



A Visual Analysis of E-Government Research in China Based on Co-word Clustering

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Abstract. The application of emerging technologies has promoted the rapid development and popularity of e-government. This paper takes 372 CSSCI papers in the field of e-government in China as the research object, and uses bibexcel, UNICET and SPSS software to perform co-word clustering analysis and visualize the clustering relationships. The research hotspots of e-government in China were found to include research on the development trend of e-government, research on the integration of e-government and new media, research on e-governance in the information society, and research on government information management and data governance. The analysis of the research hotspots provides references for the further development of e-government in China.

Keywords: e-government · big data · informatization · visualization and analysis

1 Introduction

China's e-government started in the 1980s with the construction of office automation systems. With the continuous development of digital technology, e-government has moved from the Internet era into the era of the Internet of Wisdom, and its construction has continued to develop in the direction of greater efficiency and quality. Therefore, to promote the development of e-government has become a worldwide trend and trend. From the launch of the "Government Internet Project" in 1999, to the implementation of the "Regulations of the People's Republic of China on Government Information Disclosure" in 2008, to the "Guidance on Accelerating the Work of "Internet + Government Services" in 2016, China's e-government is in the midst of the development of the Internet. China's e-government is in the process of continuous development and progress. At present, e-government research has become a hot area of common concern in information science, management and other disciplines [1].

Based on keyword clustering analysis, visual co-word network graph analysis and multi-dimensional scale analysis, this paper summarizes China's e-government research, reveals the research hotspots and main areas in e-government in China, and further clarifies the research trends in e-government.

2 Data Sources and Research Methodology

2.1 Data Sources and Preparation

In this paper, the CSSCI journals included in China Knowledge Network (CNKI) are used as data sources, mainly including “E-Government”, “Modern Intelligence” and “Journal of Intelligence”, and “e-government” is used as a keyword for the preliminary search. 2014 is the year when the Central Leading Group for Network Security and Informatization was formally established, which is an important step in the national informatization strategy. It is also a key point in the history of e-government development, so the search period was set from 2014 to 2020. After counting, 458 relevant papers were retrieved in this study. After excluding irrelevant papers such as conference announcements, volume headings, comparative studies on e-government at home and abroad and duplicate papers, the final number of sample papers was 372.

2.2 Method

In this paper, the methods of co-word analysis and cluster analysis are mainly used in analysing hotspots of e-government research. Co-word analysis refers to the number of times two or two keywords appear in the same document, and thus determine the affinity between keywords [3]. On the basis of co-word analysis, cluster analysis is used to divide keywords that are close together into one category, each category representing a specific focus of the literature [5]. Currently, co-word cluster analysis appears in the fields of economics, tourism, policy, intelligence studies, and education. For example, based on this approach, Huang Zui et al. conducted a quantitative analysis of science innovation policy changes in China, and found that China’s science and innovation policies have changed significantly in four areas: “international cooperation”, “human resources”, “institutional reform” and “research and development priorities” [4]. Ding Xueyang et al. used the method to analyse the stages of research on educational equity and the areas and themes covered by the research focus [5].

Using the co-word analysis method, with the help of software bibexcel, frequency statistics as well as co-occurrence matrix were generated for high-frequency keywords. Using the social network analysis software UCINET to draw visual knowledge maps, and similarity matrices were obtained through Excel and entered into SPSS software for clustering analysis. Accordingly, the hotspots and trends of e-government research in China are analysed in depth.

3 Analysis and Discussion

3.1 High Frequency Keyword Word Frequency Statistics and Analysis

Keywords are the result of a high degree of condensation of the content and methods of research in the literature, and word frequency statistics and analysis of keywords can transform keyword information into quantifiable data. The 372 documents were imported into NoteExpress and keyword statistics were performed. Finally, 697 keywords were obtained, and the top 31 keywords were selected as high-frequency keywords in this paper, as shown in Table 1.

