



Analysis of Hot Spots and Trends of Smart City Research in China Based on Bibliometrics

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Abstract. This paper conducts a bibliometric analysis of the literature on smart city research in the past 12 years to reveal the development status of smart city research and explore its development prospects and trends. The 1109 CSSCI documents were searched through CNKI, and CiteSpace 5.8.R3 software was used to visualize the study in several dimensions, including annual distribution of publications, distribution of major research forces, keyword co-occurrence analysis, keyword clustering analysis, keyword co-occurrence timeline mapping analysis and keyword emergence analysis. The research results show that: (1) the number of core literature on smart city research in China in the past 12 years has generally shown a steady increase; (2) most of the scholars in China lack stable cooperation in this field and the research institutions are mainly universities; (3) in terms of research hotspots, the hotspots of smart city research in China mainly include: “digital governance”, “e-government”, “big data technology”, “urban governance”, and “Information security” and other aspects. In terms of research trends, the technical support of smart cities, digital governance, and information security management are the frontier issues of current smart city research.

Keywords: Smart-city · Bibliometrics · Development Trend · Research Hotspots

1 Introduction

With the development of technology and the emergence of the wave of artificial intelligence, the concept of the smart city has emerged, which has an important leading role in the development mode of future cities [1]. Smart cities refer to cities that universally embrace Information and communication technology (ICT) is generally accepted as an indispensable and critical prerequisite for cities [2]. In November 2012, the Ministry of Housing and Construction issued the Notice on the National Smart City Pilot Project [3], and in Smart City, Pilot Project was launched in January 2013. After this, scholars at home and abroad have paid increasing attention to the research on smart cities, and scholars have conducted a lot of research on different aspects of the theory and practice of smart cities, making them increasingly one of the key research topics in the academic community [4].

However, there are relatively few studies that use bibliometric methods for econometric analysis in the field of smart cities. Bibliometric methods are disciplines that use

statistical and mathematical methods to quantitatively analyze knowledge carriers [5]. The use of bibliometric methods can visualize and analyze the literature characteristics of a research field metrologically and show its development status and trends. Therefore, this paper uses the bibliometric method based on CiteSpace.5.8.R3 to visualize and analyze the research in the field of smart cities, reflecting the research hotspots and research dynamics in this field, so as to promote the development of research in the field of wisdom in China.

2 Materials and Methods

2.1 Data Collection

The data of this paper were obtained from CNKI, firstly, the topic was set as “smart city” in the advanced search, the source category was set as CSSCI journal, and the publication year was set as 2010–2022. Finally, a total of 1203 documents were obtained, and 1091 high-quality documents were obtained after eliminating news, conference announcements, journal recommendations, etc. Finally, the selected documents were exported in Refworks format and then imported into CiteSpace 5.8.R3 for processing and analysis.

2.2 Statistical Methods

This paper uses bibliometric methods to scientifically analyse the retrieved data and identify its research hotspots and trends. The main idea of this paper is to first analyse the retrieved paper data in terms of literature year distribution, main research institution distribution and main research author distribution, followed by visualisation analysis in terms of keyword co-occurrence, keyword clustering, keyword timeline and keyword emergence to grasp the future research hotspots and development dynamics in the field of smart cities from different perspectives.

3 Results and Discussion

3.1 Analysis of Annual Amount of Papers

Figure 1 shows the number of annual publications on smart city research from 2010 to 2022. As can be seen, the number of annual publications shows an overall upward trend. From 2010 to 2014, research on smart cities in academia showed a rapid upward trend, which indicates that research on smart cities has become an emerging research field in 2010–2014; between 2014 and 2018, although the number of articles published on smart cities in 2015 and 2018 decreased slightly year-on-year, it generally showed a fluctuating upward. The annual number of articles published from 2018 to 2021 was on a rapid upward trend, peaking at 156 in 2021. As at 20 April 2022, the number of articles published in 2022 had reached 25.

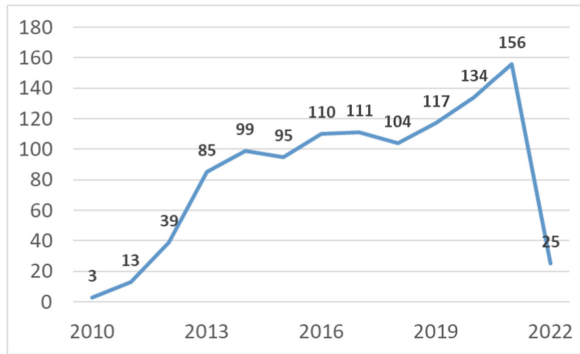


Fig. 1. Number of papers published from 2010 to 2022

Table 1. Top 5 Research Institutions

S/N	Institution	Quantity	Proportion
1	School of Public Administration, HUST	25	2.29%
2	School of Information Management, NJU	14	1.28%
3	Wuhan University Information Resources Research Center	13	1.19%
4	School of Architecture and Urban Planning, NJU	13	1.19%
5	School of Public Administration, XTU	12	1.10%

