

**Review Article****Bibliometric Analysis of Transit Ridership and the Built Environment****Maisarah Abdul Halim<sup>1,2</sup>, Teh Bor Tsong<sup>2\*</sup> and Nur Aulia Rosni<sup>2\*</sup>***<sup>1</sup>School of Geomatics Science and Natural Resources, College of Built Environment, Universiti Teknologi MARA, Malaysia**<sup>2</sup>Centre for Sustainable Urban Planning & Real Estate (SUPRE), Faculty of Built Environment, Universiti Malaya, Malaysia***ABSTRACT**

The rapid increase in urbanization calls for a thorough planning in the built environment to support public transportation ridership around the world. This review conducted a bibliometric analysis of the built environment and transit ridership from past literatures in the Web of Science (WOS) and Scopus databases. Both databases were merged to see its overview and then examined separately to see their differences. The results indicated the rapid growth of built environment and ridership studies in the past 30 years, with China being the most productive country. Top countries are followed by USA, Canada, and Australia. Using keywords, this study recognized themes in the existing research and highlighted the need to explore underrepresented themes such as other modes of transportation other than rail and the increased themes on big data analyses that include spatial and temporal data mining. The top source identified is Journal of Transport Geography, also having the highest level of local impact. This paper aims to provide reader with a comprehensive understanding on the existing literature, thereby offering novel perspectives that inspire researchers to undertake more investigations in collaboration with prominent institutions or authors, ultimately contributing to the advancement of spatial-temporal analysis domain.

*Keywords:* Bibliometric Analysis, Built Environment, Land Use Planning, Transit-Ridership, Spatial-Temporal Analysis,

**ARTICLE INFO***Article history:*

Received: 26 June 2025

Accepted: 28 April 2026

Published: July 2026

DOI: <https://doi.org/10.47836/AC.19.S1.PAPER09>*Email addresses:*[maisarahhalim@uitm.edu.my](mailto:maisarahhalim@uitm.edu.my) (Maisarah Abdul Halim)[tehbortsong@um.edu.my](mailto:tehbortsong@um.edu.my) (Teh Bor Tsong)[nurauliarosni@um.edu.my](mailto:nurauliarosni@um.edu.my) (Nur Aulia Rosni)

\* Corresponding author

**INTRODUCTION**

Built environment (BE) refers to the constructed physical surroundings in which people reside, work, and engage in various activities (Handy et al., 2002). Urban planners utilize a diverse array of terminologies to describe the constructed environment, and these terms are occasionally interchanged with “land use,” which pertains to the spatial distribution of activities (Handy et al., 2002). Knowledge

of the impact of the built environment on travel enables planners to integrate transport and land use more effectively. BE includes all structures, infrastructure, and spaces that have been designed, constructed, or altered by humans (Aston et al., 2021). The constructed environment can consist of structures, roads, parks, public spaces, transportation systems, and other man-made elements. This designed landscape significantly influences the liveability, functionality, and sustainability of communities. Ridership denotes the number of people who choose a particular mode of transportation. Measurement of public transport ridership or transit use usually involves getting data on the number of passengers using a variety of techniques.

Both the BE and Ridership data usually contain essential spatial and temporal information. The study of spatial temporal data mining is a continuous research effort, employing many advanced analytical approaches to investigate it (Chen et al., 2019; Cheng et al., 2012; Miller & Goodchild, 2015). By identifying the locations and time where data events have taken place, we can analyse their spatial correlation and address other inquiries related to location and time.

With urban areas witnessing rapid growth and a heightened focus on encouraging public transportation usage, it is essential to conduct a comprehensive investigation into the built environment (BE) variables that potentially influence ridership levels. Analyses of BE impacts on public transportation ridership have been implemented in various cities worldwide using diverse methodologies (Chen et al., 2019; Mützel & Scheiner, 2022). However, in Malaysia, there remains a significant lack of understanding regarding how the built environment affects ridership. This gap underscores the limited comprehension of the relationship between BE factors and public transportation ridership in scholarly discourse.

Various components of the BE that potentially influence ridership have been determined for multiple transportation in previous studies, such as taxi (Chen et al., 2021) and rail (Yang, 2023) from Shanghai and Chengdu, China respectively. By identifying and analysing these factors, urban planners, transportation authorities, and policymakers alike can gain valuable insights to better design and optimize transportation services, leading to improved public transportation usage and reduced congestion. This, in turn, can contribute to the optimization of service catchment areas.

The research findings for built environment and public transportation ridership have the potential to significantly impact urban development policies, promote the adoption of sustainable land use practices, and improve the accessibility and quality of services offered to communities, particularly by maximizing the usage of data and innovation in finding insights from spatial-temporal data.

