International Journal of E-Business Research
Volume 18 • Issue 1

A Review of Chinese E-Commerce Research 2001-2020

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ABSTRACT

This study reviewed EC studies in China. A total of 1,982 journal articles published between 2001 and 2020 were collected from the Web of Science database. In addition, it referred to the Five-Year Plan for Economic and Social Development of the People's Republic of China and divided the research period into five-year stages. The BibExcel, UCINET, and SPSS software programs were used to conduct co-word analysis. The results indicated that (1) Stages I–IV comprised 4, 3, 4, and 4 clusters, respectively. (2) Consumer's personalized demands were considered in EC development activities ranging from the initial EC infrastructure construction to the integration of artificial-intelligence-related technology. (3) Topics regarding consumer behaviors were centered on Stages II and III, which indicated that the research on these topics was mature. (4) Stage IV explored the new research topic of integrating smart technology into the EC and indicated the characteristics of the e-market.

KEYWORDS

Cluster Analysis, Co-Word Analysis, E-Service, Research Focus, Topic Evolution

INTRODUCTION

Research Background

Research articles are information carriers in academia. Information changes with time. It may be replaced, be merged, or cease to be effective. Researchers must read a large number of research articles to understand the major research topics and trends in a field. In 2013, China's electronic commerce (EC) trading scale surpassed that of the United States and it became the largest EC market with the fastest development worldwide. The processes of knowledge development and economic development are closely related to academic groups that generate knowledge, which has in turn generated a large number of research results on EC in China. EC is a hot topic in the fields of information and business that attracts the attention of scholars and experts in the fields of computer science, economy, management, and information. Numerous research papers on EC have been published in international

DOI: 10.4018/IJEBR.312252 *Corresponding Author

journals. These papers address different EC-related topics (Yu, McLee, & Lee, 2008) and provide different perspectives to people who are interested to discuss, research, and read these topics.

Although some scholars have investigated the hot spots and development of EC research (Duan & Zhao, 2016; Liu & Yang, 2017; Ngai & Wat, 2002; Zhang & Li, 2019), we could not obtain clear contemporary trends in EC research in China by reviewing relevant papers individually. The role of Chinese EC and the research direction of Chinese EC in different times are unclear. The EC policies and trends in academia and research in China are also unclear. When investigating the large amounts of data in academic databases, researchers must spend considerable time and effort to rapidly unearth useful data, understand current research trends, or find highly relevant and valuable data from a wide range of information.

Research Motivation

Co-word analysis has been used effectively to indicate the research trends in many academic disciplines. Co-words are keywords that map the content of research topics. Co-word analysis involves performing statistical analysis on co-words to investigate the internal connections between the literature and academic subject structures. Since its introduction in the 1970s, co-word analysis has been widely used to investigate the research development trends of various academic disciplines, such as environmental crisis management (Dai, Duan, & Zhang, 2020); the evolution of Omega products (Wang et al., 2020); higher education institutions (Vilchez-Roman, Sanguinetti, & Mauricio-Salas, 2020); technology education (Fang, 2016); science, technology, engineering, and mathematics education (Wen, Sun, & Liu, 2020); information ecology (Wang, Guo, Yang, Chen, & Zhang, 2017); and biodiversity (Nita et al., 2019). However, few studies comprising co-word analysis have investigated EC in China. Previously, people manually reviewed and classified papers or conducted cross-sectional analysis to determine research trends for a certain topic. Researchers can search academic databases, such as Web of Science (WoS), Scopus, EBSCOhost, China National Knowledge Infrastructure (CNKI), or the Airiti Library, to obtain relevant studies regarding the field to be analyzed. Thus, they can obtain relevant information and field trends to understand the overall research trend and development of a topic (Kauffman, 2001; Ngai & Wat, 2002; Chen & Lu, 2019).

The aforementioned discussion reveals that from the perspectives of EC policies, EC responses to globalization, and the demands in global competitiveness, we cannot fully understand the research topics and the activities in the EC development in China as well as the knowledge dissemination process. Understanding said aspects (i.e., EC research topics, activities, and knowledge dissemination) is thus an urgent, wide, and critical topic in today's knowledge-economy-based society. It is also a critical topic for the entire world and EC scholars. Therefore, this study conducted co-word analysis on journal articles regarding EC in China from the WoS database to understand the EC research trends in China.

Research Objectives and Methods

The study period was 2001–2020. Since the data samples obtained are as long as 20 years, the analysis in a time period may affect the subtle changes in the research topic, so time slices are used. At present, there is no clear and recognized optimal range for cutting in time periods. Generally, researchers will set appropriate time periods according to their research purposes when conducting research, and choose the appropriate time period for their research time range, which fully reflects the influence of the knowledge of the research topic. For example, Åström (2007), Cornelius, Landström and Persson (2006), Fang and Lee (2021) all use 5 years as a period for analysis; Aguillo (1996), Cornelius et al. (2006), Fang and Lee (2014), van Leeuwen and Moed (2002) suggested that the time period should be adjusted to 4-5 years according to the nature of different professional fields, and the time period should be adjusted appropriately to fully reflect the development context and trends of the research theme.

Based on the above argument. This research according to the Five-Year Plan for Economic and Social Development of the People's Republic of China, study period was divided into four 5-year

stages. The 10th (2001–2005), 11th (2006–2010), 12th (2011–2015), and 13th (2016–2020) Five-Year Plans represented Stages I, II, III, and IV, respectively. The research objective was to conduct co-word analysis on highly cited terms to discover research topics and evolution trends in EC in China. The results of each stage were then compared systematically to (a) understand the development situation, context, and basic features of the EC field since the 10th Five-Year Plan (i.e., since 2001), (b) understand the critical themes and future trends in Chinese EC, and (c) predict the appearance of the next research front.

The BibExcel, UCINET, and SPSS software programs were used to conduct co-word analysis on the keywords. Tools such as cluster analysis, strategic diagrams, and social network diagrams were used to intuitively and comprehensively present the situation, change, and trend of Chinese EC research topics at different stages. Compared with other bibliometric methods, such as co-citation analysis and bibliographic coupling analysis, co-word analysis is simpler, more flexible, and more intuitive and provides clearer results (Fang & Lee, 2014). Comprehensive analysis and statistical results were obtained in this study to examine the research trend and evolution direction in the EC field in China. These results also reflected the connections between different EC research topics.

LITERATURE REVIEW

Application of Co-Word Analysis in Various Academic Subjects and Fields

Co-word analysis is an analysis method that indicates the dynamics of scientific research (Callon, Courtial, & Laville, 1991). This method basically involves calculating the co-occurrence of professional jargons (such as keywords) in a text related to a specific academic subject or field. Subsequently, by using co-word matrices and statistical methods, the keywords are classified to determine the correlation between the text and the keywords. When two keywords appear frequently in the same paper, these keywords have a high correlation, have a high similarity, and are closely related. Co-word analysis determines the relationship between the topics in an academic subject or field. Thus, the current major research trend and research structure of a subject can be determined.

