

Research Topics and Hotspots of Complex Network in Marketing: A Visual Perspective of Knowledge Graph Based on CiteSpace

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Abstract: Based on the literature from 2012 to 2022 in Web of Science as the data source, this paper makes a big data analysis on the research status, hotspots and frontiers of complex networks. A visual analysis using CiteSpace found that: (1) The number of articles on “complex network in marketing” research keeps growing and has considerable research prospects. “Complex network in marketing” is gradually becoming a research hotspot in the marketing field. (2) “Performance”, “Innovation” and “Market” are the three hot topics in the research field of “Complex Network in Marketing”. (3) The clustering results of “Complex Network in Marketing” research can be summarized into three aspects: “social”, “evolution” and “market”. This research has certain reference value for grasping the knowledge base, research hotspots and the latest research frontier of complex network in marketing.

1. Introduction

The study of complex networks can be traced back to the 18th century, when mathematician Euler proposed the “seven-bridge problem”, abstracting the land as points and the bridges connecting the land as edges, and the points and the edges connecting the points form a network [1]. In this paper, the related literatures of “complex network” are sorted out, and it is found that “complex network” has different definitions in different fields. In this study, complex network refers to a network with high complexity [2]. Complexity refers to a nonlinear dynamic study that

adapts to the system through coevolution and cooperation [3]. In recent years, the socio-economic environment has become increasingly complex. As the economic management discipline recognizes the nonlinear characteristics of economic management activities, more and more scholars in the discipline introduce the complexity theory to carry out research. The “Causal Inference” study that won the Nobel Prize in Economics this year includes complexity theory. As a subject of economics and management, marketing needs the guidance of complexity theory more and more because of the complexity of marketing activities and participants.

Due to the limitation of research methods, the previous research in the field of marketing has adopted the traditional linear model. However, as human beings enter the mobile Internet society, human beings are increasingly integrated with the ecological cycle of nature. And the traditional linear industrial production model is increasingly threatening the complex natural balance. The human survival paradigm is changing, and human marketing behavior is showing more and more complex features that are different from those in the past. Complexity thinking holds that the world is nonlinear in nature and linearity is just a special case. Therefore, in such a non-linear world, people must use a non-linear thinking in order to obtain the correct understanding of the nature of things. The understanding of marketing essence also needs the guidance of complexity theory.

With the continuous development of globalization and informatization, the complexity of marketing has also deepened. Many scholars have a strong interest in “Complex Network in Marketing”, and have conducted extensive discussions and studies. Existing research has found that in order to make the world development more dynamic and faster, it is necessary for each organization to adapt to the turbulent and complex market environment and gain a certain market position [4]. In recent years, many academic journals have published cross-research articles on complex network and marketing [5]. Initially, most of these literatures focused on the idea of complexity, taking the complex network theory as a way to understand marketing [6]. With the continuous development of complex network in marketing, scholars begin to use complex network tools to solve practical problems in the field of marketing. Specifically, it includes marketing channels, marketing communications, marketing pricing, marketing strategies, and products. To sum up, it is necessary for marketing to carry out in-depth research by integrating complexity theory. Based on this, this paper discusses the research hotspot and future development trend of “Complex Network in Marketing” by combing and analyzing related literatures.

2. Data Sources and Research Methods

2.1 Data Sources

In this paper, the data source of Web of Science is selected. The date of data collection is June 29th, 2022. The literature type is limited to “article”, the language is English, the journal source type is “Social Sciences Citation Index”, the category is “Marketing”, and the theme is “Complex Network”. A total of 1,162 literatures were retrieved. In order to ensure the scientificity and accuracy of the research, 320 literature records were collected after analysis, among which “all records and cited references” were the main attributes to obtain sample literatures, and 320 valid data were obtained after the duplicates were removed.

2.2 Research Methods

In this study, CiteSpace software is used to visually analyze 320 documents. First, the available data are converted into data formats recognizable by CiteSpace. Then, big data analysis of “Complex Network in Marketing” is carried out from the aspects of keyword emergence, keyword co-occurrence and time map, and the research hotspots of “Complex Network in Marketing” and

the research conclusions of this paper are obtained.