## **METHODOLOGY**

### **Data Extraction**

The Web of Science (WoS) and Scopus Databases were extracted in this study to attain the data for research and bibliometric purposes. After engaging the topic search criteria and using keywords such as “built environment” or “land use”, and “ridership” or “passenger” on 13th Sep 2023, 2288 records were retrieved in WoS and another 1317 records in Scopus. Both databases were initially analysed in a merged database and then examined separately to see the overview of the records from both databases. This paper reported the results from both databases. After removal of any duplicates and leaving the records up till the year 2022, the recorded data for merged database is in the total of 2586 documents, from a total of 5708 authors worldwide. Earliest published was recorded from the year 1968. For studies based on the year 2000 onwards, the articles were recorded to be in a total of 2444 records.

### **Bibliometric Analysis**

Bibliometric analysis can be conducted using various software or packages namely CiteSpace, VOSviewer and R. In this study, the bibliometric analysis was achieved using the Bibliometrix Package in R (Aria & Cuccurullo, 2017). The methodology utilized in this research involves the utilization of tools that interprets the data obtained from the WOS and Scopus databases and were presented in diverse visual formats and tables. This research encompasses a comprehensive examination of the built environment and ridership articles, incorporating all relevant articles spanning the period mainly focused from 2000 to early 2022.

## **FINDINGS AND DISCUSSION**

### **General Trend**

The number of publications related to build environment and ridership were almost none from the first article published in year 1968, up till the 1990s as shown in Figure 1. It then began to rise significantly each year with minor fluctuations. The steady increase reported an annual growth rate of 9.9% followed by an increase in annual rate to 14.4% after the year 2000 as seen in plot in Figure 2.

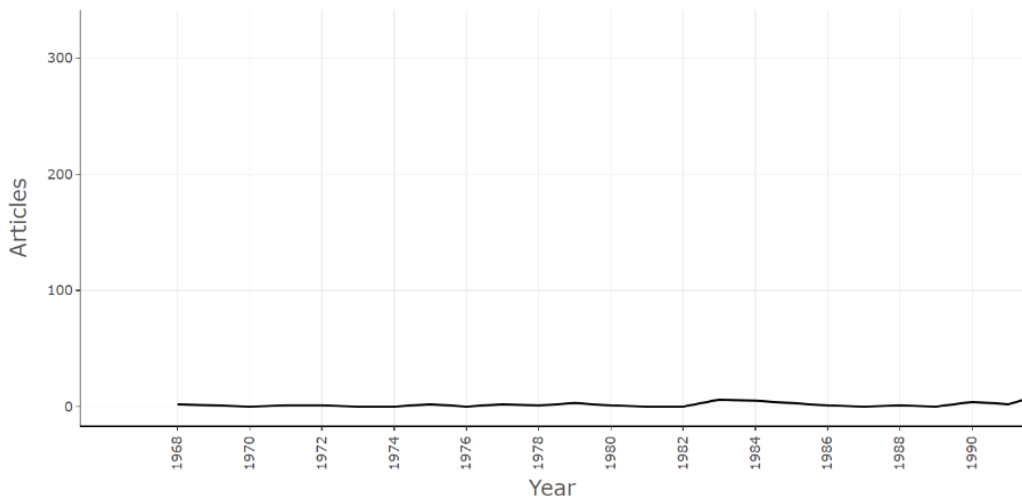


Figure 1. General publication trend from 1968 to 1990

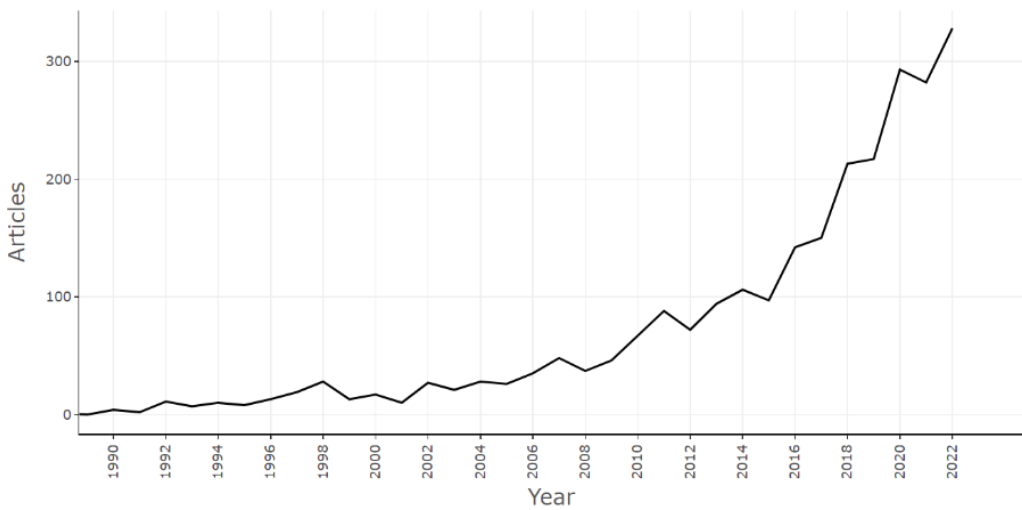


Figure 2. General publication trend from 1990 to 2022

In both WoS and Scopus, the merged database shows the top 20 countries with its number of articles as found in Table 1. China is in the top of the list followed by USA and Canada. In here we can see that Malaysia made it in the top 20 list with 26 published articles.

