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Development Trends in China's E-Commerce Research Topics

Knowledge Map Evolution in Four Planning Stages (2001-2020)

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Abstract: China's recent performance in electronic commerce has garnered global attention, but systematic exploration of this topic remains limited. This study employs methods such as co-citation analysis and social network analysis to examine journal articles related to Chinese electronic commerce (EC) research published in the WoS database from 2001 to 2020. The findings indicate that the primary driving forces behind the development of China's EC are the strengthening of industrial growth through the digital economy, the optimization of the regulatory environment, the expansion of global collaboration, and the acceleration of new economic dynamics. The United States stands as the leading country in collaborating with China in the field of electronic commerce. Universities and institutions in Hong Kong made particularly significant contributions during the first three stages (2001-2015). Across the four stages (I-IV), the evolution of research topics can be summarized as follows: (I) a focus on the development of information technology infrastructure; (II) as cross-border e-commerce grew and trust was established, both hardware and software improved; (III-IV) further exploration of smart agent systems, trust factors, transaction intentions, perceived benefits, and the integration of artificial intelligence into smart e-commerce trends.

Keywords: literature analysis; electronic commerce; cluster analysis; co-citation analysis; knowledge graph; economic development; information economics

1 Introduction

1.1 Research Background and Motivation

In 1978, China started its economic reform and opening up. After more than 40 years' efforts, China became one of the fastest growing regions in the world and jumped to become the second largest economy in the world. However, no matter from various policies or responding to the needs of globalization and global competitiveness, so far we have not

clearly understood the core of research topics and activities carried by China in the development of electronic commerce (EC), as well as the process of knowledge dissemination.

In the past, many scholars, such as Wan (2012), Xu et al. (2012), Yan, Lee and Lee (2015), He (2018), Mei and Chu (2018), reviewed China's EC. However, at limited cross-sectional time points, we are not clear about the role or emphasis direction of China's EC at different time points, or even the industrial policies, disciplines and research trends supporting EC, that is, no researchers have made a long-term longitudinal and multi-directional analysis of China's EC, which is an unprecedented, urgent and extensive major issue for us in today's knowledge-based economy society, and is also an important issue of common concern to global scholars and EC industry.

Fang and Fang (2022) conducted a co-word analysis of China's EC, examining 1,982 journal articles and 6,359 keywords published between 2001 and 2020. While their study yielded certain results, it still lacks an exploration of the knowledge citation sources and the evolution of knowledge clusters in the field of China's EC research during this period (2001 to 2020).

1.2 Research Purposes and Methods

Since the tenth five-year plan (2001-), China's economic policies have not systematically discussed the guiding direction of EC, the orientation of knowledge structure, the evolution, current situation and future trend of research topics, and the development of major research institutions and partner countries. Without bibliometrics orientation, meta-analysis, or content analysis, a proper and systematic inductive analysis has been carried out in this field. Relatively, the research in this field is still lacking and obviously weak. Therefore, this study strives for scientific, objective and effective methods, applies bibliometrics co-citation analysis and content analysis, and identifies the general situation of information revealed in this subject field from macro and micro according to the development status, knowledge structure and characteristics of China's EC subject journal articles collected in the Web of Science (WoS) database, so as to objectively understand the development status of China after economic reform and opening up and infer the future development trend of EC.

This study uses the WoS database as its research scope, offering a distinct advantage in terms of time coverage (2001-2020). The goal is to establish a knowledge structure indicator to help researchers better understand the clusters within this field and their future development directions. The study aims to reveal the evolution of China's EC knowledge clusters, key academic resources, as well as the structure, content, and development dynamics of research topics through an analysis of findings across different stages. Additionally, the study explores how EC-related economic policies and guiding programs in China have driven and supported the development of the EC environment, helping research institutions and individuals better understand emerging trends and specialized areas in the field. Ultimately, this research will enrich and expand the content and practical

applications of the EC field, providing valuable insights to academic institutions and relevant stakeholders for planning future research topics.

2 Literature Discussion

2.1 Literature Review and Analysis

Analysis of EC Research Results Included in the WoS Database

In the past, literature analysis was the most common way to make individual discussions aiming at a single specific research topic, and the most commonly used method was to sort out and analyze a large amount of data by using the related technology of bibliometrics research, so as to obtain meaningful information from it. Wan (2012) analyzed 1,242 articles in EC subject journals from 1997 to 2011 in the WoS database, discussing the distribution of research strengths of countries and regions and research institutions in this field and the current distribution of core journals. The research results point out that for most of the EC participants' behavioral rules and EC's micro-market mechanism and evolution, research on emerging EC technologies is still relatively weak. The United States in the first place, China is second (Hong Kong has the highest contribution rate, followed by Mainland China), but it is significantly more than other countries.

Xu et al. (2012) analyzed 12,718 attribute documents of EC subject in WoS database from 2000 to 2010, to understand the subject of research in this field (high-yield authors, high-yield institutions, high-yield countries) and identify the knowledge base of their field (high-influential authors, classic literature, key literature, core journals). They found that United States, China (including Hong Kong), Britain, Taiwan, Canada, Australia, South Korea, Germany and other countries and regions have outstanding output in EC research. The research design mainly applies technology acceptance model (TAM) to analyze consumers' behavior. At the same time, it is found that statistical measurement methods and psychology are the important theoretical basis of EC research. Shiau and Dwivedi (2013) analyzed six major EC journals. From the 1,064 articles published from 2006 to 2010, they identified 48 high-value articles and five research areas. They are trust, technology acceptance and technology application, e-commerce task-related application, e-markets and, identity and evaluation.

Yan et al. (2015) analyzed 8,488 EC-themed articles published in WoS database from 2000 to 2013, and determined that the three main EC fields are composed of technology, management and customer. It covers seven important sub-domains: internet, consumer behavior, customer satisfaction, online shopping, reputation, Taiwan, and knowledge management. Galipoglu et al. (2018) conducted a co-citation analysis on 70 pipeline articles in the field of EC retail and EC logistics filtered from EBSCO database, and found that EC focused on western retail environment, while the knowledge base was rooted in marketing discipline.

Fang and Fang (2022) conducted a co-word analysis of 1,982 journal articles published in the WoS between 2001 and 2020, refining and verifying 6,359 keywords. The

study examines the current status, changes, and trends of research topics in the field of China's EC across different stages, as well as contemporary research hotspots. The findings reveal that, while the initial focus was on the foundational infrastructure of EC, the research topics have since evolved to incorporate AI-related technologies and address consumers' personalized needs. The research themes are now shifting towards the integration of AI technologies into the EC environment, as well as exploring various characteristics of electronic markets. Compared to other bibliometric methods, such as co-citation analysis and bibliographic coupling, the co-word analysis used in this study is simpler and more flexible (Fang & Lee, 2021).

