REVIEW ARTICLE

Castells's "network society theory" to human geography —Analysis and comparison based on Chinese and foreign quotations

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ABSTRACT

Based on 898 English documents and 363 Chinese documents citing the Rising of Network Society, it studied that the knowledge contribution of citation content analysis and citation context analysis methods, and the knowledge contribution of Chinese and foreign quotations to human geography. The study found that "mobile space" is the most quoted theoretical view in domestic and foreign literature, and the proportion of domestic research is significantly higher than foreign research; the focus of domestic and foreign research focuses on the external spatial form and its transformation, while foreign research pays more attention on the internal spatial dynamics of network society and three types of knowledge contributions, reflecting the influence of "network social theory" on human geography. Among them, critical references reveal the shortcomings of "network social theory" point out the abstraction of "spatial duality" the importance of local space, and the limitations of research data, methods, and time background, which provides new enlightenment for the future application and innovation of "network social theory" in the field of human geography.

Keywords: Network Social Theory; Mobile Space; Human Geography; Knowledge Contribution; Citation Analysis; Citation Function

1. Introduction

Manuel Castells is a world-famous urban sociologist, and regarded as one of the most famous social thinkers of the 20th century[1,2]. Custer has written numerous works on urban society. Among them, *The Rise of the Network Society* systematically discusses the theory of "Network Society" in the information age[3–5], and it has become the most cited and influential work of Castells.

Castells's "network society theory" based on the logic of network and globalization, expounded the transformation from traditional social space to network social space, from fixed space to liquidity space. Meanwhile, it explained the geographical space and urban form under network society. It put forward the concepts and proposition of mobile space, network, globalization and information city[3–5], guiding to for understanding the relationship between network information space and geographical physical space, which has attracted wide attention of human geography scholars and played an important role in the development of human geography in the information age[6].

Under the influence of Castell's "network social theory", humanities and geography scholars mainly explored the global urban network, domestic urban network, urban grade, urban spatial structure, the relationship between physical space and cyberspace, urban planning, information city and other research topics[7–18]. But specifically, what knowledge in the "network social theory" pays tribute to the field of humanistic geography. The dedication is yet to be clarified. To clarify the problem can promote the development, and innovation of complex "network social theory" in human geography, and continuously guide the application of network logic in human geography.

The method of bibliometric analysis can elucidate the contribution and influence of important scholarship theory. However, traditional bibliometry often measured the academic impact of the literature based on the frequency of citation, but thes indicators are clearly flawed. The simple method with the reference frequency as the core ignores the importance of knowledge itself and the citation. It also ignores the relationship between the literature and the cited literature[19,20]. And analyzing the references and the reference approach break through the limitations of the citation frequency study paradigm. Citation content analysis and citation context analysis belong to this research paradigm. Specifically, the adoption of citation content analysis and citation situation analysis methods can elucidate the specific contributions of classical works from the perspective of knowledge development[22–24]. Both citation content analysis and citation context analysis require an understanding of the quoted semantic content[22,25]. Citation content analysis is used to reveal the quoted knowledge, while the citation context analysis reflects the relationship between the citation literature and the cited literature and is commonly used to analyze the author's citation cause[24,26]. Both are often applied to in the field of bibliometry and management, but rarely in human geography[20,21,27,28].

In this article, the citation content and citation situation analysis method is adopted. It aims to explore the enlightenment of Castells "network society theory" to human geography. Which knowledge in

"network society theory has been highly cited in the field of human geography? How does the "network social theory" contribute to humanistic geography? At the same time, the present research further reveals the future research focus and development direction of "network social theory" in human geography through the comparative analysis of Chinese and foreign quotations and the critical thinking of Chinese and foreign scholars.

2. Castells's "theory of network society" and its formation

Castells's "network social theory" takes the information technology revolution as the starting point, the network as the theoretical logic, and globalization as the main research perspective, and puts forward the basic view of "the network builds the new social form of our society"[3]. In the traditional sense, space is based on geographical proximity, while fixed cognition of space, time, and distance is completely subverted, and society is more and more building around flow[3]. Therefore, the new spatial form that dominates the network society transforms into "mobile space", that is, "the material organization of the social practice of shared time operating through the flow", forming the from three levels of material support, nodes and core and management elite[3]. Castells believes that there is structural splitting in the logic of flowing space and place space[3]. Although people live in the local space, places have gradually broken away from their historical and geographical roots and become functional networks, which leads to mobile space replacing place space in turn[3]. Thus, mobile space becomes the dominant of society, and the importance of local space in the network has gone beyond the importance of place itself[3,29]. In addition, Castells noted that network society is a global society and that global cities are the process of connecting advanced services, production centers, and markets in the global network[3].