Table 1  
Top published countries

Country	Articles
China	653
USA	426
Canada	107



Table 2  
*Merged database top 20 keywords*

	<b>Units</b>	<b>Total Occurrences</b>
1	Public Transportation, Public Transit, Public Transport, Passenger Transport	146
2	Land Use	131
3	Built Environment	129
4	Transport, Transportation, Transit	101
5	Rail Transit, Rail, Metro, Urban Rail Transit	93
6	Ridership, Passenger, Transit Ridership	78
7	Transit-Oriented Development, TOD	76
8	Emissions, Greenhouse Gas Emissions, Energy Consumption, Air Pollution	56
9	Sustainability, Sustainable Development, Sustainable Transport	55
10	Accessibility	47
11	Smart Card Data, Big Data	45
12	Planning, Urban Planning	38
13	Machine Learning, Deep Learning	31
14	Travel Behaviour	30
15	Mobility, Urban Mobility	29
16	Urban, Urban Form	25
17	Geographically Weighted Regression	23
18	Environment	21
19	Covid-19	19
20	Mode Choice	17

### **Web of Science Trend**

Data retrieved in WoS and refined from year 2000 to 2022 recorded to have 2038 documents from the related search string. The annual growth rate shows a percentage of 14.91% in this database from a total of 5073 authors. In a three-field-plot found in Figure 4, Country was assigned as the middle field, Author in the left field, and the Keywords were categorized as the right field. A quantity of 10 items was chosen for each field. 8 top keywords were produced from this plot, which include built environment, land use, public transport, transit-oriented development, transportation, transport, ridership, and accessibility respectively. This can be seen that words are used interchangeably in these keywords, and accessibility being one of the top keywords.

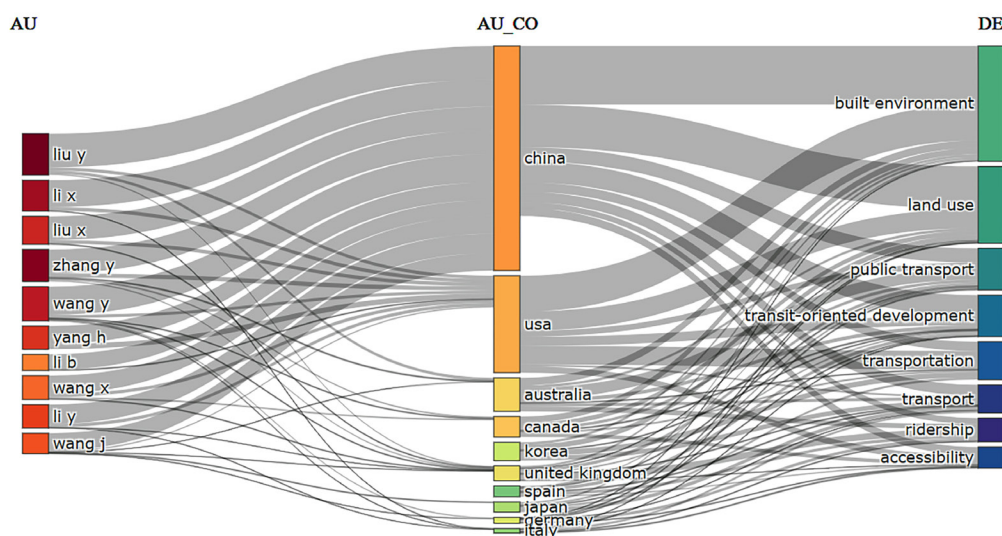


Figure 4. WoS three-field plot of authors (left), author county (Middle) and keywords (Right)

Relevant affiliations are shown in Table 3, a good opportunity to identify where can be targeted as relevant affiliation to collaborate with. Southeast University in Bangladesh has the highest number of articles, perhaps with its rapid urbanization rate in the country. It then proceeded with universities from China and Canada in the 2nd and 3rd affiliations respectively with most articles.

Table 3  
WoS top affiliations

Affiliation	Articles
Southeast University	132
Beijing Jiaotong University	86
University of Toronto	64
Southwest Jiaotong University	62
Beihang University	59
Tsinghua University	55
Tongji University	51
Chang’an University	49
University California Berkeley	49
Hong Kong Polytech University	44

In this WoS database, China, USA and Canada are in the Top 3 list for the top number of documents produced for corresponding author’s countries as shown in Figure 5. Over the period of 2000 to 2022, China has produced 1842 number of articles. All countries production generally increases over time for all the top countries.

