Understanding Digital Turn in Urban Research: A Bibliometric Analysis of Contemporary Global Urban Literature

Kent Araştırmalarında Dijital Dönüşü Anlamak: Çağdaş Küresel Kentsel Literatürün Bibliyometrik Analizi

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ÖZ

Son birkaç on yılda gerçekleşen teknolojik ilerlemeler, kentlerin karmaşık yapılarını keşfetmek, güncel kentsel sorunları anlamak ve bunlara yönelik çözümler üretmek ve gelecekteki potansiyel gelişmeleri tahmin etmek için benzersiz olanaklar yaratmıştır. Bu durum, başta şehir coğrafyası olmak üzere kent çalışmalarını içeren tüm akademik disiplinlerde önemli değişikliklere yol açmıştır. Bu çalışma, bahse konu değişikliklerin akademik bilgi üretimine nasıl yansıdığına dair kapsamlı bir anlayış sağlamayı amaçlamaktadır. Bu çalışma için Web of Science Core Collection'da bulunan kent çalışmaları alanındaki akademik literatürde büyük veri, yapay zeka (AI) ve nesnelerin interneti (IoT) gibi kavramların nasıl ele alındığına dair kapsamlı ve güncel bir inceleme yapılmıştır. Tarama sonucunda belirlenen kriterleri karşılayan toplam 2055 akademik çalışma tespit edilmiş ve Bibliometrix adlı bibliyometrik analiz yazılımı kullanılarak analiz edilmiştir. Araştırmanın sonuçları bilimsel makalelerin zamansal, mekânsal ve disiplinler arası dağılımını, yeni araştırma alanlarını ve hem sıklıkla çalışılan hem de henüz keşfedilmemiş konuları ortaya koyarak teknolojik gelişmelerin kentsel araştırmalara entegrasyonunu incelemeye yardımcı olmaktadır.

Anahtar Kelimeler: Kent Araştırmaları, Şehir Coğrafyası, Büyük Veri, Yapay Zeka, Nesnelerin İnterneti

ABSTRACT

This paper aims to examine the effects of digital technologies on academic knowledge production in the field of urban research. It provides a comprehensive overview of the evolution of technology-based urban research literature, delineates the knowledge structure, and investigates prevalent trends. The study employs bibliometric analysis to analyze bibliographical and textual data extracted from scientific documents, which allows for the discovery of the existing epistemological structure of the discipline or research domain. The research was conducted by conducting a comprehensive and up-to-date review of the literature available in the Web of Science Core Collection regarding how concepts such as big data, artificial intelligence (AI), and the Internet of Things (IoT) are discussed in academic papers in the field of urban studies. A total of 2055 academic papers that met the established criteria were identified and analyzed using bibliometric analysis software called Bibliometrix. The results of the research aid in examining the integration of technological advancements into urban research, and reveal the temporal, spatial, and disciplinary distribution of scientific articles, as well as their reflections on new research areas and both frequently studied and yet unexplored topics.

Keywords: Urban Research, Urban Geography, Big Data, Artificial Intelligence, Internet of Things

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INTRODUCTION:

Recent advances in information and communication technologies have had a revolutionary impact on academic knowledge production. The social sciences have experienced a notable rise in the utilisation of computational and numerical methods, while technical and engineering fields are growing more interested in investigating subjects that were typically linked to the social sciences (Bircan & Salah, 2022; Cioffi-Revilla, 2010; Edelmann et al., 2020). This transformation is perhaps more observable in urban research, which is inherently interdisciplinary and intersectional, than in other social science disciplines (Ibrahim et al., 2020; Kandt & Batty, 2021; Kitchin, 2016; Marasinghe et al., 2024). This paper aims to explore how this computational/digital turn has manifested itself in the production of academic knowledge about cities, and to identify points at which they intersect, through a systematic review of relevant research extracted from the Web of Science (WoS) Core Collection database using bibliometric analysis software.

Such bibliometric analyses have recently been applied in urban-related disciplines, such as urban planning, urban studies, and geography. Existing bibliometric studies in the urban research domain have been conducted, with some adopting a broad perspective using large data sets (Jakobsen et al., 2023; Sharifi et al., 2023), while others focus on specific strands such as sustainable cities, smart cities (Guo et al., 2019), or niche topics such as big-data and remote-sensing (Yu & Fang, 2023), natural language processing (Cai, 2021), big-data in urban design and planning (Hao et al., 2015; Kamrowska-Załuska, 2021) or artificial intelligence in smart cities (Allam & Dhunny, 2019; Herath & Mittal, 2022). Research that concentrates on general patterns and works with large-scale data provides a broad but superficial overview of existing knowledge (Jakobsen et al., 2023), whereas research that focuses on specific issues in the field offers a more in-depth but limited perspective with smaller data sets (Kong et al., 2020).

Situated between two approaches, each with its own strengths and limitations, this research offers a deep understanding of the symbiotic relationship between technological innovation and urban research and provides a comprehensive view of the evolving scholarly landscape. It sheds light on emerging clusters of knowledge production, quantitative and qualitative shifts, and the engagement between social science and digital sciences in urban research. In a broader context, this critical review will hopefully be a contribution to academic debates on the emergence of urban science (Alberti, 2017; Kitchin, 2016; Lobo et al., 2020) and the development of more inclusive urban studies (Brenner, 2018; Robinson, 2023; Sayın et al., 2022; van Meeteren et al., 2016).

The remainder of this paper is structured as follows. The next section presents the materials and methods used. This is followed by the main empirical part, which covers the results of both quantitative and qualitative analyses. The paper concludes with a discussion and conclusion section.

1. Materials and Methods

The steps for the literature search, selection, and data analysis are explained in the following sections.

1.1. Bibliometric Analysis

The steps for the literature search, selection, and data analysis are explained in the following sections.

This study used bibliometric analysis to develop a comprehensive overview of tech-based urban research literature, delineate the knowledge structure and its evolution, and investigate prevalent trends.

In the broadest sense:

> "The bibliometric methodology encapsulates the application of quantitative techniques (i.e., bibliometric analysis—e.g., citation analysis) on bibliometric data (e.g., units of publication and citation) (Donthu et al., 2021)."

Bibliometric analysis can be identified as an umbrella concept covering various quantitative procedures and techniques on bibliographical and textual data extracted from scientific documents to unearth the existing epistemological structure of a discipline or research domain (Glänzel, 2012). Bibliographic methods allow researchers to quantify and visualise general patterns of scientific production within author, source, affiliation, and country bases and of their interactions with each other (Niu et al., 2016), to map clusters, connections and networks, and geographical and disciplinary distributions (Agbo et al., 2021; Garrigós-Simón et al., 2021; Guo et al., 2019). Analysis can be performed using various temporal options; without selecting a specific time frame, by setting a limited time-period, or by applying multiple time frames. This makes it possible to understand how a literature has evolved over time, to recognise trends and patterns in a given period, and even to identify different cornerstones.

In addition to bibliometric data, such techniques can be applied to textual data such as keywords, titles, and abstracts. By employing these methods researchers can identify central thematic areas within a specific research discipline and examine how the body of knowledge develops and changes over time (Sharifi et al., 2023). This methodology empowers the exploration of novel and unexplored domains, while also facilitating the analysis of interactions among subjects, nations, and writers within a specific research domain. It further identifies key themes, topic evolution, and research trends over time (Rashid et al., 2021), as well as potential gaps in the literature (Jakobsen et al., 2023).

This study employed WoS Clarivate analysis tools and Bibliometrix software, an R-package tailored for quantitative and thematic bibliometric research (Aria & Cuccurullo, 2017). Facilitated by the Biblioshiny web interface application, Bibliometrix allows researchers to load, classify, filter, and analyse data in various formats (e.g., BibTex, CSV or Plain Text) without the need for coding (Büyükkıdık, 2022). In this study, data from the WoS Core Collection were transferred into Biblioshiny in plain text format.