Table 1. High frequency keyword word frequency table

Key words	Word frequency	Key words	Word frequency	Key words	Word frequency
E-government	351	Data sharing	19	Mobile government	12
Public services	50	Service-oriented government	17	Performance evaluation	11
Big data	39	Information resources	17	Public participation	9
E-governance	29	Digital government	15	Online government	8
Government websites	26	Cloud computing	14	Internet public opinion	7
Internet+	26	Government governance	14	Information security	7
Government microblogs	25	Government-people interaction	14	Open government	7
Informed society	23	New media	14	Social media	7
Public management	22	Data governance	13	Top-level design	7
Government services	21	Information disclosure	13		
Smart city	20	Government WeChat	12		

3.2 High Frequency Keyword Co-word Analysis

As can be seen from Table 1, these keywords appear more frequently in China’s e-government research papers, except for the keyword “e-government” which is exactly the same as the subject term, and to a certain extent, these keywords indicate the research hotspots of Chinese scholars. Next, the co-occurrence matrix was used to generate a keyword co-occurrence network, and the relationship between these high-frequency keywords was explored based on this network diagram. Therefore, the co-occurrence frequencies in 372 papers were counted using bibexcel software, forming a 31 × 31 co-occurrence matrix, as shown in Table 2.

According to the co-occurrence matrix, with the help of UCINET, the co-occurrence network diagram of high-frequency keywords of e-government research from 2014 to 2020 was obtained, as shown in Fig. 1, 31 high-frequency keywords formed a very close interlocking network with each other, each node represented a keyword. The size of the interconnected nodes represents the centrality of the keywords, and the thickness of the connecting line between the nodes represents the frequency of occurrence of the two sets of keywords between the nodes. From Fig. 1, we can see that: (i)the concepts in

Table 2. High frequency keyword co-occurrence matrix (part)

	Big data	E-government	E-governance	Top-level design	Service-oriented government	Public services	Public management	Public participation	Internet +
Big data	39	36	1	2	0	5	0	1	3
E-government	36	351	27	7	15	50	22	9	24
E-governance	1	27	29	0	1	6	8	1	1
Top-level design	2	7	0	7	0	0	0	0	0
Service-oriented government	0	15	1	0	17	5	3	0	1
Public services	5	50	6	0	5	50	6	1	6
Public management	0	22	8	0	3	6	22	0	0
Public participation	1	9	1	0	0	1	0	9	0
Internet+	3	24	1	0	1	6	0	0	26

the core area are “e-government”, “public services” and “big data”, which are the three largest nodes, representing their highest frequency and influence in the field. These three nodes are the largest, which means that they are the most frequent and have the greatest influence in the field. (ii) “Online government”, “government-public interaction”, “information-based society”, “public management” and “government governance” are in the transitional area. These keywords are the bridge between the central keywords and the peripheral keywords, and are also the focus of current research. (iii) Keywords in the marginal zone such as “data governance”, “public participation” and “new media” are more specific concepts and the actual focus of researchers. Although they account for a relatively small proportion of the current research, they are also indicative of research trends in e-government.

At the same time, the social network-based analysis method specifies the position and importance of an individual in the network by calculating the centrality of the nodes. The degree centrality of a point indicates the direct connection between a point at the ‘core’ of a series of relationships and other points; the betweenness centrality of a point measures the degree of control an actor has over other resources in the network; and the closeness centrality of a point indicates how much it is not controlled by others, the smaller the proximity centrality value of the point is, the more critical the point is to the network [5]. Therefore, after excluding the keyword “e-government”, the UCINET software was used to calculate the degree centrality, betweenness centrality and closeness centrality of high-frequency keywords to explain the power index of high-frequency keywords in the co-occurrence network knowledge graph (as shown in Table 3). Among the three indicators, “public services”, “big data”, “e-governance”, “information society”, “public management”, “government websites”, “government governance”, “government-public interaction” and “data sharing” all ranked in the top 10, indicating that these keywords are at the core of the network and are hot spots in the field of e-government research. The fact that “cloud computing” and “information disclosure” ranked in the top 10 of more than one kind of indicators also indicates that they have important research value in the field of e-government, and the analysis results are basically consistent with the results of the co-occurrence network diagram of high-frequency keywords.