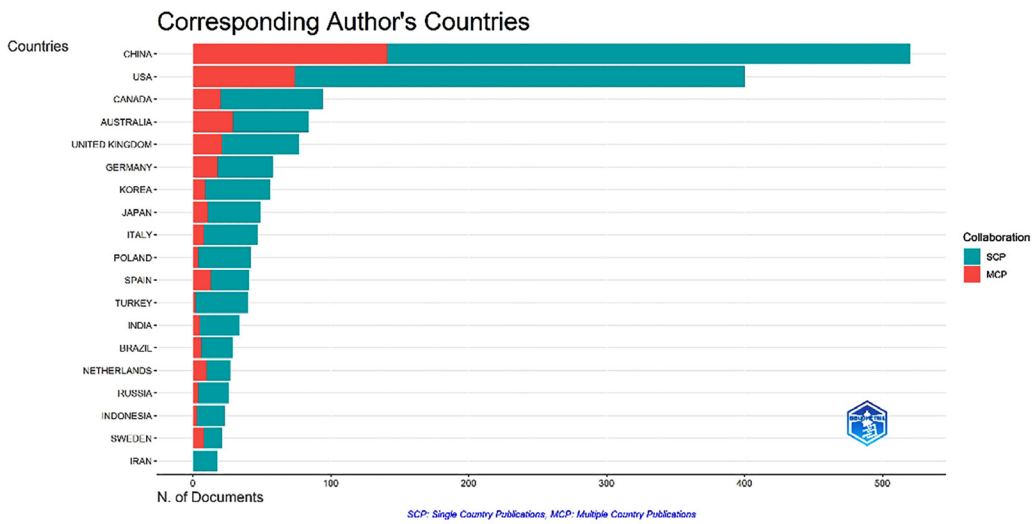


Figure 5. Top corresponding author’s countries

In terms as citation, USA tops the list as the most cited country, followed by China and Canada as seen in Figure 6.

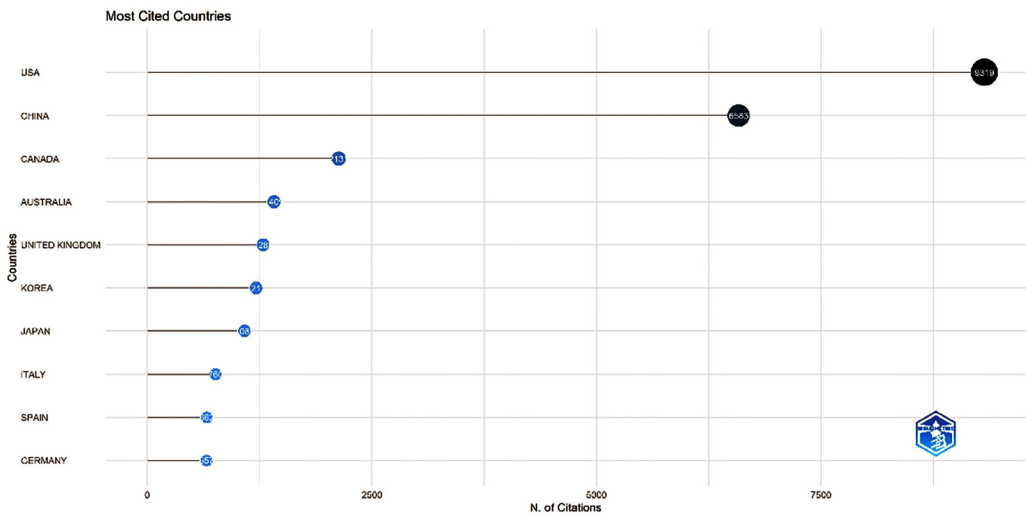


Figure 6. WoS most cited countries

Using keywords and looking at the trend over time, the terms have evolved over time from 2006 to 2022 as seen in Figure 7. One of the key findings here is that we can see how people have began to use the term Built Environment in addition to Land Use. We can also see how methodologies such as regression, deep learning and machine learning are being introduced as the new themes of research.