In recent years, co-word analysis has been widely used in various subjects. Galvez (2018) used co-word analysis to determine the research dynamics and basic structure of library and information science as well as the core fields of this subject with the most research interest. Wang et al. (2017) applied the aforementioned method to information ecology, which has become a hot field in recent years. They analyzed the topic structure and development of the aforementioned field and identified the cluster structure and the differences in its temporal and spatial evolution. Fang and Lee (2014) used co-word analysis to examine the research trends and department organization change directions of the technology education departments in Taiwanese universities between 1994 and 2013. Niu et al. (2014) used the aforementioned method to reveal the interaction between relevant academic studies and technology development for the environment and sediment in earth science. Ritzhaupt, Stewart, Smith, and Barron (2010) used co-word analysis to identify the research situation and research structure of the distance education field. Their results indicated the research trends and topics for three periods. Zhou, Sun, and Chen (2007) used the aforementioned method to review human genes studies. They revealed the research topics and development trends in genetics by using visualization tools, such as strategic diagrams.

Applying Co-Word Analysis in the Field of EC

Since the introduction of EC, numerous research topics have been investigated in this field. Studies have investigated the EC topics introduced by enterprises (Al-Qirim, 2007; Fisher, Craig, & Bentley, 2007; Molla & Licker, 2005), examined customer relationship management (Khalifa & Shen, 2009; McKnight & Chervany, 2001; Wang & Benbasat, 2008), and reviewed and classified EC-related

literature to obtain the topic development and trend evolution in this field (Kauffman & Walden, 2001; Ngai & Wat, 2002).

For example, Yan, Lee, and Lee (2015) used co-word analysis and multidimensional scaling (MDS) to analyze 8,488 EC-related research papers from the WoS database that were published between 2000 and 2013 for determining the subject structure of EC. They determined that EC comprised three major research fields, namely technology, management, and customers, and seven subfields, namely the Internet, consumer behavior, customer satisfaction, online shopping, reputation, and knowledge management. Ngai and Wat (2002) analyzed 275 papers published between 1993 and 1999 from nine journals that included EC papers. Their results indicated that the major EC-related research topics were centered on EC application, technology problems, related support and implementation, and other factors. The aforementioned four topics contained 10, 6, 3, and 2 research directions, respectively. Most relevant studies were related to cross-organizational systems, security, enterprise strategy, and the introduction of basic content. Liu and Yang (2017) studied 1622 papers on EC trust from the WoS database that were published between 2006 and 2015. They discovered three clusters, namely e-procurement, mandatory system, and hidden service, in the field of EC trust. Guo (2018) conducted co-word analysis and social network analysis on the keywords in 765 CSSCI journal articles on EC from the CNKI database that were published between 2013 and 2016. Guo discovered that the keywords mainly focused on the following eight dimensions: online shopping, cross-border EC, logistics, technology adoption, consumer behavior, online finance, business model, and agricultural EC.

The aforementioned research results indicate how different EC research topics are clustered. Researchers have adopted cross-sectional or longitudinal research perspectives as well as different times, academic databases, keywords, or journal papers to present the relationship between the research topics within an academic subject and other research topics, reveal the research topic development context and evolution trend in a certain field, and predict the future development trend in a field. However, no study has conducted a long-term systematic investigation of Chinese EC for different periods by using rigorously reviewed international journal papers. To understand the development trend of Chinese EC research in detail, this study conducted co-word analysis for examining the content and application of EC research topics.

Co-Word Analysis can Effectively Understand Research Trends

Co-word is a keyword corresponding to the content of the subject. Co-word analysis is a process of exploring the internal relevance and disciplinary structure of the document through the statistical analysis of co-words. It is a part of bibliometrics. Analytical techniques have been widely used in quantitative research in subject areas and can be used to describe and explain the knowledge organization of a subject (Lee & Jeong, 2008). Law, Bauin, Courts and Whittaker (1988) pioneered the application of co-word analysis to policies in the study of environmental acidification and the analysis of scientific change maps. Law and Whittaker (1992) took environmental acidification research as an example to draw a knowledge map of the research topic, and also verified the feasibility of co-word analysis (Whittaker, 1989). Co-word analysis reveals the relationship between research topics in a specific subject area and its clusters; horizontal and vertical research perspectives show the relationship between research topics in a specific subject area and other research topics; Explore and understand the historical context of the development of research topics in a specific subject research field and the evolution of sub-fields; explore the purpose of subject research topics through the relationship between keywords and determine their research structure (Fang & Lee, 2014).

In recent years, co-word analysis has been widely used in various disciplines. (such as: Callon et al., 1991; Fang & Lee, 2021; Kostoff & Scaller, 2001; Li, Chen, Feng, Chen, & Hou, 2020; Nguyen, 2019; Niu et al., 2014; Xu & Ma, 2021; Zhu & Zhang, 2020) and other fields. It can be seen that most of the literature starts from the perspective of the structure of research disciplines, analyzes the development context, research status, and predicts future development trends. Compared with the

research results of EC application of co-word analysis, the discussion in this area is not extensive enough. Relatively, the application in the EC subject field is significantly weaker. Since there is no analysis of common words in EC journal papers in China, this research will help to make up for the shortcomings of existing research in EC disciplines and enrich the connotation and applications of the discipline.

RESEARCH METHOD

Data Collection

The WoS database was selected as the data source because its journal articles have undergone a rigorous review mechanism. During the process of acceptance, the knowledge presented in these articles exerted critical effects and was approved by reviewers. These journal articles can be considered as certified knowledge. In addition, the publication of these journal articles meets international standards. Their high-quality academic value is well known worldwide. Thus, the research results had high reliability (Andrews, 2003). To acquire representative EC articles published by Chinese scholars, we used various combinations of keywords. Finally, we used the criteria [(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")], selected file type as "Article," and searched for all years of publication, resulting in 2,061 articles being selected.

Data selection is based on the search, retrieval, and confirmation procedure standards proposed by Sandelowski and Barroso (2007, pp. 51). First, 2,061 articles were checked for titles, and journal articles that did not meet the standards and were duplicated were excluded; Second, check the content of the summary and exclude those who do not meet the criteria; Third, check the full text and exclude EC subjects whose research targets or fields are not in China. We screened these articles one by one to remove journal articles unrelated to our research topic and removed 12 entries from 1998 to 2000. In the end, 1,982 articles were selected for analysis.). Among them, 171 articles in Stages I (2001-2005), 200 articles in Stages II (2006-2010), 390 articles in Stages III (2011-2015), and 1221 articles in Stages IV (2016-2020).

Research Framework

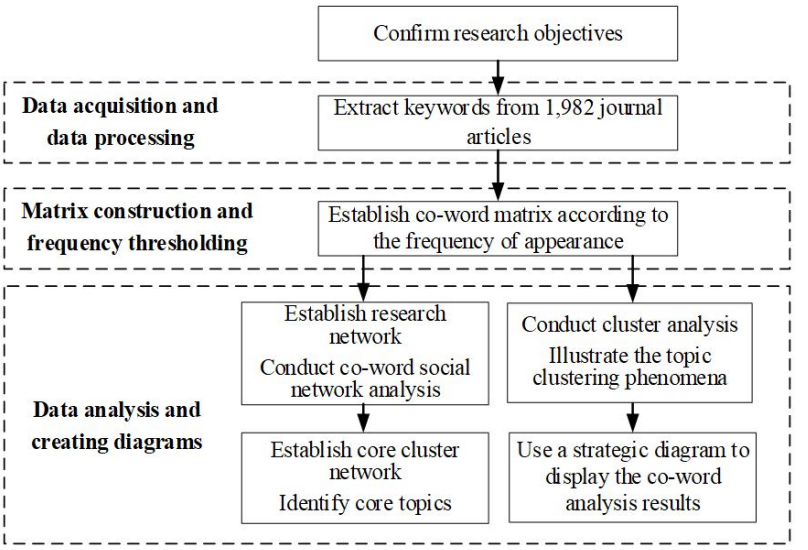
To objectively present the research subject network, this study used a dynamic three-stage research framework (Figure 1). This framework comprised the following stages: data acquisition and data processing, matrix construction and frequency thresholding, and using statistical technology (such as cluster analysis, principle component analysis, and MDS) or calculation rules to determine the structural relationships between keywords for forming a knowledge map (such as a strategic diagram) and network map (such as a social network diagram).

