Visual Analysis Of Chinese Waste Management Based On Citespace

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ABSTRACT

The scientometric literature of waste management between 2005—2019 was reviewed. The visualized co-citation network of its knowledge domain was characterized in terms of thematic concentrations of co-cited references and emerging trends of surging citations to references through a scientometric review. The dataset of 281 bibliographic records were search through topic search of Chinese Social Sciences Citation Index (CSSCI) database. The results show that through analysis, we can find that, first of all, studying the classification of Chinese urban and rural waste is the primary conceptual definition that all research faces. Secondly, there have been many results in the research on the influencing factors of garbage classification. Such articles can get some new research conclusions through empirical analysis, so such articles can often become classics. Finally, the research hotspots of waste classification management in China this year are comprehensive treatment and collaborative treatment.

KEYWORDS

Waste management, scientometric, emerging trends, conceptual definition.

INTRODUCTION

The waste has become one of the biggest problems affecting the sustainable development of human settlements in developing countries [1]. In recent 15 years, the amount of research literature in the waste domain has rapidly increased in China. China has experienced a process from end disposal to source classification, single treatment to multi-

subject joint treatment [2]. China has become the Chinese experience of waste management by constantly learning from foreign countries and combining the domestic situation. This article attempts to review the literature on waste classification in China in the past 15 years through visualization tools. By understanding the research fields and future trends of waste classification in China, we can provide theoretical and practical references for waste management in other countries. A knowledge domain is a particular field of study that creates a common ground and a sense of development of a common identity by affirming its purpose and value to members and stakeholders [3].

Research Status And Trends Of Waste Management Research

The research on domestic waste management in Western academia began in the 1970s, marked by the establishment of waste science by Dr. William L. Rathje from the University of Arizona. The research context can be roughly divided into three stages: The first stage was in the 1970s, when the research topics at this time were mainly garbage charging and terminal harmless treatment. The second stage was in the 1980s, mainly focused on source reduction. The third stage is the late 1990s in the 20th century, mainly researching waste resource utilization and reduction from the perspective of circular economy. China's waste management started late, starting in the 1880s, and has also gone through the above-mentioned development stages. In the 1980s, The treatment of urban waste in China initially focused on the end treatment process, and focused on the application of technology and the improvement of disposal capacity. Although the improvement of waste treatment technology and the improvement of treatment facilities have relieved the pressure of waste treatment to a certain extent, with the influence of multiple factors such as population growth, population urbanization, economic development, improvement of living standards, and lifestyle changes, The total amount of municipal solid waste is still showing explosive growth. Due to the frequent occurrence of pollution and explosions caused by the inadequate management of the terminal garbage dump, the Chinese government has gradually realized that it is impossible to achieve the municipal waste management goal by relying on the single link of the terminal. Therefore, reduction at the source is imperative. The strategic position of waste management has gradually shifted from waste treatment to source reduction and strengthening the coordination of collection and transportation. In order to examine the research results of waste management, this study counted the annual number of publications on waste management from 2005 to 2019, as shown in Figure 1. From the perspective of the amount of articles published, since the first article was published in 2005, research on waste has gradually flourished, indicating that waste management research has also begun to become a hot spot within 15 years and can be regarded as an emerging research field. It can also be seen from Figure 1 that the number of articles on waste classification management has increased significantly in 2019, which means that waste classification management has entered a new stage of research.
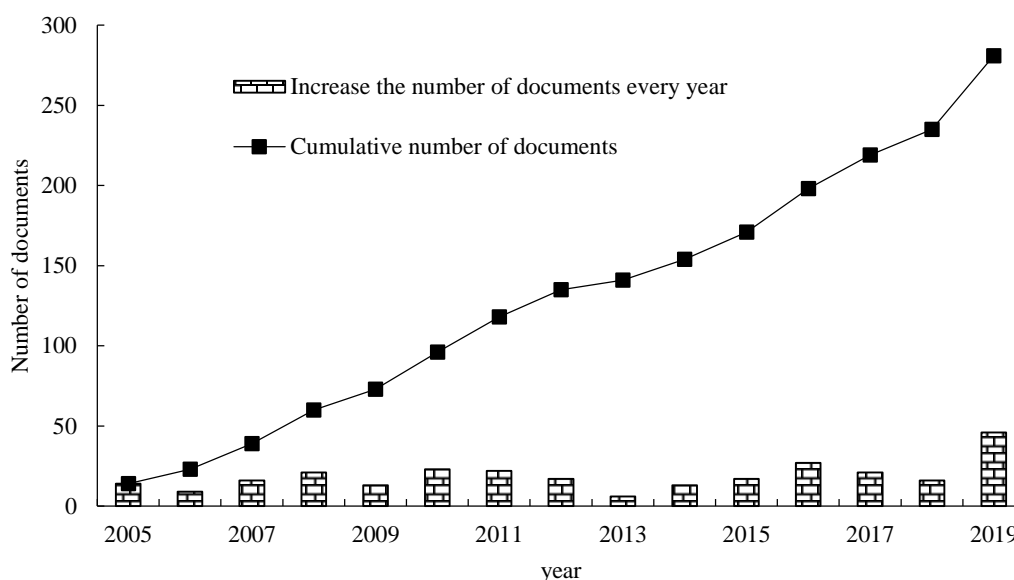
Figure 1 Research of waste management research 2005 to 2019