The formation of Castells "network society theory" stems from the transformation of Castells research paradigm under social changes in the information age. Castells's international reputation began with his book "*Urban Issues*" published in 1970s,

which marked Castells's role as a leading theorist in "new urban sociology"[30]; Castells then continued to study urban social movements and migration around the orthodox Marxist paradigm; in 1979, Castells began working in the Department of Urban Sociology at UC Berkeley, shifting academic soil from European society to the United States; based on this change and the impact of the technological development environment in California, Castells began to embrace the epoch-making technology wave in the early 1980s, and in 1989 published "Information City", indicating the budding of information sociology and network social theory research[31]; in the 90s, Castells's most landmark *Information Age Trilogy* was published. The trilogy includes *The Rise of Network Society*, *Power of Identity and End of a Millennium*, fully exploring the economy, society and culture of the information age, with a comprehensive summary of the great shift at the turn of the century[4,5,32–36]. "The Rise of Network Society" is the top priority of the Castells trilogy, which further expands Castells's academic influence and lays an important theoretical foundation for relevant scholars to understand the new social form in the information age through the "network social theory"[2].

3. Data sources and research methods

3.1 Data source

This paper searches both *The Rise of the Network Society* (1996 and 2000) and *The Rise of Network Society* (2000) in the Web of Science (WoS) Core Collection database (webofknow-ledge, respectivelycom/) and the Chinese Academic Journal Network Publishing General Library (CNKI General Library, www.cnki.net/) retrieved the journal class citation literature from 1997 to 2015 (not including master and doctoral papers, conference papers, books, etc.)[3–5]. The search results were returned to 2879 English documents and 2362 Chinese documents, involving multiple research fields such as sociology, economic geography, news media, information science and more.

Based on the above search results, this paper

further screened out the literature belonging to the category of humanistic geography research. Humanistic geography-related research is published not only in geographical journals but also in journals of similar disciplines. Therefore, in order to reflect the knowledge contribution of "network social theory" to humanistic geography as comprehensively as possible, this study appropriately expands the subject scope of humanistic geography, that is, including human geography, urban research, planning and development, regional research, etc. These areas of study were chosen because of their close association and obvious knowledge input and output relationships[37-39]. For English literature, WoS has classified its disciplines for all its included journals. This article filters out journal papers belonging to the "Geography" "Urban Studies" "Planning & Development" as well as "Area Studies"; for Chinese literature, this article filters out humanities geographic literature belonging to the above category according to the name, introduction, content style and etc. Meanwhile, for the screening results, this paper further judges the subject paradigm by reviewing the topics and abstracts of the cited literature. Finally, 898 English references and 363 articles were retained Wenshi literature was used as a study sample of this paper, and the literature inscription is recorded to the excel and download the full text.

3.2 Study method

Sieweke points out that concepts are a subset of theories that the theory contains a series of concepts that are closely related and can be used alone[26]. Therefore, this article first adopts the citation content analysis method, analyzing the cited concepts in Castells's "network society theory". Basic procedures are mainly: (1) for the reference literature, the reference content will be recorded to excel; (2) read and understand the references and then make the judgment for cited contents and summarize the theoretical viewpoint as the theory concept. If a reference contains more than one concept, then individually record and categorize each concept; for theories with the same meaning concepts are unified and classified; statistics of theoretical theory intro-

duce frequency and sort out the often cited concepts in "network social theory".