Data Acquisition and Processing Programs

Keyword lists are the most condensed core content of degree theses, conference papers, and journal articles. Keywords can represent the research topic to a considerable extent. Keywords are the simplest, most direct, and most representative indices of the core topic of a study. Therefore, in data extraction, keywords are more representative of the research topic than the full text is. When topic identification is conducted after extracting data from the full text, a keyword with different meanings in the text may be perceived as having the same meaning throughout the text. Consequently, a bias may occur in the analysis results (Lee, Chen, & Tseng, 2013).

We obtained 8,911 keywords for the 1,982 journal articles from Stages I to IV. We conducted synonym adjustment as well as analyzed and edited keywords with the same or similar meanings. For example, "social networks," "word of mouth," and "technology acceptance" were replaced by "social network," "word-of-mouth," and "technology acceptance model," respectively, to ensure

Figure 1. Research framework for presenting the dynamic research topic network



the correctness of the co-word data. After analysis and editing, 6,359 keywords were obtained from Stages I–IV as the samples for subsequent analysis (Table 1).

Establishment of the Matrix and the Threshold for Keyword Frequency

First, the high-frequency keyword threshold was determined. No consensus exists regarding the upper and lower limits of the number of keywords. A narrow scope cannot accurately reflect the subject, whereas a wide scope causes a considerable disturbance. To simplify and reduce unnecessary disturbance, we conducted several tests and considered the obtained keywords, the differences in the cumulative proportion of the word frequency, and the actual situation. Finally, we referred to the study of Price (1965), who suggested the use of 40–50 frequently cited terms, as the standard for extracting samples. Second, a co-word co-citation matrix was established. This study adopted the Spearman correlation coefficient and converted the original co-word matrix into a correlation matrix for subsequent analysis. Third, the co-word matrix was converted to NetDraw in UCINET after the analysis for map drawing. The biggest difference between the Spearman and Pearson correlation coefficients is that the Spearman correlation coefficient does not require the data source to have a normal distribution. Therefore, the Spearman correlation coefficient is suitable for nonparametric statistical methods, ranked data, or data with outliers.

Table 1. Basic Information of Chinese EC Research Topics from 2001 to 2020

Stage/year	No. of data samples	No. of research fields	Sources of publication	No. of nations/ regions	No. of keywords		No. of matrices	Frequency
					Original	Filtered		
I-2001-2005	171	32	105	12	514	389	43x43	8-2
II-2006-2010	200	44	118	20	895	703	50x50	17-2
III-2011-2015	390	59	183	30	1837	1385	50x50	44-3
IV-2016-2020	1,221	103	358	52	5665	3882	50x50	72-8

Note: The number of journals in Stage I was small, which affected the number of keywords and the corresponding frequencies; therefore, the number of co-word matrices was 43 × 43.

Knowledge Map Drawing

Among the methods for presenting knowledge maps in co-word analysis, the method with the greatest visualization advantage involves using a strategic diagram and social network diagram to depict the internal connections in the field of study and the external mutual influences for investigating the hot topics and development trends in the field.

- **Strategic Diagram:** In a strategic diagram, centrality is typically represented on the x-axis and density is typically represented on the y-axis. A high value of centrality indicates that the topic field in question has many close connections with other topic fields and that the topic is close to the network center of the corresponding research field (Bauin, Michelet, Schweighoffer, & Vermeulin, 1991). Density is used to evaluate the strength of the connection between the members (keywords) of a cluster. Thus, density is the strength of the internal connection within the cluster. It indicates the self-maintenance ability of the cluster and its development ability in a field (Callon et al., 1991). This study used the following equations, which were proposed by Lee and Jeong (2008), to calculate the centrality and density, respectively:

$$\text{Centrality } C(k) = \frac{\sum_{i \in \phi_s, j \in (\phi - \phi_s)} \mathrm{E}_{ij}}{N - n} \tag{1}$$

$$\text{Density } D(k) = \frac{\sum_{i,\ j \in \phi_s (i \neq j)} \mathrm{E}_{ij}}{n - 1} \tag{2}$$

In a strategic diagram, the first quadrant (top right corner) is an area with high centrality and high density. A high centrality indicates that a cluster has a close connection with other clusters and forms a core part of the research. A high density indicates that the nodes in a cluster are tightly connected and that studies on the corresponding topic have matured. Thus, a cluster with high density represents a leading research topic. The second quadrant (bottom right corner) is an area with high centrality and low density. Topics in this quadrant have considerable importance and a high development trend. However, their internal structure is immature (low density). The third quadrant (top left corner) is an area with low centrality and high density. The studies within a cluster in the third quadrant are mature; however, they do not have close connections with topics from other clusters; thus, the aforementioned studies are located at the margin of the research network. The fourth quadrant (bottom left corner) is an area with low centrality and low density. A cluster in this quadrant has loose connections with other clusters, and its research structure is immature. Research topics in the aforementioned cluster receive low attention and exhibit weak research power and depth. These topics are located at the margin of the entire field.

- **Co-word Social Network Analysis:** We used the Netdraw tool of UCINET to depict the EC research topics in Stages I–IV. Nodes and connecting lines were used to reveal relationships between topics. Each node represented a keyword. The thickness of the connecting lines and the line frequency indicated the closeness of the connection between research fields with similar topics and backgrounds. To increase the readability of the map, the degree of centrality is most commonly used as the basis for evaluating a node's impact scope (Everton, 2013). If the line frequency is too low, the node is set as invisible to objectively visualize the closeness between topic clusters. The size of a node is proportional to the frequency of the keyword's appearance in the co-word network. The same shape and color indicate the same cluster. Clusters 1, 2, 3, and 4 comprised red dots, yellow squares, bright green upper triangles, and light blue squares, respectively.

FINDINGS AND DISCUSSIONS

Results for the Strategic Coordinate Recognition Cluster

On the basis of the cluster analysis of co-word matrices, we calculated the centrality and density of each cluster. Moreover, strategic coordinate charts (Figs. 3–6) were drawn using the mean values of the centrality and density as the origin point.