METHOD

Selection And Identification Of The Research Publications

Scholars from multiple disciplines have produced publications focusing on various topics about waste, but this paper focuses on crowdsourcing in the field of public management. So we intend to analyze literature in Chinese Social Sciences Citation Index (CSSCI). We determined the time frame of this analysis to the last 15 years (2005–2019) due to a concerted effort to improve the clarity of derived results. The topic-search dataset is referred as the core dataset [4]. So we search keywords "waste" in topic search. The initial search resulted in 369 papers, of which we removed duplicate documents and excluded conference papers, book reviews, reviews, editorial materials, conference abstracts, book chapters, corrections, news items, covers. After in-depth reading of the papers, we get a final list of 281 papers referring to public management, on which the analysis is performed.

Bibliometrics And Visualization Analysis Supported By Citespace

In the course of bibliometrics and visualization, CiteSpace is excellent in analyzing co-cited documents and future trends. CiteSpace supports the visualization of a scientific field from bibliographic sources in terms of networks of several types of entities, including cited references, co-authors, and co-occurring keywords [5]. CiteSpace supports the visualization of a scientific field from bibliographic sources in terms of networks of several types of entities, including cited references, co-authors, and co-occurring keywords. This paper take effort to deliver more accurate and complete results of waste management domains. Individual nodes in the network can be aggregated into clusters based on their interconnectivities. Each cluster represents a distinct specialty or a thematic concentration. Other points of interest include highly cited landmark articles, articles with strong citation bursts, and keywords with a strong surge of frequency.

BIBLIOGRAPHIC LANDSCAPE

Document Co-Citation Analysis

The complete set of 281 bibliographic records were visualized and analyzed using CiteSpace. Next, the bibliographic records were extracted from the CSSCI and their document co-citation network was generated as shown in Figure 2.
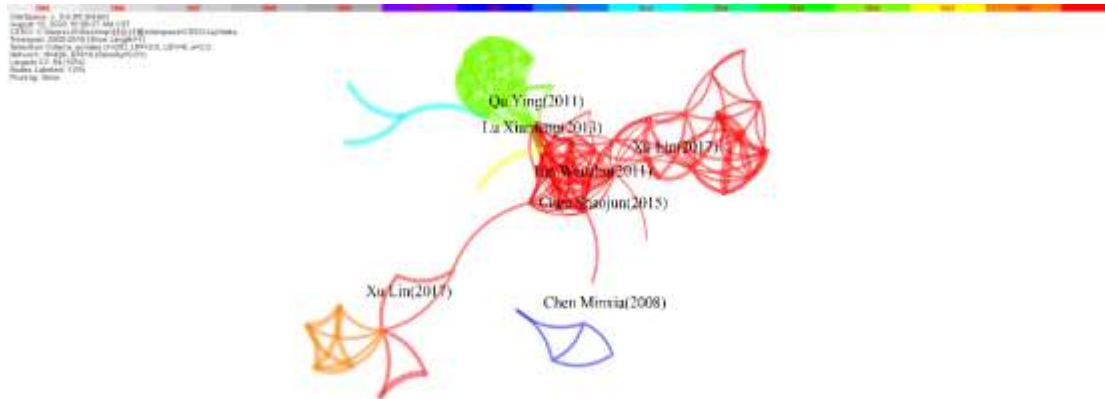