Second, the citation concept was judged using the citation context analysis method. The functional role of its theoretical view in the citation literature is reversed. How does the image citation influence the citation literature? It is worth mentioning that in foreign studies, both the "reference function" and the "reference motivation" reflect the citing reasons of the author, and both of them can replace with each other[25,40]. And the citation reasons can be interpreted from the perspective of the author's personal intent (e. g., salute to the pioneer, ceremonial quote). It can also be cast from the citation functional role angle in the cited interpretation reads (e. g., confirm theory opinion, presentation of the related study[24,41–44]. This paper considers that the function of the citation can reflect more objectively the degree of knowledge contribution of the citation. Therefore, this paper selects the citation function to analyze and interpret the citation contribution. The basic analysis steps are: (1) read and understand the reference and its context. (2) On the basis of the citation function relevant literature has revealed, combine with specific studies in the citation literature object and repeatedly deliberate, to judge the function of the citation in the citation literature use, and record the reference function of each concept[20,24,43–46]. Although some quotes are given in the citation literature appear only once but undertook more than one citation function[40]. This study only recorded the most important functional role. (3) Secondary analysis of the judgment results is made on the results, and at the same time, reference function classification is unified and streamlined. Finally, this article was integrated to 9 referencing functions (**Table 1**).

Table 1. Reference function and its interpretation

Citation function	Paraphrasing
Background information	The citation provide background information on the full text or one of these topics.
Historical document	The citation expounds the existing literature, and often appears in the theoretical exposition parts such as "introduction" and "literature review" to help readers understand a certain topic.
Strengthen demonstration	Cations appear near or in the author's views to explain and support them.
Theoretical basis	The citation is used as the theoretical basis for applying the citation literature.
Views	Cations inspire the authors to present their own research questions, perspectives or future research directions.
Case validation	Through empirical or case studies, the cited literature demonstrated the cited views, or had similar conclusions to the cited literature.
Knowledge extension	The results of the citation literature expand the knowledge conveyed by the citation.
Point out the deficiencies	The authors note the shortcomings of the cited literature.
No-valid reference	The citation appears only in the reference list but not in the main text, or the citation is misquoted.

4. References content analysis

The analysis found that the 271 concepts of The Rise of the Network Society were 1558 times cited by 898 English citation literature, of which there is 258 English citation literature citing twice or more content; 363 Chinese literature cites 102 concepts of the work, which collectively cites 542 times, and 113 literature cites twice and more content.

Table 2 lists the top 20 cited frequency concepts, which are the introduction frequency accounted for 71.2% of the total introduction frequency at home and abroad,and 62.1%, respectively. It suggests that these concepts can represent human geography scholars' opinions of the core focus of Castells's "cyber-social theory". And for the English literature, the focus of Chinese literature is more focused. As can be found in **Table 2**, Chinese and foreign citation literature consistently shows the content about the "mobile space" in the "network social theory" is the most cited. But the Chinese study cited the proportion of "flow space"(19.7%) is significantly higher than that cited in the English study (10.1%). The theory of flow space subverts the conventional void, providing interideas for scholars of humanistic geography to understand spatial morphology, the biggest contribution of geography that Castells's "theory of network social" made for the humanities, of great significance for scholars to regain their knowledge of the concept, form and its development of space of the information age[4,47,48]. In addition, "network

Table 2. Top 20 cited concepts of *The Rise of the Network Society*

English literature				Chinese literature			
No.	Concept category	Cited frequency	Proportion (%)	No.	Concept category	Cited frequency	Proportion (%)
1	Flowing space	158	10.1	1	Flowing space	107	19.7
2	Network society	130	8.3	2	The relationship of flowing space and place space	43	7.9
3	Network	117	7.5	3	The effect of information technology	35	6.5
4	The relationship of flowing space and place space	91	5.8	4	Network	28	5.2
5	The effect of information technology	76	4.9	5	Social theory of space	26	4.8
6	Globalization	68	4.4	6	Network society	23	4.2
7	Knowledge	46	3.0	7	Global cities	17	3.1
8	Stream	36	2.3	8	Time and space	14	2.6
9	Global cities	31	2.0	9	Place space	13	2.4
10	Place space	25	1.6	10	Global cities	12	2.2
11	Node	23	1.5	11	Giant city	9	1.7
12	Innovation	22	1.4	12	Stream	8	1.5
13	Geographical distance	21	1.3	13	City is a progress	8	1.5
14	The effect of technology	21	1.3	14	City network	7	1.3
15	Elite	21	1.3	15	The network has constructed a new social form	7	1.3
16	Global network	17	1.1	16	Globalization	6	1.1
17	City network	16	1.0	17	Node	6	1.1
18	Cities	16	1.0	18	Cities	6	1.1
19	Information society	16	1.0	19	Information cities	6	1.1
20	City is a progress	16	1.0	20	De-localization	6	1.1

society", "network" and "the relationship between mobile space and local space" and "the influence of information technology" have also been highly cited by Chinese and foreign literature.

