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BIBLIOMETRIC ANALYSIS AND MAPPING OF ARTICLES PUBLISHED ON THE DEGREE OF URBANISATION METHOD IN THE SCOPUS DATABASE

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ABSTRACT

The United Nations Statistical Commission agreed in March 2020 to start using the Degree of Urbanisation as a method to delineate cities, urban, and rural areas to enable international statistical comparisons. The decision consequently promotes countries to change or align their classification and/or methods of urbanisation delineation. This is expected to increase the number of studies with “degree of urbanisation” or “urban classification” keywords around the world in line with the implementation of the method. **Aim:** This study aims to determine the research trends on the degree of urbanisation in the Scopus database from the year 2013 to 2022. **Methodology and Results:** The bibliometric method was applied through the VOSviewer software (version 1.6.18, Leiden University, Leiden, Netherlands) for the analysis. The findings showed that the topics related to the degree of urbanization are under represented in terms of the number of publications and contributing nations though the trend in the number of articles published in the Scopus database has annually increased from 2017-2021. **Conclusion, significance and impact study:** This implies there is a lot of potential regarding the publication of studies on the concept of “degree of urbanization”.

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1. INTRODUCTION

The world's urban population is increasing rapidly, where it was discovered in 1950 that 70% of the world's population lived in rural settlements while only 30% were in urban settlements (Leeson, 2018). The data from the World Bank, however, showed that the urban population has more than tripled in the last 50 years as indicated by an increase from 1.32 million people in 1970 which is 36.6% of the total population to 4.38 million, 56.15% of the total population people in 2020 (World Population Projections, n.d.). It was also estimated that 55% of the world's population will be living in cities by 2050 (OECD/European Commission 2020, European Union/FAO/UN-Habitat/OECD/The World Bank, 2021).

All the United Nations Member states endorsed the 2030 Agenda for Sustainable Development in 2015 to end poverty and bring the world on a path to peace, prosperity, and provide an opportunity for all on a healthy planet (United Nations, 2022). This implies 193 countries signed the agenda as an indication of their agreement to meet the 17 Sustainable Development Goals (SDGs) and 169 targets aimed at addressing the world's diverse and complex challenges faced by human kind in 2030 (Pradhan *et al.*, 2017).

The continuous urbanization of the world was observed to have made the realization of the SDGs, especially Goal 11: Sustainable Cities and Communities, to be difficult. Several countries are struggling to satisfy the needs of their fast-growing urban populations such as urban infrastructure, water supply, housing, transportation, energy systems, and others, as well as jobs and basic services. It was also reported that the demands of the growing population have created considerable problems for cities and become one of the most significant challenges for city management. It has been demonstrated that urbanisation has an impact on the urban population health caused by declining in the acreage of public open space in the city areas and the limited availability of urban infrastructures (Sharif & Ujang, 2021; Souza & Bueno, 2022). All of these problems become the most significant challenges for city management, due to the fact that the needs have grown far faster than public management capabilities (Souza *et al.*, 2022). The problem is projected to be even more difficult for low-and lower-middle-incomenations where urbanization is expected to accelerate at the same rate with constraints in financial capacities.

The accuracy of the data published by the UN concerning global urbanization and comparisons among countries is observed to be questionable in addition to the difficulty associated with the achievement of SDG 11 in several countries due to different specific reasons. It is important to note that the current global comparison of cities and urbanizations is through the data collected based on the definition of each nation without focusing on their disparities (Satterthwaite, 2010). This can, therefore, lead to bias or difficulty in ascertaining the actual trend due to the differences in these definitions (Bocquier 2005, United Nations, Department of Economic and Social Affairs 2018). The World Urbanization Prospects 2018 report published data on urban and rural populations and areas from 233 countries and approximately half of the definitions mentioned a minimum population size, either alone or in conjunction with other indicators or criteria. The most common thresholds used are 5,000 in 27 countries and 2,000 in 24 countries while Japan and China are the extreme examples with 50,000 and 100,000, respectively (United Nations, Department of Economic and Social Affairs 2018, Dijkstra *et al.*, 2018). Moreover, OECD classifies urban areas into four types which include large metropolitan areas with a population of 1.5 million or more, metropolitan areas with 500,000 to 1.5 million, medium-sized urban areas with 200,000 to 500,000, and small urban areas with 50,000 to 200,000. The organization further applied the population density with a threshold of 1,500 inhabitants per square km as part of the population size criteria in 2020 (OECD, 2020). Researchers from different countries have also formulated definitions to strengthen the consistency of their analysis (Satterthwaite, 2010). The combination of these different approaches is difficult due to the influence their definitions possibly have on the results, thereby, making the comparison of the most basic indicators such as population size and city area to be difficult.

The UN is expected to propose an internationally recognised definition or classification for urban areas in order to allow an effective comparison of urban trends and performance among different countries of the world. This is due to the fact that the UN urbanization report can provide a more accurate comparison analysis and information regarding the urban performance to be used in formulating development priority programmes or policies. Therefore, Dijkstra, L. *et al.*, (2018) introduced a new methodology called the degree of urbanisation during the 16th Conference of IOAS 19-23 September 2018, Paris, France to harmonise the definitions of an

urban area currently being applied globally. The United Nations Statistical Commission also promoted this Degree of Urbanisation in March 2020 as a method to delineate cities and urban and rural areas in order to facilitate international statistical comparisons. The development of this new method is to improve the comparability of urban and rural indicators considering the significant variations in the definitions proposed by different nations. This implies several Sustainable Development Goals (SDG) indicators can be assessed and analysed using this new method, thereby, allowing more reasonable and reliable comparisons between the urban and rural areas in any country (Dijkstra *et al.*, 2021).

The Degree of Urbanisation is a new method to capture the urban-rural continuum. It is not based on the administrative boundary but is designed to identify the type of areas on a 1 km² grid. This was achieved by classifying each grid cell as an urban center, an urban cluster, or a rural grid cell based on population density, population size, and proximity. "An urban center is defined as contiguous grid cells with a density of at least 1,500 inhabitants per square km and a total population of at least 50,000, an urban cluster is defined as contiguous grid cells with a density of at least 300 inhabitants per square km and a total population of at least 5,000, and rural grid cells are defined as neither" (Dijkstra *et al.*, 2021). Therefore, a city is an area where most of the population is in urban centers, a town or a suburb is where most of the population is in urban clusters, and a rural area is where most of the population is in rural grid cells. Most of the method's processes make use of the Geospatial Information Systems technology which allows for the mapping and the modelling of urban morphological parameters (Oyugi, 2020).

2. RESEARCH METHODOLOGY

A bibliometric approach was applied in this study to identify and analyse trends related to the research on the degree of urbanisation method. The Bibliometric analysis was applied for the quantitative and descriptive analysis of books, articles, or other publications (Price, 1976; Ellegaard and Wallin, 2015; Jia, Chen, and Wu, 2021; Souza *et al.*, 2022). The method has been recently used in several professional fields to visualize the status, characteristics, evolution, and development trend of knowledge (Bornmann and Mutz, 2015; Mingers and Leydesdorff, 2015; Souza *et al.*, 2022; Jia and Wu, 2021). It can measure production indices or research patterns and also to analyse the evolution, disposition, and structure of groups producing and using

literature (Ramos-Rodríguez and Ruiz-Navarro, 2004; Souza *et al.*, 2022). Moreover, the VOSviewer software (version 1.6.18, Leiden University, Leiden, Netherlands) designed specifically for the construction and visualization of bibliometric maps was used to present the results (Cobo *et al.*, 2011; Souza *et al.*, 2022). This enables cluster visualization which assumes that the group has a similar research approach (van Eck and Waltman, 2010; Souza *et al.*, 2022). It is important to note that the research process is in four stages of workflow which include data selection, data extraction, data analysis, and interpretation, and discussion and conclusion as indicated in Figure 1.