3.2 Research Institutions Analysis

Table 1 shows the distribution of the top 5 major research institutions in terms of the number of publications on smart city research. As can be seen from the table, the institution with the most number of publications is the School of Public Administration of Huazhong University of Science and Technology, followed by universities such as the School of Information Management of Nanjing University, School of Architecture and Urban Planning of Nanjing University, and School of Public Administration of Xiangtan University. It can be found that universities are the most important research force in the field of smart city research. However, it is also found that the percentage of papers published by these institutions is relatively low, with the highest only reaching 2.29%. In addition, there is only one research institute among the top 5 research institutions, and there is no other social research force, which indicates that the research on smart cities from all walks of life still needs to be strengthened.

3.3 Core Authors Analysis

Table 2 shows the top 10 core authors in smart city research, from which it can be found that the scholar with the most publications is Feng Zhen with 12, followed by Kai Zou, Gang Li, Xiaolin Xu, etc., with 10. Then, the visualization map of core authors in smart city research was drawn using CiteSpace software as shown in Fig. 2.

Table 2. TOP 10 Key Authors

Name	Quantity	Name	Quantity
Feng Zhen	12	Gang Song	8
Kai Zou	10	Ye Guo	7
Gang Li	10	Xiaomi An	6
Xiaolin Xu	10	Zhiwei Tang	5
Yang Li	8	Yi Zhang	5



Fig. 2. Author Cooperation Network Map

In Fig. 2, it can be found that scholars researching smart cities have emerged in almost all periods, indicating that the field has been receiving attention and concern from scholars, such as Feng Zhen, Gang Li, and Xiaolin Xu. In addition, it is also found that some scholars have formed a small group of scientific cooperation, such as Kai Zou-Qingyang Zhangzhong- Shang Xiang, Gang Song-Xiaomi An-Nan Zhang, etc., which indicates that these scholars have established cooperation among themselves and formed a stable cooperative research group. However, it is also found that some scholars such as Xiaolin Xu and Shiwei Wang are isolated nodes and have not established collaborative relationships with other scholars, lacking communication and cooperation, although they have published a lot of articles.

3.4 Keyword Co-occurrence Analysis

Keywords are a summary of an article to a high degree and are the terms that best reflect the core content of the article. Therefore, by studying and visualizing the keywords of papers in the field of smart cities, it is possible to summarize the research hotspots and development trends in the field. The keywords were counted by the obtained data and plotted into a table as shown in Table 3. In addition, the keyword co-occurrence mapping of smart city research using CiteSpace software is shown in Fig. 3.

Combining Table 3 and Fig. 3, we can find that the centrality and frequency of “Smart City”, “Big data” and “E-government” are relatively high, indicating that these keywords occupy the core position. This indicates that these keywords occupy the core position

Table 3. Top 20 Research Keywords

S/N	Keyword	Centrality	Frequency
1	Smart City	1.07	578
2	Big Data	0.10	81
3	E-government	0.04	64
4	Urban Governance	0.04	58
5	Internet of Things	0.02	32
6	Informatization	0.02	30
7	Top-level Design	0.00	24
8	Cloud Computing	0.01	23
9	Smart Community	0.02	23
10	Urbanization	0.05	21

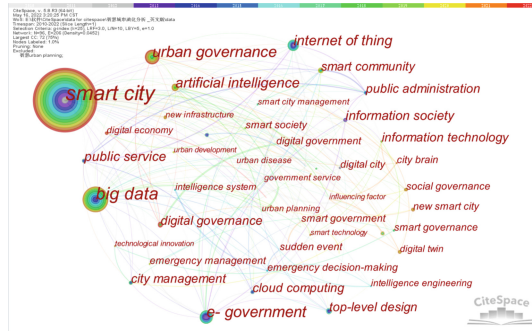


Fig. 3. Keyword Co-occurrence Map

and have a certain radiation effect on other keywords such as “Cloud Computing” and “Internet of things”. In addition, from 2010 to 2022, scholars mainly focus on “E-government”, “Urban Governance”, “Internet of Things”, “Informatization”, and “Smart City” in the field of smart city research. “Informatization”, “Top-level Design“, “Cloud Computing”, “Smart Community” and The research is carried out in hot spots such as “Urbanization”.

3.5 Keyword Clustering Analysis

To further summarize and summarize the field, the keyword network was clustered and analyzed using CiteSpace based on keyword co-occurrence (Fig. 3). The LLR algorithm was used to obtain 91 clustering results, and the first 5 clustering results were filtered as shown in Fig. 4. The clustering results are “#0 Smart City”, “#1 Artificial Intelligence”, “#2 Emergency Decision-making”, “#3 E-government”, “#4 Information Technology”.