Figure 2. Key articles in waste management

In this network, these nodes represent cited references from the collected articles, and the links in the network represent co-citation relationships.We can further conclude three focal points from Figure 2. Firstly, larger node sizes imply that the article is an important one within the knowledge domain. Second, the lines around a node represent a citation burst. Thirdly, The time bar at the top of Figure 2 corresponds to the color in the figure. We can observe the key areas of waste management research in different years through the color.

Table 1 presents the seven top-cited articles associated with the term "waste" between 2005 and 2019. In order to show the basic situation of these articles more clearly, we made the detailed information into a table1.

Table 1. Six critical articles in waste management

Frequency	Title	Author	Year	Centrality	Journal
8	Research on the Influencing Factors of Municipal Waste Classification	Lin xu	2017	0.01	Journal of Public Management
8	External pressure mechanism and induction mechanism in waste sorting management	Xianfeng lu	2013	0.00	Urban Problem
5	The Dilemma of Urban Domestic Waste and System Innovation ——Taking Taipei City's Domestic Waste Collection and Management as an Example	Wenzhu tan	2011	0.01	Urban Development Studies
4	Contradiction between Will and Behavior: Research on the Classification Mechanism of Urban Residents' Domestic Waste	Shaojun chen	2015	0.00	China Population，Resources and Environment
4	Crowdsourcing as a solution to distant search	Ying qu	2011	0.01	Journal of Applied Statistics and Management
4	omparison of Domestic and Foreign Urban Domestic Waste Charging Experience	Minxia chen	2008	0.00	China Economist

Through visualization and literature analysis, it can be found that articles that study the influencing factors of garbage classification have high citations. There are a total of six articles in Table 1, five of which are related to the research on the influencing factors of garbage classification, which reflects that in some high-level articles in China, most of the influencing factors are studied. For example, the first is a paper by Xu et al [6], which discussed various factors affecting the classification of urban waste in China at the macro policy level and at the micro individual level. The second is XianFeng Lu work [7], which based on the theory of environmental psychology. It also analyzed the influence of internal factors such as personal habits, environmental protection awareness, economic man rationality and external factors such as legal systems, departmental management, publicity and education on residents' garbage classification behavior. YingQu [8] and ShaoJun chen[9]both start from the perspective of studying residents, and use the behavior of the residents at the source to improve the overall effectiveness of garbage classification. YingQu analyzed the influencing factors of garbage classification and focused on exploring the influence of residents' behavior. Slightly different from Qu Ying, ShaoJun chen conducted an empirical analysis of the factors and differences that affect the willingness and behavior of urban residents to separate garbage, and further explored the internal mechanism of garbage classification Wenzhu Tan[10] also studied the influencing factors of garbage classification.

However, his research is from the perspective of the dilemma of garbage classification. In the context of the six garbage situation, Wenzhu Tan reflects on traditional garbage collection and treatment methods. It analyzed the institutional reason of the dilemma, and innovated waste management and disposal systems to solve the waste problems faced by Chinese cities. He promoted the effectiveness of garbage classification by studying the obstacles to promote garbage classification. Other highly cited articles study the charging system for garbage sorting. Among them, Chen Minxia's articles are cited the most [11]. This article compared the charging experience of Chinese cities and other countries to provide theoretical and practical reference for domestic waste management in China. In summary, articles on the subject of research on the influencing factors of garbage classification are more likely to become classics, and at the same time, such articles can have more reference value and research significance.