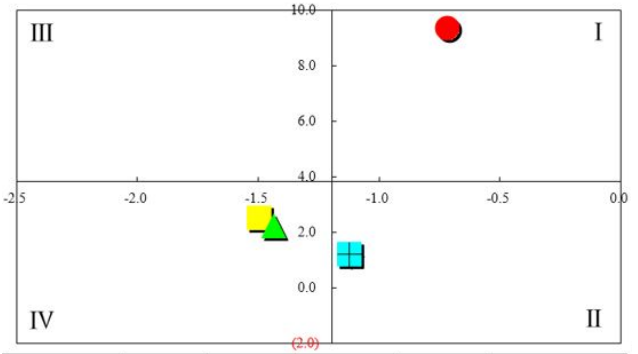
Stage I (2001–2005)

The research topics in Stage I belonged to four clusters (Figure 2) located in Quadrants I, II, and IV. Cluster 1 in Quadrant I, namely information system facility and management, had high centrality and density and represents a relatively stable and mature research field. This cluster was located in the center of the studies in Stage I. Cluster 4 in Quadrant II, namely digital verification information management, had high centrality and low density, comprising studies that analyzed, identified, evaluated, and explained business activities in e-services to extract information that is hidden, is unknown, and has potential application value. The aforementioned cluster had considerable room for development. Cluster 2 (digital copyright protection management) and Cluster 3 (e-market recommender system) in Quadrant IV had low centrality and density. These clusters had weak internal connections among nodes and weak external connections with other clusters. They included studies located at the margin of Stage I. However, as indicated by the EC development in China, Stage I was a time of infrastructure building (Yuan, 2001). The topics of digital watermarking, copyright protection, and digital rights management in Cluster 2 as well rating style, user similarity, collaborative filtering, and machine learning in Cluster 3 might be integrated with other clusters in the future or might become independent focuses of research.

Stage II (2006–2010)

The research topics in Stage II belonged to three clusters (Figure 3) located in Quadrants I, II, and IV. Cluster 1 in Quadrant I, namely trust and information management, had high centrality and density. Papers in this cluster, such as those investigating the marketing strategy and innovative activity that influenced online shopping and trust through the use of information technology systems to effectively

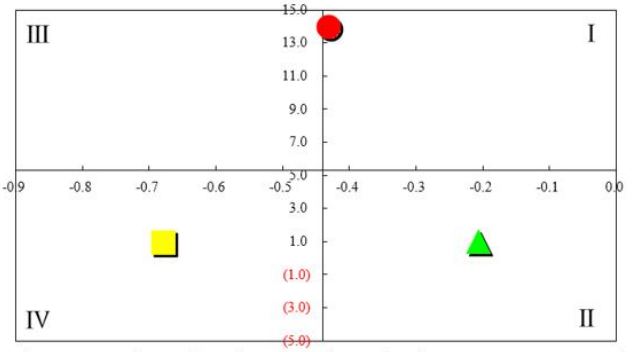
Figure 2. Strategic diagram for Stage I (2001–2005)



Cluster	1	2	3	4	Average value
Centrality	−0.721	−1.498	−1.438	−1.123	−1.195
Density	9.346	2.515	2.221	1.184	3.816

(1) Information system facility and management
(2) Digital copyright protection management
(3) E-market recommender system
(4) Digital verification information management

Figure 3. Strategic diagram for Stage II (2006–2010)



Cluster	1	2	3	Average value
Centrality	−0.431	−0.679	−0.207	−0.439
Density	13.988	0.904	0.971	5.288

(1) Trust and information management
(2) E-market information management strategy
(3) C2C consumer behavior

obtain information for analysis, were located in the center of this quadrant. Cluster 3 in Quadrant II, namely C2C consumer behavior, had high centrality and low density. Its characteristics depended on the trust between consumers, purchasing behavior, word-of-mouth interaction, and consumer attitude. The strategies identified by the studies in this clusters were intended to lower individual consumers' trust, which warrants further investigation. The topics in Cluster 3 are worthy of attention in the future. Cluster 2 in Quadrant IV, namely e-market information management strategy, had low centrality and density. It had loose connection with other clusters, and its internal structure was immature. Data mining, decision support systems, competitive models, and logistics management as well as their associated activities may be merged into other clusters in the future or may become independent focuses of research.

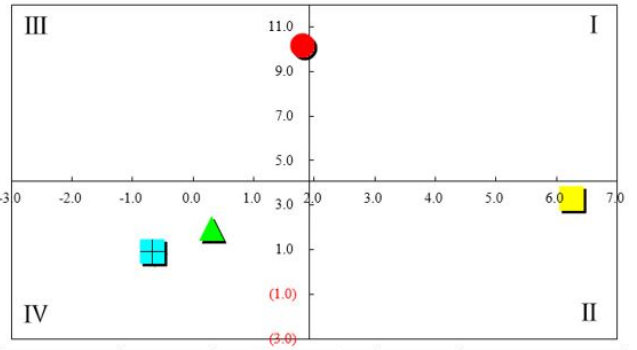
Stage III (2011–2015)

The research topics in Stage III belonged four clusters (Figure 4) located in Quadrants II, III, and IV. Cluster 2 in Quadrant II, namely trust and service quality, influenced consumers' perceptions and the perceived value of the e-service, and were closely related. The cluster had a close relationship with other research clusters but had a loose internal relationship. Cluster 2 did not include any core research trends; however, the topics in this cluster had high potential for development. Cluster 1 in Quadrant III, namely e-finance and social commerce, had a centrality of 1.798, which was extremely close to the mean value of 1.921 in the center of the diagram. This cluster was a relatively mature research cluster. Cluster 3 (privacy and mobile payment) and Cluster 4 (marketing and cyber security) in Quadrant IV included topics related to trust and safety of the seller and consumer. Because Quadrant IV exhibited low centrality and density, the aforementioned clusters had a weak connection with other clusters and a loose internal structure. Therefore, the research topics in Clusters 3 and 4 were new, underdeveloped, and marginal research topics.

Stage IV (2016–2020)

The research topics in Stage IV belonged to four clusters (Figure 5) located in Quadrants I, II, and IV. Cluster 1 in Quadrant I, namely e-finance and social perception, had the highest cohesion and connection. It exhibited mature development and a strong connection with other clusters. Thus, Cluster 1 included mainstream topics in Stage IV. Cluster 2 in Quadrant II, namely e-market

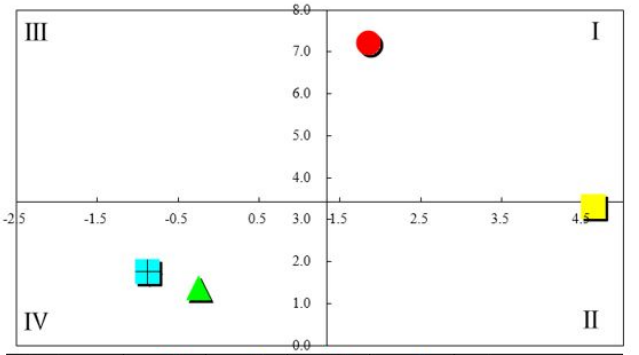
Figure 4. Strategic diagram for Stage III (2011–2015)



Cluster	1	2	3	4	Average value
Centrality	1.798	6.243	0.309	−0.668	1.921
Density	10.164	3.282	1.922	0.928	4.074

(1) E-finance and social commerce
(2) Trust and service quality
(3) Privacy and mobile payment
(4) Marketing and cyber security

Figure 5. Strategic diagram for Stage IV (2016–2020)



Cluster	1	2	3	4	Average value
Centrality	1.846	4.624	-.245	−0.878	1.337
Density	7.220	3.307	1.377	1.764	3.417

(1) E-finance and social perception
(2) E-market and service perception
(3) Business information smart analysis
(4) Social EC consumer perception

and service perception, followed the quality–value–satisfaction–loyalty paradigm. In Cluster 1, a trade-off existed between perceived gains and losses. This cluster had a certain degree of connection with other clusters, yet its internal structure was not mature and had room for further development. Cluster 3 (business information smart analysis) and Cluster 4 (social EC consumer perception) in Quadrant IV had low centrality and low density. The studies in these clusters used IT and artificial intelligence (AI) to conduct feature learning and application on information (data) and to explain and predict consumers' intentions and behaviors in EC trades for providing a reference to future researchers.