Co-word refers to keywords that represent the content of a research topic, while co-word analysis is a statistical method used to explore the intrinsic relationships and disciplinary structure within literature. It is a technique for mapping the dynamics of scientific research (Callon, Courtial & Laville, 1991). The basic concept involves calculating and analyzing the co-occurrence of specialized terms (such as keywords) within documents in a specific academic field. This analysis further classifies the keywords using a co-word matrix and statistical methods, helping to reveal the relationships between documents and keywords. When two keywords appear together more frequently in the same paper, their relevance and similarity are considered higher, and their proximity in the co-word network is closer. This method helps determine the relationships between research topics in a given field, revealing current trends and the structural dynamics of research.

However, this study employs co-citation analysis to complement the findings of Fang and Fang (2022) and further reveal the evolutionary clusters within China's EC, including the structure, content, and developmental dynamics of research themes.

Analysis of EC Research Results Included in the China National Knowledge Infrastructure (CNKI)

The China National Knowledge Infrastructure (CNKI) database is currently the Chinese full-text database with the most comprehensive collection of source documents, the widest range of disciplines, and the fastest update time in China. Mei and Chu (2018) analyzed 2,884 articles on EC topics included in the CNKI database from 1998 to 2016. The research mainly focused on: (1) consumer trust, (2) product pricing, (3) user privacy, (4) consumer behavior, (5) information dissemination effect, (6) uncertainty in exchange relations, and (7) EC system model. The subject areas involve economics, information, documentation, law, journalism, and communication, education, statistics, etc., with economics as the mainstay. Pan and Shao (2009) analyzed the 907 EC academic papers published in CSSCI journals from 2003 to 2008 in order to grasp the characteristics and trends of EC research in China in recent years and found that current research mainly focuses on corporate e-commerce strategy and EC environment etc.

Wang and Rui (2016) used co-word analysis to analyze 290 SCI, EI, and CSSCI journal articles collected by CNKI database during 2004-2015. The study found that EC research during this period was mainly concentrated on the Internet and supply chain, Data mining and other topics, social EC has become an emerging field of research. He (2018)

analyzed the CNKI database with co-words and analyzed 1,134 EC theme articles collected from 2005 to 2016. The study found that EC research focused on the B2B model, value chain, supply chain, etc. Co-occurrence analysis, or co-occurrence word analysis, is a type of co-occurrence analysis, which is part of information retrieval and scientometrics. A common way to cluster together the files related to the subject. If the same words are used in two documents, there will be co-occurrence words or co-words between the two documents. The more co-occurring words, the more similar the themes of the two documents (Zeng, 2024).

Looking back at the previous relevant literature, we can vaguely see some directions of China's EC research, and we also find that the previous relevant literature shows some research gaps and limitations. At present, little is known about the distribution and structure of EC research topics under the intertwining of economic policies and social development in China. In addition, the previous studies are all from the perspective of the structure of the subject field, analyzing the development context, the current research situation, and predicting the future development trend. The results show that the application of co-citation analysis can reveal the relationship between research topics and their clusters in specific subject areas. From the perspective of horizontal and vertical research, the relationship between research topics in specific disciplines and other research topics is expressed. Explore and understand the historical context of research topics and the evolution trend of sub-fields in specific subject research fields.

2.2 China's E-Commerce Economic Policy Plan

The "Five-Year Plan" is an important blueprint for China’s national development plan. Each five-year plan is mainly based on the prevailing foreign economic situation at the time, as well as China’s own internal economic development trends and problems. To systematically formulate the goals and directions of the national economic and social development vision for the next five years.

During 2001-2005 (Tenth Five-Year Plan): The tenth five-year plan is precisely China’s transformation from a planned economic system to a market economic system, and the impact of economic globalization and Internet globalization. Promote economic and social informatization, and actively promote informatization in the fields of finance, taxation, and trade. Increase the popularity and application of computers and the Internet, accelerate the development of EC, strengthen the development and utilization of information resources, especially the development of industrialization driven by informatization, and the networked production and operation and consumption methods have gradually penetrated all levels of the economy and society. From an economic perspective, the development of EC is not only the acquisition of new technological tools and the change of business models for the Chinese economy but more importantly, the promotion and adjustment of the economic structure on a new platform, which determines the competition of the Chinese economy in the 21st century. In 2005, EC transaction volume reached 1,688.9 billion yuan (CNY) (Yuan, 2001; Zhang, 2005).

During 2006-2010 (Eleventh Five-Year Plan): This is the first time that China has introduced the development of the overall EC structure at the national level, clarified the

development principles of EC during the "Eleventh Five-Year Plan" period, popularized and deepened the application of EC, enhanced electronic certification, online transactions, online payments, modern logistics, credit, security protection and market supervision. In 2009, the transaction volume of EC reached 3.8 trillion yuan (CNY), and in 2010 it reached 457 million yuan (CNY), reflecting the integration of the network economy and the real economy, focusing on improving the supporting environment, and promoting the full integration of EC into economic and social development. Industrialization drives industrialization, promotes informatization with industrialization, optimizes all aspects of the industrial structure, and embarks on an EC development path with Chinese characteristics (Yang, 2007; Yi, 2005).

During 2011-2015 (Twelfth Five-Year Plan): Apply EC to promote the construction of a modern commerce and trade circulation system, focus on improving the development environment, improve application standards, stimulate market vitality, stimulate national consumption, promote the upgrading of the service industry, and give full play to the role of EC in the production and operation of innovative enterprises. At the same time, in the context of shrinking world markets and increasing import and export pressures, Chinese companies continue to explore domestic and foreign markets with the help of cross-border e-commerce and expand a large number of B2B and B2C e-commerce platforms with their own characteristics. The scale of EC transactions increased from 6 trillion yuan (CNY) in 2011 to 21.8 trillion yuan (CNY) in 2015, and it surpassed the United States in 2013 to become the world's largest and fastest-growing EC market. Comparing the data at the end of the Eleventh Five-Year Plan and the Twelfth Five-Year Plan, China's EC transaction volume and online retail transaction volume have averaged annual growth rates of over 35% and 50%, respectively (Meng, 2017; Zhang, 2016).

During 2016-2020 (13th Five-Year Plan): Clarify the five major tasks of EC's development direction, focus, and path: (1) Accelerate the upgrading of EC quality; (2) Promote the deep integration of EC and traditional industries; (3) Develop the EC factor market; (4) Improve the EC livelihood service system; (5) Optimize the EC governance environment. The policy establishes three major development indicators, namely, by 2020, the non-EC transaction volume will reach 40 trillion yuan (CNY), the total online retail sales will reach 10 trillion yuan (CNY), and the number of EC-related practitioners will reach 50 million. Fully integrate EC into all areas of the national economy and form an EC industry with global influence; the other is to pay equal attention to promotion and regulation, strictly regulate the market order and market competition environment, and supervise the development quality of EC platforms and EC enterprises, especially credit system construction, establish a good image and build an international reputation and brand (Zhang, 2017; Zhao, 2017).

