear the necessity for additional research in the public transportation integration components that were highlighted in the current work, and it also predicts a rise in publications in these areas over the next five years.

4. Conclusion and Recommendations

One of the most prevalent problems worldwide is public transportation and making decision for the framework of it. Most studies and research are primarily concerned with travel time difficulties, which results in the ignoring of other factors. All public and private transportation-related concerns are covered, studied, and analyzed under the umbrella phrase "decision-making in transport." One of the many limitations this study has faced is the inability to discuss the use of public transportation in urban and rural areas. The purpose of the current assessment is to clarify the decision making of public transportation and demonstrate the need for additional research in this area. Also, the current effort has analyzed several areas that define the concept of transport and gather sufficient data.

This study has found that when examining public transportation decision-making, a few aspects, including sustainability, accessibility, models, and network system, must be taken into account. On the other hand, our research produced a number of useful suggestions for encouraging sustainable growth and development. Based on the quantity of existing publications and citations in the WOS database and the cluster categorization carried out by the VOSviewer software, growth in publications linked to public transport integration in several areas was projected in the current assessment.

The results of this study have confirmed the need of paying special attention to public transportation integration, which will be crucial in fully satisfying future demands for high-quality and efficient transportation.

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