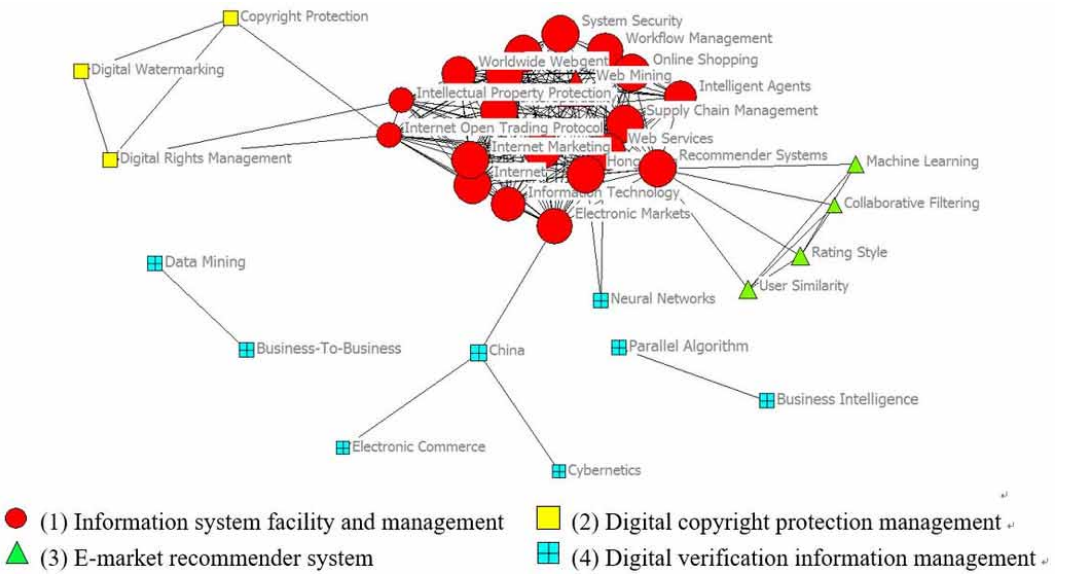
Analysis of the Co-Word Social Network Diagram

Stage I (2001–2006)

Stage I comprised four clusters (Figure 6). The diagram radiated outward with Cluster 1 as the center. Cluster 1 was the largest cluster in the diagram and contained 20 keywords, in which the nodes were close together, and most of them were regarding information system perspectives on EC trades, such as recommender systems, electronic markets, and workflow management. Among them, the dense nodes in recommender systems were closely and directly connected to the nodes representing rating style, user similarity, collaborative filtering, and machine learning in Cluster 3. A recommender system is an information-filtering smart business system that is used for predicting users' ratings or preferences for an object. It provides complete shopping decision support and information services for customers. For example, Cheung and Tian (2004) used machine learning for conducting collaborative filtering of similar information between products and consumers to increase the precision of recommendations. This concept has also been used and integrated into topics in Cluster 3. For example, Li, Lu, and Li (2005) stated that a personalized recommender system can resolve the problem caused by the inability to obtain precise recommendations based on multiple interests and multiple contents through conventional collaborative filtering.

Cluster 2 contained three keywords. The main topic in this cluster was protection measures, such as encryption and additional usage rules for digital content. For example, the digital rights management node in this cluster was connected to the Internet open trading protocol, and intellectual property protection nodes in Cluster 1. Cluster 4 was located on the margin of the network diagram and had decentralized nodes. Its topics were related to information technology and included cybernetics, data mining, neural networks, and parallel algorithm. Cybernetics is a discipline studying how a dynamic system maintains a balance or stable state under changing environmental conditions. The aforementioned characteristics of clusters demonstrated that the construction of information system infrastructure was the main focus of China's EC services during Stage I.

Figure 6. Co-word network diagram (line frequency [3] 0.2) for Stage I (2001–2005)



Stage II (2006–2010)

Stage II comprised three clusters (Figure 7). The diagram radiated outward with Cluster 1 as the center. Cluster 1 was the largest cluster in the diagram and contained 24 keywords. The nodes were centralized and mainly related to consumer (client) behavior and trust in the trading environment, followed by the use of information system management to understand trading details. The major keywords (nodes) were online customer, retailing, Internet shopping, and e-marketing environment, which indicated that in Stage II, studies were attempting to resolve problems and bottlenecks in the EC system (i.e., the consumer behavior, marketing environment, purchasing behavior, trust, service, and delivery), obtain solutions for the aforementioned problems, and provide a source of competitiveness for enterprises in the new EC environment (Su, Li, & Cui, 2009; Qureshi et al., 2009).

Clusters 2 and 3 were located below Cluster 1. Clusters 2 and 3 were loosely connected internally and located at the margin of the network diagram. Cluster 2 mainly included topics related to the EC information system and management, covering numerous design factors for optimizing the user experience, promoting user-generated content to disseminate product and brand information, and improving e-service quality to maintain a favorable relationship with clients.

C2C and consumer behavior were the emerging research topics in Cluster 3. Some scholars have adopted conventional variables that affect consumer behavior, such as cognition, emotions, and socialized commerce characteristics, to conduct studies on C2C and consumer behavior. Some scholars have adopted theories related to sociology or the social network to examine online consumer behaviors. As EC developed in China, an increasing number of scholars attempted to integrate the sociology and the social network for exploring C2C and consumer behavior from a new perspective. However, few and scattered results, which complemented Cluster 1, were obtained.

Stage III (2010–2015)

Stage III comprised four clusters (Figure 8). Cluster 1 contained 21 keywords. Its nodes were tight and large in the inner circle but loose and small in the outer circle. The analysis of the strategic coordinate diagram depicted in Figure 8 revealed that Cluster 1 was located in Quadrant III and near Quadrant

Figure 7. Co-word diagram (line frequency ³ 0.1) for Stage II (2006–2010)