Identification And Interpretation Of Clusters

We used CiteSpace to explore research patterns and emerging trends in the body of knowledge in terms of key clusters of articles. Figure 3 shows clusters labeled with title terms. The size of a cluster's label is proportional to the size of the cluster.
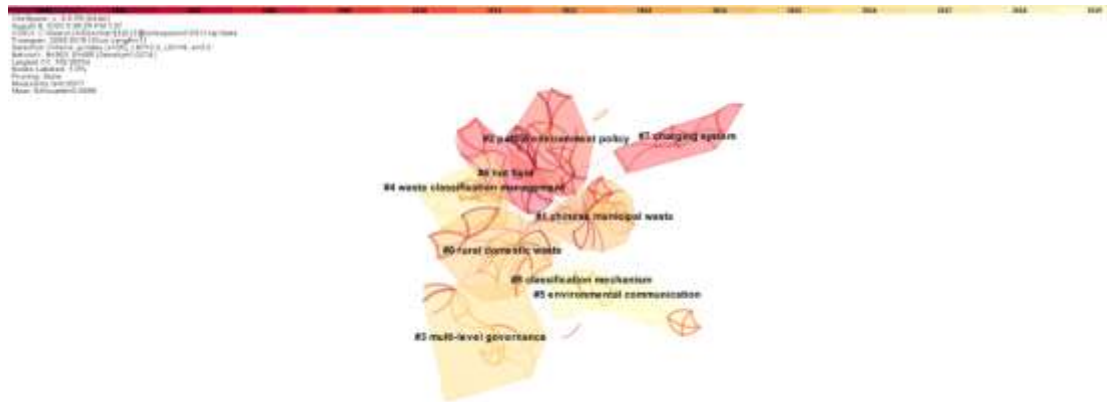
Figure 3. Clusters visualization based on a document co-citation network.

To characterize the nature of a cluster, CiteSpace can extract noun phrases from the titles of articles that cited the cluster based on three specialized metrics—LSI, log-likelihood tests (LLR) and mutual information tests (MI).

LLR usually gives the best result in terms of the uniqueness and coverage of themes associated with a cluster. Table 2 details the top 9 clusters in rank order.

Table 2. Top-ranked clusters in waste management

ID	Silhouette	Size	Label (LSI)	Label (LLR)	Label (MI)	Mean (Cite Year)
0	0.959	37	Analysis	Rural domestic waste	Social capital	2012
1	0.964	33	Municipal household waste	Chinese municipal waste	Municipal domestic waste	2011
2	0.903	30	Megacities	Public environment policy	Living garbage	2008
3	0.969	27	Public facilities planning	Multi-level governance	Panyu incineration plant	2014

4	0.981	22	Recycling	Waste classification management	Garbage disposal service	2014
5	0.969	15	Production	Environment communication	Alternative media	2014
6	0.972	12	thorw	Hot field	Municipal solid waste regulation	2007
7	0.988	10	Charing system	Charging system	Oreiented collection	2007
8	0986	6	Paradox between willingness and behavior	Classification mechanism	Rural domesic waste	2016

As shown in Figure 3, rural domestic waste and Chinese municipal waste are the two largest clusters. classification mechanism is the youngest clusters, and hot field and charging system are the oldest cluster. The values of the silhouettes for each cluster are greater than 0.5, suggesting robust and meaningful results.

The largest cluster, rural domestic waste (#0), consists of 37 member articles. The two most active citers in this cluster are Yajuan Jia [12] and Jinxia Wang [13]. According to the titles of these citers in this cluster, research works related to the determinants and suggestions of rural domestic waste. China is a large agricultural country with a large agricultural population, so most researches focus on the management of waste classification in rural areas. Around 2011, most villages did not have facilities for disposing of domestic solid waste, and more than half of the villages had no one to manage domestic solid waste. Only some villages started to formulate relevant management plans. These citers found that capital investment is one of the keys to solving the problem of rural domestic waste. It is necessary to learn from the practice model of pilot villages, maximize strengths and avoid weaknesses, and choose effective waste classification and treatment according to local conditions.

The second largest cluster (#1) in this knowledge domain, Chinese municipal waste, has 33 member articles and an average publication year of 2011. The most active citer to this cluster is Chuanhui Liao [14].In 2013, China began to conduct research on the classification of municipal waste, with Liao Chuanhui's research being the most classic. This article mainly analyzes the main influencing factors of municipal waste classification. In China, urban and rural waste classification have different influencing factors, so Chinese scholars usually define the research area first.

