Research and Effectiveness Evaluation of Word-of-Mouth Marketing Strategies Based on Social Media

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Abstract. The rapid development and popularization of mobile internet technology have changed the way information is obtained and communicated. Various social media and e-commerce websites have emerged one after another, providing convenience for the public to participate in online comments and creating a good communication environment for Internet Word of Mouth (IWOM). Social networks are either a brand new internet application, a revolutionary way of information exchange, or a disruptive business model, but they are also a powerful booster for integrating the virtual world of the internet with the real world of humanity. Word of mouth (WOM) communication on social media has the characteristics of anonymity, fast communication efficiency, and rich communication forms, as it is utilized by many enterprises as a marketing model with low investment and high returns. Using social media platforms for word-of-mouth marketing (WoM) has advantages that traditional marketing models cannot match, but it also brings challenges to enterprises. This article constructs an optimization model for e-commerce WoM strategy based on social media and demonstrates the existence of the optimal solution. Analyzed the advantages of using social media for WoM and provided relevant marketing strategies, hoping to provide reference for relevant researchers.

Keywords: Social media; Word of mouth marketing strategy; Effectiveness evaluation.

1. Introduction

With the development of the economy and society, people's work methods and pace of life have undergone significant changes compared to before. Leisure time has shown a fragmented characteristic, and the demand for interactive expression, information, and other information is constantly increasing [1]. The emergence of new media has catered to people's new needs. With the development of the internet and the emergence of various online platforms, consumers can obtain product information through various channels, including other people's usage experience, evaluations, etc. [2]. Since the concept of WOM was proposed, a large number of studies have confirmed its impact on consumer purchasing decisions [3]. Consumer purchasing behavior is influenced by various factors, the most important of which is the WoM of the product, and this information is actively collected by consumers.

With the high popularity and rapid development of the Internet, channels for information and evaluation of brands and products have gradually shifted to the internet. Consumers publish and disseminate various forms of information, and the concept of IWOM has been derived from traditional WOM [4]. IWOM has the characteristics of fast dissemination speed, wide range, and independent dissemination, therefore, its dissemination effect is far greater than traditional marketing, and it is also a better choice for small and medium-sized enterprises [5]. Especially in the current highly developed mobile internet environment, there are more channels for information dissemination and faster speed, so the dissemination range and impact coverage of IWOM information will reach an unprecedented breadth [6]. Mobile devices have brought more convenient network experiences and more efficient and accurate information transmission services, which have become the mainstream mode of accessing the Internet, further promoting the development of diversified consumption scenarios and better integration of online and offline, and have had a profound impact on various industries, including the retail industry. We are in the era of the internet, and small and medium-sized enterprises should keep up with the development trends of the times, seize the opportunities of internet marketing, and promote the development of enterprises. As the most

prominent feature of the Internet 3.0 era, netizens are gradually accustomed to receiving information input in the network information flow to replace active search behavior, which means that the virtual interaction range and depth between consumers and potential consumers are wider and deeper than before. The mobile internet has freed itself from the constraints of time and space, exhibiting unique characteristics such as mobility, convenience, and fragmentation. Consumers can interact and exchange opinions through various mobile platforms at any time, and pay timely attention to the products they are interested in [7].

WoM has a significant impact on the advertising effectiveness of enterprises. When enterprises engage in advertising promotion, without IWOM marketing, the scope of advertising influence will be limited, and the resulting effects will be greatly reduced [8]. People can browse and post comments anytime and anywhere through mobile apps such as WeChat, Weibo, and Taobao, habitually sharing consumer experiences. The speed and scope of information dissemination increase, and information becomes more transparent. Any negative comment about a company or product may spread quickly, leading to huge losses or bankruptcy for the company. WoM based on social media platforms has advantages that traditional marketing models cannot match, but it also brings challenges to enterprises. This article constructs an e-commerce WoM strategy optimization model based on social media and demonstrates the existence of the optimal solution.