3. Analysis of Research Results

3.1 Annual Publication Volume Analysis

In this paper, the statistical analysis of the annual number of articles published in relevant literatures shows that (Figure 1): Starting from 2012, the number of articles published each year showed a single-digit growth, reaching 32 in 2015, and after a short decline in 2016, it increased to 34 in 2018, and then showed a small increase every year. Starting from 2019, the number of articles published each year exceeded 35, reaching a high of 49 in 2021. Generally speaking, although there are some fluctuations, the research on “Complex Network in Marketing” is on the rise. It shows that academic circles pay more and more attention to the research of complex systems in marketing, and “Complex Network in Marketing” has gradually become a research hotspot in the field of marketing.

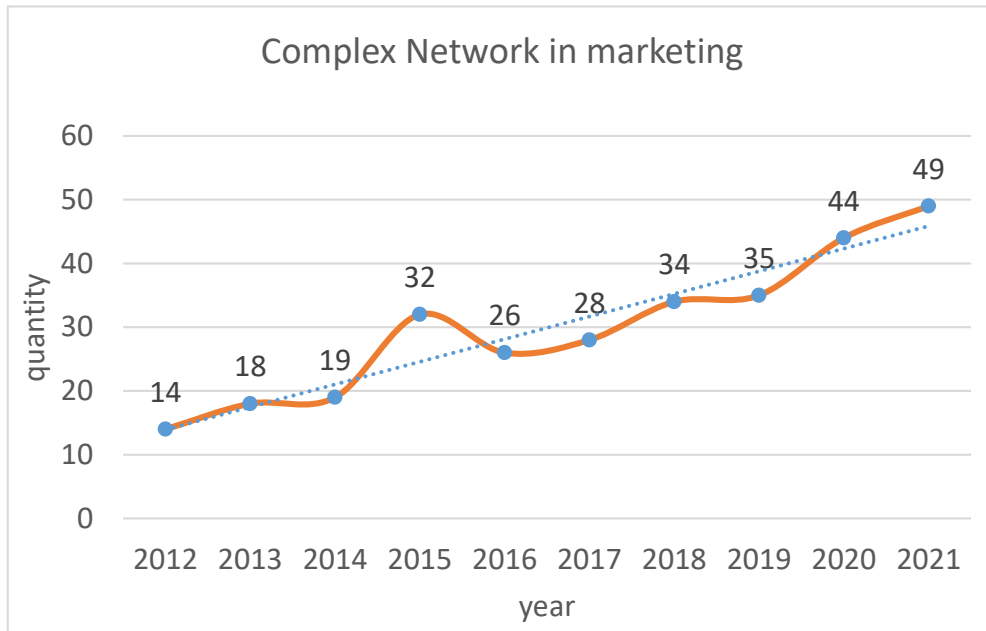


Figure 1: 2012-2021 Trends of Publication Number of Literature Related to “Comple Network in Marketing”

3.2 Research Highlights Analysis

The emergent terms can, to some extent, reveal the emerging research areas that emerge at a certain node and are predictive of the future direction of the research topic [6]. The emergent words of the complex network (Figure 2) reflect the general development path of the study, and the higher the strength of the emergent words, the more frequently the keywords appear in the study years.

