

# Research on the Application of Complex Network Theory in Enterprise Brand Marketing

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**Abstract.** The basic view of complexity science is that the structure of complex systems will determine the function and behavior of the system. Based on the complex network theory, abstract the corporate brand marketing as the diffusion behavior of the corporate brand in the marketing network, and spread the corporate brand in the marketing network. The behavior is described. On this basis, a targeted marketing method for different node constituents in the corporate brand marketing network and a method for reducing the threshold of corporate brand marketing network diffusion using marketing theory are proposed.

## Introduction

The study of the system as an important scientific concept originated from the Austrian theoretical biologist Bertalan Fei, who believed that the system was a "complex of the elements of interaction." At present, the definition of the system in the academic world is that the system is an organic whole with specific functions combined by several components (elements) of interaction and interdependence. As can be seen from the definition of the system, the system must have three characteristics: first, the system is composed of several elements; second, these elements interact and relate to each other; third, because of the interaction between the elements, the system acts as A whole has specific features. From the three characteristics of the system can naturally be associated with another concept "network." A network is a collection of nodes and the edges that connect them. From a system point of view, the network is a special type of system. Its components are the nodes of the network, and the relationship between the elements is the edge of the network. From another perspective, the network can also serve as a structural model for the topological characteristics of the reaction system. Therefore, the structure of any system can be abstracted as a "network model", that is, the components of the system are abstracted into nodes of the network, and the interaction between the components is abstracted into the edges of the network.

The basic idea of complexity science is that the structure of a complex system will determine the function and behavior of the system. Enterprise brand marketing is the process in which the company's brand marketing can be seen through the use of various marketing strategies to enable the target customers to form an identity with the corporate brand and thus deeply spread the brand of the company to the hearts of consumers. The proliferation of corporate brands in the marketing network. Drawing on the complex network theory, further research on the diffusion behavior of corporate brands in the marketing network is of great significance for modern corporate brand marketing. Based on the complex network theory, this paper establishes the network topology structure of enterprise brand spread in the marketing network, describes the diffusion behavior of corporate brand in the marketing network, and discusses the enlightenment of complex network theory to corporate brand marketing from two aspects: First, different marketing methods are used to market different quality nodes on the marketing network; secondly, factors affecting the brand diffusion threshold are analyzed, and countermeasures to reduce the diffusion threshold are proposed.

## Overview of Complex Network Theory

Complex network theory studies the commonalities between various networks that look different from each other and the pervasive methods of dealing with them. In recent years, complex network

research has penetrated into many different fields such as mathematical science, engineering science, and social science. Complex network theory can be summarized as two aspects: the statistical nature of complex networks and existing complex network models; and the guiding significance of complex networks to real networks.

### **Statistical Properties of Complex Networks and Existing Complex Network Models.**

Complex network research is to examine the nature of large-scale nodes and their connections in a network from a statistical perspective. These differences in nature mean different network topologies, and the differences in network topology lead to differences in network system functions. There are three main properties of complex networks: The average path length, The clustering coefficient, and The degree distribution, which are interpreted as the average of the distance between all pairs of nodes, and the nodes in the network. The aggregation situation and the number of other nodes connected to a node in the network. In addition, complex networks have the properties of Network Resilience, betweenness, and the correlation between degrees and aggregation coefficients. Network resilience refers to the impact of network node deletion on network connectivity; the median is divided into edge mediator and node mediator, which refers to the proportion of all the shortest paths in the network passing through the edge or the node; network moderate and The correlation between the aggregation coefficients is used to describe the differences between different network structures.