2. Methodology

2.1 Social media and word-of-mouth marketing

Social media can be referred to as social media, which mainly utilizes social networks, online communities, blogs, and other internet platforms for marketing and customer relationship maintenance [9]. Using social media for marketing can help companies increase brand exposure, cultivate user loyalty through direct interaction with consumers, and explore new market demands and expand new sales and service methods on social media platforms, thereby reducing marketing costs. In general, social media marketing tools include various forms such as Weibo, WeChat, forums, blogs, etc. In the past, the main way for businesses to influence consumers was through one-way publicity and reporting through mass media such as newspapers, radio, television, and outdoor advertising. There is a significant difference between social media and traditional media marketing, mainly reflected in the way and content of communication.

The emergence of social media has given enterprises or businesses the opportunity to independently publish information, conduct marketing activities, and establish connections and relationships with users. Enterprises or businesses can independently publish information about brands and products on Weibo, WeChat, forums, Tieba, and various types of SNS websites [10]. Compared with traditional media's one-way communication and single style, social media has many advantages such as precise audience, fast information dissemination, and diverse methods. Social media has transformed communication from one-way to unlimited dissemination, fully mobilizing the enthusiasm of the audience, actively participating in the promotion process of the product WoM, helping to reduce marketing costs, and also providing the possibility for refined WOM communication. Not only can enterprises or businesses engage in the most direct information dissemination and interaction with users on social media platforms, recommending information more accurately to target users, but consumers can also choose to accept marketing information of certain products that they are interested in or reject marketing information that they are not interested in, thus achieving a more humane way of information transmission [11].

Attracting user participation is undoubtedly the most prominent role of social networks. Through communication with users, it allows them to participate in the research and development, design, production, and other aspects of enterprise products. This not only allows users to have emotions about the company's products and increase their willingness to purchase, but also allows users to share products through WOM, achieving the goal of reducing advertising costs and increasing product exposure [12]. In the absence of information technology, people relied on the form of word of mouth

to transmit information, which is consistent with the literal meaning of WOM and is itself a form of information dissemination. WOM refers to the verbal evaluation of a product by consumers; WoM, on the other hand, explores how enterprises can intervene and influence the process and effectiveness of WOM dissemination, in order to maximize the positive image of the enterprise and reduce and eliminate negative impacts. WoM is a direct and effective way of information dissemination, allowing recipients to enjoy both physical and spiritual aspects of product consumption, thereby promoting secondary consumption and multi-level dissemination of products through "interpersonal communication". Since the concept of WOM was proposed, a large number of studies have confirmed its impact on consumer purchasing decisions. In today's society, many industries are facing a severe competition situation of product homogenization. In this situation, WoM has become a necessary means of promoting new products and expanding market share. WoM has had a significant impact on the lives of the people, especially in recent years with the rise of social networks, which undoubtedly has a booster effect on the WoM of enterprises. In the social network environment, user participation will have an important role in the WOM sharing of enterprise products and services.