The third largest cluster (#2) is public environment policy which has 30 member articles and an average publication year of 2008. The most active citer to this cluster is Daqing Mao in 2006 [15]. These studies mainly promote the establishment of China's public environmental policies by introducing foreign experience.

The fourth largest cluster (#3) is multi-level governance which has 30 member articles and

an average publication year of 2014. The most active citer to this cluster is XikangZhao [16]. In the classification and management of rural waste in China, the four-level waste collection and transportation model of "household classification, village collection, township transfer, and county treatment" vigorously promoted by various regions is a typical multi-level management system. The effective operation of this system requires attention to both downward and outward decentralization. In this field of cluster (#3), the focus is on the research of multi-government cooperation and coordination.

The fifth largest cluster (#4) in this knowledge domain, waste classification management, has 22 member articles and an average publication year of 2014. The above highly cited literature also mentions the research influence mechanism on waste classification, which is a very important field of waste classification management research The most active citer to this cluster are the XianfengLu [17] and WeixiaLv [18]. Lu Xianfeng's article is mainly based on the theory of environmental psychology, which analyzes the influence of internal factors such as personal habits, environmental awareness, "economic man" rationality and legal systems, department management, publicity and education and other external factors on residents' garbage classification behavior. LvWeixia studied Japan's research mechanism, that is, based on diversified garbage classification publicity and education, protected by a legal system for garbage classification management with clear responsibilities, and used strict punishment and supervision measures as external pressure to effectively support and Incentive policies are the motivation to provide countermeasures and suggestions for waste classification management in China. The researchers concluded that citizen participation, education and publicity, legal constraints, government incentives, and multi-agent collaborative governance are the main successful experiences of Japanese waste

classification management. Therefore, the exploration of the impact mechanism of waste classification is an important research direction for the study of waste management.

The sixth largest cluster (#5) is environment communication has 15 member articles and an average publication year of 2014. This type of research emphasizes the integration of communication subjects. The most active citer to this cluster is Zuosujiang [19]. They emphasize that the government and social organizations should choose adaptive strategies and adjust flexibly according to the characteristics of the local political environment, resource endowments, and their own development stages, so as to effectively promote the classification of urban waste and make breakthroughs. "Garbage Siege" is in a dilemma. Discover the communication mode of risk communication among the subjects by exploring the information convection of different communication subjects and the abnormal characteristics of risk communication between each other.

The seven largest cluster (#6) is hot fields which has 12 member articles and an average publication year of 2007. The most active citer to this cluster is JianmingWang [20]. This type of article mainly focuses on the development of the theory and practice of the garbage charging policy. The eighth largest cluster (#7) is charging system which has 10 member articles and an average publication year of 2007. The most active citer to this cluster is XiGuo Yin [21]. This type of research is mainly to scientifically rationalize garbage disposal costs. For example, some studies are based on the design of market-oriented urban sewage and garbage disposal coordination system.

Finally, the term classification system also represents a cluster which has 6 member articles and an average publication year of 2016. This cluster is the newest one in which the most active citer in this cluster Shaojun Chen [22]. One of the latest major research

directions is the research on the mechanism of garbage classification. This research emphasizes the long-term cooperation and coordination of multiple subjects, and through mechanisms to keep the entire garbage classification mechanism in a stable state.

References With Strong Citation Bursts

Significant increases of research interests within the waste knowledge domain are characterized by publications that experienced citation bursts. Figure 4 shows the top 10 references with the strongest citation bursts during the period between 2005 and 2019.

Top 10 References with the Strongest Citation Bursts

References	Year	Strength	Begin	End	2005 - 2019
Zhang Yue, 2005, Environment and Sustainable Development, V0, P46	2005	1.5799	2006	2008	
Lu Huanliang, 2004, Building Technology, V0, P44	2004	1.0386	2007	2009	
Chen Minxia, 2008, China Economist, V0, P72	2008	2.3168	2010	2011	
Barr S, 2003, Local Environment, V8, P4	2003	1.1519	2010	2011	
Dinda S, 2004, Ecological Economics, V49, P0	2004	1.1285	2011	2012	
Ansell C, 2008, Journal of Public Administration Research and Theory, V18, P4	2008	0.9332	2013	2016	
Zhan Shaowen, 2012, Urban Problems, V0, P57	2012	1.4036	2013	2016	
Qu Ying, 2011, Journal of Applied Statistics and Management, V30, P42	2011	1.2873	2016	2019	
Lu Xianfeng, 2013, Urban Problems, V0, P86	2013	2.6028	2016	2019	
Tan Wenzhu, 2011, Urban Development Studies, V0, P95	2011	1.9682	2017	2019	

Figure 4. Top 10 references with strong citation bursts

As shown in Figure 4, most of the references started to burst in year 2006, one reference started to burst in year 2007,2011and 2017.