The selection of an appropriate database requires satisfying certain transparency requirements associated with bibliometric studies which include a set of implicit and explicit criteria for the documents (Herrera-Franco *et al.*, 2021). The use of the term "degree of urbanisation" in the urban and regional planning field is relatively new because it was approved by the United Nations Statistical Commission in 2020 to be used in defining and delineating cities as well as urban and rural areas in order to facilitate international statistical comparisons (Dijkstra *et al.*, 2021). Therefore, data were acquired using terms considered to have some similarities and/or close relations to the "degree of urbanisation".

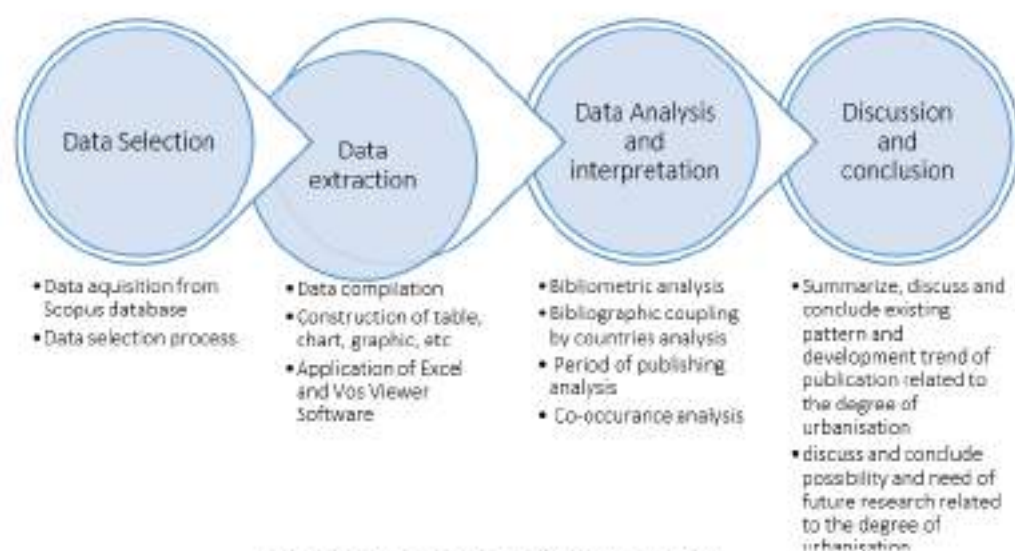


Figure 1 Four steps of bibliometric analysis

Data was collected online from Scopus scientific database on 7 February 2022 using the search terms "degree of urbani*" OR "urban classification" AND "urban area". The Scopus

database was selected based on its broad coverage of scientific documents reviewed by blind peers as well as its use as a platform that facilitates the export of bibliographic information (López-Muñoz F *et al.*, 2008; Ruban *et al.*, 2019). A total of 479 publications were found after the search.

The publications were further processed to focus more on the relevant and qualified data needed for this study which are related to urbanisation and methods of delineating urban-rural areas. The process involves filtering the data obtained from the first phase using some criteria such as the focus on those published in the past 10 years from 2013 to 2022 due to the fact that the term “degree of urbanisation” is relatively new, and this reduced the number of publications to 303. The search was further narrowed to the subject areas most related, among the available options in the VOSviewer software menu, to the urban and regional planning field that are “environmental science” and “earth and planetary sciences” and this led to the reduction of the publications to 156 documents. The final step was to limit these search to specific publicationssuch as “article journal”, “final publication”, and “English”, there by, leaving only 130 publications for the bibliometric analysis (see Figure 2).

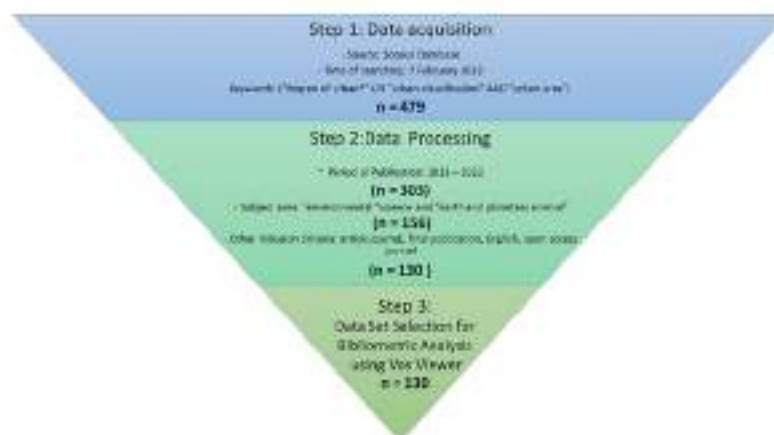


Figure 2 Data selection flow diagram

The VOSviewer software was used at the data extraction stage to process the selected data required for the construction and visualisation of the bibliometric network. The data were further screened and cleaned using the thesaurus file and verification menus in the software. The thesaurus file has the ability to merge different options of all items required to be analysed

such as the author name, organization name, country name, or a cited reference (van Eck and Waltman, 2010). It is also useful for data cleaning and standardising names or terms, especially those related to the research purpose (Ahmi, 2021).

3. RESULTS AND DISCUSSION

The Scopus journal database search produced only 130 English articles on the “degree of urbanisation” from 2013 to 2022 as previously stated. The average number of annual publications was observed to be below 15 but increased from 2017 up to 2022 as indicated in Figure 3. This phenomenon was associated with the introduction of the degree of urbanisation nomenclature by Dijkstra *et al.*, in 2018. Moreover, the number of publications in 2022 cannot be compared with the others because the data were collected in February and it is expected to exceed those recorded in 2021 in line with the global application of the method (Dijkstra *et al.*, 2021). It was discovered that there are very few publications on the subject even though there seems to be an increasing trend.

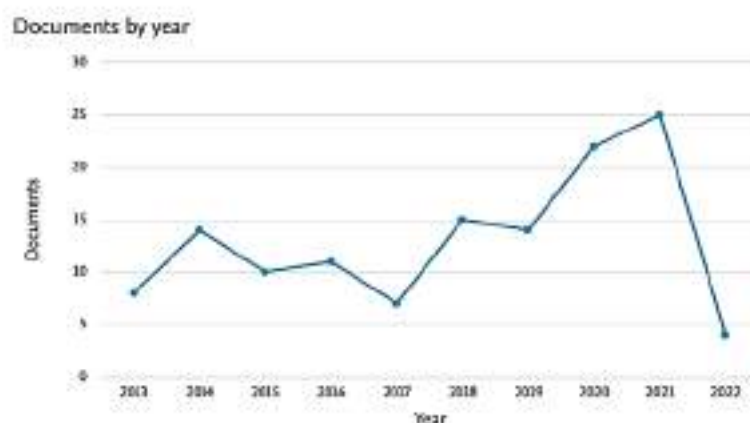


Figure 3 Development trend of published article from 2013 to 2022

Bibliographic coupling in VOSviewer also has the ability to quantify the references of a set of documents, especially the countries involved. This method was applied, and the findings showed that 51 countries have a threshold of at least one article and the top ten based on the number of articles published within the study period of 2012-2022 are presented in the following Table 1.