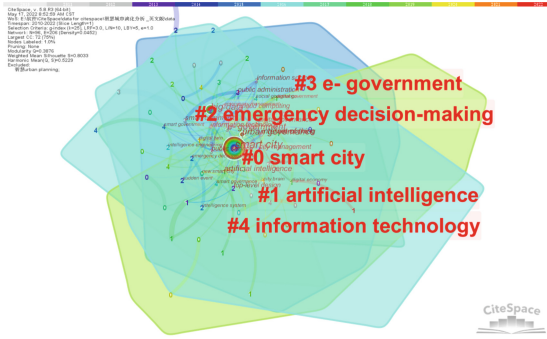


Fig. 4. Keywords Clustering Map

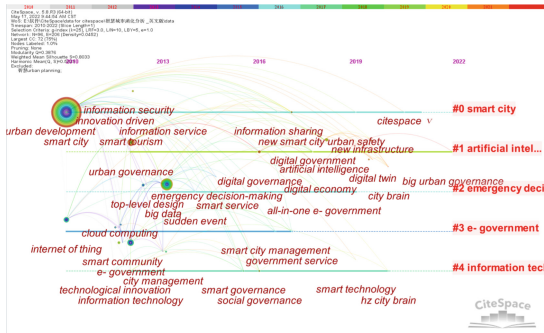


Fig. 5. Keyword Co-occurrence Timeline Map

3.6 Keyword Co-occurrence Timeline Mapping

By selecting “Timeline View” in the control panel, the keyword co-occurrence timeline of smart city research is plotted as shown in Fig. 5, from which it can be seen that: Firstly, the keywords #0 (Smart City) and #1 (Artificial Intelligence) etc. represent a relatively long period, and are the hotspots of research that many scholars are more concerned about. Secondly, several typical keywords deserve attention, such as “Big Data” “E-government” “Urban Governance” and other high-frequency keywords, and other new keywords appearing one after another in the group They are the important basis of research in the field of smart city research and need to be focused on. For example, “Internet of Things” appeared in 2010, and “Cloud Computing” appeared in 2012, and its hotness has decreased compared with other keywords.

3.7 Keyword Emergence Analysis

The emergent words indicate the words that appear more frequently in a certain period, and the analysis of the emergent words can show the annual development and research

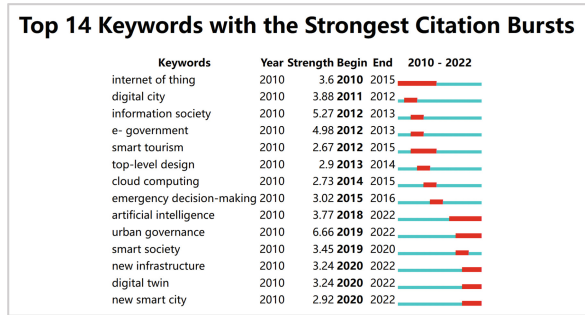


Fig. 6. Keywords Emergence Map

dynamics of the research field. Therefore, in this paper, based on the keyword co-occurrence, we use CiteSpace.5.8.R3 to draw a keyword emergent graph, as shown in Fig. 6, and we get 14 emergent words in total.

The graph shows that “Internet of Things”, “Digital City”, “Information Society”, “E-Government” and “Cloud Computing” are the terms that emerged earlier and are also the topics that received early attention from scholars; in addition, “New Infrastructure” and “Digital Twin” and “New Smart City” have been strong since around 2022 and will continue to exert influence on the field of smart city research for some time to come.

4 Conclusions

This paper conducts a bibliometric analysis of the 1109 pieces of literature collected based on CiteSpace.5.8.R3, and the final conclusions drawn are as follows. Firstly, in terms of literature productivity, the literature on smart city research in the past 12 years has generally shown a steady upward trend, which indicates that the research on smart cities has become a more popular research field and has received much attention from scholars. Secondly, in terms of the main research forces, the research institutions in this field are mainly universities, and other social research institutions still need to increase their research efforts for this field. In addition, only some scholars in this field have collaborative relationships with each other, and there are still most scholars who have not established collaborative relationships with other scholars, and thirdly, from the viewpoint of research hotspots and trends, combining the results of keyword co-occurrence, clustering, timeline mapping, and current social empirical hotspots, the future research directions of smart cities mainly include the following aspects: (1) Technical support for smart cities. The construction of smart cities cannot be built without the support of the Internet and big data technology, and how to make big data technology better serve to support smart city research will be a hot topic. In addition, future research may focus on identifying and discovering new technologies to be applied in the construction of smart cities. (2) Digital governance and information security management. Compared with traditional cities, smart cities are data-driven management, which may involve data privacy and information security issues. As a result, data governance, management models and information security management in smart cities will also become important research hotspots.

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