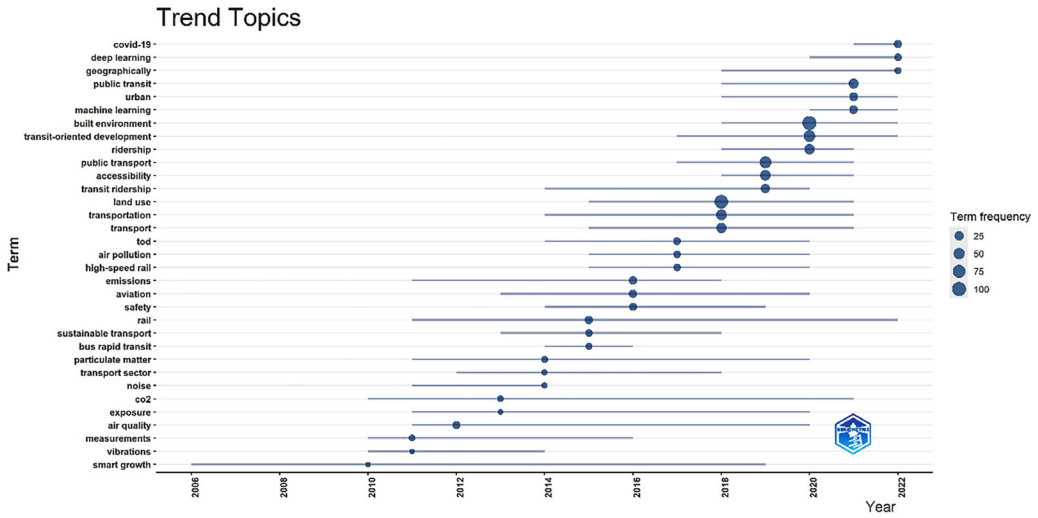


Figure 7. WoS trend topics

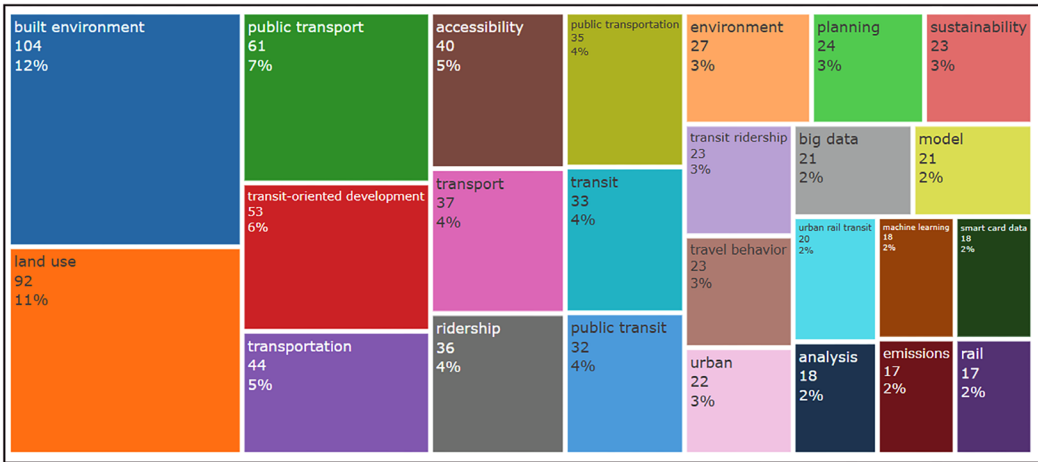


Figure 8. WoS keyword treemap

The percentage of usage for top identified keywords is shown in Figure 8, also showing the number of articles. For example, transit-oriented development has been mentioned in 53 articles, amounting to 6%. Figure 9 depicted the co-occurrence network of keywords used among published articles. Two main clusters that are land use and built environment show the interconnecting sub-themes in each cluster.



In Scopus, the list of Top Affiliations can be found in Table 4. The list of universities is slightly different than that of WoS, where other universities made it in the top 10 list such as University of Maryland and Monash University.

Table 4  
Scopus top affiliations

Affiliation	Articles
Southeast University	47
Beijing Jiaotong University	41
Southwest Jiaotong University	38
University of California	37
Tongji University	25
Wuhan University	24
Tsinghua University	23
University of Toronto	23
Monash University	20
University of Maryland	18

In the corresponding author's countries, unlike in WoS, Malaysia made in the top 20 list with 8 number of documents from Scopus database. As seen in Figure 11, China still dominates in the top. This proves the need for more publication in WoS for Malaysia.

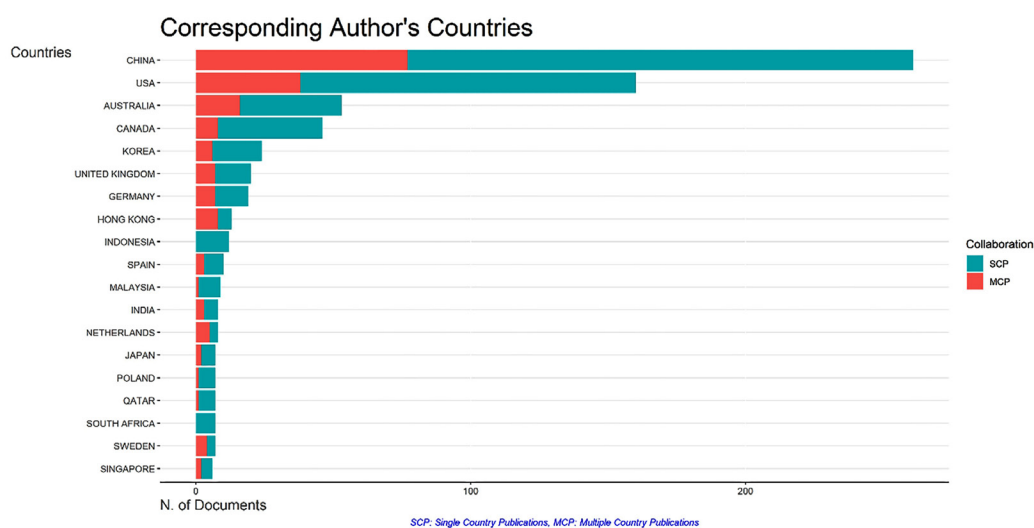


Figure 11. Scopus corresponding author's countries

Overall, both WoS and Scopus show similar top countries and themes therefore it is unnecessary to plot almost-identical results. In general, the most frequent words can be found in Wordcloud depicted in Figure 12. In Figure 13, the treemap shows the division of top keywords. The examination of keywords reveals authors or researchers' focus on a specific area of study.