In comparison, Chinese and foreign literature has similarities and differences for the "network social theory" knowledge absorption. Both Chinese and foreign literature pay great attention to the network society association theory about the new space and social form, networked logic, information age background, and arguments about globalization. Besides, English literature pays more attention to Castells in the network social theory for the interpretation of economic and social development transformation and its connotation. For example, in the economic aspect, it reflects the knowledge of the information age as a factor of production and the attention of the innovation atmosphere in the new industrial space;

in the social aspects, it reflects the attention for the essence of the dominant status in the mobile space and its special organization and information society formation[3,4]. Chinese literature paid more attention to Castells's cognition and understanding of spatial connotation and performance and new forms of cities in the information age. For example, Chinese literature pays more attention to the "social theory of space" and "time and space". Castells sees space as an interaction and fusion with time and society. He put forward the "space is the manifestation of society" and the "space is not a copy of society, space is society ", " space is the crystallization time " *et al.*[4]. In addition, "World City", "mega-City", "Information City" and other cognition of the new forms of cities in the information age have also attracted the attention of the Chinese literature. To sum up, for the "network society theory", the difference is essen-

tially reflected in that English focuses on the intrinsic spatial dynamics of the network society, while Chinese literature focuses on the external spatial expression of the network society. On the one hand, this difference may arise from the different social and economic backgrounds and development stages of Chinese and foreign human geography research, and on the other hand, it is due to the different paths of knowledge transmission. Specifically, due to the different stages of social and economic development, the attention of Chinese human geography research on information technology and the human shift of research paradigm lags behind western social[49], with more emphasis on the impact, role and support of material space itself and material space transformation on human behavior and activities[49]. Therefore, in the information age, the western humanities geography research not only focus on the "network social theory" in spatial, social and economic overall change, also highlights the internal performance of the change and the attention of human driving force, and Chinese humanities geography research is more focused on the information age spatial form change, for its internal social and economic driving force is less attention. From the point of the knowledge communication path, foreign scholars based on the original English works convenience can dig "more rich network social theory" content and connotation, and domestic scholars rely on translation, and for Chinese translation often hit the most relevant arguments with geographical space, especially on the rise of the network society in chapter 6 "related content of flow space", and through secondary communication to further strengthen the influence of these arguments.

5. Reference function analysis

Tables 3 and 4 present the functional contribution and knowledge development contribution of "network social theory" respectively in China and foreign literature. From the perspective of reference function, Chinese and foreign literature takes "network social theory" as the most historical literature and background data in the research, followed by "strengthening demonstration" and "theoretical ba-

sis", while the functional functions of "viewpoint inspiration", "case verification", "knowledge expansion" and "pointing out deficiencies" are the least reflected. In addition, 18 Chinese literature and 9 English documents have invalid references, accounting for 5.0% and 1.0% in the study sample respectively, reflecting the lax citation behavior of small literature, conducive to the development of "network social theory" in the field of human geography, and such a problem is more serious in Chinese literature.

The first 8 citation functions reveal 3 types of knowledge development contributions, namely "knowledge dissemination", "knowledge inheritance" and "knowledge innovation", reflecting the varying degrees of influence of "network social theory". Most of the promotion of the spread of "network social theory", enhances the popularity of the theory, Chinese reference (69.0%) and the analysis of English reference (71.5%). However, "knowledge dissemination" is a kind of shallow learning result, which promotes knowledge development is very limited[50]. Less than a third of the quotations bear the role of "knowledge inheritance" and "knowledge innovation". "Knowledge inheritance" indicates that the author inherited and recognized the knowledge view of Castells's "network society theory", applying the theory to research and strengthening the understanding of the theory. "Knowledge innovation" is the biggest contribution to the knowledge integration of degrees among the three, and it is an important reflection that "network social theory" develops again in the field of human geography in an innovative way.