1.2. Selection and Collection of Data

The data for this research were extracted from the WoS database, which is the oldest and one of the most reliable academic indexing platforms. Since the WoS Core Collection contains only top-ranking scientific publications it promises a high-level of academic credibility. Hence, the WoS database is mostly employed in studies conducting bibliometric literature analyses. To obtain the most relevant data to serve the purposes of this research, certain filtering criteria were set in advance and applied. To enhance scientific reliability and minimise the risk of duplication, only 'articles' and 'conference proceedings' were considered as document types; other types, such as books, chapters, and dissertations, were excluded from the scope. The search string consists of a combination of compound keywords concatenated with the "or" and "and" operators. The search location was selected as title, and search prompt was determined as TI= (Urban OR City OR Cities) AND TI= ("Artificial Intelligence" OR "Big Data" OR "IOT" OR "Data Visualisation"). To observe the most extensive time-period of the relevant research, no time filter was applied. The data were updated on November 4, 2023.

Table 1 presents a breakdown of the dataset, comprising 2055 academic papers published from 1986 to 2023. Among these, 1283 were articles, and 717 were conference proceedings. The average age of

the documents in the dataset is 3.59 years with a 15.12% annual growth rate. This shows the existence of a relatively recent but consistently expanding collection of scholarly works.

Table 1. Breakdown of the data

Description	Indicator	Results
Main Information	Timespan	1986:2023
	Sources (Journals, Books, etc)	1126
	Documents	2055
	Annual growth rate %	15,12
	Document average age	3,59
Document Contents	Average citations per doc	16,38
	Keywords plus (id)	1583
	Author's keywords (de)	4764
	Authors	6317
	Authors of single-authored docs	193
	Single-authored docs	211
	Co-Authors per doc	3,84
	International co-authorships %	31,82
Document Types	Article	1283
	Proceedings paper	717
	Missing	55

Source: WoS Core Collection, 2023

The dataset comprised contributions from 6317 different authors, with an average of 3.84 authors per document. There were 211 single-authored documents written by 193 different authors. This indicated a high level of academic cooperation. However, only about one-third of these collaborations are international, suggesting limited cross-border cooperation in the creation of scholarly content. The dataset encompasses a rich semantic landscape, as evidenced by the presence of 1583 Keywords Plus (ID) and 4764 Author's Keywords (DE). This abundance of keywords reflects the diverse and multifaceted range of topics and themes covered within the dataset.

The analysis program first conducted a bibliographic survey of the literature, including the topics studied, types of studies, countries, and disciplines. Thematic analyses were performed using authors' keywords. A total of 4764 keywords were identified in the texts, some of which were repetitive in content. To minimise the repetition problem and consolidate the keywords with the same meaning, a synonym list was compiled, containing the most commonly used terms such as "smart cities - smart city" and "IoT - internet of things." As a next step, 74 keywords directly referencing the selection criteria, such as "big data," "artificial intelligence" and "IoT" were removed from the list. This decision was made to avoid the dominance of these terms in the results and to allow for greater attention to the details.

2. Results

2.1. Publication Output and Growth Trend

Figure 1 shows the research output during the period spanning from 1986 to 2023. The first scientific paper that satisfied these research criteria was published in 1986. Between 1986 and 1999, the average annual publication and citation rates were 0.85 articles and 1120, respectively. This indicates a relatively low level of research activity throughout the 13-year period. The subsequent period, ranging from 2000 to 2013, exhibited a moderate increase in research activity, averaging one article

and three citations per year. Therefore, data for these periods are therefore presented as annual averages rather than individual values, to provide a more accurate overall trend.

Figure 1. Sum of Publications and Citations per Year (1986-2023)
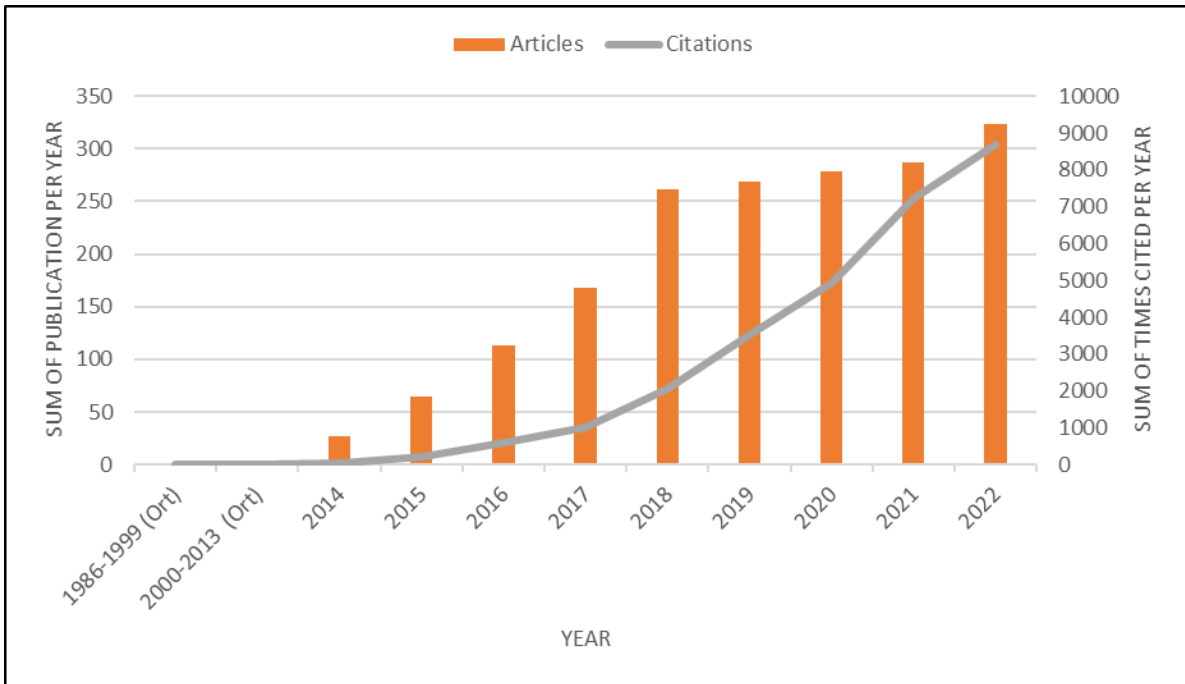
Source: WoS Core Collection, 2023

The first remarkable increase in academic production was recorded in 2014, with 27 published articles and 54 citations. Comparable progress was recorded in 2015, with the average annual number of articles and citations increasing to 64 and 219, respectively. This upward trend in scientific research will continue in the following years, reaching its peak in 2022, with an average of 324 articles and 8704 citations per year. The year 2023 is not represented in the table owing to its incomplete nature.

As of November 4, 2023, the cumulative number of articles published in the last 37 years had reached 2005, and the number of citations had exceeded 28,000. Nevertheless, 95% of these developments have occurred over the last 20 years. This implies that the interaction between digitalization and urban research is a relatively recent phenomenon and is likely to snowball in the coming years.

2.2. Scientific Output by Regions, Countries and Affiliations

The distribution of scientific production across countries and regions, as well as internal and cross-border collaborations, reveals the global spatial dynamics that dominate literature. A total of 97 countries have contributed to the research from 1986 to the present, yet the spatial distribution is quite uneven. Based on the data presented in Table 2, the top 20 countries produced approximately 80% of the existing research. The top three performers, namely China, India, and the USA, jointly account for approximately half of the total research output, demonstrating significantly higher productivity than other nations.