2.3 Co-citation Analysis in The Time Period of The Research Topic

When using co-citation analysis to explore the evolution of research topics and research frontiers in a specific academic field, there is currently no precise or universally accepted optimal time slice for citation analysis. Generally, researchers define appropriate

time intervals based on their research objectives, selecting periods that best reflect the influence of the research topics (Boyack & Klavans, 2010; Fang & Lee, 2021). This study examines China's EC research literature over a 20-year period (2001-2020), using China's Five-Year National Development Plans as the time slices, dividing the timeline into four stages (I-IV). Bibliometric co-citation analysis is then applied to understand the characteristics of research topics in each time period and to track the evolution of research themes across these stages. Additionally, the study explores the development of EC in China, revealing both the evolution of research topics and the active research frontiers during the four planning stages.

2.4 Co-citation Analysis Can Effectively Understand Research Trends

Co-citation is used to measure when two (or more) documents are cited by other documents at the same time, then the two documents (cited documents) have thematic conceptual relationship. For example: A and B two documents, regardless of their publication time, as long as they are cited by one or more later documents at the same time, then A and B are said to have a co-citation relationship. The greater the number of co-citations, the higher the relevance of the content. Through comparisons at different times, we can find out the changes in the development model of subject themes and concepts, and establish a measurable link between the two articles (Garfield, 1996).

Co-citation analysis can be broadly categorized into Document Co-citation Analysis (DCA), Journal Co-citation Analysis (JCA), and Author Co-citation Analysis (ACA). DCA analyzes the co-citation relationships between documents to understand group networks and their changes. It uncovers the structural relationships between co-cited reference documents, thereby reflecting the research fields, development trends, and core literature within a discipline. JCA, which focuses on journals as the unit of analysis, uses co-citation relationships and their intensity to determine the disciplinary nature of journals and identify core journals. ACA, on the other hand, examines the works of researchers within the same field to understand changes in author groups and infer the development trends of a discipline (White & McCain, 1998). Therefore, co-citation analysis emphasizes the similarities between co-cited documents, journals, or authors.

However, co-citation analysis based on authors and journals assumes that the basic units are individuals and publishing institutions, viewed as independent knowledge production units. This approach tends to overlook the collective activities and dialogical relationships within a discipline's community (Su, 2004). DCA, by contrast, uses cited documents as the basic unit to establish co-citation network relationships, clustering large numbers of documents through citation links to form a discipline-based cluster network. This approach reflects the connections and structural characteristics of disciplinary knowledge, revealing the links and development trends within the field, making it widely applicable. Co-citation analysis has been successfully applied to study various fields to clarify their development, such as Human Resources, strategic management, management, and organizational science (Fernandez-Alles & Ramos-Rodríguez, 2009; Nerur, Rasheed & Natarajan, 2008; Ramos-Rodríguez & Ruíz-Navarro, 2004). Based on the above discussion,

this study uses Document Co-citation Analysis (DCA) to explore the development trends of research topics in China's e-commerce field.

3 Research Methods

3.1 Research Tools

Cobo, López-Herrera, Herrera-Viedma, and Herrera (2011) conducted a comparative study of nine scientometric analysis tools (Bibexcel, CiteSpace, CoPalRed, IN-SPIRE, Leydesdorff's Software, Network Workbench Tool, Science of Science (Sci2) Tool, VantagePoint, and VOSViewer). They found that each tool has its strengths and weaknesses, and no single tool is capable of addressing all scientometric tasks. Therefore, this study combines Bibexcel with SPSS statistical software, UCINET social network analysis software, and NetDraw visualization software to overcome the limitations of individual tools. Bibexcel is used for file checking, calculating co-occurrence frequencies, and generating raw matrix data for analysis (Persson, 2024). SPSS is employed for Spearman correlation coefficient transformations and cluster analysis. UCINET is used to convert matrix data into a format suitable for graphical representation in NetDraw, providing a visual depiction of the relationships between clusters of research topics and illustrating their proximity and strength.

3.2 Sample Database

The WoS database contains a variety of authoritative and high-impact academic journals around the world, covering natural sciences, engineering technology, biomedicine, social sciences, arts and humanities and other fields. Among them, SCIE provides citation indexes and abstracts of about 8,000 scientific and technological journal articles, covering more than 150 subject topics such as science, engineering, medicine, and agriculture. SSCI provides citation indexes and abstracts of more than 2,700 social science journal articles, covering more than 50 subject topics including anthropology, history, law, management, psychology, politics, and society (NSYSU, 2024).

In order to obtain representative articles on China's EC research topics, the search keywords are ((TS=("e-commerce") OR TS=("electronic commerce") OR TS=("ecommerce") OR TS=("Electronic business") OR TS=("ebusiness") OR TS=("e-business")) and (CU=("China") OR CU=("Chinese")) and the file type is "Article". A total of 2,061 records were retrieved (data as of April 30, 2020). After a detailed review and the exclusion of journal articles unrelated to the research topic, 1,982 records were selected for analysis. Select journal articles included in the WoS database, because the journal articles have been strictly reviewed, and the knowledge content described in the accreditation process has played an important role. Successfully approved by reviewers, these journal articles can be regarded as "certified knowledge"; secondly, the journal articles are all based on international standards, which improves the reliability of the analysis results (Andrews, 2003).

3.3 Data Processing Program

Up to now, there is no unified opinion on the selection of the upper and lower limits of the high frequency of co-citation analysis. If the selection range is too small, it can not truthfully reflect the discipline cluster it represents; on the contrary, it will bring considerable interference, so as to simplify and reduce unnecessary interference. At present, there are several methods to determine the upper and lower limits. The first method is to choose the upper and lower limits according to the researcher's own experience or research purpose, but this method has certain randomness and subjectivity; the second is based on the suggestion of Price (1965) that 40-50 frequently quoted high frequencies are used as the benchmark; the third is to use Zipf's law to help determine the upper and lower limits of high frequency (Donohue, 1974). In this study, after testing the above methods many times, Price's suggestion was finally taken as the basis for the number of samples extracted.

3.4 Draw the I-IV Stage Graph

The graph reveals the relationship between nodes and connecting lines. Each node represents a highly cited document. The higher the line frequency intensity (or the thicker the line), the closer the research field and the similar theme background between them; on the contrary, it is more dispersed and more peripheral. The size of nodes is proportional to the frequency of their appearance in co-cited networks. The same shape and color represent the same cluster, otherwise different clusters. In order to increase the readability of the graphs, if the line frequency intensity value is too low, it will be set invisible and only show similar high correlation. Generally, centrality is used to measure the influence of nodes' connection status in the network in UCINET graph. Centrality has three main measurement forms. In this study, the most commonly used degree centrality is used as an index to measure the size of nodes' influence range (Liu, 2014), and the graph is drawn in a cluster way to increase the readability between cluster topics, hoping to objectively and visually reflect the distance, strength and orientation of China’s EC research topics.