"Knowledge Innovation" involves 4 categories of reference functions, which are illustrated below. In terms of "viewpoint inspiration", Dong Chao *et al.* put forward the flow space in the geographical sense according to the meaning of "flow space"[51]. On the "case validation" side, Beaverstock's empirical study on the transnational elite supports Custer's "flow space" logic[52]. Chinese and foreign literature has made "knowledge expansion" on "flow space" and 'the relationship between flow space and place space". For example, Zhen Feng expanded the "space dualism" of flow space and placement space, and

Table 3. Citation function in Chinese literature

Knowledge development contribution	Reference function	Induced frequency	Accounting for (%)	Top 10 cited concepts
Knowledge dissemination (374)	Background information	186	34.3	Flow space (32), the influence of information technology (22), the relationship between flow space and site space(21), Network Society (13), Network (11), World City (7), Social Theory of Space (5),Global city (5), the network constitutes the new social form (5), city (4), mega city (4),Stream (4), Time and Space (4)
	Historical document	188	34.7	Flow Space (36), Network (11), Impact of Information Technology (10), Social Theory of Space (9), Relationship between mobile space and place space (9), world city (9), place space (8), network club will (7), global city (6), City is a process (5), delocalization (5)
Knowledge inheritance (34)	Strengthen demonstration	119	22.0	Flow space (22), the social theory of space (12), the relationship between flow space and place space (9), Time & Space (7), Space (4), City is a process (3), Innovation (3), Elite (3), Network (3), Network Social (3), the Impact of Information Technology (3)
	Theoretical basis	16	3.0	Flow space (10), the relationship between flow space and place space (2), liquidity (2) and empty space Inter- (1), Network (1)
Knowledge innovation (16)	Views	4	0.7	Network (2), flow space (1), node (1)
	Case validation	3	0.6	Flow Space (1), Pearl River Delta (1), New Industrial Space (1)
	Knowledge extension	4	0.7	Flow space (2), the relationship between flow space and place space (1), Time and space (1)
	Point out the deficiencies	4	0.7	Flow space (2), the relationship between flow space and place space (1), Time and space (1)
Does not benefit from knowledge development	No-valid reference			Only occurrence or incorrect references in the reference list (18)

Note: numbers in parentheses are the frequency of citation.

proposed the ternary space composed of real space, virtual space and gray space. Nielsen found that although East Jutland is not a global city, it also has three levels of flow space characteristic, expanded the understanding of "flow space"[47,53].

The citation function of "pointing out the deficiencies" comes from the critical thinking of scholars, which provides important clues for the in-depth development of "network social theory" in humanistic geography. The English literature points out the limitations of "network social theory" rather than the Chinese literature. Overall, there is great debate about "flow space", "the relationship between flow space and local space" and "network". It can be found that the most concerned theoretical views are also often the most controversial views. This study is summarized in the main controversy below (where 1 and 2 were proposed mainly by foreign studies, 3 was proposed jointly by domestic and foreign litera-

ture).

1) "Spatial dualism" is too abstract and inhuman. Foreign research has critically on the theoretical defects of "spatial dualism" constructed by "flow space" and "local space". For example, Majoor criticized the absolutes of "spatial dualism", noting that "flow space" and "local space" are too abstract and he thought it might exist a space between the two[54]. Jakobsen *et al.* and Smith put a similar view, while arguing that "mobile space and "network" theories have obvious "technical deterministic" color, too much emphasis on the impact of information technology on the network, and not enough attention to actors in the network, and therefore inhuman[55,56].

2) In the network society, "mobile space" is not better than "place space", "local space" is equally important as "flow space". Foreign studies make critical thinking on the relationship between flow space and local space and question the superiority of flow

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space to some extent. For example, Taylor stressed that global cities also have local characteristics, arguing that Castells's assertion that "global cities are not a place, but a process" denies the local characteristics of global cities. He believed that the flow can connect to global cities because global cities are first the "local"[57]. Marcinczak and van der Velde questioned the replacement of mobile space for local space, and pointed out that although mobile space was dominant in the network society, "mobile space" was not omnipotent leading to the loss of "local" self, local actors can control and influence local development, so "local" has the social and independent development ability that does not depend on "mobile space"[58].