Table 2. Distribution of Articles Across Countries

| Country	Region	Papers	Collaborations	SCP	MCP
CHINA	Asia-Pacific	1432	573	416	157
INDIA	Asia-Pacific	482	212	170	42
USA	North America	457	169	125	44
ITALY	Western Europe	234	98	70	28
UNITED KINGDOM	Western Europe	189	73	45	28
SAUDI ARABIA	Middle East	179	60	27	33
KOREA	Asia-Pacific	162	77	48	29
AUSTRALIA	Asia-Pacific	138	53	20	33
SPAIN	Western Europe	124	53	33	20
PAKISTAN	Asia-Pacific	107	25	14	11
CANADA	North America	94	39	28	11
GERMANY	Western Europe	82	36	23	13
JAPAN	Asia-Pacific	79	35	22	13
FRANCE	Western Europe	78	23	16	7
BRAZIL	Latin America	67	29	20	9
MALAYSIA	Asia-Pacific	64	25	12	13
GREECE	Eastern Europe	53	24	12	12
TURKEY	Eastern Europe	52	22	19	3
EGYPT	Middle East	49	21	9	12
PORTUGAL	Western Europe	15	23	17	6

Source: WoS Core Collection, 2023

At the regional level, there are three major hubs in which academic research agglomerate. With outstanding performance from China and India, as well as noteworthy contributions from Japan and South Korea, the Asia Pacific region confirms its position as the leading hub for relevant literature. The Asia-Pacific is followed by Western Europe and North America respectively. In the former, the research is more evenly distributed among the main contributing countries of Italy, the UK, Spain, Germany, and France, whereas in the latter, the US carries almost all of the burden. The Middle East, with contributions from Saudi Arabia and Egypt, and Eastern Europe, with Greece and Turkey, have emerged as new hubs in the literature.

An analysis of scientific output across countries provides a comprehensive overview of collaboration patterns in the literature. This includes both Single Country Production (SCP) and Multiple Country Production (MCP). The data indicates a high level of research collaboration, with the majority of studies being multi-authored, accounting for approximately 90% of the total number of papers. However, international collaborations account for only around 30% of all research outputs. This suggests that the majority of collaborations are between authors from the same country. Of the 20 countries presented in the table, only two have a higher rate of international collaboration than internal collaboration.

Figure 2 provides a visual depiction of international collaboration and shows that the most productive nations, including China, the United States and India, are also among the top performers in collaboration. However, compared to their national collaborations, their international performance, especially that of India, was significantly lower. Among the top collaborators, only Australia has a high level of international collaborative performance in relation to both its total output and domestic collaborations.

Figure 2. Country Collaboration Map
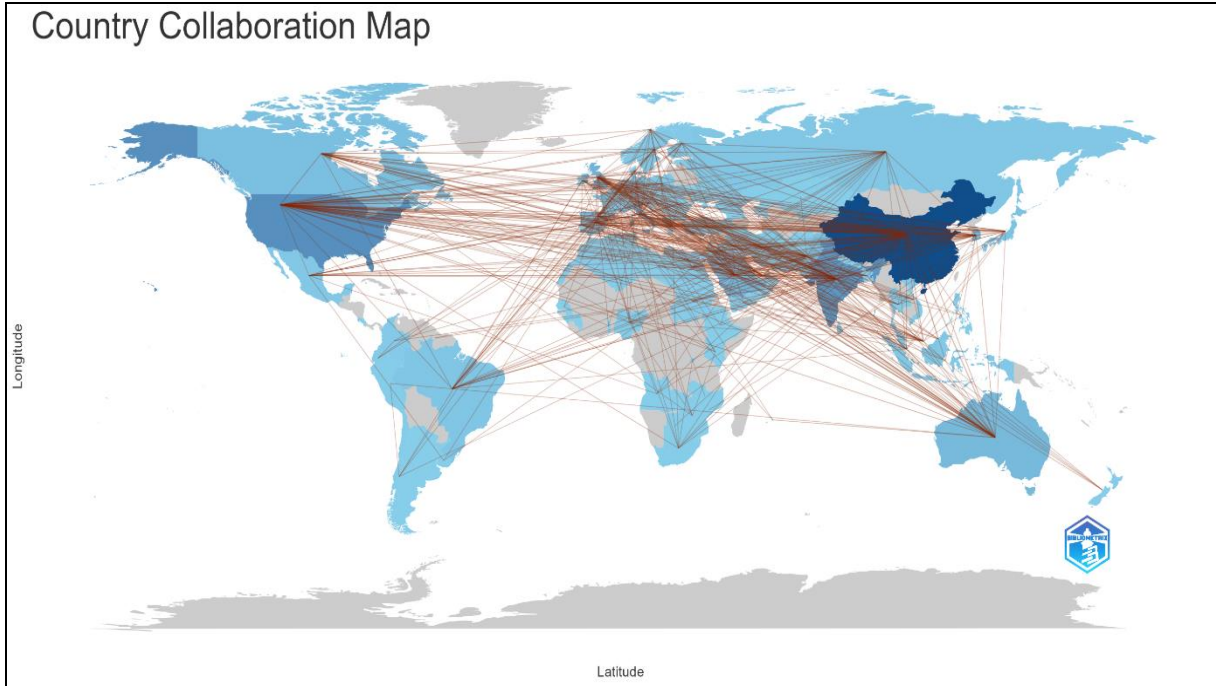
Source: WoS Core Collection, 2023

The pattern of existing cross-border cooperation is depicted in Figure 3, and it is characterised by three distinct clusters. The most noteworthy aspect of this figure is the intense cooperation between China and the USA, which suggests the existence of an intercontinental research network (Cluster 1). Western European countries, with the exception of the United Kingdom, primarily engage in intracontinental cooperation (Cluster 2). In contrast, the United Kingdom is part of a more diverse research network (Cluster 1). The third cluster, led by India, includes countries from the Middle East and Asia, with the exception of Ireland, Portugal, Canada, and Mexico.

Figure 3. The Network of Academic Collaboration between Countries
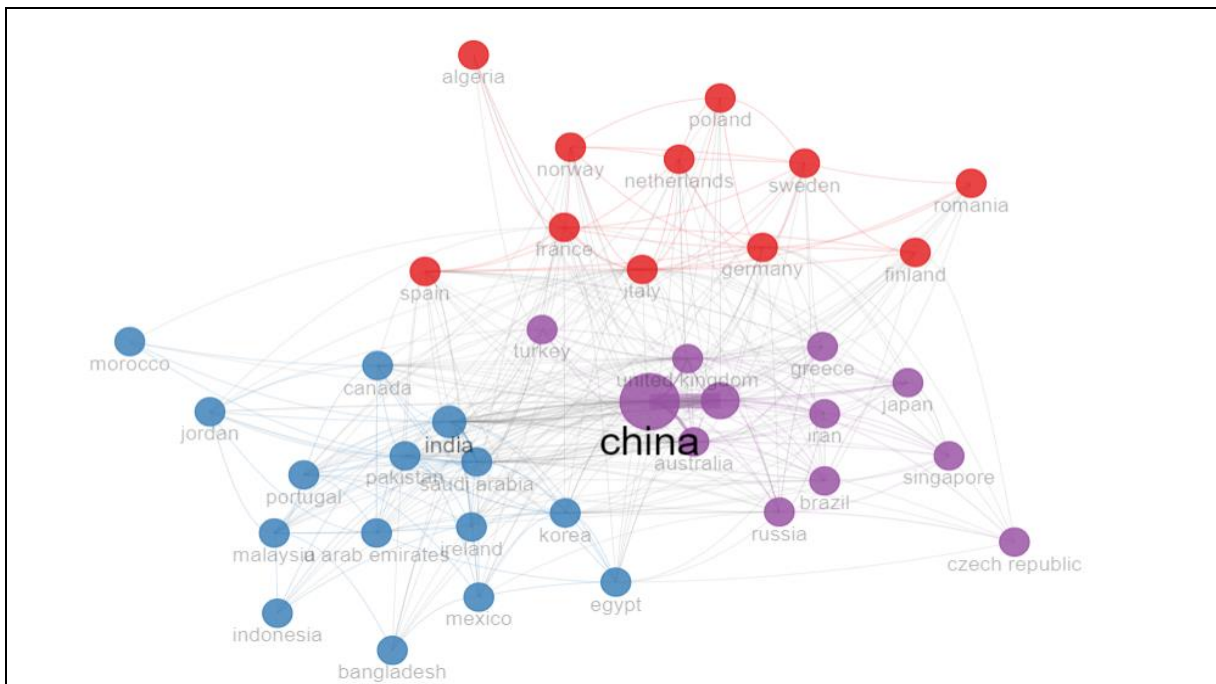
Source: WoS Core Collection, 2023