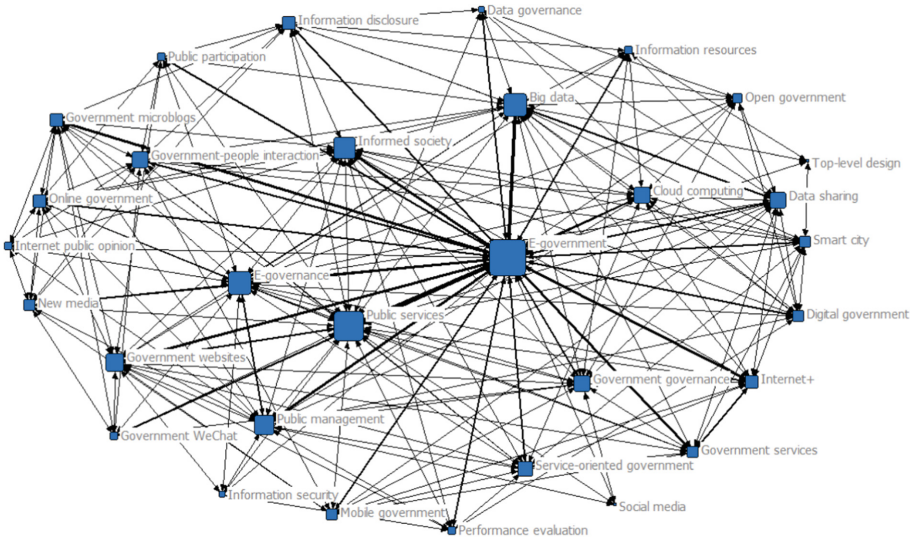


Fig. 1. High frequency keyword co-occurrence network diagram

Table 3. High-frequency keyword network centrality (part)

Num	Degree centrality		Closeness centrality		Betweenness centrality	
1	Public services	82.759	Public services	85.294	Public services	13.879
2	Big data	65.517	Big data	74.359	Big data	8.619
3	E-governance	65.517	E-governance	74.359	E-governance	7.422
4	Informed society	58.621	Informed society	70.732	Public management	4.925
5	Public management	55.172	Public management	67.442	Government websites	4.663
6	Government websites	51.724	Government websites	67.442	Informed society	3.943
7	Data sharing	48.276	Data sharing	65.909	Government governance	3.719
8	Government governance	48.276	Government governance	65.909	Government-people interaction	3.264
9	Government-people interaction	48.276	Government-people interaction	65.909	Data sharing	2.693
10	Cloud computing	44.828	Cloud computing	64.444	Information disclosure	2.4

3.3 High Frequency Keyword Clustering Analysis

The essence of cluster analysis is to divide the entire data into a number of finite categories, such that the differences in attributes within the same category are infinitely small and those between different categories are infinitely large [7]. Cluster analysis diagrams can visually reveal the research hotspots and research classifications in the field of e-government [8].

Firstly, Excel was used to convert the co-word matrix into a similarity matrix, part of which is shown in Table 4. In the similarity matrix, the closer the value is to 1, the closer the relationship between the two keywords is. It can be seen from Table 4 that “big data” is more closely related to other keywords and is one of the research centres.