The existing complex network models mainly include small world networks and scale-free networks. Most real networks have small cosmopolitan (smaller shortest path) and aggregative (relatively large aggregation coefficients), for which Watts and Strogatz proposed a small cosmopolitan and highly aggregated in 1998. Network model, they construct a network between the regular network and the random network (referred to as WS network) by randomly connecting each edge in the rule network to a new node in the network with probability. It has a smaller average path length and a larger aggregation coefficient, while the regular network and the random network are special cases where the WS network is 0 and 1, respectively. After the introduction of the WS model, many scholars have made further improvements on this basis. The most widely used one is the so-called NW small world model proposed by Newman and Watts. In fact, when the network nodes are small and the network nodes are large, the theoretical analysis results of the two models are the same. We collectively call them small world models. The small world model can well describe the small world and high aggregation of the real world, but the theoretical analysis of the small world model shows that the degree distribution of its nodes is still in the form of exponential distribution. The empirical results show that for most large-scale real networks, the power distribution is used to describe their degree distribution more accurately. Many networks have a power-law distribution with no peaks relative to the exponential distribution. Most nodes have only a few connections, while a few nodes have a large number of connections. There is no feature scale in a random network, so it is called a scale-free network. Barabási and Albert proposed the famous "BA model" to explain the formation mechanism of scale-free networks: I believe that the previous network model did not consider the two important properties of real networks - growth and preferential connectivity, the former means continuous There are new nodes to join in, the latter means that new nodes come in and prefer to connect nodes with large degrees in the network. They not only gave the BA model generation algorithm and carried out the simulation analysis, but also used the average field method in statistical physics to give the analytical solution of the model. The results show that after a long period of evolution, the degree distribution of the BA network no longer changes with time, and the degree distribution is stable to the exponential power law distribution. In addition to the classic small world model and scale-free network model, scholars have proposed some other network models to describe real-world network structures, such as weighted evolution network models and local world evolution network models.

### **The application significance of complex network research.**

The structural research of complex networks is important, but the ultimate goal is to understand and explain the behavior of network systems based on the operation of systems based on these networks. The current field of complex network applications is mainly to study the dissemination and diffusion behaviors on the network, such as the spread of viruses on computer networks, the

prevalence of infectious diseases in the population, and the spread of rumors in society. Traditional network diffusion models are mostly based on rule networks. The depth of complex network research has led us to re-examine this issue. Below we focus on the description of corporate brand marketing from the diffusion behavior under complex networks.

### **Description of the Diffusion Behavior of Corporate Brands in Marketing Networks**

The essence of brand marketing is to deeply spread the brand of the company into the process of marketing network, to enhance the consumer's recognition of the brand of the company, so as to achieve the purpose of promoting sales. Understanding the mechanism of disease transmission is one of the original research purposes of network communication and spread. Generally, nodes are used to represent individuals infected or infected with diseases. If two individuals can directly infect and be infected in some way, this is considered There is a connection between the two individuals, so that the topology of the propagation network is obtained, and then a correlation model can be established to study the propagation behavior. This method of researching disease transmission draws on the research of corporate brand marketing diffusion network, and regards the process of enterprise brand marketing as the diffusion of brand in marketing network, and uses nodes to represent individuals in enterprise brand marketing system, if two If there is a brand diffusion relationship between nodes in a certain way, it can be considered that there is a connection between the two, and then the topology map of the enterprise brand diffusion network is obtained (see picture 1).

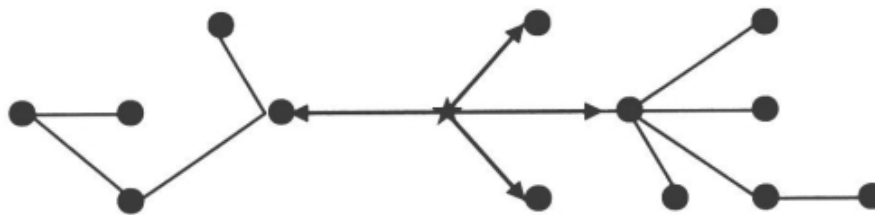


Figure. 1 Topology diagram of the enterprise brand diffusion network

### **The Composition of the Diffusion Node and its Microscopic Operation Mechanism.**

The company's brand marketing network is composed of enterprises, branding marketing agents (Singing-agent) and consumers. In reality, the corporate brand marketing network usually has a large and complex network structure due to the different distribution of enterprises, brand marketing agents and consumers at all levels and the various connections between them. The corporate brand marketing process can also be seen as the diffusion process of the corporate brand from the enterprise through the sales agents at all levels, and finally spread to the vast number of consumers, or the corporate brand from the enterprise to the sales agents at all levels, and finally to the consumer's communication. process. Therefore, enterprises, sales agents at all levels and consumers constitute the diffusion node of corporate brands in the marketing network.