The current distribution of academic production in the literature demonstrates a lack of balance across the world, with a concentration of production and collaborations in a few select countries. This suggests that there is no significant change in the trend of geographical concentration in urban theory making. However, it is also worth noting that there is a notable shift in the hub of academic knowledge production, with the relocation of the main centre from the Western Europe-North America Axis to the Asia-Pacific region, as evidenced by the impressive performance of China and India.

2.3. Disciplines and Research Topics

The distribution of publications among academic fields indicates a remarkable diversity, with 114 distinct disciplines recorded 4000 times. Despite this richness, it is evident from Figure 4 that technology-based fields dominate the relevant urban research significantly. Computer Science, Engineering, and Telecommunications rank among the top three, with a combined occurrence of 2900 times. This suggests that approximately 75% of all publications in the literature are directly contributed by at least one of these three fields. The relatively modest contributions of disciplines such as Chemistry, Materials Science, Physics, Construction, and Transport further accentuate the dominance of the basic sciences and engineering fields.

Figure 4. Top Disciplines in the literature
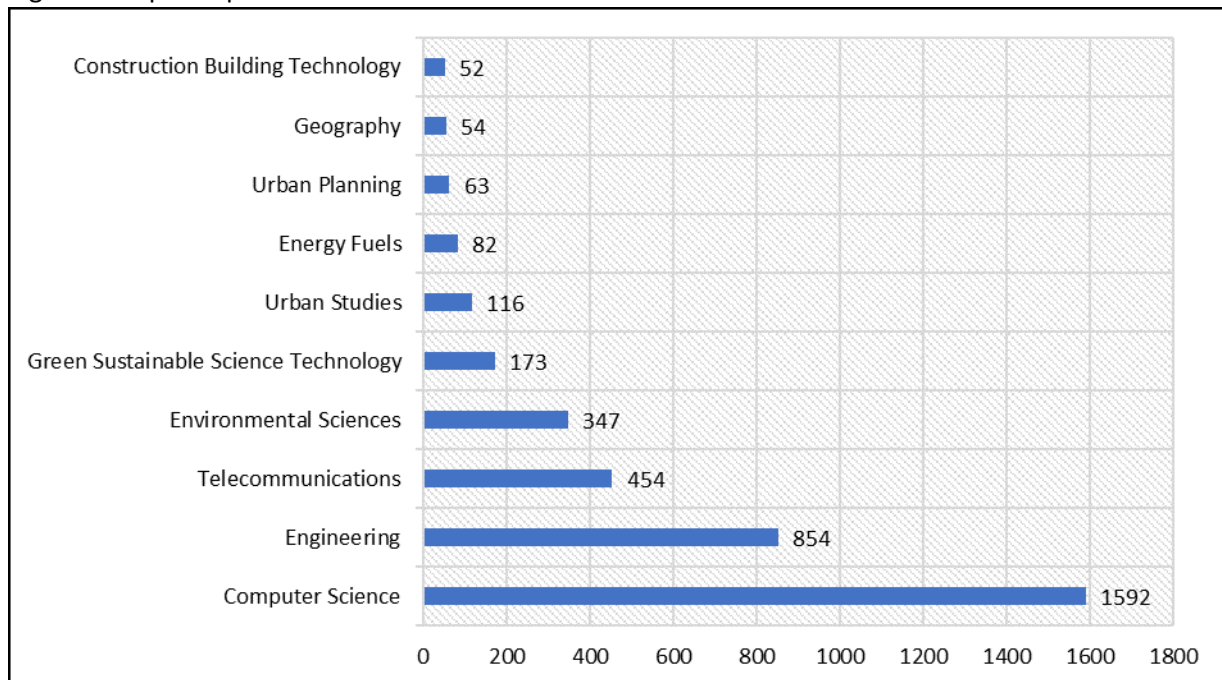
Source: WoS Core Collection, 2023

The disciplines that are directly linked to the study of cities, such as Urban Planning, Geography, and Urban Studies, have unfortunately been overshadowed by the leading technical disciplines. These three fields have only a total of 263 occurrences, which arguably represents less than 10% of the literature. Moreover, further investigation reveals that other significant areas of the Social Sciences, including Economics, Area and Development studies, Political Science, and Sociology, also suffer from comparable neglect and receive minimal attention in scholarly works.

Figure 5. Research in Social Science
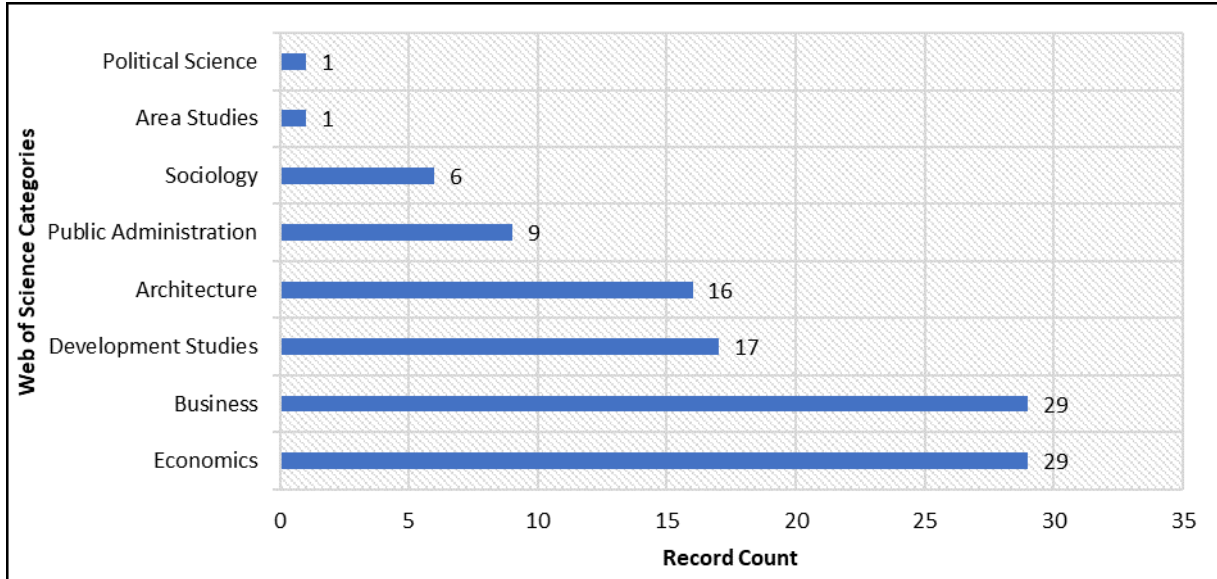
Source: WoS Core Collection, 2023

Table 3 below presents a brief list of more prominent debate topics, at the meso and micro levels identified by WoS itself. It is obvious in the table that contemporary urban research has a multi-disciplinary characteristic, ranging from technical fields such as Artificial Intelligence and Machine Learning to social sciences such as Political Science and Human Geography. The results also indicate a strong level of disciplinary permeability (Hérubel, 2020), where Economics and Sociology blend with Urban Geography, Engineering with Political Science, Security and Air Pollution issues with Information and Communication Technologies. Nevertheless, although there is a blend of technical and social science topics, certain technical topics, such as Internet of Things (641) and Traffic Flow (73), have significantly higher record counts in comparison to social science topics such as Public Administration (3) and Gentrification (9). This suggests that the primary focus of the literature is on technically and quantitatively measurable issues, such as air pollution, traffic, and waste management, which are likely to be faced by metropolitan cities.