3.5 Cluster Naming

The naming of clusters is primarily based on degree centrality in the UCINET network diagram, which reflects the influence of connectivity within the network. The naming process relies on the common concepts of the larger nodes as a basis. For clusters that are difficult to name, the research team further reviews and discusses the journal articles within the cluster. Although the goal is to remain objective and inclusive, the final naming may still be influenced by subjective interpretations.

3.6 Research Limitations

Document co-citation analysis has its own limitations. This technology gathers cited and cited documents that reach a certain threshold to form a cluster, which will omit some recent documents that may have potential influence. Price (1965) found that the peak value of document citation was the second year after the publication of the document, which meant that the recent works were difficult to highlight in the co-citation analysis.

Secondly, the search time of this study is only until the end of April 2020, and there is a phenomenon of missing analysis for the subsequent published journal articles in the same year. However, from the finding of Price (1965) and the amount of 1,221 data obtained in the fourth stage, the subsequent published journal articles have little influence on the clustering relationship of highly cited documents, but they are worth tracking.

Third, the relevant research samples are aimed at exploring the subject of EC in China. The collection of EC themes for the publication of the time delay between the writing and publication of the paper may be omitted. However, from the number of documents obtained from the research and the partner countries and regions, the impact in this regard is limited.

Fourthly, although the document co-citation analysis has the objectivity of quantitative analysis, it needs further qualitative research on the factors such as the purpose of cited materials, the influence scope and level of cited documents on the content of cited documents, etc. The addition of these factors may cause changes in the results of document co-citation analysis.

4 Discovery and Discussion

4.1 Basic Information of the Sample

In Stage I (2001-2005) 171 articles came from 105 journals, covering 32 research fields, 12 partner countries and regions, and 3,123 cited articles. In Stage II (2006-2010), 200 articles come from 118 journals, with 44 research fields, 20 partner countries and regions, and 6,686 cited documents. In Stage III (2011-2015), 390 articles came from 183 journals, with 59 research fields, 30 partner countries and regions, and 13,761 cited documents. In Stage IV (2016-2020), 1221 articles came from 358 journals, with 103 research fields, 52 partner countries and regions, and 43,687 cited documents (as shown in Table 1).

Table 1. Basic data table of EC research topics in china from 2001 to 2020

Stage	Number	Research field	Publication source	Countries and regions	Number of documents	
					Original	Select
2001-2005	171	32	105	12	3,465	3,123
2006-2010	200	44	118	20	8,157	6,686
2011-2015	390	59	183	30	18,584	13,761
2016-2020	1,221	103	358	52	61,519	43,687

Note: Mainland China is not included in the calculation.

The basic information of the four stages show the high growth of EC research topics in China, and the research field has shifted from the computer information-related professional topics to business management, involving the technical basis of EC implementation, website management, EC system design, and related applications, EC technology-related algorithms and methodology, and other related topics. With the different stages of China's EC economic policy and the needs of the EC environment, shift

to business management, market foundation (advertising and marketing, market entities, market characteristics), etc., and the practical application of EC-based systems (such as SCM, CRM, EDI, etc.). USA has always been an important partner of China, followed by Australia, England, Singapore, Taiwan and Canada (as shown in Table 2).

Table 2. First three main research fields, partner countries and contribution institutions from 2001 to 2020

	Research field	Number	Partner country	Number	Main institutions	Number
2001-2005	Computer science information systems	61	USA	30	Hong Kong Polytechnic University	23
	Computer science theory methods	61	Singapore	8	University of Hong Kong	20
	Computer science artificial intelligence	42	Canada	6	City University of Hong Kong	19
2006-2010	Computer science information systems	74	USA	30	City University of Hong Kong	38
	Management	43	Canada	22	Hong Kong Polytechnic University	24
	Computer science artificial intelligence	34	Singapore	11	Tsinghua University	18
2011-2015	Computer science information systems	119	USA	114	City University of Hong Kong	45
	Information science library science	69	Australia	16	Chinese Academy of Sciences	30
			Singapore	12	Huazhong University of Science Technology	23
	Management	64	Taiwan	12		
2016-2020	Computer science information systems	325	USA	216	Chinese Academy of Sciences	73
	Business	190	Australia	54	City University of Hong Kong	51
	Management	187	England	42	Zhejiang University	48

It can be seen from this that these countries and regions are often the main choice for Chinese students (Wiki, 2024). In terms of institutional contribution, Hong Kong's universities have a very high degree of institutional contribution, especially in the first three stages, in which the visibility of Chinese universities increased in stage III-IV, and in stage

IV, the Chinese Academy of Sciences took the lead, followed by the City University of Hong Kong. The contribution degree in research institutions and countries and regions is different from the order pointed out by the research of Wan (2012), that is, with the passage of time and space, today (stage IV) Mainland China has become the first place, followed by Hong Kong. And this motivation cannot be separated from the support of China's national EC economic policy. Only by strengthening the construction of the EC environment can the development of the EC be better promoted.

4.2 Interpretation of Co-cited Network Analysis Results

Stage I (2001-2005)

This stage is the tenth five-year plan period (as shown in Figure 1). The graph forms the left and right sides. The larger clusters in the graph are cluster 1 and cluster 4, and the size of the nodes and the closeness of the distance between the nodes are relatively larger and closer than those of other clusters, and vice versa. The nodes in the cluster are relatively small, the distance between the nodes is far away, which is relatively loose, and the correlation with other nodes is weak. The main research topics in this period include system performance, trust, market, information, application, and behavior, but its essence is still more focused on technical fundamentals, reflecting that EC research has moved from preliminary basic technology to modern business implementation with commercial factors aspect technology.