3)Network studies lack targeted empirical data,

Table 4. Citation function in English literature

Knowledge development contribution	Reference function	Induced frequency	Accounting for (%)	Top 10 cited concepts
Knowledge dissemination (374)	Background information	472	30.3	Network Society (49), Mobile Space (37), the Impact of Information Technology (37), Network (31), Global Chemical (27), the relationship between flow space and local space (19), flow (12), knowledge (10), geographic distance from (9), City (8), Global City (8), Information Society (8)
	Historical document	642	41.2	Flow space (54), network (56), network social (48), the relationship between flow space and local space (39), Globalized (29), Impact of Information Technology (23), Knowledge (23), Flow (16), place space (14), Node (12), Innovation (11), Global City (10), Geographic Distance (10), Global Network (9), the Impact of Technology (8), Urban Networks (8), Multinationals (8), Global Economy (8), Networking Maforms a new social form (8)
Knowledge inheritance (34)	Strengthen demonstration	318	20.4	Flow space (33), network (23), network social (22), the relationship between flow space and local space (21), the Impact of Information Technology (13), Knowledge (13), Elite (12), Globalized (7), Innovation (6), The Impact of Technology (5), Global Network (5), City is a process (5), stream (4), Global City (4), Node (4), the Global Economy (4)
	Theoretical basis	76	4. 9	Mobile space (12), the global city (7), the relationship between mobile space and local space (5), the giant city City (5), Network Society (5), World City (4), City is a process (3), real virtual (3), Time Free Time (3), Urban Network (2), Network (2), Information Revolution (2)
Knowledge Innovation (16)	Views	4	0.3	Networks (1), relationship between flow space and local space (1), Impact of Information Technology (1), globalization(1)
	Case validation	4	0.2	Urban network (1), flow space (1), node (2)
	Knowledge extension	3	0.3	Flow space (1), labor (1), the relationship between flow space and local space (1)
	Point out the deficiencies	39	2.5	Flow space (8), global (4), network (3), the relationship between flow space and local space (2), Geographic distance (1), stream (2), network social (1), global urban (1), local space (1), node (1), the influence of technology (1), mega city (1), liquidity (1), network constitutes the new society Morphology (1), Airport (2), Mobile (1), neostructuralist (1), National (1), World City Network Vioxx (1), the difference between capital and labor (1), the global and local relationship (1), the role of location (1), a multinational company with the (1)
Does not benefit from knowledge development	No-valid reference			Only occurrence or incorrect references in the reference list (9)

Note: Numbers in parentheses are the conceptual frequency of citation.

effective measures, and considerations for mobile information technology. In foreign studies, Taylor pointed out that Custer mainly used national-level data, and that the data is too macroscopic will reduce the accuracy of network research[59]. Similarly, Wall *et al.* argue that Castells's empirical studies on globalization and world urban networks lack support for more micro-detailed data[60]. Devriendt *et al.* have pointed out similar data problems while pointing out the difficulty of data acquisition, and the lack of detailed targeted data is a common problem in world urban network studies[61,62]. In domestic research, such as Wang Mingfeng, Ning Yuemin and Shen Lizhen pointed out that Castells's network research mainly relies on some cases and lacks matching empirical evidence with it, so the explanation of complex network social theory is relatively limited. Due to Castell's simple measure of the urban network, Yao Yongling and Tang Yanzhe pointed out from the perspective of research methods that although Custer elaborated on the urban nodes in cyberspace, there was no suitable method was found to measure the factor flow and connection between cities[63–65]. In addition, due to the constraints of the time background, Zhen Feng *et al.* noted that Castells's network research emphasized the impact of fixed information technology without considering today's mobile information technology background[66].

6. Conclusions and discussions

This paper studies the knowledge contribution of Manuel castells's "network social theory" based on the analysis and comparison of Chinese and foreign quotations to humanistic geography by using the method of citation content analysis and citation context analysis. On the one hand, this study is beneficial to promote the application and innovation of network social theory in human geography. on the other hand, Castells is a famous sociologist, so the contribution of disciplines, which is beneficial to knowledge innovation.

The results of the citation content analysis found that the "flow space" is the most quoted theoretical view of domestic and foreign studies, and the citation proportion of domestic studies is significantly higher than that of foreign studies. In addition, there are some differences in the attention of the "network social theory" in domestic and foreign research. Domestic research pays more attention to the external spatial form and spatial transformation of the network society, while foreign research pays more attention to the internal spatial dynamics of the network society. On the one hand, this difference may originate from the different social and economic backgrounds and development stages of Chinese and foreign human geography research. On the other hand, it stems from the different paths of knowledge transmission.