Top 12 Keywords with the Strongest Citation Bursts

Keywords	Year	Strength	Begin	End	2012 - 2022
value creation	2012	2.8	2013	2014	
service	2012	2.8	2013	2014	
transition	2012	2.47	2013	2015	
determinant	2012	2.92	2014	2017	
dynamics	2012	2.36	2015	2018	
market	2012	2.37	2016	2016	
perspective	2012	2.96	2017	2019	
social media	2012	2.54	2017	2017	
evolution	2012	3.05	2018	2019	
dynamic capability	2012	2.44	2018	2020	
system	2012	2.48	2021	2022	
policy	2012	2.42	2021	2022	

Figure 2: Year ranking of keyword emergence in complex network research

(1) Based on research emergent terms, this paper argues that the evolutionary path of nearly a decade of research on complex networks in marketing can be divided into the following three stages:

(2) The first phase of research focused on value creation networks (2013-2015), which concentrated on exploring the determinants of firm value creation and how firms could better meet target customer needs and achieve value innovation through value networks. For example, Pagani (2013) argues that a firm's competitive advantage exists in the control nodes with the greatest value and power in the value network, and he used a dynamic network model to reveal how incremental innovation could be generated in digital business for value creation, using the European and U.S. broadcast industries as the subject of his study [7]. Krenz et al. (2014) argue that the spatial distribution of value chains in the network increases the complexity of value creation, leading to possible conflicts between enterprise management objectives and knowledge management objectives, while knowledge intermediaries have a supportive role for value creation networks and facilitate the harmonious symbiosis between enterprise management objectives and knowledge management objectives [8]. Jones et al. (2013) studied the value created by network marketing engagement teams in a value network perspective and proposed the Strategic Network Marketing Model (SNMM) [9]. Research at this stage uses network relationship theory to reveal, to some extent, the role of marketing activities in creating sustainable value along the value chain [10].

(3) The second phase of the study focused on the market itself and social media research (2016-2017). For example, Tian et al. (2016) conducted a simulation analysis of e-commerce marketplace networks and found that e-commerce order parameters are closely related to the specific structure of e-commerce marketplace networks, and that under certain parameters e-commerce marketplace networks can achieve an orderly macro-structure and institutional order [11]. Wang et al. (2017) conducted a spatio-temporal analysis of the Chinese consumer market using complex network theory, and the results showed that the consumer market network has the property of collaborative movement and different regions play different roles in the consumer market [12]. Meanwhile, many scholars have used social network theory to study social structure, for example, Puga-Gonzalez & Sueur (2017) used a modeling approach to study the social network behavior of macaques and found that the spatial structure in the model is similar to the spatial structure of macaques and can work in the complex social network of macaques [13]. On this basis, scholars began to focus on the application and research of complex network theory in social network marketing. For example, Zhu J et al. (2015) used WeChat as a research object and analyzed the topology of the social network platform using complex network analysis methods to reveal the

small-world properties of the WeChat network [14]. Chen et al. (2018) modeled and analyzed the information dissemination trajectory of WeChat users to explore their behavioral preferences [15]. Park et al. (2016) found that active management of the Facebook platform by the Korean government can promote tourism through complex network analysis [16].

(4) The third phase of the research focuses on the evolution and dynamics of complex network models (2018-2022). For example, Wang (2022) developed a new e-commerce model and established a personalized marketing strategy optimization model by using the improved neural network algorithm [17]. Bhattacharya et al. (2019) analyzed the phenomenon of digital marketing by constructing a mathematical model and applying an epidemiological approach to reveal the mechanism of the spread of viral marketing in social networks [18]. Pereira et al. (2021) used a new multi-objective optimization approach to improve the value of medical performance marketing and proposed a data-driven optimization model to predict user conversion [19]. Wan et al. (2018) proposed a model of the dynamics of opinion evolution of consumer online reviews to explore the interaction of consumer online reviews [20]. Sohrabi & Karimi (2019) designed a spam filtering system for Facebook platform using optimization algorithms such as ant colony optimization and differential evolution in order to improve Facebook user satisfaction [21]. Numerous scholars have optimized specific problems in the field of marketing through complex networks, especially in the application of optimization in social network marketing. However, existing studies have not been able to fully reveal the reasons for the flourishing of social platforms in the field of marketing, and most scholars are trying to continuously optimize social media platforms using complex web tools to improve consumer satisfaction and loyalty, thus keeping social media flourishing and better innovating marketing models to attract consumers' attention and ultimately achieve marketing objectives [22]. In this context, it is necessary to use complex network theory to study relevant issues in the field of marketing.