In the corporate brand marketing network, the related diffusion of corporate brands is mainly reflected in two aspects: the proliferation of products and the diffusion of information related to products. There are two main ways for corporate brands to spread with products: First, the more common corporate brands are delivered to consumers by brand marketing agents; the second is that enterprises directly reach consumers. The spread of brand-related information is also an important part of brand marketing. The focus of corporate brand marketing is mainly the spread of brand-related information. Through the role of various marketing tools and tools, publicizing corporate brands and attracting the attention of consumer groups is also the purpose of modern corporate brand marketing. As far as the diffusion of brand information is concerned, it can be reached by consumers through brand marketing agents, or directly spread by consumers to consumers, and can be spread through the mouth-to-mouth of consumers. More consumer groups.

### **Behavioral Description of Corporate Brand Diffusion Network.**

Drawing on the classic disease propagation model SIS model and SIR model, it is assumed that the diffusion nodes in the enterprise brand diffusion network are divided into three types: one is a node that has accepted the information related to the brand or brand of the enterprise, and the other is easy to accept the brand of the enterprise or A node for brand related information. There is also a node that is unwilling or unacceptable for brand or brand-related information. This node can be thought of as a node that is disconnected from the network.

Firstly, one or several nodes in the network are randomly selected as nodes that have accepted enterprise brand or brand related information, and the rest are other nodes. In each time period, the nodes that have accepted the enterprise brand or brand related information turn the neighboring nodes into probabilities. The node that accepts the information is called the diffusion rate; at the same time, each node that has received the relevant information of the brand or brand of the enterprise becomes a node that is unwilling or unable to accept the information related to the brand or brand according to a predetermined exit rate. Rules are executed simultaneously throughout the network. Obviously, the greater the spread, the smaller the exit rate, and the greater the spread of the company's brand and its related information. We define the ratio of diffusivity to exit rate as the diffusion intensity. Research shows that according to the propagation theory on complex networks, there is a threshold of infection intensity in the corporate brand communication model. If the diffusion emphasis is greater than the threshold, then the corporate brand will continue to spread to a stable range. At this time, the proportion of the number of nodes that have accepted the corporate brand or brand-related information to the total number of nodes is the scope of the spread of the company's products; If so, the corporate brand will eventually be eliminated by the market after a certain period of diffusion.

### **Causes of Diffusion Threshold in Enterprise Brand Marketing Network.**

The propagation threshold theory of complex networks believes that there is always a positive infection intensity threshold for both regular networks and small world networks, while the diffusion intensity threshold for scale-free networks is very close to zero. Although the real-world corporate brand marketing network is closer to the scale-free network, its diffusion threshold exists. If the threshold of the corporate brand marketing network is 0, then the company's brand will spread through its marketing network indefinitely, which is obviously not true in reality. In the research of corporate brand marketing network, combined with the principle of marketing, we define the threshold of corporate brand marketing network diffusion as the adverse consequences of the unfavorable factors affecting corporate brand marketing. There are many factors that affect the threshold of corporate brand marketing network diffusion: From a macro perspective, the transformation of government policies, the emergence of new technologies, and the shrinking of industries will all affect the threshold changes; at the micro level, internal crisis (including finance) Crisis, product crisis, human resource crisis, etc.) and external crisis of the enterprise (such as the emergence of strong competitors, the improvement of consumer quality, etc.) will also affect the change of threshold.