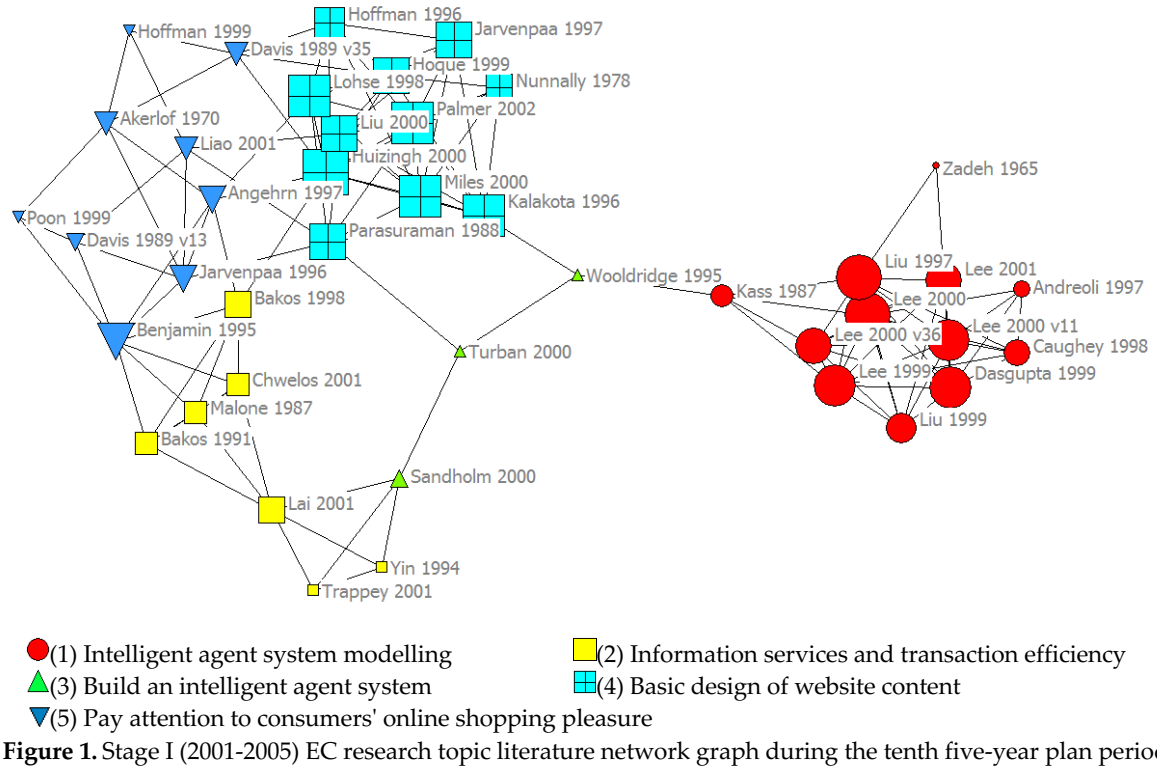


Figure 1. Stage I (2001-2005) EC research topic literature network graph during the tenth five-year plan period

Cluster 1 is composed of 12 nodes, mainly including Liu1997, Dasgupta1999, Lee2000 and Lee2000v11. This cluster is based on automatic and integrated neural network

identification agent identity, network trajectory mining technology, dynamic link, AI modeling, and intelligent agents to summarize the goods and services of various businesses in the electronic market, which makes it easier for consumers to find the required goods, compare and purchase them, and becomes the main research focus of this cluster (Dasgupta, Narasimhan, Moser & Melliar-Smith, 1999; Lee & Liu, 2000a, 2000b; Liu & Lee, 1997).

Cluster 2 consists of 7 nodes, mainly Bakos1998 and Lai2001. The new electronic market on the Internet, hierarchy, marketing strategy and cultural differences between the East and the West are mainly used to improve transaction processing efficiency in EC economy, play the role of information, electronic data exchange (EDI), goods, services and payment, and reduce the coordination cost, technical cost and competition cost between buyers and sellers (Bakos, 1998; Lai, Humphreys & Sculli, 2001).

Cluster 3 is composed of three nodes, with Sandholm2000 as the main node, paying attention to the main opportunities, limitations, problems, risks and intelligent agents in the electronic market, focusing on the information infrastructure, including consumer behavior, marketing strategy, market research, advertising and publishing, applications, online payment, public policy and infrastructure, and the design and construction of AI agent system (Sandholm & Huai, 2000).

Cluster 4 is composed of 11 nodes, mainly Huizingh2000, Kalakota1996, Miles2000 and Lohse1998. Focus on EC website content design, combining emerging technologies and network infrastructure. Discuss issues related to EC business, explanations, and key technologies that form the foundation of EC website applications. Analyze finance and accounting, electronic money, and secure electronic payment, which constitute the basis for EC to purchase or sell products and services, and to support the EC platform with information technology (Huizingh, 2000; Kalakota & Whinston, 1996; Lohse & Spiller, 1998; Miles, Howes & Davies, 2000).

Cluster 5 consists of 9 nodes, mainly Benjamin1995, Jarvenpaa1996 and Angehrn1997. It serves B2C electronic market with information infrastructure, improves traditional marketing channels, logistics and dealer structure, adjusts and organizes business by using the Internet, improves consumers' online shopping experience, satisfaction and pleasure, and their awareness of online products, thus creating B2C electronic market value (Angehrn, 1997; Benjamin & Wigand, 1995; Jarvenpaa & Todd, 1996).

In the first period, for the popularization of the Internet, a little literature began to discuss topics related to the digital market and the use of the Internet. This period is mostly distributed to discuss EC infrastructure, information security and information systems, such as database security, network security, information system security, electronic data interchange (EDI), and the user's system operation and behavior. Security related issues, etc., Information systems are discussed on the main axis of technology, innovation, risk, performance, and function.

Stage II (2006-2010)

At this stage, four research clusters are determined (as shown in Figure 2). The cluster 2 is the largest in the graph, followed by cluster 1, whose nodes are relatively closer than other clusters, and also in a leading position in the research field at this stage, focusing on developing and verifying trust factors, consumer behavior intentions, reducing information asymmetry risks and other issues; issues such as the influence of culture on trust formed by the nodes of cluster 3 and cluster 4 in the left part of the graph are relatively weak and loose. The main research topics in this period are biased towards public interests, such as laws and regulations, credit system construction, and risk and safety. It shows that only a sound public interest system can enable online consumers to use the benefits of EC with confidence. At the same time, it analyzes consumers from the theoretical perspective of TAM and TPB, and further understands consumer attitudes and subjective norms to predict the willingness to use information equipment and reflect consumers' online shopping behaviors and needs.

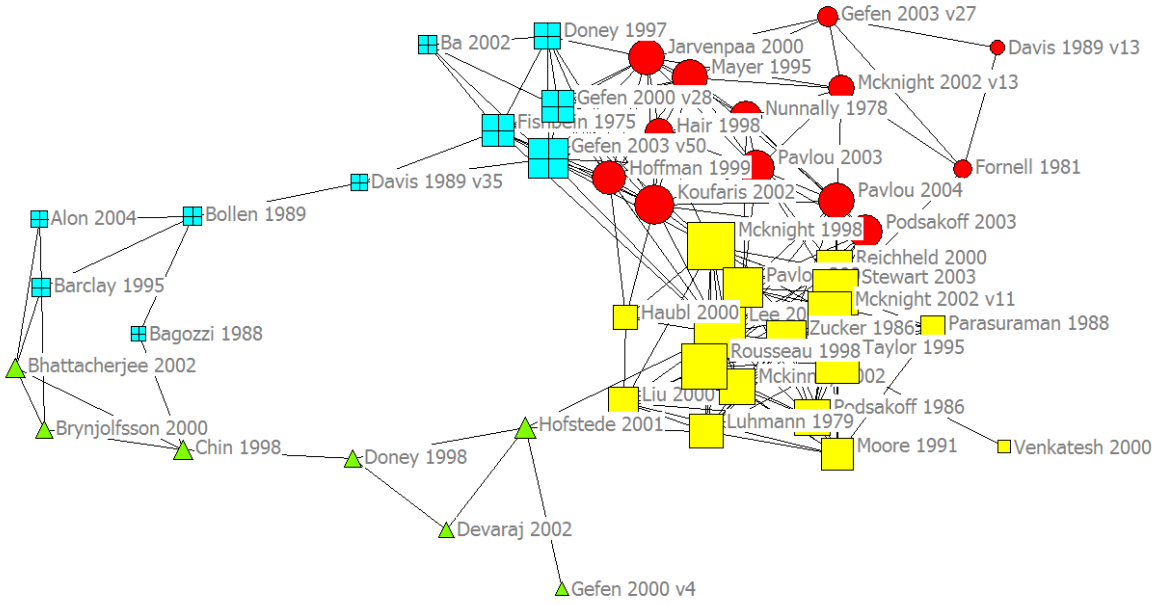


Figure 2. Stage II (2006-2010) EC research topic literature network graph during the eleventh five-year plan period