Table 1 Top 10 countries by the number of articles

Ranking	Country	Region*)	Documents	Citations	Total Link Strength
1	China	Asia Pacific	34	1018	14
2	United States	North America	22	534	16
3	Germany	Europe	13	508	11
4	Italy	Europe	12	218	2
5	Australia	Asia Pacific	8	261	5
6	United Kingdom	Europe	7	119	5
7	Brazil	South America	6	36	0
8	Poland	Europe	6	89	1
9	Spain	Europe	6	34	5
10	France	Europe	4	41	1

Note: *) Based on International Telecommunication Union (ITU), the UN

Table 1 shows that China has the highest number of articles with 34 followed by the United States with 22, Germany with 13, and Italy with 12. However, Europe was observed to have the highest number of publications based on the region with 6 countries out of the top 10. This simply indicates that the degree of urbanization term is better known in European countries. It was confirmed in Table 2 that most of the published articles are from the European Region. This can be associated with the fact that, first, the pioneers of the method, Dijkstra *et al.*, work in European universities and institutions. Secondly, it was developed in collaboration with the European Union (EU) and applied in several member countries.

Table 2 Countries with three or fewer publications

No. of Document	Region	Country
3	Europe	Denmark, Sweden, Finland
2	Europe	Austria, Belgium, Hungary, Iceland, Switzerland
	Asia Pacific	Japan, South Korea
	South America	Colombia, Mexico
	North America	Canada
	Africa	South Africa
1	Europe	Bosnia and Herzegovina, Croatia, Estonia, Netherlands, Norway, Portugal, Serbia, Slovakia, Slovenia, Turkey
	Asia Pacific	Hong Kong, India, Indonesia, Nepal, New Zealand, Taiwan, Vietnam
	South America	Chile, Costa Rica, Ecuador
	Middle East	United Arab Emirates, Egypt, Iran, and Israel
	Africa	Ghana, Nigeria

The bibliographical analysis of countries can be used to demonstrate the existing interconnection between them. This is indicated by the symbolization of countries by nodes and their relationships by the line connecting the nodes. Moreover, the size of the node is a function of the number of documents while a shorter line between two nodes indicates a closer relationship between the publications of the two countries (Guo *et al.*, 2019). The linkages between the top 10 countries with a minimum of 4 documents are presented in Figure 4 and it was discovered that they form 3 main clusters, 35 links, and 1,353 total link strength. Every cluster is shown with a different colour. Cluster 1, red, consists of Australia, Brazil, China, Germany, and the United Kingdom; Cluster 2, green, consists of France, Poland, and the United States, and Cluster 3, blue, consists of Italy and Spain. The findings showed that Cluster 1 has the strongest relationship with China, Germany, and Australia observed to have the best productivity and number of citations. It also seems wider in terms of regional relations by covering 3 regions which include Asia Pacific (Australia and China), South America (Brazil), and Europa (Germany and the United Kingdom). Meanwhile, Cluster 2 covers Europe (France and Poland) and North America (United States), and Cluster 3 only covers Europe. The relationship between countries in Cluster 1 appears to have more significant implications on the design of programmes to promote international research collaboration and knowledge diffusion (Syarif 2020). Moreover, a common inter-regional collaboration phenomenon is observed in the three clusters despite the continuous encouragement of globalization. This is indicated by the increase in regional collaboration in the last five decades in comparison to international collaborations. The communities collaborating globally before the year 2,000 were frequently based on historical, geopolitical, or colonial lines but the trend has changed in recent years with the increasing alignment observed to be associated with the simple division of countries by region (Syarif, 2020). The application of the degree of urbanization method globally is expected to discontinue the collaboration based on the historical, geopolitical, and colonial lines. This trend is observed from the formation of very strong relations between China, Germany, and the United States representing the Asia Pacific, Europe, and North America regions respectively as indicated in Figure 4 where each has 9 links. The links show that they have relations with other most productive countries.

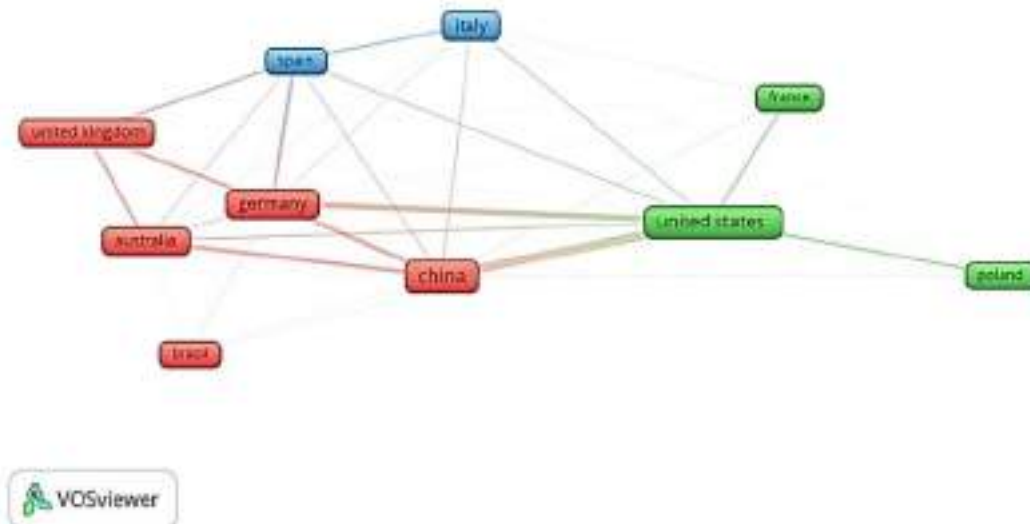


Figure 4 Relationship between the top 10 countries

The publications were further explored to determine the relationships between the 51 countries with at least one publication based on the detailed total documents, citations, and total links strength in each cluster as indicated in Table 3. It is important to note that the number of clusters formed is 10 and the top 10 countries were discovered to be spread in almost all clusters except in Clusters 7, 9, and 10.

The bibliometric analysis of the 51 countries indicates 10 clusters, 281 links indicating the relationship between countries, and 4,149 total link strength as presented in Figure 5. It is important to note that three countries or nodes were excluded by the VOSviewer because they are not connected. This signifies the largest set of connected countries only consists of 48 countries excluding Croatia, Slovenia, and Slovakia.

The relationship between the clusters seems to be very strong except for clusters 7, 9, and 10, and tends to be oriented toward the US, China, and Germany. These three countries more or less influence the orientation of the academic mindset and knowledge globally as indicated by the fact that their publications are mostly cited by authors from other countries. It is very fortunate that the three countries also show very strong relations and represent different regions which are North America, Europe, and the Asia Pacific.

Table 3 Countries, total documents, citation, and total links strength in each cluster

Cluster	No. of Country	Country	Documents	Region	Citations	Total Link Strength
1	11	Austria	2	Europe	28	239
		Brazil	6	South America	36	21
		Ecuador	1	South America	1	201
		Hungary	2	Europe	53	100
		Iran	1	Asia Pacific	2	12
		Israel	1	Europe	26	44
		Mexico	2	South America	36	36
		Netherlands	1	Europe	5	148
		Nigeria	1	Africa	5	148
		South Africa	2	Africa	14	40
		Spain	6	Europe	34	405
2	9	Bosnia and Herzegovina	1	Europe	2	7
		Estonia	1	Europe	0	95
		Finland	3	Europe	41	248
		Iceland	2	Europe	105	220
		Italy	12	Europe	218	179
		Poland	6	Europe	89	73
		Portugal	1	Europe	1	9
		Serbia	1	Europe	1	7
		Sweden	3	Europe	54	248
3	8	Canada	2	North America	35	100
		China	34	Asia Pacific	1018	953
		Egypt	1	Arab States	1	7
		Hong Kong	1	Asia Pacific	9	5
		Taiwan	1	Asia Pacific	34	5
		Turkey	1	Europe	84	96
		United Arab Emirates	1	Arab States	1	91
		4	4	Chile	1	South America
Germany	13			Europe	508	985
India	1			Asia Pacific	10	49
Indonesia	1			Asia Pacific	15	69
5	4	South Korea	2	Asia Pacific	27	83
		Switzerland	2	Europe	49	117
		United States	22	North America	534	1066
		Vietnam	1	Asia Pacific	38	17
6	3	Colombia	2	South America	0	36
		Costa Rica	1	South America	0	33
		France	4	Europe	41	64
7	3	Japan	2	Asia Pacific	3	119
		Nepal	1	Asia Pacific	2	119
		Tunisia	1	Arab States	2	119
8	3	Australia	8	Asia Pacific	261	423
		New Zealand	1	Asia Pacific	74	137
		United Kingdom	7	Europe	119	377
9	2	Denmark	3	Europe	49	284
		Ghana	1	Africa	2	40
10		Belgium	2	Europe	122	77
		Norway	1	Europe	28	73