Table 5

*Top WoS journal sources*

<b>Sources</b>	<b>Articles</b>
Journal of Transport Geography	96
Transportation Research Record	87
Sustainability	76
Transportation Research Part A-Policy and Practice	56
Transportation Research Part D-Transport and Environment	47
Transport Policy	31
Journal Of Advanced Transportation	29
Cities	25
Transportation	25
International Journal of Sustainable Transportation	17

However, there are a slight difference in the sources local impact by H-index as tabulated in Table 6. In here, it can be seen that Sustainability, although charts the top 3 in the most sources, the H-index is slightly lower which is 15. Overall, we can see that the Year Start are in various years, encompassing as early as 2002 and still evolving over time with increasing number of papers over the years as seen in Figure 14.

Table 6

*WoS local impact*

<b>Element</b>	<b>H-Index</b>	<b>No. of Papers</b>	<b>Year Start</b>
Journal of Transport Geography	33	96	2009
Transportation Research Part A-Policy and Practice	25	56	2004
Transportation Research Part D-Transport and Environment	21	47	2002
Transportation Research Record	17	87	2007
Cities	16	25	2011
Sustainability	15	76	2015
Transport Policy	15	31	2006
Journal of Cleaner Production	13	16	2017
Transportation	12	25	2002
Atmospheric Environment	11	12	2003

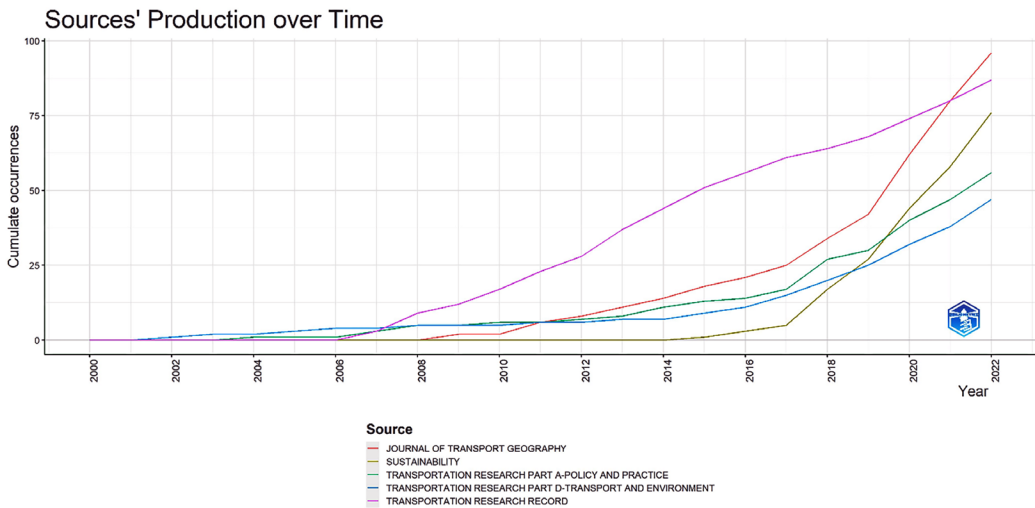


Figure 14. WoS source’s production over time

### Scopus Sources

Since high percentage of journals indexed in Web of Science are also indexed in Scopus (Singh et al., 2021), the list of top 10 journals in Scopus database is almost similar to that of WoS. Table 7 shows the list of top 10 sources in the Scopus database.

Table 7  
Top Scopus sources

Sources	Articles
Transportation Research Record	73
Journal of Transport Geography	59
Sustainability (Switzerland)	36
Transportation Research Part A: Policy and Practice	24
Transportation Research Part D: Transport and Environment	22
Transportation	20
Cities	17
Transportation Research Procedia	16
Transport Policy	15
Journal of Advanced Transportation	14

The H-Index local impact is lower than WoS as seen in Table 8, although the list of sources are almost similar. Sources production trend over time is similar to WoS.

Table 8

*Scopus local impact*

Element	H-Index	No. of Papers	Year Start
Journal of Transport Geography	26	59	2009
Transportation Research Part D: Transport and Environment	18	22	2005
Transportation Research Record	18	73	2000
Cities	13	17	2011
Transportation Research Part A: Policy and Practice	13	24	2004
Sustainability (Switzerland)	12	36	2016
Transport Policy	12	15	2006
Transportation	11	20	2002
Accident Analysis and Prevention	7	7	2019
Atmospheric Environment	7	7	2005

**Authors*****Web of Science Authors***

In terms of most relevant authors as seen in Figure 15, Liu Y charts the list with 29 publications published, followed by Zhang Y and Li X with 26 and 24 respectively. For the most locally cited author, Sung H is the most local cited author, the top in the list with 142 local citations.