Table 4. High frequency keyword similarity matrix (part)

	Big data	E-government	E-governance	Top-level design	Service-oriented government	Public services	Public management	Public participation	Internet +
Big data	1.000	0.738	0.476	0.614	0.445	0.580	0.458	0.531	0.550
E-government	0.738	1.000	0.731	0.679	0.699	0.806	0.740	0.714	0.715
E-governance	0.476	0.731	1.000	0.422	0.510	0.640	0.770	0.522	0.487
Top-level design	0.614	0.679	0.422	1.000	0.433	0.465	0.430	0.462	0.445
Service-oriented government	0.445	0.699	0.510	0.433	1.000	0.662	0.616	0.462	0.511
Public services	0.580	0.806	0.640	0.465	0.662	1.000	0.674	0.558	0.626
Public management	0.458	0.740	0.770	0.430	0.616	0.674	1.000	0.489	0.463
Public participation	0.531	0.714	0.522	0.462	0.462	0.558	0.489	1.000	0.457
Internet+	0.550	0.715	0.487	0.445	0.511	0.626	0.463	0.457	1.000

Next, the similarity matrix was imported into SPSS statistical software for cluster analysis, and the obtained cluster analysis is shown in Fig. 2. Finally, SPSS was used to conduct a multi-dimensional scale analysis of high-frequency keywords in e-government, resulting in a visual mapping, as shown in Fig. 3. $Stress = 0.1921 \leq 0.2$, $RSQ = 0.8269 \geq 0.6$, representing a good fit for this time. The multidimensional scaling method is a statistical research method that classifies and then analyses similar relationships between samples or variables in complex dimensions as distances in a two-dimensional plane.[3] Multidimensional scaling diagram more visually show the position of individual keywords in the research field and the distance of their relationship to each other.

As can be seen from Figs. 2 and 3, the above keywords can be divided into four clustering groups, as shown in Table 5. Cluster 1 focuses on the development trend of e-government, which is an Internet-based platform for government services that makes mobile government a reality and is gradually becoming a new means of government governance. Cluster 2 focuses on the specific application of e-government in the new media, effectively play the role of new media, correctly guide online public opinion, and enhance social governance capacity. Cluster 3 focuses primarily on e-governance in the information society, government websites and other platforms are important platforms for the