Table 3. Meso and Micro Topics in Current Literature

Meso Topic	Micro Topics	Record Count
Artificial Intelligence & Machine Learning	Clustering	10
	Intrusion Detection	18
Environmental Sciences	Aerosols	13
	Air Pollution	24
Forestry	Deep Learning	11
	Ecosystem Services	28
Hospitality, Leisure, Sport & Tourism	Place Attachment	28
	Tourism	13
Human Geography	House Prices	9
	Agglomeration Economies	12

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|	Gentrification	9
Knowledge Engineering & Representation	Big Data	32
	Complex Networks	22
	Crowdsourcing	15
Political Science	Public Administration	3
	Deliberative Democracy	1
	Geoengineering	2
	Volunteering	1
Remote Sensing	Light Pollution	30
Security Systems	Blockchain	47
Sustainability Science	Municipal Solid Waste	29
Telecommunications	Internet Of Things	641
	Vehicular Ad Hoc Networks	24
	Wireless Sensor Networks	29
Transportation	Road Safety	16
	Traffic Flow	73
	Travel Behavior	87

Source: WoS Core Collection

This disparity highlights a conceivable disparity in research focus and emphasizes a stronger inclination towards technological aspects in the realm of urban studies. This information underscores the significance of reevaluating research priorities to guarantee a more balanced allocation of attention across social science disciplines in future urban research endeavours.

2.4. Basic, Emerging and Underexplored Themes

To provide a comprehensive understanding of the evolving polytypic nature of urban research extensive keyword analysis was conducted. The original list comprised of 4675 words that were repeated a total of 9320 times. Of these words, 3916 (82%) appeared only once, whereas 435 (9%) appeared twice. The analysis was then repeated, excluding specific terms mentioned in the methodology section and words that appeared only once. As a result, 795 keywords were identified, with only 52 appearing more than ten times in the papers. The 20 most frequent ones of these 795 words are depicted in Figure 6.

This analysis demonstrates that research on smart cities has been a prevalent subject in urban studies. The term "smart city" significantly outperforms other frequently mentioned keywords, with a substantial gap of 753 appearances. This finding underscores the significance of the concept of "computing" in urban research, which serves as an indicator of digitalisation. Furthermore, the prominence of keywords directly related to urban policies, such as urban planning (18), sustainability (37), waste management (21), and air pollution (17), highlights the intersection of the common ground between digital technology and urban studies.

Figure 6. Most Relevant Keywords
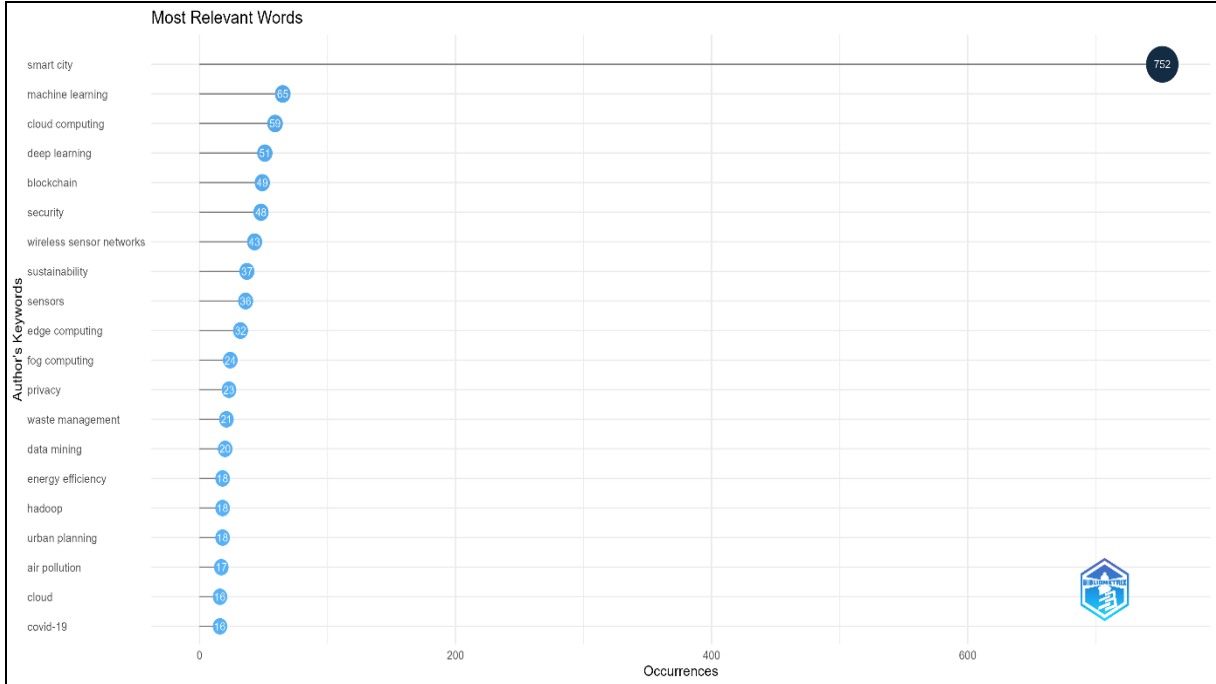
Source: WoS Core Collection, 2023

In addition, to observe the evolution of popular topics over time, a trend analysis was performed by examining the frequency of the author keywords extracted from the dataset (see Figure 7). A time span from 2015 to 2022, a minimum word frequency of five or three words per year, and a word label size of five were set for the analysis. To obtain a more balanced landscape, the term 'smart city' was excluded from the analysis. Until 2018, the number of prominent topics appeared to be limited to less than three. Additionally, niche topics such as "waste collection" and "maproduce, or overly broad topics such as "human mobility, seem to have gained prominence. These were followed by technical buzzwords such as cloud computing, wireless sensor networking, and security. In 2020, these issues are expected to become increasingly important. Since 2021, sustainability has become more prominent, possibly owing to the Covid-19 pandemic.

Figure 7. Trending Topics in 2014-2022
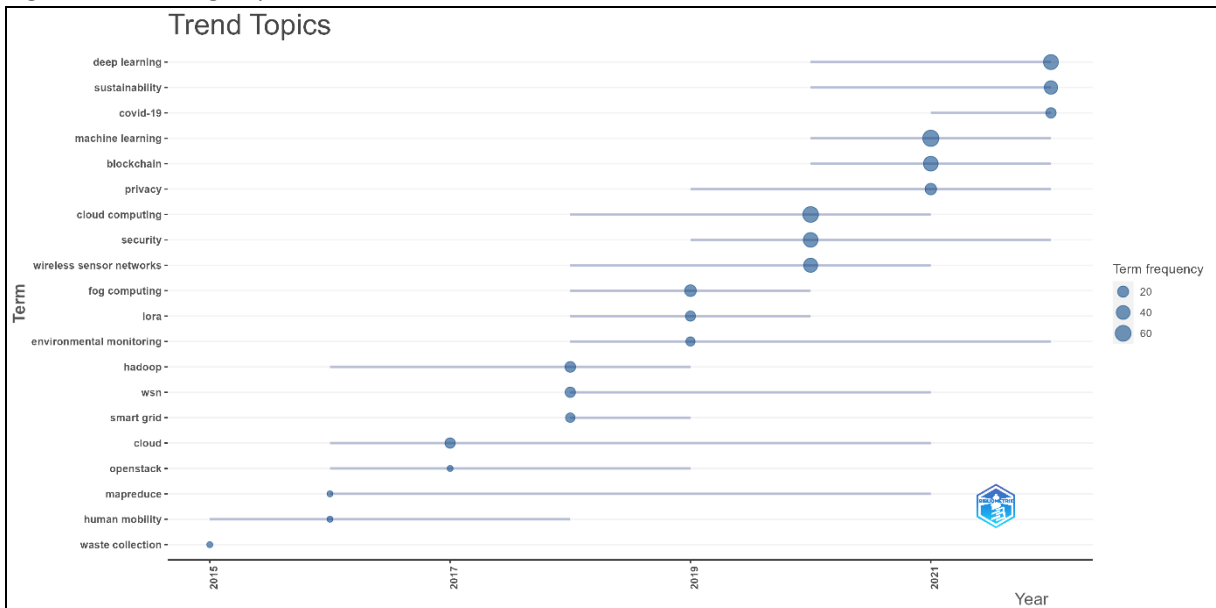
Source: WoS Core Collection, 2023