The results of functional analysis show that "network social theory" has played nine functional roles and made three kinds of knowledge contributions in domestic and foreign research. Most of the citation literature will use the theoretical views of the network society as the historical literature and background data in the research, only a small number of studies are substantially inspired by the theory, or to verify, expand the relevant theories, or point out the shortcomings of the theoretical views. From the perspective of knowledge development, the citation content has made contributions to "knowledge dissemination", "knowledge inheritance" and "knowledge innovation", which reflects the progressive knowledge interaction from shallow to deep. Among them, most of the references promote "knowledge dissemination", but the influence on cultural geography is relatively shallow. Only a few studies have explored the theory at a deeper level and promoted the "knowledge innovation" of the theory in the field of humanistic geography.

"Point out deficiencies" reflects the critical thinking of scholars, but its occurrence probability is very rare. The English literature points out the limitations of the "network social theory" to a greater extent than the Chinese studies. Overall, scholars mainly point out the shortcomings of the "network society theory" from three aspects: "spatial dualism" is too abstract and single; "mobile space" is not superior to "local space"; the empirical data and measurement methods of the network research are flawed and lack mobile information technology con-

sideration.

Castells's "network society theory" provides a crucial basic theory for human geography re-understanding of space and society, and Chinese and foreign research on the focus of the theory and related scholars' critical thinking about the theory for the future from the perspective of humanistic geography research network society clarified the research focus and breakthrough direction. This article mainly summarizes it in the following four aspects:

1) breaks through the cognitive paradigm of "spatial dualism" and explores the discovery of diversified spatial forms. Humanistic geography scholars need to dialectically view the "spatial dualism" constructed by mobile space and local space. It is necessary to admit that "spatial dualism" provides new insights into understanding the spatial form of the information age, but the relevant theoretical views are more abstract and single. Therefore, it is necessary to break through the binary structure division of the space under the network society, at the same time to jump out of the thinking pattern of "technology determinism", based on the research thinking of "human technical space", explore and discover diversified spatial forms, to promote the perfect development of "network social theory" in human geography.

2) strengthens the research and excavation of the independent development potential of local space, and promotes the balanced development of "mobile space" and "local space". In the network society, although the mobile space is considered as a new form of spatial development, the "mobile space" does not completely dominate the network society, and it cannot be ignored that the role and status of the "local space" in the network society and their independent development ability. Therefore, in the future, for the network society, humanistic geography research should constantly explore and explore the independent development potential of local space, and explore the influence and role of local actors on local space. At the same time, it is necessary to reveal the interaction relationship between flow space and local space through empirical analysis and case study and promote the balanced development of flow space and local space.

3) based on new data, new methods, new technology environment, support, and rich "network social theory". Given the data and methods of "network social theory", and future research should constantly discover and use new supporting data (including big data, real-time data, data from different social backgrounds and different spatial levels) and new research methods (such as dynamic simulation methods, machine learning methods, etc.) to support and enhance network research. At the same time, we should actively connect with the era of mobile Internet, study the network space based on mobile communication technology, and constantly enrich the "network social theory".

4) promotes network social research from the perspective of human geography from focusing on "objectivize space" to "human-oriented space". Domestic and foreign research for "network social theory" focus difference enlightenment China for network society research needs to focus from "materialized space" to "human space", not only focus on material space for residents behavior and support, more need to pay attention to people as a social body in the information age of life, production needs and individual differences, at the same time to obtain a geographical spatial change of human nature, thus based on this for material space. At the same time, Chinese research also needs to further explore the internal social and economic driving force of material space transformation, and find the action mechanism of social and economic transformation on material space reconstruction. In addition, Castells's "network social theory" is a systematic theory involving many aspects. It is also necessary for domestic research to deeply understand the rich connotation of "network social theory" through the original work system, and conduct dialectical thinking, to deepen the application of the theory in humanistic geography.

Although the method employed in this study has been widely used in bibliometry, it is inevitably influenced by subjective judgment and experience. It is necessary to establish a more objective judgment in the future.

For in-depth research, we can explore the use

of natural language processing technology, machine learning and text mining to study the knowledge contribution of classical theory to human geography[24]. In addition, since the mid-19 80s, Castells's academic thoughts on the information society have a certain relevance, so it is also of great significance to explore Casterlls's theoretical perspective from the perspective of integrity for the contribution of humanistic geography. At the same time, although Castells's theory is a typical representative of the global "network social theory", but other relevant scholars (such as Peter J Taylor) for the extension of the theory has also largely contributed to human geography, so it is necessary to explore the influence of "network social theory" from the perspective of integrated ideas on human geography.

Conflict of interest

The authors declare that they have no conflict of interest.

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