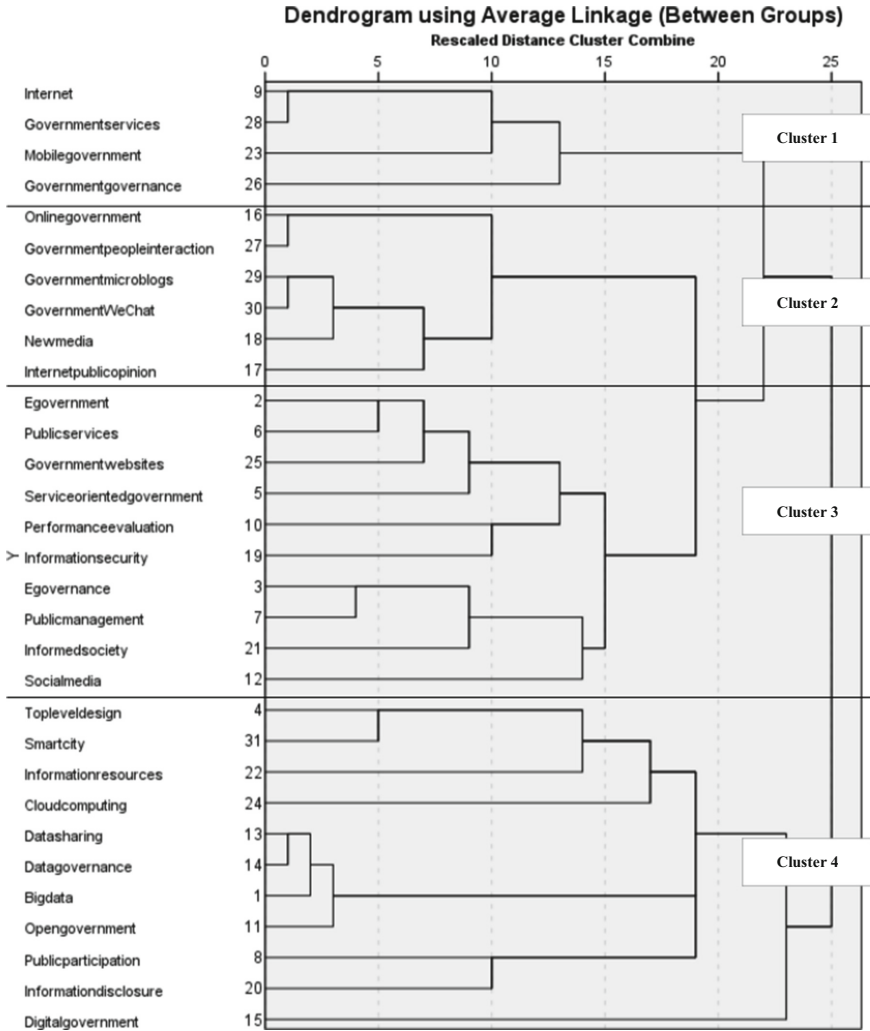


Fig. 2. Cluster analysis diagram

government to release information and interact with the public, create a service-oriented government while ensuring information security. Cluster 4 focuses on government information management and data governance, making full use of information resources and maximising their usefulness, improving the availability and authenticity of information resources; data governance and sharing can effectively solve the problem of data ownership, avoid the fragmented development of data and provide support for building a digital government.

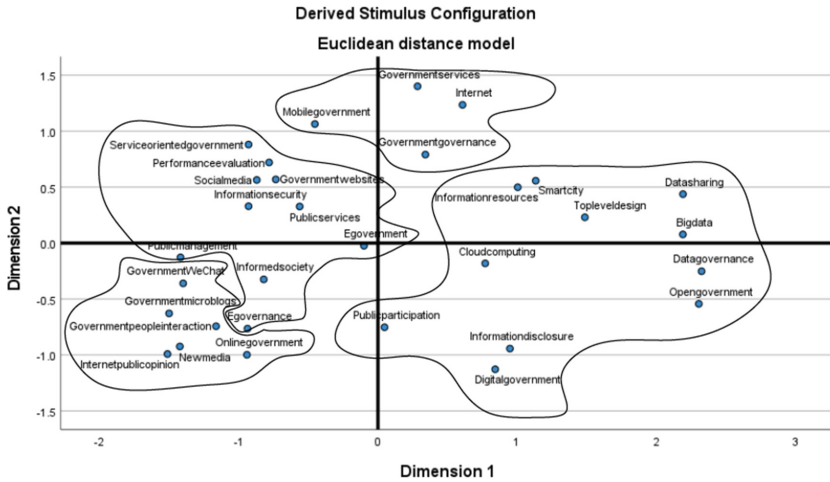


Fig. 3. Multidimensional scaling diagram

Table 5. Clustering results

Clusters	Clustering results
Cluster 1	Internet+, Government services, Mobile government, Government governance
Cluster 2	Internet governance, Government-people interaction, Government WeChat, Government Microblog, New media, Online public opinion
Cluster 3	E-government, Public services, Government websites, Service-oriented government, Performance evaluation, Information security, E-governance, Public management, Information society, Social media
Cluster 4	Top-level design, Smart city, Information resources, Cloud computing, Data sharing, Data governance, Big data, Open government, Public participation, Information disclosure, Digital government

4 Findings

Based on the results of the above co-word analysis, cluster analysis and multi-dimensional scale analysis, and combined with relevant literature, the research hotspots in the field of e-government in China in recent years can be further analysed and studied, this section analyses and discusses the research hotspots in the field from the following four perspectives.