Note: The country in bold indicates the top countries

Bibliometric Analysis and Mapping of Articles Published on the Degree of Urbanisation Method in the Scopus Database

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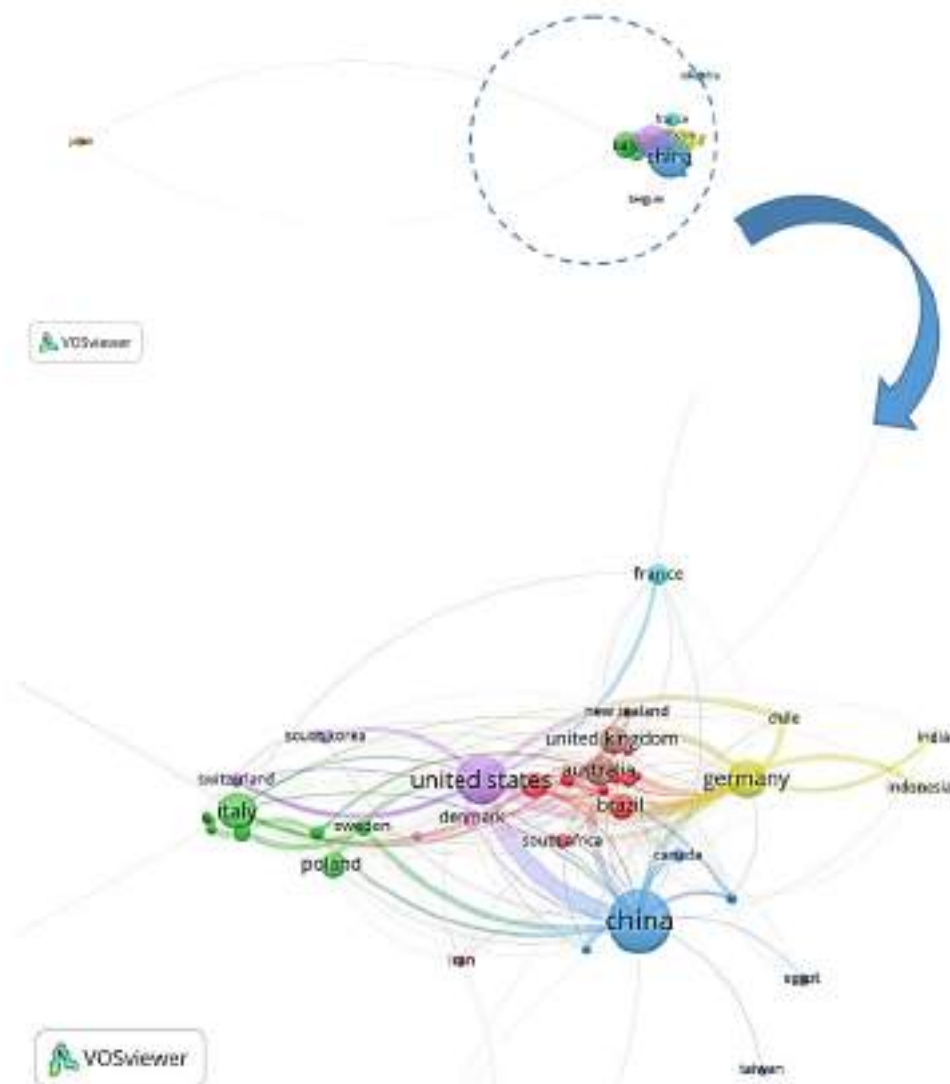


Figure 5 Bibliometric analysis of 51 countries

The development map of publications on the degree of urbanisation subject in the world is indicated by the distribution pattern of 51 countries that have contributed at least 1 article as presented in Figure 6. It was discovered that the research on this concept has been almost spread around the world with the Middle Eastern and African regions observed to be a bit slow to respond to this new method of urban classification. It is, however, important to show an

analysis with the ability to show keywords and their connections in order to form a network to display those appearing most frequently in the field of study (Herrera-Franco *et al.*, 2021).

A total of 1,886 keywords were found in the database but only 16 occurred in the documents at least 10 times. The keywords were observed in 3 Clusters with 16 nodes, 106 links, and a total link strength of 919 as indicated in Figure 7. Cluster 1 seems to have more discussion on the process, physical form, and impacts of urbanisation as indicated by keywords such as Urban Areas, Urbanisation, City, Rural Area, Environmental Impact Assessment, and Pollution. Cluster 3 consists of ecosystem services, urban ecology, urban planning, and watershed which are keywords considered to be mostly included in the urban and regional science field. Meanwhile, Cluster 2 was observed to be related to terms such as GIS, Land Use, Methods, Population, and Urban Growth.

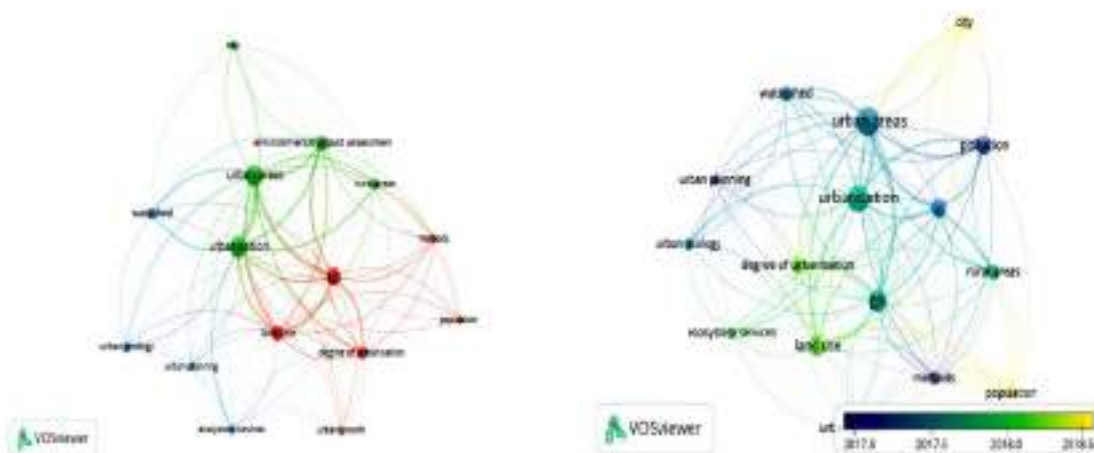


Figure 7 Co-occurrence network of all keywords and overlay visualisation

The term 'degree of urbanisation' occurred in 28 documents and has a relationship with 15 nodes, thereby, indicating its link with all keywords in Clusters 1, 2, and 3. It was observed to have appeared in Cluster 2 with eight other terms including GIS, Land Use, Methods, Population, and Urban Growth. These terms are associated with the application of the method in a specific location or country on the national, province, or local scales. This denotes the progressive adoption of the term by researchers and national and international institutions have the ability to significantly improve international comparability in line with Principle number 9 of Fundamental Principles of the UN Official Statistics which states that the "use of

international standards by statistical agencies in each country concerning international concepts, classifications, and methods promotes the consistency and efficiency of statistical systems at all official levels" (United Nations, 2013) as adopted from (Dijkstra *et al.*, 2021).