Cluster 1 "Establish verification trust factor" is composed of 13 nodes, with Koufaris2002, Mayer1995, Pavlou2003, Pavlou2004 and Jarvenpaa2000 as the main nodes. Emphasis is placed on overcoming the factors of building trust in EC environment lacking typical interpersonal interaction, verifying trust, and evaluating and explaining the psychological experience and feelings of consumers' perceived usefulness (PU) and perceived ease-of-use (PEU) in online environment behavior with TAM (Jarvenpaa, Tractinsky & Vitale, 2000; Koufaris, 2002; Mayer, Davis & Schoorman, 1995; Pavlou, 2003; Pavlou & Gefen, 2004).

Cluster 2 "Consumer Uncertainty Perception" is composed of 17 nodes, mainly including Lee 2001, Mcknight1998, Rousseau1998, Stewart2003 and Mcknight2002v11. Collect relevant applicable theories, such as TAM and theory of planned behavior (TPB), to know about consumers, to understand whether consumers trust products they can't see or touch, and to overcome consumers' negative views on online transaction risks and uncertainty, especially business integrity, goodwill and website quality (Lai, Humphreys & Sculli, 2001; McKnight, Choudhury & Kacmar, 2002; McKnight, Cummings & Chervany, 1998; Rousseau, Sitkin, Burt & Camerer, 1998; Stewart, 2003).

Cluster 3 "Cross-border E-commerce and Trust" is composed of seven nodes, mainly Hofstede2003, Bhattacherjee2002, Brynjolfsson2000 and Doney1998. It mainly focuses on developing cross-border e-commerce, trusting and verifying trust, understanding the culture and transaction relations of various countries and regions, measuring consumers' preference and satisfaction with EC channels by TAM, transaction cost analysis and service quality, and explaining some doubts about B2C brand, popularity and trust and traditional shopping channels (Bhattacherjee, 2002; Brynjolfsson & Smith, 2000; Doney, Cannon & Mullen, 1998; Hofstede, 2003).

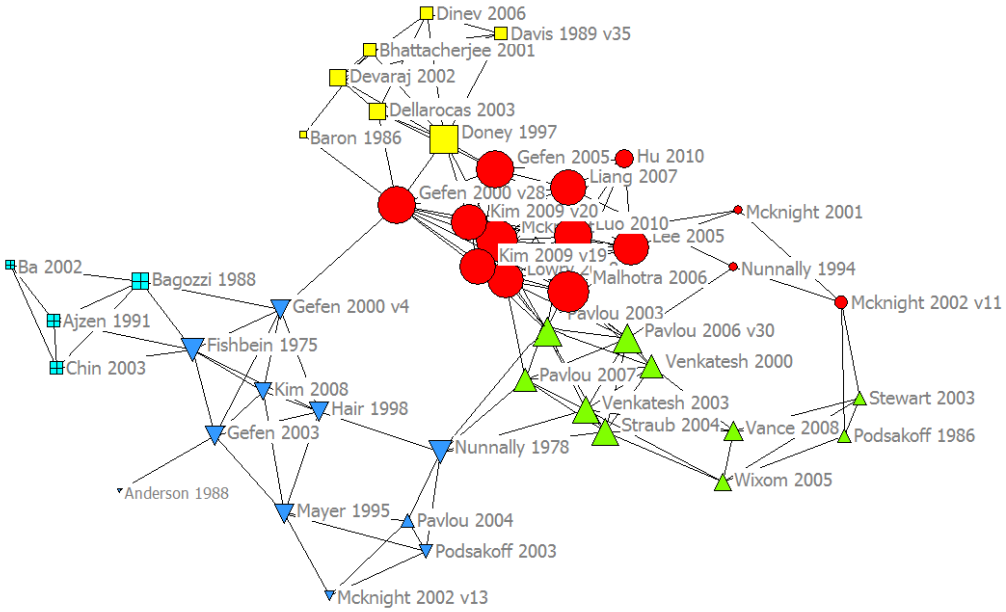
Cluster 4 "Goodwill and willingness to repurchase" is composed of 11 nodes, mainly including Gefen2003v50, Fishbein1975, Gefen2000v v28 and Doney1997. It focuses on understanding the importance of trust between buyers and sellers, using TAM to discuss the influence of IT interface interaction on consumers' experience changes, customers' willingness to repurchase products they trust in websites, and whether online feedback mechanism can reduce information asymmetry, enhance merchants' sales trust and lead to higher consumers' repurchase behavior (Doney & Cannon, 1997; Fishbein & Ajzen, 1975; Gefen, 2000; Gefen, Karahanna & Straub, 2003b).

During the second period, China officially released the EC industrial economic policy, focusing on topics such as electronic authentication, online transactions, online payments, modern logistics, credit, security protection, and market supervision. The proportion of software and hardware technologies and information security issues in the first period has been significantly reduced. On the contrary, EC-related business management issues have increased, such as web technology, programming languages, the establishment of electronic markets and B2C markets, and the use of information technology by enterprises. Continue to ferment.

Stage III (2011-2015)

At this stage, five research clusters are determined (as shown in Figure 3). The upper right corner of the map is cluster 1, cluster 2 and cluster 3; In the lower left corner, there are nodes and clusters 4 and 5 with relatively small and loose density. This period continues the credit system of the second period, discusses trust relationships, transaction intentions, satisfaction, reduces the risk of information asymmetry, confirms the relationship between trust factors and focuses on the service support of the EC trading platform. The EC service model is constructed by factors such as platform website service quality, purchase intention, and perfect credit system. To better explore the needs of consumers and pre-sales and after-

sales services, verify the needs of enterprises, understand from the perspective of consumers, and improve and enhance the development of EC in a targeted manner. At this time, there is no evidence related to EC cluster infrastructure construction.