4.1 Researches on the Development Trend of E-Government

New public service theory, service-oriented government theory, information security theory, holistic governance theory and open government theory are the theoretical foundations for the development of e-government. Based on the above theories, the research

on the development trend of e-government in China can be summarised into three areas: the development of e-government informatization, the research on government services and the research on the standard system related to government governance. New public service theory emphasises the public as the centre of attention and the public service as the purpose of government work and thus the achievement of the public interest. [9] E-government itself is a management model that relies on Internet technology to provide public services to social groups. It should be adapted to the new public service theory to create a new form of public service with the concept of “big data + Internet + government”, which is also a breakthrough and focus point for the reform of the government governance model [10]. A multi-level information security guarantee system should be constructed in the process of e-government informatization development to solve information security problems [11]. Mobile government is a typical representative of the development process of e-government informatization, which helps to achieve open government affairs and build a service-oriented government. There are still some problems in the current development of mobile government, such as the overall quality of service, unclear planning and design, the phenomenon of fragmentation of services and uneven levels of public use [12]. In order to improve the quality of government services, it is necessary to consider the impact of policy requirements, technological application capabilities, political drive, and institutional environment on the city government’s Internet service capabilities [13]. Holistic governance emphasizes the use of integration, coordination and networking to solve problems in government governance and reform. In order to cope with the problems such as information silos in the development of e-government, research on standard systems mainly including four areas: construction of e-government informatization standards, construction of a standard system for government services, standardization of open government services at the grassroots level and exploration of a standard system for e-government interoperability. However, in the current research process, the theoretical and practical combination is not close enough. It is necessary to start from the construction of the current situation, analyze the root of the problem, test the research results in practice, and promote the high-quality development of e-government as well as the reform of government governance model.

4.2 Research on the Integration of E-Government and New Media

In the context of big data, government microblogs, government weibo and government APPs have emerged one after another in response, enriching the channels of online information services. In 2018, the State Office issued the Opinions on Promoting the Healthy and Orderly Development of New Media for Government Affairs, elevating new media for government affairs as “an important channel for the Party and government to contact the masses, serve the masses and bring them together” [14]. The scope of research by Chinese scholars has focused on the communication effects of new government media, the optimization path and the governance of online public opinion. The new government media has the function of releasing government information, guiding social opinion and improving the government’s social governance capacity. With the help of big data technology, the appropriate “soft text” communication strategy can be used to enhance the communication effect of the new media of government [15]. With the increasing number of new government media, the problems in practice have been

exposed, such as the lack of influence of new media for government affairs on the image of the government and the public, the lack of initiative in platform construction and the lack of interaction between new media platforms, as well as the lack of full use of government data resources, all of which have affected the communication effect [16]. The government should attach importance to the construction of new media for government affairs, rely on the advantages of big data, adhere to the people-centered approach, and make use of the development mechanism combining multiple modes to optimize its development and improve its social influence [17]. As one of the mainstream media in China, the new media for government affairs should actively participate in the governance of online public opinion. Online public opinion governance includes early warning of online public opinion, the need for guidance and the formulation of guidance strategies. When participating in online public opinion management, new media for government affairs should establish a positive concept of public opinion, harness the power of multiple guidance and flexibly use public opinion response methods, so that the public opinion guidance mechanism and the new government media matrix can play a linkage role [18]. Therefore, it is necessary to focus on the synergistic development of e-government and new media, the construction of a new media matrix, the diversity of communication strategies and the improvement of the ability to integrate and utilise big data resources, in order to achieve the social communication effect of “ $1 + 1 > 2$ ”.

4.3 Research on E-Governance in the Information Society

E-governance is an important part of the national governance system, including public management and services, e-government information construction and other aspects. Domestic scholars' research on e-governance in the information society mainly covers three aspects: public services, continuous use of government websites and government performance evaluation. As early as 2011, Ning Jiajun pointed out that building a service-oriented e-government centered on the public will improve the government's basic public service capabilities [19]. Government websites are an important part of the construction of service-oriented e-government, and the study of users' continuous use behaviour on government websites is conducive to improving the construction of government websites and, in turn, the information construction of e-government. Research on the sustained use of government websites has gone through four stages: the technology acceptance model, the information system success model, the expectation confirmation theory and the expectation confirmation model of sustained use of information systems [20]. The public intention to continue using government websites influences the construction of government websites to a certain extent, while the quality of information, system quality and service quality of public service centres significantly affects the public's intention to use government websites as well as government performance [21]. In addition, e-government performance evaluation is a new model of government management services and governance, and the current research areas are mainly in government information disclosure, government website construction and application, and electronic government public service system construction and application. In order to improve user experience and build a service-oriented government, the performance evaluation system should be based on three aspects: the level of content construction, the degree of functional perfection and the effectiveness of user experience [22]. According to the current