Thematic map analysis was applied to identify dominant and emerging themes as well as declining and niche research areas in the literature. The number of words was taken as 500, and the minimum cluster frequency (per thousand docs) was taken as four to determine maximum diversity in the literature. Figure 8 presents a graphical visualisation of the analysis results.

The thematic map consisted of 14 clusters, each with distinct themes. Among these, social media, governance, urban planning, and remote sensing appeared as niche themes. The emerging themes space only contained COVID-19 and China, which can be ascribed to the pandemic's influence. The basic (developing) themes were comprised of two clusters: machine learning, deep learning, sustainability, and cloud computing, blockchain, and security. The motor (developed) themes were, in contrast, centred around air pollution, wireless sensor networks, and energy efficiency.

Fig. 8 Thematic Map by Authors' Keywords
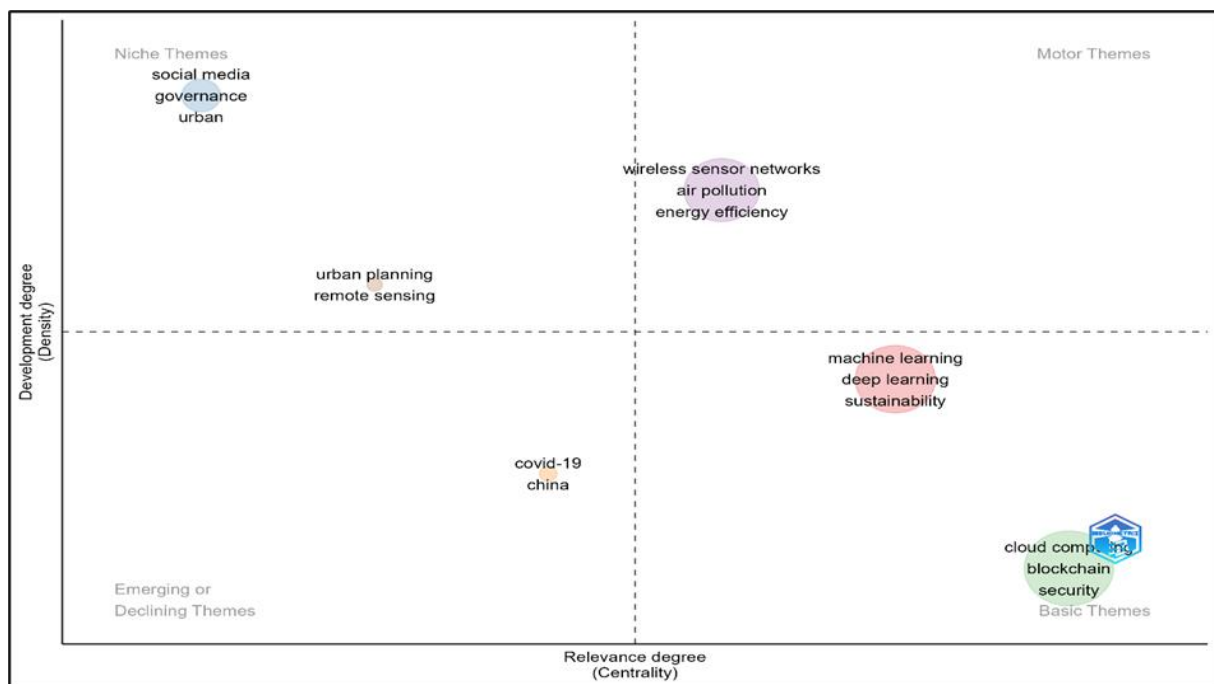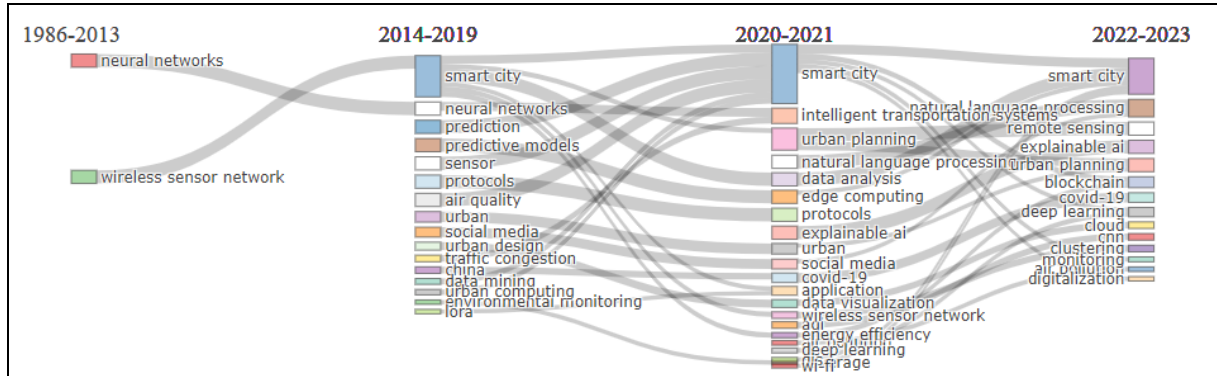

Source: WoS Core Collection, 2023

To examine how the literature has evolved over time, a periodic thematic analysis based on author keywords was performed. The analysis identified four different time periods by establishing three different cut-off points. The first period, referred to as the incubation period, encompasses the years between 1986 and 2014. The second period was characterised as the raising period, during which a new threshold was established to determine whether the topic of covid-19 had any impact on the studied themes. The final period, which extended from 2022 to 2023, emerged as a result of this analysis. The results of the analysis are presented visually in Figure 9.

The primary focus during the initial period was on wireless sensor networks and social media. Discussions and studies in this area increased from the second period up until 2015. In order to assess the impact of the pandemic, we have considered the years 2020 and 2021 as a distinct period. Through an examination of the publications, three thematic clusters emerged: neural networks, wireless sensor networks, and urban and land dynamics. It is noteworthy that the latter two clusters appear to constitute a specific research strand that persists in later periods.

In P2, 37 distinct research clusters emerge, reflecting a burgeoning literature base. However, the concept of smart cities predominates, with subsequent clusters exhibiting fewer occurrences, such as cloud systems, urban computing, social media, simulation models, and traffic. It is noteworthy that China has emerged as a research strand in the keywords. In P3, the prominence of Smart City persisted. New trends in Urban Planning and Edge Computing, both of which are closely linked to smart cities, have been observed. Wireless sensor networks appear as clusters and in the context of transportation and smart city applications.