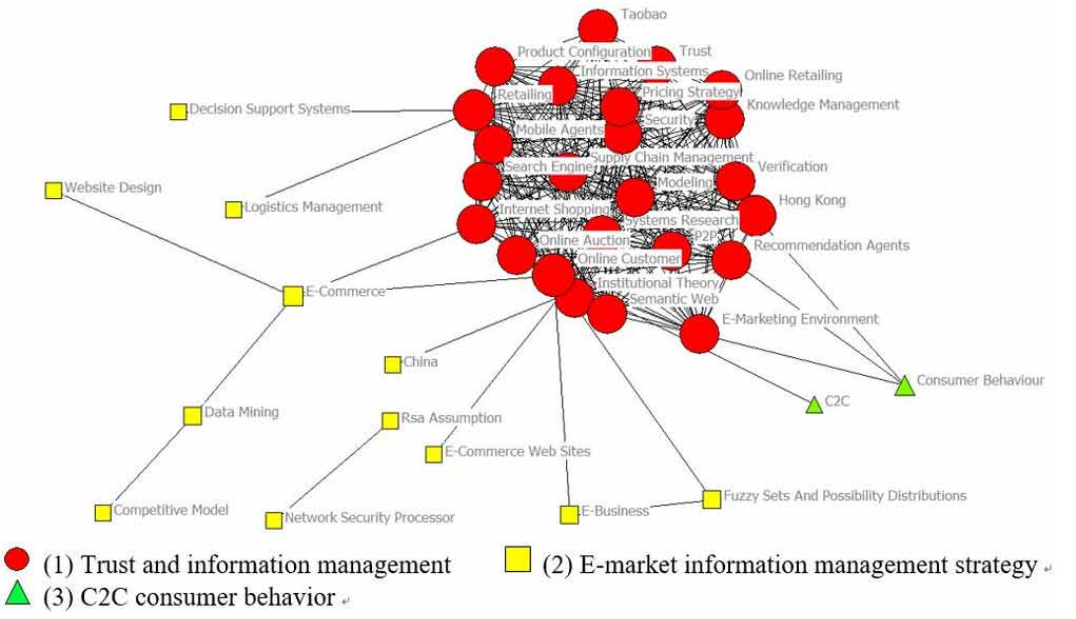
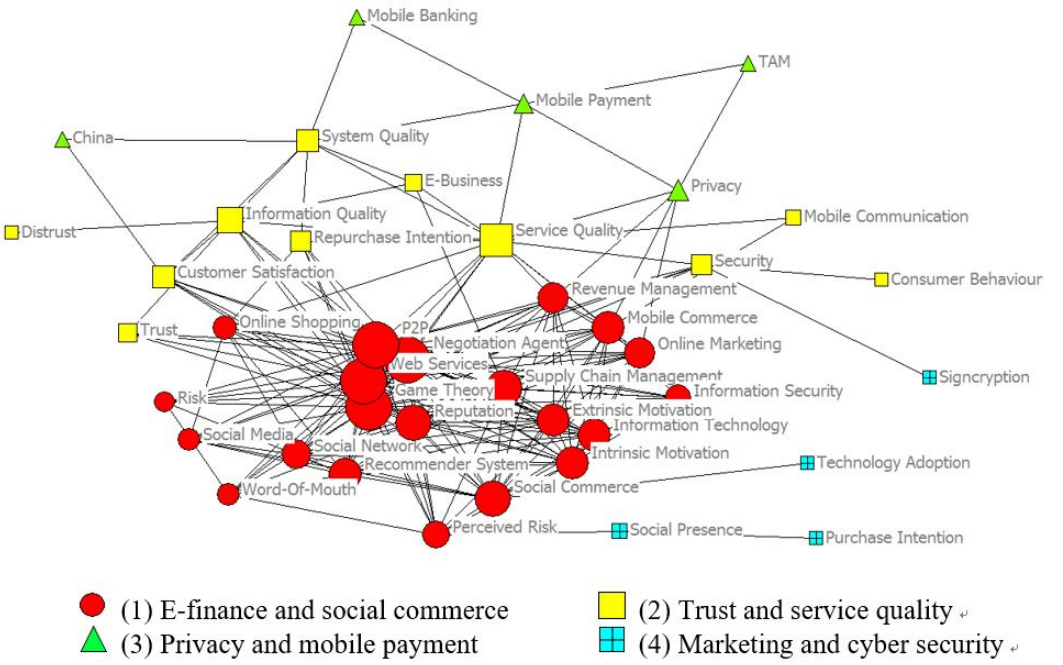


Figure 8. Co-word diagram (line frequency [3] 0.35) for Stage III (2016–2015)



I. By analyzing the information of the nodes, we determined that the large nodes in the inner circle were mostly related to smart information systems, such as web services, peer-to-peer (P2P) lending, game theory, and negotiation agents. Moreover, the nodes in the outer circle were related to the use of e-markets for realizing online shopping benefits, such as word-of-mouth, perceived risk, social networks, recommender systems, online shopping, and social media.

Cluster 2 comprised nine keywords and was located between Clusters 1 and 3. It acted as a bridge between Clusters 1 and 3. The largest node in Cluster 2 was service quality, followed by information quality. From the perspective of EC, factors (inputs) such as perceived value and risk affect service quality. Moreover, loyalty and consumer behavior are the results (outputs) of service quality. Consumer satisfaction is the center of all factors. It connects the inputs and outputs. Trust refers to service provider not just a product but also precise, latest, comprehensive, and unbiased information to consumers. For example, Jia, Cegielski, and Zhang (2014) stated that EC service quality should cover technical service quality, content service quality, and customer service quality, all of which are key factors influencing consumer satisfaction, trust, and sustainability of EC technology. The aforementioned factors also have a positive influence on repurchase intention (Sharma & Wang, 2015).

Clusters 3 and 4 had relatively few nodes and a loose internal structure. The nodes in Cluster 3, such as privacy and mobile payment, protect consumer privacy during online trading and assist financial enterprises in e-payment. Cluster 4 contained nodes related to the degree of similarity to face-to-face interaction when two parties communicate through digital media. A high degree of similarity enhances consumers' purchase intention. The node "signcryption" was connected to the node "security" in Cluster 2. These nodes ensure the safety, comprehensiveness, and nonrepudiation of online trading. An in-depth analysis of the two nodes revealed that they triggered the development of the security trade system in the EC ecosphere with the related collaboration nodes, despite their classification into different clusters.

Stage IV (2016–2020)

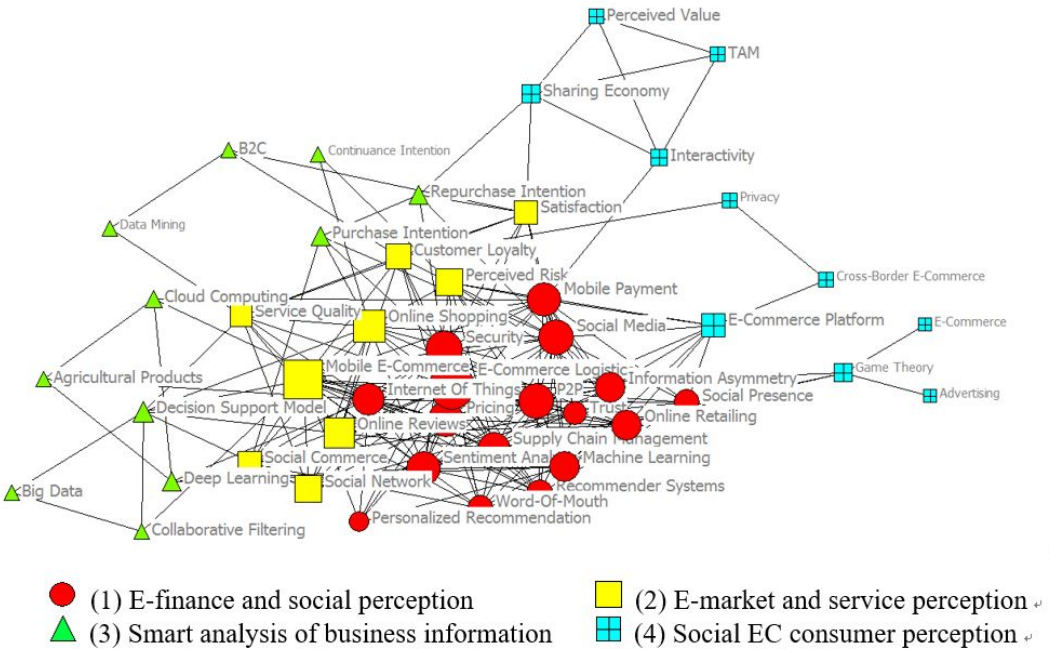
Stage IV comprised four clusters (Fig. 9). Cluster 1 was located at the bottom of the network diagram and to the bottom right of Clusters 2 and 3. Cluster 4 was located at the top right of Cluster 1 and was connected to Cluster 1. Cluster 2 bridged Clusters 1 and 3.