3.3 Research Hotspot Analysis

In this paper, a keyword co-occurrence map is constructed from 320 literatures (Figure 3). Each node represents a keyword, and the size of the node and keyword indicates the node weight. The larger the weight, the higher the relevance of the keyword to the topic. The map results are shown in Figure 3. In this paper, 324 nodes and 1715 links between keywords are obtained. Throughout the map, the keywords such as “Performance”, “Network”, “Innovation” and “Market” are large, indicating their high frequency. To some extent, it shows that Performance, Network, Innovation, Market and complex network research have high correlation. Especially, “Market” is clearly presented in the atlas, which shows that scholars have begun to pay attention to the application of complex network in the marketing field. The research on marketing network based on complex network is a research hotspot that will inevitably appear when the marketing field is further studied.

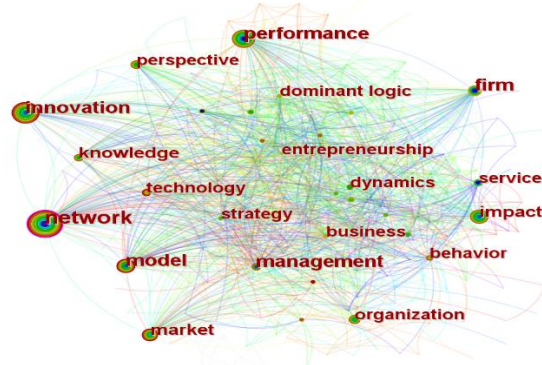


Figure 3: Keyword co-occurrence map

In addition, this paper counts the top ten keywords of “complex network” related research frequency (Table 1). The frequency reflects the common concerns of scholars in a certain period of time to some extent. The higher the keyword frequency, the more it can represent the research hotspots in a certain period of time. Centrality reflects the importance of keywords. The higher the centrality, the higher the importance of keywords.

Table 1: Key words statistics of the top 10 complex network frequencies

	Count	Centrality	Year	Keywords
1	76	0.33	2012	Network
2	56	0.13	2012	Innovation
3	53	0.17	2012	Performance
4	38	0.18	2015	Market
5	34	0.10	2014	Impact
6	32	0.17	2013	Model
7	31	0.09	2014	Perspective
8	28	0.12	2012	Management
9	28	0.10	2012	Firm
10	26	0.05	2012	Organization

Through the co-occurrence analysis of key words of complex network research, we can get the main hot spots of this research:

“Performance”, “innovation”, “market”, “impact”, “model” and “dynamics” are the core issues in the study of “Complex Networks” in recent ten years.

The high frequency of “Impact” shows that scholars pay more attention to the effect and influence of adopting complex network methods in enterprise marketing activities.

“Performance”, “Innovation” and “Market” show that the positive effects of complex network methods on enterprise marketing model innovation, marketing performance improvement and target market control are the research focus of scholars.

The emergence of the terms “Model” and “Dynamics” reflects the in-depth study of the optimization of complex network methods in the field of marketing and their application in marketing dynamic events.

3.4 Research Frontier Analysis

In order to understand the research process of complex network more clearly, this paper uses CiteSpace to cluster the literatures, and obtains the timeline cluster map of complex network keywords (Figure 4) to explore the research frontier of complexity. In the timeline clustering map, CiteSpace is a cluster that describes keywords along a horizontal timeline. Clusters are arranged vertically on the far right in descending order, and numbered from 0, which means the largest cluster. In general, when $Q > 0.3$, the clustering structure of map division is obvious; When $S > 0.7$, the clustering effect is reliable. In this paper, the Q value and S value of the timeline cluster map are 0.4044 and 0.7414, which indicates that the cluster structure is significant and effective. According to the vertical data on the right, seven kinds of clustering results can be seen: “#0 social networks”, “#1 evolution”, “#2 strategic alliances”, “#3 market”, “#4 collaborative consumption”, “#5 cooperation” and “#6 entrepreneurial orientation”. The largest cluster is “#0”. Before 2012, some scholars began to explore the mechanism of complex networks from the perspective of social networks. Then “#1”, in various periods, scholars have done a lot of research on the evolution of complex networks in different marketing environments. Cluster “#3” reflects that scholars' research on “Complex Network in marketing” has returned to the market itself, and finally “#6”. At this stage, scholars pay more attention to the positive role of complex network in market orientation and