The concept of sustainability, in relation to urban development and smart cities, has emerged as a prominent cluster in recent times. The COVID-19 pandemic, originating from the China cluster, is perceived as an emerging trend that continues to be a popular research theme. The smart city theme remains dominant and is fuelled by a variety of disciplines, although its importance seems to be waning. Emerging trends such as blockchain technology, machine learning, and specific issues related to monitoring and security, as well as privacy concerns, are becoming increasingly popular and studied in tandem.

Figure 9. Thematic Evolution Map 1986-2022

Source: WoS Core Collection, 2023

In summary, the analysis of keywords in urban research reveals several significant patterns. Smart cities, often accompanied by discussions of digitalisation and sustainability, have become a prominent theme in the literature. Secondly, technical terms such as sensors, networks and computing have emerged as popular themes. Thirdly, under the influence of the pandemic, novel concerns such as COVID-19, air pollution, waste collection, energy efficiency, and China have emerged in the recent period. Finally, and most interestingly, urban planning and governance remained niched in the technology-based urban literature.

Discussion and Conclusion

Recent advances in information and communication technologies have led to substantial changes in the ontological characteristic of contemporary urban studies. In addition to the massive development in the number of published academic research, particularly in the interdisciplinary collaborations, the technological surges have introduced novel approaches, new concepts and techniques with urban research (Sharifi et al., 2023). This shift in other saying has manifested itself as a growing engagement of engineering and technical disciplines with social science disciplines traditionally linked to studies on cities:

> "Statistical and computational methods and quantitative techniques are currently being fully exploited in numerous social science disciplines including sociology, political science, and public administration (...) (Bircan & Salah, 2022, p. 2)."

This integration in a positive sense signifies an increasing academic collaboration between scientific disciplines, whereby computer science, engineering and telecommunications intersect with economics, sociology and urban geography. However, as this research shows, the disciplinary contribution to this collaboration is highly asymmetrical, with traditional social science disciplines being overshadowed by the increasing dominance of computational disciplines in urban research. One result of this shift is that certain technical topics, such as transportation, traffic, air pollution, and waste management, have a much higher number of published works than social science topics such as public administration, gentrification, migration, and inequalities. Considering this turn, one could argue that the primary focus of the literature is on issues that are more technically and quantitatively measurable and are typically encountered by metropolitan cities. The emergence of smart cities as a distinct and increasingly dominant research theme further supports this trend.

The findings have implications for two current debates in the urban studies literature. The first debate concerns the geography of urban theory development. It has long been argued that global urban research has been dominated by a Western, Eurocentric perspective, reflecting the experiences of a small proportion of the world's population and excluding a significant part of the world from the centre of theory making (Bunnell, 2019; Roy, 2016; Sheppard et al., 2013). The data suggest that the focus of theory development in global urban studies has shifted from its traditional base, the Western Europe-North America axis, to the Asia-Pacific region, with China and India at the forefront of academic production. This however raises questions about the inclusivity of urban research and the need for a more comprehensive geographic representation, which is the second topic of discussion.

Arisen from categorical objections to the conceptual fallacies of western-oriented urban approaches, the need for the development of a more inclusive and pluralistic body of global urban research has been a matter of long and intense debate in the critical urban literature (Brenner, 2018; Robinson, 2022; Sayın et al., 2022; van Meeteren et al., 2016). Despite seems to challenge the traditional landscape, the recent orbital change in the geography of academic production does not serve to develop a more comprehensive and inclusive urban theory as knowledge production continues to be concentrated in a few selected countries.

By using bibliometric analysis techniques, this study explored how technological advancements have influenced academic knowledge production in urban studies, by underscoring shifts in disciplinary dominance, research focus, global knowledge production, and the intricate interplay between technology and the social dimensions of urban studies. The analysis revealed that technological concepts such as big data, artificial intelligence, and the IoT have permeated urban research over the past decade, emerging as an independent research domain. The proliferation of these concepts has of course remarkably escalated the volumes of research outputs, citations, international collaborations, and cooperation between different disciplines. However, the analysis suggests that this trend has gone beyond mere quantitative developments and has caused a significant shift in research dynamics, methodological approaches, thematic foci, and the traditional nature of theory-building in urban studies.

Conflict of Interest *The author(s) declare that they do not have a conflict of interest with themselves and/or other third parties and institutions, or if so, how this conflict of interest arose and will be resolved, and author contribution declaration forms are added to the article process files with wet signatures.*

Ethical Approval

In this article, ethics committee approval is not required, and a consent form affirming that a wet-signed ethics committee decision is not necessary has been added to the article process files on the system.

REFERENCES:

Agbo, F. J., Oyelere, S. S., Suhonen, J., & Tukiainen, M. (2021). Scientific production and thematic breakthroughs in smart learning environments: a bibliometric analysis. *Smart Learning Environments*, 8(1). https://doi.org/10.1186/s40561-020-00145-4

Alberti, M. (2017). Grand Challenges in Urban Science. *Frontiers in Built Environment*, 3. https://doi.org/10.3389/fbuil.2017.00006

Allam, Z., & Dhunny, Z. A. (2019). On big data, artificial intelligence and smart cities. *Cities*, 89, 80–91. https://doi.org/10.1016/j.cities.2019.01.032

Aria, M., & Cuccurullo, C. (2017). bibliometrix : An R-tool for comprehensive science mapping analysis. *Journal of Informetrics*, 11(4), 959–975. https://doi.org/10.1016/j.joi.2017.08.007

Bircan, T., & Salah, A. A. A. (2022). A Bibliometric Analysis of the Use of Artificial Intelligence Technologies for Social Sciences. *Mathematics*, 10(4398). https://doi.org/10.3390/math10234398

Brenner, N. (2018). Debating planetary urbanization: For an engaged pluralism. *Environment and Planning D: Society and Space*, 36(3), 570–590. https://doi.org/10.1177/0263775818757510

Bunnell, T. (2019). Inclusiveness in Urban Theory and Urban-Centred International Development Policy. *Journal of Regional and City Planning*, 30(2), 89. https://doi.org/10.5614/jpwk.2019.30.2.1

Büyükkıdık, S. (2022). A Bibliometric Analysis: A Tutorial for the Bibliometrix Package in R Using IRT Literature. *Eğitimde Ve Psikolojide Ölçme Ve Değerlendirme Dergisi*, 13(3), 164–193. https://doi.org/10.21031/epod.1069307

Cai, M. (2021). Natural language processing for urban research: A systematic review. *Heliyon*, 7(3), e06322. https://doi.org/10.1016/j.heliyon.2021.e06322

Cioffi-Revilla, C. (2010). Computational social science. *WIREs Computational Statistics*, 2(3), 259–271. https://doi.org/10.1002/wics.95

Donthu, N., Kumar, S., Mukherjee, D., Pandey, N., & Lim, W. M. (2021). How to conduct a bibliometric analysis: An overview and guidelines. *Journal of Business Research*, 133, 285–296. https://doi.org/10.1016/j.jbusres.2021.04.070

Edelmann, A., Wolff, T., Montagne, D., & Bail, C. A. (2020). Computational Social Science and Sociology. *Annual Review of Sociology*, 46(1), 61–81. https://doi.org/10.1146/annurev-soc-121919-054621

Garrigós-Simón, F., Sanz-Blas, S., Narangajavana, Y., & Buzova, D. (2021). The Nexus between Big Data and Sustainability: An Analysis of Current Trends and Developments. *Sustainability*, 13(12), 6632. https://doi.org/10.3390/su13126632

Glänzel, W. (2012). Bibliometric methods for detecting and analysing emerging research topics. *El Profesional De La Informacion,* 21(2), 194–201. https://doi.org/10.3145/epi.2012.mar.11