Cluster 1 comprised 18 keywords, and its nodes were close to each other. The large nodes included e-commerce logistics, P2P lending, security, mobile payment, supply chain management, social media, and sentiment analysis. These nodes were used to establish the EC service method, and they turned to focus on the needs of enterprises and consumers. Thus, the aforementioned nodes triggered the development of the logistics, information technology, and finance industries. For example, Liu (2020) and Jiang, Wang, Guo, & Gong (2019) have studied the last mile delivery service in rural areas of China. The characteristics of rural logistics are long transportation distance and low consumption density. Rural logistics are influenced by four basic factors: convenience for the return of goods, integrity of the goods, preannouncement of delivery, and delivery cost.

The larger nodes in Cluster 2 included mobile e-commerce, online reviews, and online shopping. These nodes focus on informativeness and normativeness and emphasize the EC social network and social commerce (s-commerce). Consumers are no longer restricted to a specific shopping platform. They perform personalized individual or community shopping according to their requirements. Influence from peers can considerably promote consumer online shopping behavior (Hu, Chen, & Davidson, 2019). For example, according to Zhang, Chu, and Xue (2019), shops use online reviews posted on social media to determine consumer preference and identify where their products require improvement. Thus, shops aim to redesign products so that they possess the advantages of precise consumer positioning, centralized commodity, and professional services; satisfy consumers; and shape consumer loyalty.

The nodes in Cluster 3 were related to the fragmentation of information in the EC system. These nodes reinforced e-services involving AI smart technology, such as collaborative filtering, deep learning, cloud computation, big data, and data mining. These nodes can be used to overcome

Figure 9. Co-word diagram (line frequency ³ 0.28) in Stage IV (2016–2020)



the limitations of conventional marketing models by adopting smart dynamic services and overall integration to conduct in-depth communication with consumers from multiple perspectives, such as the active, interactive, and user care perspectives. For example, Lei (2020) used a deep learning algorithm to increase the precision of EC decisions for determining the investment or trading service quality of the Internet or enterprises.

Cluster 4 had a large node called "e-commerce platform," which was connected to the nodes "cross-border e-commerce" and "privacy." E-commerce platforms are mainly divided into B2B, B2C, and C2C platforms. Cross-border e-commerce has the characteristics of being global, intangibility, anonymity, multilateralization, directness, small batch size, high frequency, short order cycle, long delivery cycle, difficulty in digitization and supervision, wide-area coverage, and mixed varieties. The B2C model was the focus of said platforms (He & Qian, 2017). However, the key to success does not lie in the value of the product but in the value brought by the overall network ecology, which should be able to rapidly perceive enterprise and consumer dynamics and needs and provide comprehensive services. Because privacy is easily infringed, information disclosure related to group shopping experience has a positive influence on privacy. The aforementioned factors had a critical effect on promoting enterprise growth and business model innovation in China (Sun, Fang, & Hwang, 2019).

Summary

Cluster Study of Topic Development and Evolution

The strategic coordinate diagrams for Stages I–IV indicate the research topic development and evolution in the field of EC in China from 2001 to 2020. The research topic development system can be divided as follows: Stage I: EC application platforms that can cover each industry, including infrastructure such as Internet technology and information system technology; Stage II: change from the development of EC application platforms and information systems to the initiation of EC business activities; Stage III: an EC business period focusing on consumer behavior; and Stage IV: introduction of a smart system to enhance the EC business.

Stage I was the period of China's 10th Five-Year Plan (2001–2005). Four research topics were identified for this stage. In particular, the use of information technology to trigger EC development substantially improved the economic and social informativeness in China. The introduction of new technology and tools into China's economy resulted in a change in enterprise operation models in the country. More importantly, EC platform promotion and the adjustment of the economic structure enhanced China's future economic competitiveness.

Stage II was the period of the 11th Five-Year Plan (2006–2010). Three clusters were identified for this stage. Research on the topics in this cluster resulted in the comprehensive integration of EC into socioeconomic development, optimization of each detail in the industry structure, integration of the online and tangible economies, and comprehensive development of the online environment to trigger economic growth. Research topics such as digital authentication, online trading, payment, logistics, credit, security protection, and market monitoring paved the road for the development of EC that is unique to China.

Stage III was the period of the 12th Five-Year Plan (2011–2015). The research system of the previous stage continued to be improved in Stage III. The service awareness of businesses significantly improved, which enhanced the digital service quality and promoted consumer purchase intention. The online shopping experience also improved substantially. Terminal equipment was moved from the PC end to the mobile end. Moreover, as cross-border e-commerce expanded in Chinese and foreign markets, a group of B2B and B2C EC platforms were formed.

Stage IV was the period of the 13th Five-Year Plan (2015–2020). During Stage IV, the subjective level of EC comprehensively increased with the maturity of information technology and the further evolution of the Internet. This phenomenon triggered the transformation and upgrade of the traditional industry. The number of studies on smart EC increased with the development of big data, which decreased the distance between consumers and the market. The economy, market, industry

structure, product, service, and flow between them were profoundly altered by the development in said technologies. In addition, enterprise and consumer value and behavior as well as the job and labor markets were transformed.

Keyword Development and Evolution in the Co-Word Network

Supply chain management was a key factor throughout the four stages, and its evolution trend was clear. Supply chain management was the core of enterprise operation management and involved using suitable information management technology to manage the material flow, information flow, and cash flow. The scope of supply chain management included all activities from upstream suppliers to final consumers. Seamless process chain management was achieved. Logistics was one factors confining EC development. An optimal end-to-end management method is required to respond to consumers with high speed and flexibility at a low cost.

P2P lending, security, and trust were important factors in Stages II–IV. With regard to P2P, since the 2008 financial crisis, with advances in Internet technology and increases in the Internet penetration rate, credit investigations and credit activities have been conducted through big data analysis. The aforementioned tasks have filled the gaps in the financing of small and medium-sized enterprises and individuals. In Stage III, 2013 was a period of rapid development of these tasks, which became the hottest field of Internet finance. However, it involved the risk of illegal fundraising. Moreover, problems such as withdrawal restrictions, bankruptcy, hacking, website operation difficulties, and stopped operation created new challenges in finance monitoring in China (Park & Tussyadiah, 2020; Wang & He, 2015). With the further development of EC, interactive problems such as logistics, credit, security, mobile payment, privacy, service quality, satisfaction, and purchase intention surfaced gradually. These problems reflected people's focuses. Enabling businesses and consumers to rest at ease and enjoy the convenience brought by EC is a key aspect of EC research.