enterprise positioning. Therefore, from the clustering results, the research on “Complex Network in marketing” began with social networks, then went to network evolution, and then to market orientation. Therefore, this paper summarized the clustering results of complex networks into three aspects.

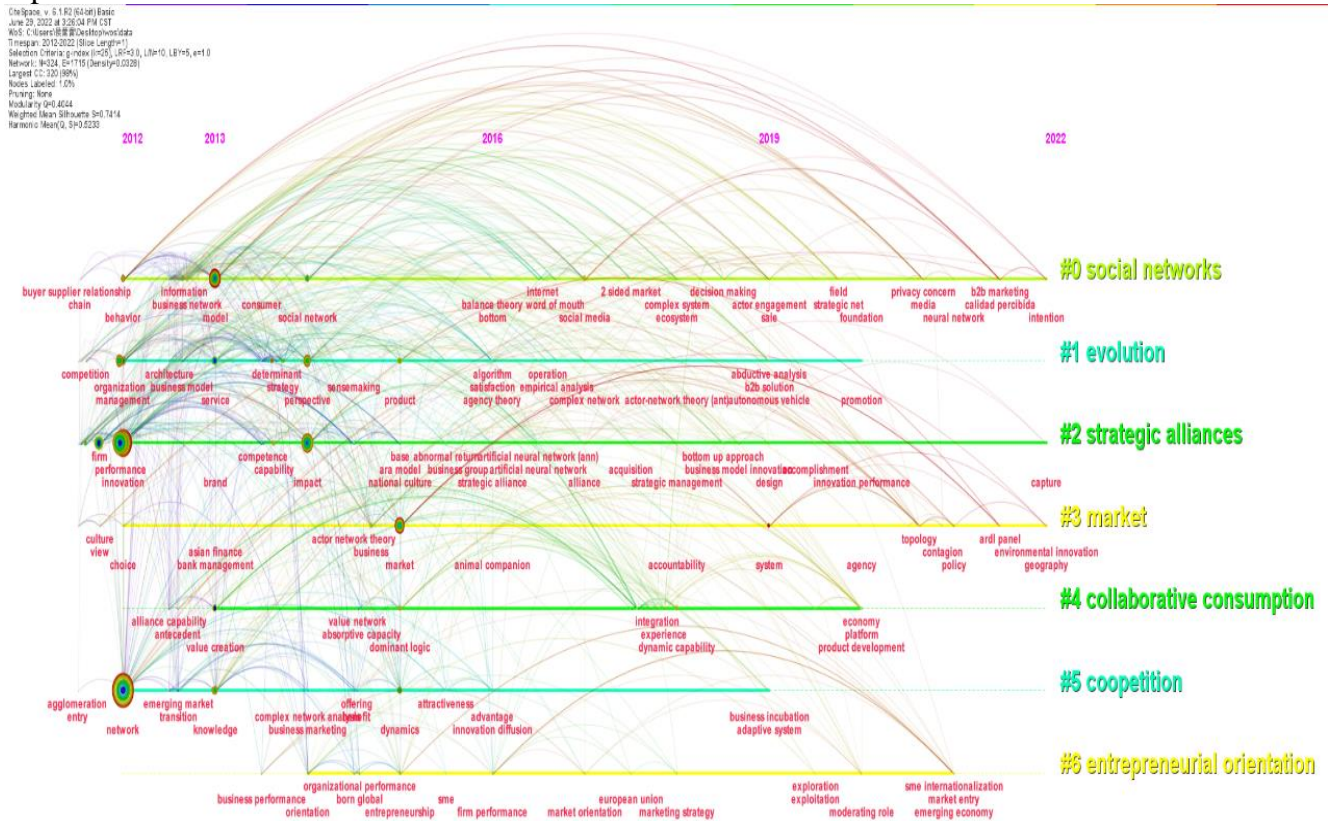


Figure 4: Keywords Timeline Cluster Map

(1) Social. It mainly exists in cluster #0, and the co-occurrence identifiers are “social network” and “social media”, which indicates that scholars are very concerned about the research and application of social network theory and complex network theory in marketing, especially social network marketing. The existing research found that social networks of both individuals [23] and animals [24] have the properties of complex networks such as small-world networks and scale-free networks. With the rapid development of the Internet, many scholars have done a lot of research on social networking media based on WeChat, Weibo, Facebook, twitter and other platforms, trying to explain the operating mechanism of social networking, accurately control the user portraits of consumers, help enterprises formulate more effective marketing strategies, and promote the innovation and development of digital marketing and relationship marketing [15-17].

(2) Evolution. It mainly exists in clusters #1, #4 and #5, with co-occurrence identifiers such as “complex network”, “dynamics” and “value network”. In recent years, with the rapid development of complex networks, a large number of new networks have emerged in the real world, and many complex systems exist directly or indirectly in the form of complex networks, such as disease transmission networks, community structure networks and so on [25]. Besides modeling and analyzing complex networks, solving dynamic events with complex network methods has become a hot topic in current research, such as disease risk transmission, consumer risk perception, network control and other issues [26]. Although some achievements have been made in complex network optimization, there are still some problems to be solved. The application of complex network optimization in marketing is still a hot issue that needs to be studied urgently.

(3) Market. It mainly exists in clusters #2, #3 and #6, and the co-occurrence logos are “market orientation”, “marketing strategy” and “strategic management”, etc. Scholars' initial research on the market by using complex network tools mostly focused on the stock market [27] and energy resource markets such as oil [28] and coal [29]. With the rapid development of big data, Internet of Things, and cloud platform, the marketing channel has developed