(1) Goodwill and consumer decision-making behavior
(2) Trust and satisfaction of buyers and sellers
(3) Consumer online perception behavior
(4) Reduce the risk of information asymmetry
(5) Third-party trust guarantee

Figure 3. Stage III (2011-2015) EC research theme literature network graph during the twelfth five-year plan period

Cluster 1 "Goodwill and Consumer Decision-making Behavior" is composed of 14 nodes, mainly Malhotra2006, Mcknight1998, Gefen2000v28, Luo2010 and Gefen2005. It pays attention to the initial trust function, trust and satisfaction, customer trust and transaction intention, brand alliance and website quality in organizational relationship, and understands the uncertainty of information community, discusses the decision-making process of prepurchase, purchase and postpurchase, and understands the emerging applications of mobile commerce (Gefen, 2000; Gefen & Straub, 2005; Luo, Zhang & Shim 2010; Malhotra, Kim & Patil, 2006; McKnight, Cummings & Chervany, 1998).

Cluster 2 "Satisfaction of trust between buyers and sellers" is composed of 7 nodes, mainly Doney1997, Dinev2006 and Devaraj2002. It focuses on the trust relationship between buyers and sellers, B2C satisfaction preferences, privacy calculations, online reputation, and explains the influence of merchant trust and sales staff's likability on sales performance. Transaction trust between buyers and sellers and expected satisfaction with EC channels are important factors affecting Internet consumer transactions (Devaraj, Fan & Kohli, 2002; Dinev & Hart, 2006; Doney & Cannon, 1997).

Cluster 3 "Consumer Online Perception Behavior" is composed of 10 nodes, mainly Pavlou2007, Pavlou2006v30, Venkatesh2003 and Straub2004. It brings together the

applicable theories related to EC environment, expands such as TAM and TPB theory to explain incentive model, innovation diffusion theory and social cognition theory, deduces the process of consumers' perceived behavior, intention, attitude and subjective norm in applying EC, understands the uncertainty in online trading relationship, and mitigates its potentially harmful influence on B2C transactions (Pavlou & Fygenson, 2006; Pavlou, Liang & Xue, 2007; Straub, Boudreau & Gefen, 2004; Venkatesh, Morris, Davis & Davis, 2003).

Cluster 4 "Reduce the risk of information asymmetry" is composed of 4 nodes, with Bagozzi1988 as the main node. It confirms a new method of market trust, and properly discusses it with IS, TPB, such as attitude, subjective norm, control perception and behavioral intention, so as to solve the possible change conditions that can not be detected or estimated, and reduce the risk of information asymmetry in transactions, thus bringing good reputation to the seller (Bagozzi & Yi, 1988).

Cluster 5 "Third Party Trust Guarantee" is composed of 13 nodes, mainly Nunnally1978, Fishbein1975, Gefen2000v4, Gefen2003 and Hair2009. It explores the beliefs, attitudes, intentions and behaviors that affect the trust between buyers and sellers, and identifies consumers' purchase decision-making behaviors with the theories of TAM and psychology, including weak (market-driven) and strong (legal constraint) mechanisms, especially the feedback mechanism, third-party custody services and credit card guarantees, which contribute to the generation of trust (Fishbein & Ajzen, 1975; Gefen, Karahanna & Straub, 2003a; Gefen, Straub & Boudreau, 2000; Hair, Black, Babin & Anderson, 2009; Nunnally, 1978).

In the third period, open up cross-border e-commerce to optimize all aspects of the industrial structure, and deepen the research on relationship behavior on B2B, B2C, or C2C. Among them, "trust" related issues account for the largest proportion; however, there are related documents on the discussion of EC infrastructure It is rare. In contrast to the rise of the issue of online users (consumers), the number of documents focused on the intention or behavior of online shopping has increased significantly.

Stage IV (2016-2020)

At this stage, five research clusters are determined (as shown in Figure 4). The larger cluster in the graph is cluster 4, followed by cluster 1. On the left is cluster 3. The node size and node compactness are small and loose, and the correlation with other clusters is weak. This stage continues the importance of "trust" in stage III. The main research topics focus on system support, models, and technical services; as well as business and management, corporate strategy, evaluation, services, and business transaction models. Such as goodwill, consumer behavior, repurchase intentions, online recommendation systems, trust transfer, and perceived benefits, etc., involve research on business operation and management, to dig deeper into consumer needs to achieve a greater degree of improvement. Therefore, it reflects the concerns of scholars that their current implementation environment and technical support are not perfect enough, and strengthen the prerequisite and guarantee for the implementation of environmental construction to promote the healthy development of EC.

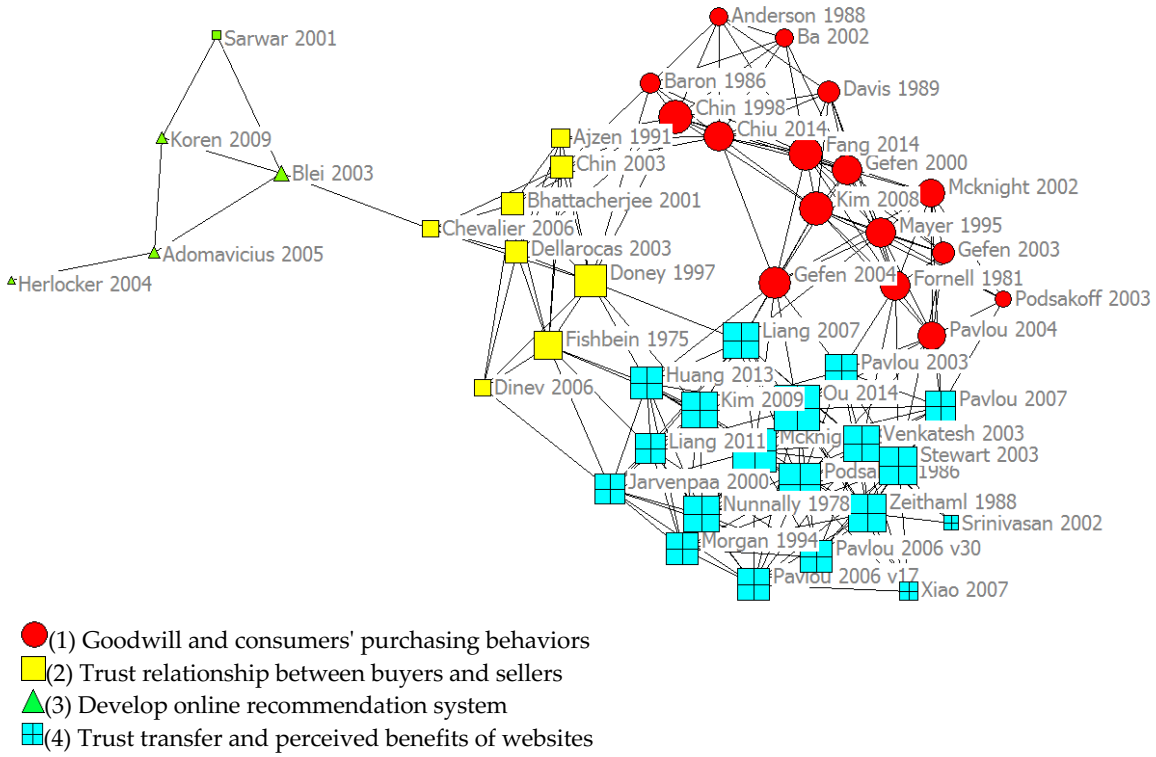


Figure 4. Stage IV (2016-2020) EC research topic literature network graph during the thirteenth five-year plan period

Cluster 1 "Goodwill and Consumer Behavior" is composed of 16 nodes, mainly Kim2008, Fang2014, Chin1998, Gefen2004 and Fornell1981. It focuses on trust, satisfaction, perceived effectiveness and prediction of consumer behavior. It affects consumers, goodwill, personal privacy, transaction security and other issues, and eases the influence of business reputation on consumers' trust, satisfaction and perceived risk, especially in decision-making (Chin, 1998; Fang et al., 2014; Fornell & Larcker, 1981; Gefen & Straub, 2004; Kim, Ferrin & Rao, 2008).