Table 4 Results of the co-occurrence network of author keywords

Cluster	All Keywords	Occurrences	Total link strength	Average Publication Year
1	City	13	48	2018
	Environmental Impact Assessment	38	166	2017
	Pollution	37	155	2017
	Rural Areas	22	90	2017
	Urban Areas	76	277	2017
	Urbanisation	73	238	2017
2	Degree Of Urbanisation	28	100	2018
	GIS	54	185	2017
	Land Use	45	179	2018
	Methods	16	73	2017
	Population	11	45	2018
	Urban Growth	11	39	2017
3	Ecosystem Services	12	55	2018
	Urban Ecology	17	57	2017
	Urban Planning	10	44	2017
	Watershed	21	87	2017

The "degree of urbanisation" needs further development considering the fact the use of the term and other related keywords were mostly published in 2017 or later as shown in Table 4. Therefore, it is very necessary and important for the academic community in each country, especially UN members, to conduct research related to the degree of urbanization and determine its impact on new urban classification and delineation to local and national urban statistical data as well as its implications for urban policies, plans, and programmes.

4. CONCLUSION

The Degree of Urbanisation is a new method developed to define cities, urban, and rural areas. It was launched in 2017 by Dijkstra *et al.*, and has since been supported by the United Nation

Statistical Commission to be used globally in providing more accurate national statistical comparisons. The relative newness of this method led to the conduct of this study to explore the articles published concerning the term in the Scopus database over the last 10 years using bibliometric analysis. A total of 130 articles were observed to have been published in English from 2013 to 2022 with only 51 countries from Europe, Asia Pacific, and North America observed to have contributed more out of the 193 UN member states. The analysis showed the need for further studies on the degree of urbanisation method as well as the implications and/or impacts of its application on national, provincial, or local scales of any country.

Certain limitations were observed in this study which includes the (i) exclusive use of only the Scopus database despite the existence of others such as the Web of Science and (ii) non-consideration of publications in other languages except English. These limitations are recommended to be considered in broadening the scope of future research.

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BIBLIOMETRIC ANALYSIS AND MAPPING OF ARTICLES PUBLISHED ON THE DEGREE OF URBANISATION METHOD IN THE SCOPUS DATABASE

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ABSTRACT

The United Nations Statistical Commission agreed in March 2020 to start using the Degree of Urbanisation as a method to delineate cities, urban, and rural areas to enable international statistical comparisons. The decision consequently promotes countries to change or align their classification and/or methods of urbanisation delineation. This is expected to increase the number of studies with "degree of urbanisation" or "urban classification" keywords around the world in line with the implementation of the method. **Aim:** This study aims to determine the research trends on the degree of urbanisation in the Scopus database from the year 2013 to 2022. **Methodology and Results:** The bibliometric method was applied through the VOSviewer software (version 1.6.18, Leiden University, Leiden, Netherlands) for the analysis. The findings showed that the topics related to the degree of urbanization are under represented in terms of the number of publications and contributing nations though the trend in the number of articles published in the Scopus database has annually increased from 2017-2021. **Conclusion, significance and impact study:** This implies there is a lot of potential regarding the publication of studies on the concept of "degree of urbanization".

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KEYWORDS

- Bibliometric analysis
- Degree of urbanization
- Urbanisation delineation
- VOSviewer

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1. INTRODUCTION

The world's urban population is increasing rapidly, where it was discovered in 1950 that 70% of the world's population lived in rural settlements while only 30% were in urban settlements (Leeson, 2018). The data from the World Bank, however, showed that the urban population has more than tripled in the last 50 years as indicated by an increase from 1.32 million people in 1970 which is 36.6% of the total population to 4.38 million, 56.15% of the total population people in 2020 (World Population Projections, n.d.). It was also estimated that 55% of the world's population will be living in cities by 2050 (OECD/European Commission 2020, European Union/FAO/UN-Habitat/OECD/The World Bank, 2021).

All the United Nations Member states endorsed the 2030 Agenda for Sustainable Development in 2015 to end poverty and bring the world on a path to peace, prosperity, and provide an opportunity for all on a healthy planet (United Nations, 2022). This implies 193 countries signed the agenda as an indication of their agreement to meet the 17 Sustainable Development Goals (SDGs) and 169 targets aimed at addressing the world's diverse and complex challenges faced by human kind in 2030 (Pradhan et al., 2017).

The continuous urbanization of the world was observed to have made the realization of the SDGs, especially Goal 11: Sustainable Cities and Communities, to be difficult. Several countries are struggling to satisfy the needs of their fast-growing urban populations such as urban infrastructure, water supply, housing, transportation, energy systems, and others, as well as jobs and basic services. It was also reported that the demands of the growing population have created considerable problems for cities and become one of the most significant challenges for city management. It has been demonstrated that urbanisation has an impact on the urban population health caused by declining in the acreage of public open space in the city areas and the limited availability of urban infrastructures (Sharif & Ujang, 2021; Souza & Bueno, 2022). All of these problems become the most significant challenges for city management, due to the fact that the needs have grown far faster than public management capabilities (Souza et al., 2022). The problem is projected to be even more difficult for low-and lower-middle-incomenations where urbanization is expected to accelerate at the same rate with constraints in financial capacities.

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The accuracy of the data published by the UN concerning global urbanization and comparisons among countries is observed to be questionable in addition to the difficulty associated with the achievement of SDG 11 in several countries due to different specific reasons. It is important to note that the current global comparison of cities and urbanizations is through the data collected based on the definition of each nation without focusing on their disparities (Satterthwaite, 2010). This can, therefore, lead to bias or difficulty in ascertaining the actual trend due to the differences in these definitions (Bocquier, 2005, United Nations, Department of Economic and Social Affairs 2018). The World Urbanization Prospects 2018 report published data on urban and rural populations and areas from 233 countries and approximately half of the definitions mentioned a minimum population size, either alone or in conjunction with other indicators or criteria. The most common thresholds used are 5,000 in 27 countries and 2,000 in 24 countries while Japan and China are the extreme examples with 50,000 and 100,000, respectively (United Nations, Department of Economic and Social Affairs 2018, Dijkstra *et al.*, 2018). Moreover, OECD classifies urban areas into four types which include large metropolitan areas with a population of 1.5 million or more, metropolitan areas with 500,000 to 1.5 million, medium-sized urban areas with 200,000 to 500,000, and small urban areas with 50,000 to 200,000. The organization further applied the population density with a threshold of 1,500 inhabitants per square km as part of the population size criteria in 2020 (OECD, 2020). Researchers from different countries have also formulated definitions to strengthen the consistency of their analysis (Satterthwaite, 2010). The combination of these different approaches is difficult due to the influence their definitions possibly have on the results, thereby, making the comparison of the most basic indicators such as population size and city area to be difficult.

The UN is expected to propose an internationally recognised definition or classification for urban areas in order to allow an effective comparison of urban trends and performance among different countries of the world. This is due to the fact that the UN urbanization report can provide a more accurate comparison analysis and information regarding the urban performance to be used in formulating development priority programmes or policies. Therefore, Dijkstra, L. *et al.*, (2018) introduced a new methodology called the degree of urbanisation during the 16th Conference of IOAS 19-23 September 2018, Paris, France to harmonise the definitions of an

urban area currently being applied globally, the United Nations Statistical Commission also promoted this Degree of Urbanisation in March 2020 as a method to delineate cities and urban and rural areas in order to facilitate international statistical comparisons. The development of this new method is to improve the comparability of urban and rural indicators considering the significant variations in the definitions proposed by different nations. This implies several Sustainable Development Goals (SDG) indicators can be assessed and analysed using this new method, thereby, allowing more reasonable and reliable comparisons between the urban and rural areas in any country (Dijkstra et al., 2021).