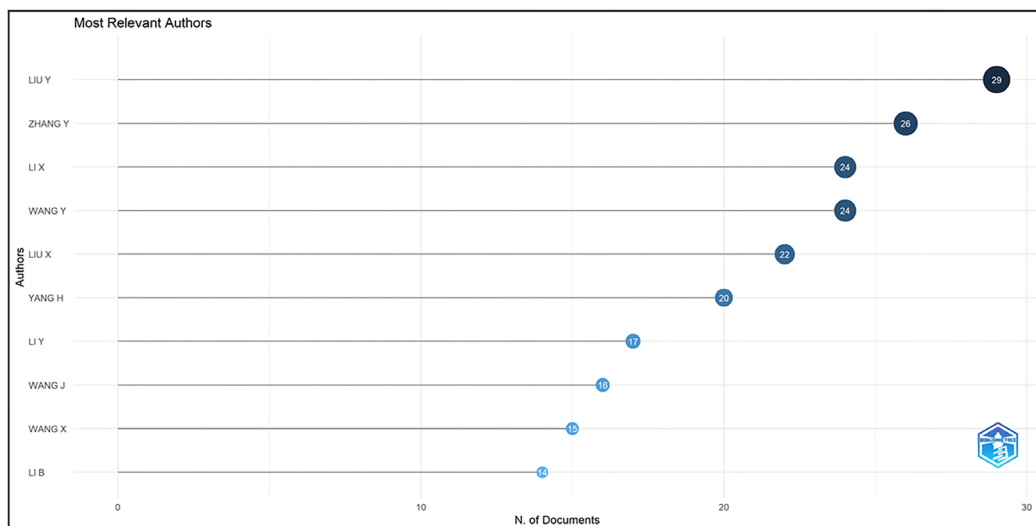


Figure 15. WoS most relevant authors and number of documents

***Scopus Authors***

As shown in Figure 16, In terms of most relevant authors in Scopus the list of names is almost familiar as ones observed in WoS with some additional new names. Yang H charts the list with 20 publications published, followed by Wang Y and Liu Y with 19 and 18 respectively.

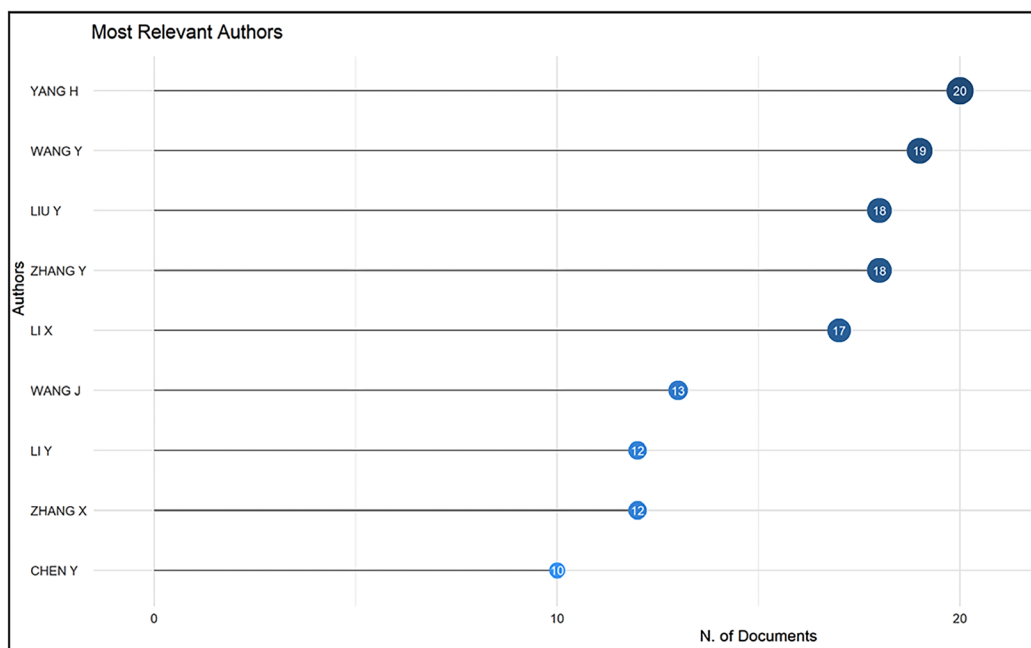


Figure 16. Scopus most relevant authors

## CONCLUSION AND DISCUSSION

This study offers an analysis of current trends and settings in the field of built environment and public transportation ridership research, drawing on a comprehensive review of scholarly literature sourced from prominent scientific databases that are WoS and Scopus. The trend is going up relatively fast and show the need to expand the study in specific authors' country which is Malaysia. The significant expansion of publications, especially during the past twenty years, highlights the growing focus on the impact of urban planning on public transportation usage. Through bibliometric approach, we have successfully identified the most significant and trustworthy sources pertaining to the built environment and ridership of public transit, such as Journal of Transport Geography. Growing countries in research concerning the built environment and transportation ridership were identified. China has been the biggest contributor to the field, succeeded by the USA, Canada, and Australia. This dominance illustrates the significant urbanisation issues confronting these nations, particularly in swiftly growing metropolitan areas like China. The nation's proactive investments in public transport infrastructure, especially train networks, could clarify its significant presence in the literature.