Guo, Y.-M., Huang, Z.-L., Guo, J., Li, H., Guo, X.-R., & Nkeli, M. J. (2019). Bibliometric Analysis on Smart Cities Research. *Sustainability*, 11(13), 3606. https://doi.org/10.3390/su11133606

Hao, J., Zhu, J., & Zhong, R. (2015). The rise of big data on urban studies and planning practices in China: Review and open research issues. *Journal of Urban Management*, 4(2), 92–124. https://doi.org/10.1016/j.jum.2015.11.002

Herath, H., & Mittal, M. (2022). Adoption of artificial intelligence in smart cities: A comprehensive review. International *Journal of Information Management Data Insights*, 2(1), 100076. https://doi.org/10.1016/j.jjimei.2022.100076

Hérubel, J.-P. V. M. (2020). Disciplinary Permeability, Academic Specializations, and University Presses. *Publishing Research Quarterly,* 36(1), 17–31. https://doi.org/10.1007/s12109-019-09707-y

Ibrahim, M. R., Haworth, J., & Cheng, T. (2020). Understanding cities with machine eyes: A review of deep computer vision in urban analytics. *Cities*, 96, 102481. https://doi.org/10.1016/j.cities.2019.102481

Jakobsen, K., Mikalsen, M., & Lilleng, G. (2023). A literature review of smart technology domains with implications for research on smart rural communities. *Technology in Society*, 75, 102397. https://doi.org/10.1016/j.techsoc.2023.102397

Kamrowska-Załuska, D. (2021). Impact of AI-Based Tools and Urban Big Data Analytics on the Design and Planning of Cities. *Land*, 10(11), 1209. https://doi.org/10.3390/land10111209

Kandt, J., & Batty, M. (2021). Smart cities, big data and urban policy: Towards urban analytics for the long run. *Cities*, 109, 102992. https://doi.org/10.1016/j.cities.2020.102992

Kitchin, R. (2016). The ethics of smart cities and urban science. Philosophical Transactions. *Series A, Mathematical, Physical, and Engineering Sciences*, 374(2083). https://doi.org/10.1098/rsta.2016.0115

Kong, L., Liu, Z., & Wu, J [Jianguo] (2020). A systematic review of big data-based urban sustainability research: State-of-the-science and future directions. *Journal of Cleaner Production*, 273, 123142. https://doi.org/10.1016/j.jclepro.2020.123142

Lobo, J., Alberti, M., Allen-Dumas, M., Arcaute, E., Barthelemy, M., Bojorquez Tapia, L. A., Brail, S., Bettencourt, L., Beukes, A., Chen, W.-Q., Florida, R., Gonzalez, M., Grimm, N., Hamilton, M., Kempes, C., Kontokosta, C. E., Mellander, C., Neal, Z. P., Ortman, S., . . . Youn, H. (2020). Urban Science: Integrated Theory from the First Cities to Sustainable Metropolises. *SSRN Electronic Journal.* Advance online publication. https://doi.org/10.2139/ssrn.3526940

Marasinghe, R., Yigitcanlar, T., Mayere, S., Washington, T., & Limb, M. (2024). Computer vision applications for urban planning: A systematic review of opportunities and constraints. *Sustainable Cities and Society*, 100, 105047. https://doi.org/10.1016/j.scs.2023.105047

Niu, J., Tang, W., Xu, F., Zhou, X., & Song, Y. (2016). Global Research on Artificial Intelligence from 1990–2014: Spatially-Explicit Bibliometric Analysis. *ISPRS International Journal of Geo-Information*, 5(5), 66. https://doi.org/10.3390/ijgi5050066

Rashid, S., Rehman, S. U., Ashiq, M., & Khattak, A. (2021). A Scientometric Analysis of Forty-Three Years of Research in Social Support in Education (1977–2020). *Education Sciences*, 11(4), 149. https://doi.org/10.3390/educsci11040149

Robinson, J. (2022). Introduction: Generating concepts of 'the urban' through comparative practice. *Urban Studies*, 59(8), 1521–1535. https://doi.org/10.1177/00420980221092561

Robinson, J. (2023). *Comparative urbanism: Tactics for global urban studies.* IJURR studies in urban and social change book series. John Wiley & Sons Ltd.

Roy, A. (2016). What is urban about critical urban theory? *Urban Geography*, 37(6), 810–823. https://doi.org/10.1080/02723638.2015.1105485

Sayın, Ö., Hoyler, M., & Harrison, J. (2022). Doing comparative urbanism differently: Conjunctural cities and the stress-testing of urban theory. *Urban Studies*, 59(2), 263–280. https://doi.org/10.1177/0042098020957499

Sharifi, A., Khavarian-Garmsir, A. R., Allam, Z., & Asadzadeh, A. (2023). Progress and prospects in planning: A bibliometric review of literature in Urban Studies and Regional and Urban Planning, 1956–2022. *Progress in Planning*, 173, 100740. https://doi.org/10.1016/j.progress.2023.100740

Sheppard, E., Leitner, H., & Maringanti, A. (2013). Provincializing Global Urbanism: A Manifesto. *Urban Geography*, 34(7), 893–900. https://doi.org/10.1080/02723638.2013.807977

van Meeteren, M., Bassens, D., & Derudder, B. (2016). Doing global urban studies. *Dialogues in Human Geography*, 6(3), 296–301. https://doi.org/10.1177/2043820616676653

Yu, D., & Fang, C. (2023). Urban Remote Sensing with Spatial Big Data: A Review and Renewed Perspective of Urban Studies in Recent Decades. *Remote Sensing,* 15(5), 1307. https://doi.org/10.3390/rs15051307

EXTENDED ABSTRACT

Research Problem:

This paper aims to examine the effects of digital technologies on academic knowledge production in the field of urban research.

Research Questions:

The primary interest of the research is to quantify and visualise the symbiotic relationship between technological innovation and urban research and offers a comprehensive view of the evolving scholarly landscape. It sheds light on emerging clusters of knowledge production, quantitative and qualitative shifts, and the engagement between social science and digital sciences in urban research.

Literature Review:

The study used bibliometric analysis to develop a comprehensive overview of tech-based urban research literature, delineate the knowledge structure and its evolution, and investigate prevalent trends. Although such bibliometric analyses have recently been applied in urban-related disciplines, some

research concentrates on general patterns and works with large-scale data provides a broad but superficial overview of existing knowledge, whereas research that focuses on specific issues in the field offers a more in-depth but limited perspective with smaller data sets. Situated between two approaches, each with its own strengths and limitations, this research offers a deep understanding of the symbiotic relationship between technological innovation and urban research and provides a comprehensive view of the evolving scholarly landscape.

Methodology:

The study employs bibliometric analysis to analyse bibliographical and textual data extracted from scientific documents, which allows for the discovery of the existing epistemological structure of the discipline or research domain. The research was conducted by conducting a comprehensive and up-to-date review of the literature available in the WoS Core Collection regarding how concepts such as big data, artificial intelligence (AI), and the Internet of Things (IoT) are discussed in academic papers in the field of urban studies. A total of 2055 academic papers that met the established criteria were identified and analysed using bibliometric analysis software called Bibliometrix.

Results and Conclusions:

The key founds of the analysis are presented below.

- The research output on urban studies has shown significant growth in recent years, with a peak in 2022.

- China, India, and the USA are the top contributors to urban research, showing higher productivity compared to other nations.

- Most studies are multi-authored, but collaborations are predominantly within the same country, indicating a high level of domestic collaboration.

- The global distribution of academic production in urban studies is concentrated in a few select countries, causing an imbalance.

- The analysis of keywords reveals the prominence of smart cities, digitalization, sustainability, and technical terms like sensors and networks.

- Emerging topics influenced by the COVID-19 pandemic include air pollution, waste collection, energy efficiency, and China as a research theme.

- Urban planning and governance remain niche areas within the technology-based urban literature.