Cluster 2 "Satisfaction of trust between buyers and sellers" is composed of 8 nodes, mainly Doney1997, Fishbein1975, Bhattacherjee2001 and Dellarocas2003. It mainly identifies the trust relationship between buyers and sellers, brand building, quality assurance, consumer satisfaction, consumer repurchase intention, cognitive usefulness and online reputation feedback mechanism, and the substantial difference and verification between customer acquisition and continuous shopping behavior (Bhattacherjee, 2001; Dellarocas, 2003; Doney & Cannon, 1997; Fishbein & Ajzen, 1975).

Cluster 3 "Develop an online recommendation system" is composed of 5 nodes, mainly Blei2003. It uses Latent Dirichlet allocation as a latent semantic analysis to evaluate the types and data sets that users are using, and incorporate millions of real-time interactive users and browse product web information or services to generate a high-quality system to give recommendations, provide more flexible and less intrusive product recommendation

types, and provide personalized recommendations and evaluations (Blei, Ng & Jordan, 2003).

Cluster 4 "Website Trust and Perceived Benefits" is composed of 19 nodes, mainly including Ou2014, Mcknight1998, Podsakoff1986, Zeithaml1988 and Stewart2003. It is concerned about initial trust, transfer of trust, trust and satisfaction, trust and risk in organizational relationship, and discusses consumer acceptance, trust views on price, quality, value and merchants with TAM, so as to improve and enhance the brand image of merchants, including mutual understanding, mutual benefit and harmonious relationship (McKnight, Cummings & Chervany, 1998; Ou, Pavlou & Davison, 2014; Podsakoff & Organ, 1986; Stewart, 2003; Zeithaml, 1988).

In the IV period, the topic of online consumers became the focus, including a large number of related topics such as website technology, website content, and website quality. Internet technology and applications are approaching maturity, and the security of Internet use has attracted people's attention again. Consumers and Supplier (merchant) issues are focused on the "trust side" discussion, and agent-related issues have also attracted attention from researchers. For example, TAM, TPB related theories or cross-organizational information systems are the focus of scholars. When consumers and suppliers (merchants) cannot conduct face-to-face transactions, they need to use the trading platform. Trust becomes the key to the success of the transaction. Factors, so how to improve the trust level of the whole process have become an important topic, which has made many researchers invest in this topic.

5 *Conclusions and Recommendations*

5.1 Conclusion

This study employs bibliometric mapping to compare the evolutionary relationships across four different stages (I-IV), shedding light on the knowledge structure and development trends in the field of China's EC over the past 20 years (2001-2020). It also builds upon the work of Fang and Fang (2020), who used co-word analysis but lacked insights into the knowledge citation sources and the evolution of knowledge clusters during this period. This study further uncovers the dynamics of the knowledge cluster evolution chain in China's EC, offering deeper insights. These findings not only help researchers develop a clearer understanding of the clusters within this field and their future development directions, but also provide an objective framework for exploring knowledge clusters in China's EC research.

As time progresses or policy directions shift, research topics in EC across different stages (I-IV) lead to the formation of seemingly new cluster names. Further analysis reveals that these clusters consistently revolve around the dual roles of informatization driving industrialization and commercialization, while industrialization and commercialization, in turn, promote informatization. The focus expands to improving credit systems, service environments, and integrating into various economic sectors of social development, optimizing industrial structures, and aligning with the real economy. As time and

environmental demands change, the names of these clusters evolve, becoming key mediating knowledge within specific clusters or across subfields.

The research findings indicate that the primary driving force behind the development of China's EC lies in strengthening industrial growth momentum through the digital economy, optimizing the regulatory environment, expanding global collaboration, and accelerating new economic dynamics. Whether within the digital economy, information economy, or smart economy, EC is poised to become a core component of economic activity. It also serves as a key factor in connecting major clusters, with new research themes emerging at the periphery of the knowledge map. This suggests that the relationships linked to the main evolution pathways of China's EC will likely attract significant interest from scholars.

Even within a single cluster, there are a variety of topics. Notable areas of focus include information science, network infrastructure, technical support, business management, EC models, credit relationships, and consumer behavior. To date, B2B and B2C models remain the primary components of the EC market. China's EC is expected to maintain its rapid growth, fully integrating digital technologies such as big data, artificial intelligence, and blockchain to build a more collaborative digital ecosystem and provide a more stable user experience, thereby enhancing the sense of benefit for society as a whole.

5.2 Recommendations

From the EC knowledge evolution path across stages I-IV (2001–2020), we can discern emerging trends in the future development of EC research topics. This suggests that the EC field is continually refined in a cyclical process, shaped by the interplay of economic policies across different eras and time periods. Such an evolving dynamic warrants further investigation and in-depth exploration. Secondly, close research institutions and partner countries and regions with China's EC. In terms of geographical location, Hong Kong, Taiwan, and Singapore have the same cultural background and language as China, and should be more in-depth and active to establish a stable academic exchange mechanism. It will undoubtedly be of great benefit to China to accelerate the internationalization of EC. Third, EC's research topics include behavioral research on TAM and TPB technology adoption, credit system and information system evaluation research, which are fully reflected in classic and key literature. With the development of big data, artificial intelligence, biotechnology, and cognitive technology, advanced cognitive neuroscience methods are gradually being applied to behavioral research on information systems, including research on credit. This is an important direction that EC scholars should pay close attention to.

Therefore, it is recommended that future research broaden its scope by incorporating a variety of academic databases, journal types, and data sources, while exploring the topic using different research methods. This approach aims to provide a more comprehensive study and analysis of the knowledge structure of EC, leading to a deeper understanding and further development of the field. Additionally, it is suggested that future research on the knowledge structure and development trends of EC integrate methods such as content

analysis of research literature, which will aid in more effectively identifying key patterns. This will help clarify the relationships between citations, the shifts between paradigms, and ultimately enable a more complete mapping of the interdisciplinary knowledge framework within the field of EC research in China.

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