The analysis of themes using keywords and the identification of emerging or declining trends within this subject matter enable other researchers to identify the most noteworthy research gap, hence facilitating the exploration of the optimal solution. A notable observation is the under-representation of alternative transport modes, especially buses,

as well as developing mobility forms like ride-hailing and on-demand services. Current study predominantly focusses on rail transportation, with terms like “rail transit,” “metro,” and “urban rail transit” regularly exhibiting high frequency rankings. For example, there are a lot of rail studies among the most mentioned keywords, so there is a higher need for other modes of transportation such as bus or even ride-hailing or on-demand services. The function of rail as a fundamental component in urban transport networks within densely populated areas can be attributed to this attention. Bus services and other transit modalities that are adaptable are necessary for daily commuting in developing nations like Malaysia. Train network such as mass rapid transit (MRT) is still expanding in the country for residents to fully utilize; consequently, the use of feeder buses may help in increasing train ridership. This is by getting passengers further away from train station to get to train station such as MRT, complementing areas that are not covered by rail network. The influencing built environment to feeder bus ridership can be studied in the future.

From the themes we have also identified an increased topics on big data analyses that include spatial and temporal data mining. The overview that highlighted growing emphasis on big data and sophisticated analytical methodologies has included machine learning, deep learning, and geographically weighted regression. The aspect of spatial analysis is of utmost importance as built environment and transportation mainly involve geographic space. One of the top keywords identified is geographically weighted regression possibly being used as one of the methods in assessing spatial data. These methods are important for understanding the complicated time and space-based connections between the built environment and transit use. Previous studies by Chen et al. (2019) and Miller and Goodchild (2015) have illustrated the significance of built environment study in transportation usage and the importance of spatial-temporal analysis. The combination of these methods into future research can provide more detailed insights into how local surroundings, including walkability, land use diversity, and transit accessibility, influence daily ridership. Thus, subsequent research should investigate these domains more comprehensively, especially from a spatial-temporal perspective that might explain the dynamic patterns of ridership across various transportation modes.

In comparison with prior literature, this study offers a more extensive chronological analysis of the field’s progression from 1968 to 2022, in contrast to other reviews and meta-analyses (Aston et al., 2021). After 2000, global initiatives have focused on sustainable urban mobility as supported by Sustainable Development Goals. Keywords such as “emissions,” “energy consumption,” and “sustainability” indicate the required academics acknowledge in the necessity for public transit to improve mobility while simultaneously aiding in climate change mitigation efforts. The findings could also potentially aid aspiring researchers in identifying prospective collaborators from all over

the world. Both WoS and Scopus have similar top contributors, and Zhang Y contributed the most in the merged database. Spatial-temporal analysis is having an increased interest in themes worldwide, implying significant motivation to dive more into studies that can be done locally in developing country like Malaysia.

There are contributions of these findings for policymakers such that the analysis highlights the necessity of customising policies in transit infrastructure to specific built environment and environmental situations. For example, there are no specific guidelines in the selection of bus stations for feeder buses to gather more passengers to rail stations in Malaysia. Rail-based transit systems may have succeeded in certain dense urban nations, others, especially in the developing world like Malaysia, may derive more advantages from investments in feeder buses, bus rapid transit (BRT) systems or adaptable on-demand services. The expanding body of literature on transit-oriented development (TOD) stresses the necessity for organized urban and transportation planning. By establishing neighbourhoods that prioritise pedestrian accessibility to transit stations, reduce the duration of journeys, and promote a variety of land uses, urban areas can increase transit ridership (Handy et al., 2002). Such techniques are essential in heavily populated areas where traffic congestion and pollution are ongoing issue. All in all, investigations in this built environment and transportation field can directly influence policies that augment urban mobility, diminish greenhouse gas emissions, and elevate the general quality of life for urban inhabitants. This study delineates key trends and deficiencies in the literature, offering a framework for future research to tackle significant challenges in urban transport planning. For example, additional research on non-rail transportation modes, big data analytics, and spatial-temporal patterns can directly influence urban transit system design, enhancing inclusivity, efficiency, and sustainability.

## **ACKNOWLEDGEMENT**

Authors wish to thank and acknowledge the Ministry of Higher Education Malaysia and Universiti Teknologi MARA (UiTM) for their sponsorship throughout the study under the SLAB/SLAI Scholarship Scheme. Special thanks also go to colleagues in School of Geomatics Science and Natural Resources, College of Built Environment, UiTM and Centre for Sustainable Urban Planning & Real Estate (SUPRE) Universiti Malaya for providing facility and guidance that contributed to the achievement of this study.

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