from online and offline to multi-channel and omni-channel mode. Scholars have begun to pay attention to the application of complex network theory in e-commerce market [12]. With the in-depth development of the digital era, artificial intelligence technology can be seen everywhere in the consumer market. The marketing modes such as livestreaming marketing and Short Video Platform E-commerce livestreaming are constantly innovating, and the network structure of the consumer market is becoming more and more complex. Using complex network tools to solve market problems may become the focus of future research.

4. Research Conclusions and Prospects

Based on 320 documents obtained from Web of Science, this paper uses CiteSpace visualization method, co-occurrence analysis to show the research situation of complex networks, high-frequency keyword co-occurrence analysis to explore the development path and research hotspots of complex networks, and keyword clustering to explore the research frontier and research context of complex networks.

The research on “Complex Network in Marketing” still has considerable research prospects, with the number of related studies increasing, the research scope enriching, the research focus concentrating, and the close connection with the background of the times and the market situation. In the future development, scholars can continue to conduct in-depth research to achieve the goal of using complex network tools to improve the marketing ability of enterprises.

The research focus of “Complex Network in Marketing” mainly focuses on Performance, network, Innovation, Market and so on. In the future research, scholars need to further expand their research perspectives. For example, under the background of the rapid development of omni-channel mode, new purchase methods such as community group purchase and E-commerce livestreaming are constantly emerging. How to use complex network tools to construct user portraits of consumers in omni-channel network and realize accurate marketing needs further discussion.

In recent years, the research direction of “Complex Network in Marketing” is reflected in “social media”, “evolution”, “dynamic capability” and “system” and so on, which shows that scholars have been studying “Complex Network in Marketing” continuously. At the same time, with the continuous development of information technology and the innovation of marketing channels, the connection between complex network and marketing is getting closer and closer, and the related research is developing in the direction of using the optimized complex network model to solve dynamic market problems.

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