The Degree of Urbanisation is a new method to capture the urban-rural continuum. It is not based on the administrative boundary but is designed to identify the type of areas on a 1 km² grid. This was achieved by classifying each grid cell as an urban center, an urban cluster, or a rural grid cell based on population density, population size, and proximity. "An urban center is defined as contiguous grid cells with a density of at least 1,500 inhabitants per square km and a total population of at least 50,000, an urban cluster is defined as contiguous grid cells with a density of at least 300 inhabitants per square km and a total population of at least 5,000, and rural grid cells are defined as neither" (Dijkstra et al., 2021). Therefore, a city is an area where most of the population is in urban centers, a town or a suburb is where most of the population is in urban clusters, and a rural area is where most of the population is in rural grid cells. Most of the method's processes make use of the Geospatial Information Systems technology which allows for the mapping and the modelling of urban morphological parameters (Dyugi, 2020).

2. RESEARCH METHODOLOGY

A bibliometric approach was applied in this study to identify and analyse trends related to the research on the degree of urbanisation method. The Bibliometric analysis was applied for the quantitative and descriptive analysis of books, articles, or other publications (Price, 1976; Eilegaard and Wallin, 2015; Jia, Chen, and Wu, 2021; Souza et al., 2022). The method has been recently used in several professional fields to visualize the status, characteristics, evolution, and development trend of knowledge (Bormann and Mutz, 2015; Mingers and Leydesdorff, 2015; Souza et al., 2022; Jia and Wu, 2021). It can measure production indices or research patterns and also to analyse the evolution, disposition, and structure of groups producing and using

literature (Ramos-Rodriguez and Ruiz-Navarro, 2004; Souza et al., 2022). Moreover, the VOSviewer software (version 1.6.18, Leiden University, Leiden, Netherlands) designed specifically for the construction and visualization of bibliometric maps was used to present the results (Cobo et al., 2011; Souza et al., 2022). This enables cluster visualization which assumes that the group has a similar research approach (van Eck and Waltman, 2010; Souza et al., 2022). It is important to note that the research process is in four stages of workflow which include data selection, data extraction, data analysis, and interpretation, and discussion and conclusion as indicated in Figure 1.

The selection of an appropriate database requires satisfying certain transparency requirements associated with bibliometric studies which include a set of implicit and explicit criteria for the documents (Herrera-Franco et al., 2021). The use of the term "degree of urbanisation" in the urban and regional planning field is relatively new because it was approved by the United Nations Statistical Commission in 2020 to be used in defining and delineating cities as well as urban and rural areas in order to facilitate international statistical comparisons (Dijkstra et al., 2021). Therefore, data were acquired using terms considered to have some similarities and/or close relations to the "degree of urbanisation".

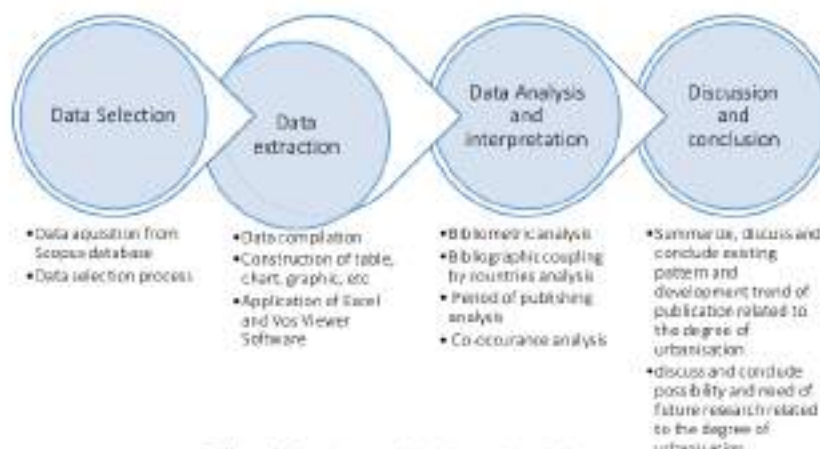


Figure 1 Four steps of bibliometric analysis

Data was collected online from Scopus scientific database on 7 February 2022 using the search terms "degree of urbanisation" OR "urban classification" AND "urban area". The Scopus

database ¹ was selected based on its broad coverage of scientific documents reviewed by blind peers as well as its use as a platform that facilitates the export of bibliographic information (López-Muñoz F. *et al.*, 2008; Ruban *et al.*, 2019). A total of 479 publications were found after the search.

The publications were further processed to focus more on the relevant and qualified data needed for this study which are related to urbanisation and methods of delineating urban-rural areas. The process involves filtering the data obtained from the first phase using some criteria such as the focus on those published in the past 10 years from 2013 to 2022 due to the fact that the term "degree of urbanisation" is relatively new, and this reduced the number of publications to 303. The search was further narrowed to the subject areas most related, among the available options in the VOSviewer software menu, to the urban and regional planning field that are "environmental science" and "earth and planetary sciences" and this led to the reduction of the publications to 156 documents. The final step was to limit the search to specific publications such as "article journal", "final publication", and "English", there by, leaving only 130 publications for the bibliometric analysis (see Figure 2).



Figure 2 Data selection flow diagram

The VOSviewer software was used at the data extraction stage to process the selected data required for the construction and visualisation of the bibliometric network. The data were further screened and cleaned using the thesaurus file and verification menus in the software. The thesaurus file has the ability to merge different options of all items required to be analysed

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such as the author name, organization name, country name, or a cited reference (van Eck and Waltman, 2010). It is also useful for data cleaning and standardising names or terms, especially those related to the research purpose (Ahmi, 2021).

3. RESULTS AND DISCUSSION

The Scopus journal database search produced only 130 English articles on the “degree of urbanisation” from 2013 to 2022 as previously stated. The average number of annual publications was observed to be below 15 but increased from 2017 up to 2022 as indicated in Figure 3. This phenomenon was associated with the introduction of the degree of urbanisation nomenclature by Dijkstra et al., in 2018. Moreover, the number of publications in 2022 cannot be compared with the others because the data were collected in February and it is expected to exceed those recorded in 2021 in line with the global application of the method (Dijkstra et al., 2021). It was discovered that there are very few publications on the subject even though there seems to be an increasing trend.

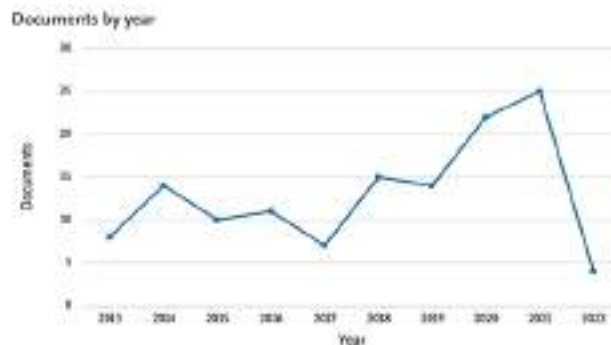


Figure 3 Development trend of published article from 2013 to 2022

Bibliographic coupling in VOSviewer also has the ability to quantify the references of a set of documents, especially the countries involved. This method was applied, and the findings showed that 51 countries have a threshold of at least one article and the top ten based on the number of articles published within the study period of 2012-2022 are presented in the following Table 1.