The topics identified in both Stages III and IV included mobile payment, perceived risk, privacy, purchase intention, repurchase intention, service quality, s-commerce, social media, social network, social presence, technology acceptance model, word-of-mouth, and game theory. Among these topics, game theory examines the profit division problems among e-enterprises (manufacturers and retailers), express companies, and platforms. The use of game theory enables EC businesses to provide high-quality services.

With regard to EC and smart technology, trading and consumer information were used in the data mining process (Stages I, II, and IV) to obtain useful data, such as potential clients and preferred product types, for predicting sales on the basis of product characteristics. The aforementioned data were used as references for evaluating marketing strategies for clients. Currently, most EC platforms use a recommender system based on collaborative filtering algorithms (Stages I, III, and IV). The advantage of this system is that it can rapidly recommend products to consumers. However, in a virtual shopping world, consumers face not only vast and mixed information but more risk and uncertainties than they did in a tangible world. Although website information can be easily accessed, consumers prefer to join social networks (Stage IV) to effectively screen out opinions from people with similar preferences. Consumers consider the products recommended by the aforementioned people as a basis to determine whether they should make a purchase. This part of the findings is similar to the results of Han, Xu, & Chen (2018) on social commerce; however, this research has expanded to obtain recommender systems and collaborative filtering.

Consumer-centered smart business and marketing business procedures integrated machine learning and deep learning models. Smart technologies—such as searching, marketing, personalized recommendations, service quality, price adjustment, supply and demand forecast, distribution to repurchase, fraud detection, and chatbots—can clearly identify consumer characteristics in the market. Thus, the aforementioned technologies can be used to obtain satisfactory and realistic consumer experiences to enhance transformation and sales. From the technology perspective, the expanded use of the recommender system provided enterprises with client-centered marketing strategies, which

indicated that increasing importance of using EC and AI-related technology to conduct data analysis. The results of this study are similar to those of Yan, Lee, and Lee (2015); Ngai and Wat (2002); Liu and Yang (2017); and Guo (2018) with more systemic and extended description, indicating that advances can be achieved in EC by integrating AI technology into it.

CONCLUSION AND SUGGESTIONS

Conclusion

Most studies that have reviewed the research in a professional field have not divided the collected data into different periods for analysis. A few studies have divided the collected data into different periods; however, the short duration of the research period in these studies may not cover the duration of policy application. The present study is the first to analyze the National Economic and Social Development Plan of China in terms of 5-year segments. We examined how research trends varied in different 5-year periods. No researchers have used this method to study the development of EC in China. Based on the documents searched in the WoS database from 2001 to 2020, this research conducts common word analysis, strategic coordinate map analysis and social network analysis of Chinese EC representative documents, and maps the results into strategies through MS Excel and UCINET Coordinate maps and knowledge maps. In order to understand the current status, changes and trends of the research themes of China's EC in the past 20 years, in order to present the knowledge content structure of China's EC field. After comparison and analysis, we identified four, three, four, and four clusters in Stages I–IV, respectively. Similarities and differences were observed in the research trends in the four stages. The EC environment in China exhibited advances with time during the research period. These advances corresponded to the implementation of EC economic policies; thus, this study has considerable value.

The numbers of journal articles in Stages I–IV were 171, 200, 390, and 1,221, respectively. Stage IV shows that China attaches great importance to EC and is entering a period of high attention to the development of rural EC and cross-border EC. Stages I: The research focus shifted from developing information system and Internet infrastructure for EC to assisting traditional enterprises in their initial application of EC. Stages II: Informatization was used to trigger enterprise online trading. Online trading promoted informativeness and research topics such as social economy, public benefits, and safety under the enterprise development and business trading environment. Thus, a stable foundation was established for EC development. Stages III: As cross-border EC expanded, it overcame numerous technology problems and was comprehensively integrated into China's economic and social development. Thus, research on digital authentication, online transaction, payment, logistics, credit, security protection, and market supervision in China increased for optimizing each detail of the industry structure. In particular, during Stage IV (2016–2020), EC companies focused on consumers' personalized demands, actively integrated AI-related technology into their platforms, stopped using traditional sales models, and used active marketing and diverse communication models to generate increased profits for the Chinese economy and create new opportunities for people as well as challenges. Topics such as consumer behavior and consumer rights were not a part of the high-frequency keywords in Stage IV. The aforementioned subjects were mainly researched during Stages II and III (2006–2015), which indicated that these topics had matured.

In Stage IV, moving towards integrating smart technology into new research topics in the EC environment, fully integrating it into various fields of production and life. Such as cross-border e-commerce, rural e-commerce, and various characteristics of the electronic market, which enable enterprises or rural products to continuously meet consumer needs and promote the development of EC. Four clusters were obtained: e-finance and social perception, e-market and service perception, business information smart analysis, and social EC consumer perception. It can be seen that China still faces problems such as irregularity, inadequacy, imbalance, and vulnerability to infringement of privacy in the development of EC. The monopoly and unfair competition of platform companies have

become prominent. The high-quality development opportunities and challenges of EC coexist, and it will become a new research development with China in promoting rural EC and cross-border EC. At the same time, China will play an important role in smoothing the internal circulation of domestic economic transactions and the external circulation of foreign economic transactions through EC.

Suggestions

This study only analyzed journal articles collected from the WoS database. This study has certain limitations. First, biased results may be obtained when using only keyword co-occurrence to analyze research topics. Keyword co-occurrence analysis does not completely reflect the penetration characteristics of academic subjects. Second, only the research topic development and evolution in each stage were analyzed in this study. This study did not examine the overlap degree of the topics in different stages. Third, a review of the relevant literature indicated that many in-depth studies have been conducted on the professional applications of academic subjects in recent years. However, few studies have conducted co-citation analysis in the EC field. We suggest that future studies should collect more comprehensive data and enhance their research methods to completely reflect the hotspots and theme evolution process in the EC field. They may use citation, bibliographic coupling, co-citation, and content analysis to investigate the development and evolution of research topics in an academic subject and to conduct in-depth investigations on the degree of cross-domain interactions.

The forward-looking directions for EC research are recommended: (1) The mission of EC in the economic and social development of various countries can be expanded to explore. And also the distribution of research topics to observe research trends and changes in research paradigms; (2) Exploration of the EC development indicator system can be carried out, such as industrial EC penetration rate, rural EC transaction volume, cross-border EC transaction volume, and other sub-field indicators, which will help better reflect the scale benefits of EC development and more accurately grasp the development of EC Characteristic trends; (3) Explore EC development principles and policy guidance, such as fair competition, anti-monopoly, and prevention of disorderly expansion of capital; (4) Explore the global layout of the digital industry chain, play the main role of EC in the international cooperation of the digital economy and the rules of the digital field, etc., so as to enrich the research in the field of EC or related research in bibliometrics.

We discovered that global EC will maintain its trend of rapid growth in the future. With the rapid development of information systems, which will provide EC with a solid technological foundation, the function and service system of EC will become more mature and comprehensive. As the economies of different regions in China grow, the amount of EC- and bibliometrics-related research in China will increase.

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