situation in specific provinces and cities, an overall performance management model for e-government can be established that is integrated, linked and coordinated with “government openness, ‘Internet+ government services’ and government website intensification” [23]. Currently, the national integrated online government services platform has been put online for trial run in 2019, which to a certain extent reflects the service capability of “one network for all”. But in the process of service government transformation, the integration of online and offline services has not been fully achieved. In the future, important issues such as system building for e-governance, public participation and interaction, information security in information technology construction and evaluation of the effectiveness of policy implementation will require continuous attention.

4.4 Research on Government Information Management and Data Governance

At the national level, a number of documents on information management and data governance have been promulgated since 2015, including the Action Plan for Promoting the Development of Big Data, the Interim Measures for the Management of Government Information Resources Sharing, the Guidelines for the Construction of the “Internet+ Government Services” Technical System and so on, the documents provide a plan for effectively promoting data sharing in e-government [24]. In academic research, three aspects of information management and data governance are mainly studied: the current situation, framework system design and relevant policy standards. Local governments in China have insufficient capacity to apply data analysis techniques, inadequate internal management and external collaboration mechanisms, and inadequate security to prevent risks in the process of data governance [25]. One of the main reasons for these problems is that the framework system for government information management and data governance in China is not perfect, and a data governance framework can be constructed in accordance with relevant theories, focusing on government information management aspects and realizing embedded government data governance [26]. Policy support is essential for the governance of the current situation and the design of the framework system. Therefore, it is necessary to study and interpret the relevant policies. The relevant policy research mainly focuses on government data openness policy, data security policy, privacy protection policy, open licensing policy, infrastructure policy and government data governance policy, etc., and suggestions can be made accordingly. For example, the open government data subject system can be improved in four aspects: the legal subject system, the subject integration system, the coordination system of responsibilities and powers, and the subject exemption system [27]. And in the process of data opening, the principles of openness, quality, timeliness, equality, balance of interests and security should be followed [28]. Our government, as one of the subjects of e-government information management and data governance, should not only establish a reasonable concept of data governance, and build a dynamic balance mechanism for information security and privacy protection, but also grasp the extent of data utilization wisely to avoid leading to an over-reliance on data [29]. Therefore, it is necessary to consider the characteristics of information sharing and existing problems in the era of big data and the current situation of data governance in China, and further deepen the research on the optimization of data emergency management system and information sharing security,

so as to guarantee the effectiveness of information management and data governance in China.

5 Summary

The continuous development of the Internet has brought development opportunities and challenges for e-government. Through a visual analysis of the CSSCI-included literature in the field of e-government in China from 2014 to 2020, this paper finds that the research hotspots of e-government in China broadly involve four fields. Although the research results of e-government have gradually increased in recent years, there are still problems such as a single research perspective, insufficient integration of theory and practice, and lack of dynamic analysis of research. Therefore, a systematic, relevant, dynamic and universal paradigm of e-government research should be established to promote the in-depth development of e-government theoretical research. There are also some shortcomings in this study: (i) the sample data is limited, and there may be bias in grasping the research hotspots. (ii) the research data is time-sensitive, which may make the analysis of research hotspots and research status have stage characteristics; (iii) the bibliometric analysis can reflect the hot spots and research trends in this field, but the interpretation of the visual charts is somewhat subjective and generalised.

At present, the accelerating process of internationalisation and modernisation and the rapid spread of new technologies will certainly bring new impetus to the field of e-government in China. Therefore, the future development of e-government in China still needs to be studied in depth and on an ongoing basis.

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