**Bibliometric Analysis and Mapping of Articles Published
on the Degree of Urbanisation Method in the Scopus Database**

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Table 1 Top 10 countries by the number of articles

Ranking	Country	Region*	Documents	Citations	Total Link Strength
1	China	Asia Pacific	34	1018	14
2	United States	North America	22	534	16
3	Germany	Europe	13	508	11
4	Italy	Europe	12	218	2
5	Australia	Asia Pacific	8	261	5
6	United Kingdom	Europe	7	119	5
7	Brazil	South America	6	36	0
8	Poland	Europe	6	89	1
9	Spain	Europe	6	34	5
10	France	Europe	4	41	1

Note: *) Based on International Telecommunication Union (ITU), the UN

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Table 1 shows that China has the highest number of articles with 34 followed by the United States with 22, Germany with 13, and Italy with 12. However, Europe was observed to have the highest number of publications based on the region with 6 countries out of the top 10. This simply indicates that the degree of urbanization term is better known in European countries. It was confirmed in Table 2 that most of the published articles are from the European Region. This can be associated with the fact that, first, the pioneers of the method, Dijkstra et al., work in European universities and institutions. Secondly, it was developed in collaboration with the European Union (EU) and applied in several member countries.

Table 2 Countries with three or fewer publications

No. of Document	Region	Country
3	Europe	Denmark, Sweden, Finland
2	Europe	Austria, Belgium, Hungary, Iceland, Switzerland
	Asia Pacific	Japan, South Korea
	South America	Colombia, Mexico
	North America	Canada
	Africa	South Africa
1	Europe	Bosnia and Herzegovina, Croatia, Estonia, Netherlands, Norway, Portugal, Serbia, Slovakia, Slovenia, Turkey
	Asia Pacific	Hong Kong, India, Indonesia, Nepal, New Zealand, Taiwan, Vietnam
	South America	Chile, Costa Rica, Ecuador
	Middle East	United Arab Emirates, Egypt, Iran, and Israel
	Africa	Ghana, Nigeria

The bibliographical analysis of countries can be used to demonstrate the existing interconnection between them. This is indicated by the symbolization of countries by nodes and their relationships by the line connecting the nodes. Moreover, the size of the node ¹ is a function of the number of documents while a shorter line between two nodes indicates a closer relationship between the publications of the two countries (Guo et al., 2019). The linkages between the top 10 countries with a minimum of 4 documents are presented in Figure 4 and it was discovered that they form 3 main clusters, 35 links, and 1,353 total link strength. Every cluster is shown with a different colour. Cluster 1, red, consists of Australia, Brazil, China, Germany, and the United Kingdom; ¹⁵ Cluster 2, green, consists of France, Poland, and the United States, ¹⁵ and Cluster 3, blue, consists of Italy and Spain. The findings showed that Cluster 1 has the strongest relationship with China, Germany, and Australia observed to have the best productivity and number of citations. It also seems wider in terms of regional relations by covering 3 regions which include Asia Pacific (Australia and China), South America (Brazil), and Eurcpa (Germany and the United Kingdom). Meanwhile, Cluster 2 covers Europe (France and Poland) and North America (United States), and Cluster 3 only covers Europe. The relationship between countries in Cluster 1 appears to have more significant implications on the design of ¹⁸ programmes to promote international research collaboration and knowledge diffusion (Syarif 2020). Moreover, a common inter-regional collaboration phenomenon is observed in the three clusters despite the continuous encouragement of globalization. This is indicated by the increase in regional collaboration in the last five decades in comparison to international collaborations. The communities collaborating globally before the year 2,000 were frequently based on historical, geopolitical, or colonial lines but the trend has changed in recent years with the increasing alignment observed to be associated with the simple division of countries by region (Syarif, 2020). The application of the degree of urbanization method globally is expected to discontinue the collaboration based on the historical, geopolitical, and colonial lines. This trend is observed from the formation of very strong relations between China, Germany, ¹⁶ and the United States representing the Asia Pacific, Europe, and North America regions respectively as indicated in Figure 4 where each has 9 links. The links show that they have relations with other most productive countries.

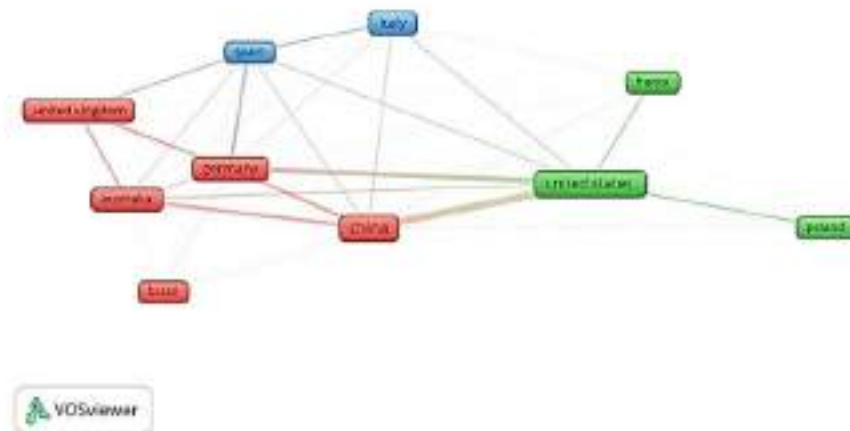


Figure 4 Relationship between the top 10 countries

The publications were further explored to determine the relationships between the 51 countries with at least one publication based on the detailed total documents, citations, and total links strength in each cluster as indicated in Table 3. It is important to note that the number of clusters formed is 10 and the top 10 countries were discovered to be spread in almost all clusters except in Clusters 7, 9, and 10.

The bibliometric analysis of the 51 countries indicates 10 clusters, 281 links indicating the relationship between countries, and 4,149 total link strength as presented in Figure 5. It is important to note that three countries or nodes were excluded by the VOSviewer because they are not connected. This signifies the largest set of connected countries only consists of 48 countries excluding Croatia, Slovenia, and Slovakia.

The relationship between the clusters seems to be very strong except for clusters 7, 9, and 10, and tends to be oriented toward the US, China, and Germany. These three countries more or less influence the orientation of the academic mindset and knowledge globally as indicated by the fact that their publications are mostly cited by authors from other countries. It is very fortunate that the three countries also show very strong relations and represent different regions which are North America, Europe, and the Asia Pacific.

**Bibliometric Analysis and Mapping of Articles Published
on the Degree of Urbanisation Method in the Scopus Database**

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from October 1st, 2022 to September 30th, 2022

Table 3 Countries, total documents, citation, and total links strength in each cluster

Cluster	No. of Country	Country	Documents	Region	Citations	Total Link Strength
1	11	Austria	2	Europe	28	239
		Brazil	6	South America	35	21
		Ecuador	3	South America	1	201
		Hungary	2	Europe	53	100
		Iran	3	Asia Pacific	2	12
		Israel	1	Europe	25	44
		Mexico	3	South America	35	36
		Netherlands	1	Europe	5	148
		Nigeria	1	Africa	5	148
		South Africa	2	Africa	14	40
		Spain	6	Europe	34	405
2	9	Bosnia and Herzegovina	1	Europe	2	7
		Estonia	1	Europe	0	95
		Finland	3	Europe	41	248
		Iceland	2	Europe	100	220
		Italy	12	Europe	218	179
		Poland	6	Europe	89	73
		Portugal	1	Europe	1	9
		Serbia	1	Europe	1	7
Sweden	3	Europe	54	248		
3	8	Canada	2	North America	35	100
		China	34	Asia Pacific	1018	953
		Egypt	1	Arab States	1	7
		Hong Kong	1	Asia Pacific	0	5
		Taiwan	1	Asia Pacific	34	5
		Turkey	1	Europe	84	96
		United Arab Emirates	1	Arab States	1	91
4	4	Chile	1	South America	49	174
		Germany	13	Europe	508	985
		India	1	Asia Pacific	10	49
		Indonesia	1	Asia Pacific	15	69
5	4	South Korea	2	Asia Pacific	27	83
		Switzerland	2	Europe	49	117
		United States	22	North America	534	1056
		Vietnam	1	Asia Pacific	38	17
6	3	Colombia	2	South America	0	36
		Costa Rica	1	South America	0	33
		France	4	Europe	41	64
7	3	Japan	2	Asia Pacific	3	119
		Nepal	1	Asia Pacific	2	119
		Tunisia	1	Arab States	2	119
8	3	Australia	8	Asia Pacific	251	423
		New Zealand	1	Asia Pacific	74	137
		United Kingdom	7	Europe	119	377
9	2	Denmark	3	Europe	49	284
		Ghana	1	Africa	2	40
10		Belgium	2	Europe	122	77
		Norway	1	Europe	28	73

Note: The country in bold indicates the top countries

interesting fact that all countries in the Commonwealth of Independent States (CIS) including Russia have not been involved in the research publications on the degree of urbanisation.