There are two documents starting in 2010, 2013 and 2016 respectively. Table 3 shows the representative references for seven groups by the beginning time of burst.

Table 3 Representative references with the strongest citation bursts

References	Year	Citation Burst		
		Strength	Begin	End
Zhang.2005	2005	1.58	2006	2008
Lu.2004.	2004	1.04	2007	2009
Chen.2008	2008	2.32	2010	2011
Dinda S.2004	2004	1.13	2011	2012
Ansell C.2008	2008	0.93	2013	2016
Qu.2011	2011	1.29	2016	2019
Tan.2011	2011	1.97	2017	2019

In the group of year 2006, the top one reference with the strongest citation bursts is YueZhang [23]. The article first clarifies the connotation and main forms of the garbage charging policy, and focuses on the economic theory of measuring user charges. Through learning from the practical experience of various countries, combined with the reality of China's waste management, analyze the preliminary practice of waste charging policies in China. Finally, suggestions on the design and implementation of China's municipal solid waste charging policy are put forward.

In the group of year 2007, the top one reference with the strongest citation bursts is HuanliangLu [24].By summarizing the causes of secondary pollution in waste treatment and summarizing the types of pollutants, a "comprehensive method" was proposed to prevent heavy metals and dioxins.

In the group of year 2010, the top one reference with the strongest citation bursts is MinxiaChen [25].This article compares the differences between domestic and foreign cities in the domestic waste charging system to explore a more effective charging system.

In the group of year 2011, the top one reference with the strongest citation bursts is Dinda S. This article analyzes the impact of garbage disposal on the ecological economy from the perspective of ecological economy. The value selection of waste treatment technology innovation in the construction of eco-city proposes innovative countermeasures and suggestions for scheme design and system specifications.

In the group of year 2013, the top one reference with the strongest citation bursts is Ansell.C and Shaowen Zhan. Through a field investigation in the main urban area of Xi'an,

using the Conditional Valuation Method (CVM) and the binary logistic method, the total economic value and the influencing factors of the willingness to pay of the residents' municipal solid waste classification and recycling reduction management were analyzed. Garbage sorting and recycling enables people to enjoy the benefits of environmental improvement while gaining benefits.

In the group of year 2016, the top two references with the strongest citation bursts are YingQu [26] and XianfengLu [27]. Lu'article compares the differences between domestic and foreign cities in the domestic waste charging system to explore a more effective charging system. These two articles are based on the theory of environmental psychology and analyze the influence of internal factors such as personal habits, environmental awareness, and "economic man" rationality, as well as external factors such as legal systems, department management, publicity and education, on residents' waste classification behavior. The conclusion drawn is that to increase the enthusiasm of urban residents to participate in waste classification management requires attention to the joint action of external pressure mechanisms such as legal regulation, government control, and economic punishment, and induction mechanisms such as ideological education, economic compensation, and public opinion support.

In the group of year 2017, the top one reference with the strongest citation bursts is WenzhuTan [28]. This article takes the classified collection and management of domestic waste in Taiwan as an example, the dilemma and system innovation of urban domestic waste.

CONCLUSION

According to the network visualization and the document co-citation analysis supported by CiteSpace, we explored the key clusters of articles and identified research patterns and emerging trends in the literature. Through analysis, we can find that, first, in the field of waste management in China, distinguishing urban and rural waste classification is the first two clear directions for scholars to choose such topics. Second, there have been many results in the research on the influencing factors of garbage classification. Such articles can get some new research conclusions through empirical analysis, so such articles can often become classics. Third, the recent research hotspots of waste classification management in China have gradually shifted to emphasizing cooperation, comprehensive governance, and collaborative governance among multiple entities.

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