In a certain macro environment, specific to the brand marketing network, there are four main reasons for affecting the threshold of corporate brand marketing network diffusion: First, the natural extinction of the components of the diffusion node, such as the death of the consumer and the closure of the sales agent, Bankruptcy and so on. Second, the members of the diffusion node stop paying attention to the brand due to changes in demand. Third, the components of the diffusion node are losing money, such as the sales agent leaving because of the more attractive enthusiasm of the competitors. Fourth, the components of the diffusion node are not satisfied with the loss, such as consumers turn to competitors because they are not satisfied with the brand's products.

### **The Enlightenment of Complex Network Theory on Enterprise Brand Marketing**

The ultimate goal of complex network research is to understand and explain the behavior of systems based on these systems by studying the structure to predict and control the behavior of the network system. In the above, we analyze the composition of the diffusion nodes in the brand marketing

network and its micro-operation mechanism, describe the diffusion behavior of the brands in the network, and find out the causes of the diffusion threshold. Next we will explore the implications of complex networks for corporate marketing management.

#### **Enterprise Brand Marketing Strategy Selection Based on Complex Network Theory.**

According to the above description of the behavior of the corporate brand marketing diffusion network, we can select marketing methods to market the diffusion node constitutors in the network.

For the node components of the corporate brand marketing network that are easy to accept corporate brand or brand related information, we can use a customized marketing approach to market their preferences from different entry points. For example, in terms of the differences in age and economic strength of node builders, they are marketed in terms of style and price, thereby increasing the spread of corporate brands in the marketing network.

For nodes that have accepted corporate brand or brand related information, a relationship marketing approach can be used. In the brand marketing network of the company, the satisfied brand agent continues to represent the existing brand; the satisfied consumer reuses a certain brand product that has already been consumed; at the same time, the oral promotion of the consumer can establish a good image of the corporate brand and attract More consumers rely on the brand and use the brand's products, which expands corporate brand marketing and increases the spread of corporate brands.

Personalized marketing methods can be used for nodes that are unwilling or unable to accept brand or brand related information. Enterprises directly face specific consumers, and carry out marketing according to the special requirements of consumers, enhance the impression of corporate brands among these consumers, and make potential consumers of corporate brands become real consumers of brands as much as possible, thereby increasing corporate brands. The spread.

#### **The Reduction of Corporate Brand Marketing Network Diffusion Threshold Based on Marketing Theory.**

For the reasons that affect the diffusion threshold, we look for ways to improve it from the principles of marketing. Modern marketing tells us that by choosing the right marketing strategy and using the right marketing tools, companies can ultimately achieve brand awareness and profitability. For reducing the threshold of corporate brand marketing network diffusion, there are three aspects:

First, according to the self-organization phenomenon of complex networks in complex system theory, through reasonable marketing, enterprises can expand the number of new nodes in the brand marketing network that are connected with existing diffusion nodes. For example, scale-free networks have the nature of growth and preferential connectivity, and companies can give certain central nodes in their marketing network certain permissions to make low-cost marketing strategies that increase the number of new connections to these hub nodes. Thereby the network grows, offsetting the increase in threshold due to the natural extinction of the diffuser node constructor.

Second, companies can use more enticing marketing tools than competitors to stabilize the diffusion nodes in the marketing network and enhance the satisfaction of node builders, thereby enhancing the robustness of the sales network and reducing the diffusion threshold of the network. .

Third, marketing has the role of information feedback for companies. Enterprises should pay attention to the feedback information obtained during the brand marketing process. On the one hand, they can develop new products that can continuously meet the needs of consumers. On the other hand, they can improve existing products and services and improve brand satisfaction, thus preventing competitors from consuming. The competition for the participants further reduces the diffusion threshold of the network.

## **Conclusion**

This paper explores the enlightenment of complex network theory on corporate brand marketing through the description of brand diffusion behavior in corporate brand marketing network. In the research, we neglected the micro-interaction mechanism between diffusion nodes in different corporate brand marketing networks and the mathematical abstraction of brand marketing network diffusion behavior. The use of complex network theory to conduct a microscopic and quantitative analysis of modern enterprise brand marketing management deserves further study.

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