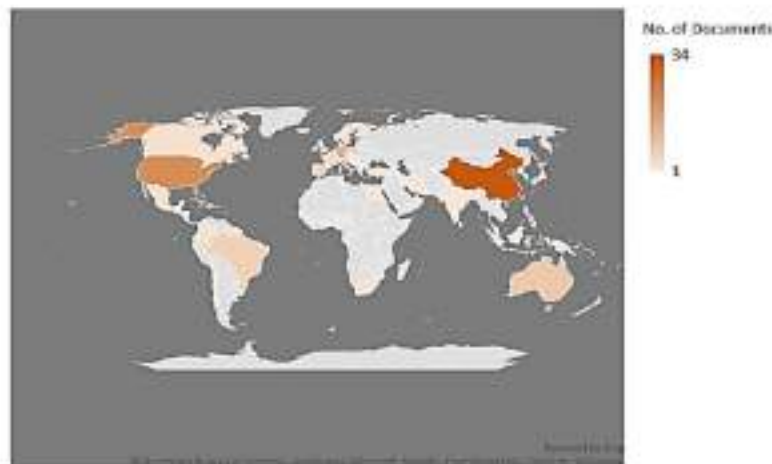


Figure 6 World distribution map by number of published documents

The development of Scopus database publications on the degree of urbanization was observed to be very limited compared to the number of UN member countries. This is indicated by the fact that the organization has 193 member states around the world (Syarif, 2020) but only 51 countries which 26% were found to have published related articles from 2013 to 2022. Meanwhile, the UN has agreed to implement the degree of urbanization method as soon as possible in delineating and classifying rural-urban areas in order to increase the accuracy of comparison among countries in terms of population growth and density, basic urban infrastructures conditions, urban characteristics, and problems (Bocquier, 2005; United Nations, Department of Economic and Social Affairs, 2018).

This finding showed that the research on this topic is in the early stages of development, and much is required to be conducted. The Degree of Urbanisation is a technical method, and this indicates it needs to be applied and evaluated in each country to confirm the possibility of its future application throughout the globe. Moreover, studies related to this concept can be tracked by analysing the Co-Occurrence Network of All Keywords which is a type of bibliometric

analysis with the ability to show keywords and their connections in order to form a network to display those appearing most frequently in the field of study (Herrera-Franco *et al.*, 2021).

A total of 1,886 keywords were found in the database but only 16 occurred in the documents at least 10 times. The keywords were observed in 3 clusters with 16 nodes, 106 links, and a total link strength of 919 as indicated in Figure 7. Cluster 1 seems to have more discussion on the process, physical form, and impacts of urbanisation as indicated by keywords such as Urban Areas, Urbanisation, City, Rural Area, Environmental Impact Assessment, and Pollution. Cluster 3 consists of ecosystem services, urban ecology, urban planning, and watershed which are keywords considered to be mostly included in the urban and regional science field. Meanwhile, Cluster 2 was observed to be related to terms such as GIS, Land Use, Methods, Population, and Urban Growth.

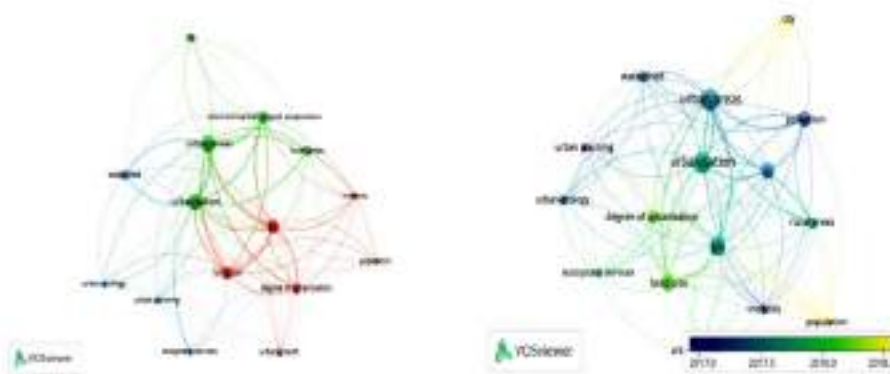


Figure 7 Co-occurrence network of all keywords and overlay visualisation

The term 'degree of urbanisation' occurred in 28 documents and has a relationship with 15 nodes, thereby, indicating its link with all keywords in Clusters 1, 2, and 3. It was observed to have appeared in Cluster 2 with eight other terms including GIS, Land Use, Methods, Population, and Urban Growth. These terms are associated with the application of the method in a specific location or country on the national, province, or local scales. This denotes the progressive adoption of the term by researchers and national and international institutions have the ability to significantly improve international comparability in line with Principle number 9 of Fundamental Principles of the UN Official Statistics which states that the "use of

international standards by statistical agencies in each country concerning international concepts, classifications, and methods promotes the consistency and efficiency of statistical systems at all official levels" (United Nations, 2013) as adopted from (Dijkstra et al., 2021).

Table 4 Results of the co-occurrence network of author keywords

Cluster	All Keywords	Occurrences	Total link strength	Average Publication Year
1	City	13	48	2018
	Environmental Impact Assessment	38	166	2017
	Pollution	37	155	2017
	Rural Areas	22	90	2017
	Urban Area	76	277	2017
	Urbanisation	73	238	2017
2	Degree Of Urbanisation	28	100	2018
	GIS	54	185	2017
	Land Use	45	179	2018
	Methods	16	73	2017
	Population	11	45	2018
	Urban Growth	11	39	2017
3	Ecosystem Services	12	55	2018
	Urban Ecology	17	57	2017
	Urban Planning	10	44	2017
	Watershed	21	87	2017

The "degree of urbanisation" needs further development considering the fact the use of the term and other related keywords were mostly published in 2017 or later as shown in Table 4. Therefore, it is very necessary and important for the academic community in each country, especially UN members, to conduct research related to the degree of urbanization and determine its impact on new urban classification and delineation to local and national urban statistical data as well as its implications for urban policies, plans, and programmes.

4. CONCLUSION

The Degree of Urbanisation is a new method developed to define cities, urban, and rural areas. It was launched in 2017 by Dijkstra et al., and has since been supported by the United Nation

Statistical Commission to be used globally in providing more accurate national statistical comparisons. The relative newness of this method led to the conduct of this study to explore the articles published concerning the term in the Scopus database over the last 10 years using bibliometric analysis. A total of 130 articles were observed to have been published in English from 2013 to 2022 with only 51 countries from Europe, Asia Pacific, and North America observed to have contributed more out of the 193 UN member states. The analysis showed the need for further studies on the degree of urbanisation method as well as the implications and/or impacts of its application on national, provincial, or local scales of any country.

Certain limitations were observed in this study which includes the (i) exclusive use of only the Scopus database despite the existence of others such as the Web of Science and (ii) non-consideration of publications in other languages except English. These limitations are recommended to be considered in broadening the scope of future research.

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**Bibliometric Analysis and Mapping of Articles Published
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