2.2 Model Building

In social e-commerce, customers who have already purchased products influence their neighbors with a probability of $q(0 \leq q \leq 1)$ through WOM, thereby triggering purchases. When a new product spreads in social networks with different topological characteristics, the mechanisms and paths that dominate the diffusion process are different, and the final diffusion performance will also vary due to the influence of different mechanisms and paths. Based on this propagation mechanism, a mathematical model for WOM diffusion is proposed, followed by a marketing optimization model. The specific structure is shown in Figure 1. Individuals exposed to social networks are inevitably influenced by other members of the network, and the effect of interpersonal communication is particularly evident in the persuasive and decision-making stages from innovation to decision-making.
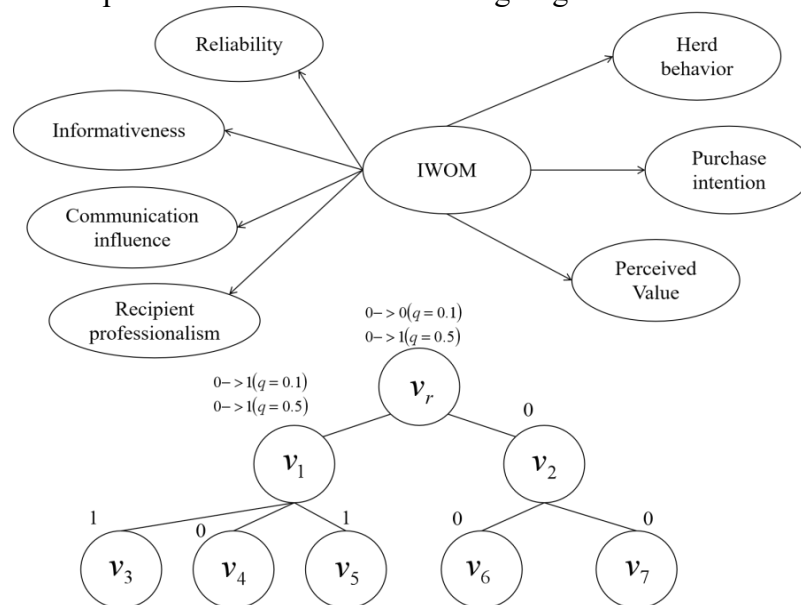

Figure 1 WoM optimization model

Considering that interpersonal connections in the internet environment follow a power exponential distribution and exhibit significant heterogeneity, it is assumed that G has scale-free network characteristics. When the network is large enough, G is a random graph with a fixed degree distribution. To distinguish between root nodes and sub nodes in the network, $P_{0,k}$ represents the degree distribution of root nodes and $P_{1,k}$ represents the degree distribution of sub nodes. Assuming that the root node v_r in G has $\deg(r)$ that may affect its neighbors, then $\deg(r)$ follows the distribution

$P_{0,k}$. Considering that the node degree values of a scale-free network follow a distribution function with a power exponent of λ, i.e. $P_k \propto k^{-\lambda} (k \in N_+, 2 < \lambda < 3)$, the probability distribution of $\deg(r)$ is

$$\Pr ob[\deg(r) = k] = P_{0,k} = \frac{k^{-\lambda}}{\sum_{k=1}^{\infty} k^{-\lambda}},$$

$$(k \in N_+, \lambda \in (2,3))$$

(1)

The key user set selection problem is defined as the KPP-Pos problem, aiming to find a key user set containing k nodes and use these k nodes as seed users to leverage their influence to promote the diffusion of new products throughout the entire network. Define the function C_K to represent the intergroup cohesiveness of K and $(V - K)$. The element a_{ij} in the adjacency matrix A represents the adjacency relationship between nodes: if i is connected to j, then $a_{ij} = 1$; otherwise, $a_{ij} = 0$. d_{ij} represents the shortest distance between node i and node j. Our goal is to maximize C_K. C_K can be defined based on different angles. From the perspective of the number of edges in a set, C_K can be expressed as equation (2).

$$C_K = \sum_{j \in V-K}^{i \in K} U a_{ij}$$

(2)

U is an aggregate function. Furthermore, considering the influence of distance factors between nodes, C_K can be expressed as equation (3):

$$C_K = \sum_{j \in V-K}^{i \in K} U r_{ij}^m$$

(3)

The meaning of function r_{ij}^m is as follows: if node i can reach node j through a length of m or a shorter distance than m, then $r_{ij}^m = 1$; otherwise, $r_{ij}^m = 0$. If the distance is further weighted, C_K can be expressed as equation (4):

$$C_K = \sum_{j \in V-K}^{i \in K} U \frac{1}{d_{ij}}$$

(4)

Equations (2), (3), and (4) correspond to "group centrality", "group $m-$reachable centrality", and "group proximity centrality", respectively.

Before social e-commerce enterprises engage in WoM, the probability of customer purchase intention is $p^- (0 \leq p^- \leq 1)$. Enterprises choose customers with a ratio of $\rho (0 \leq \rho \leq 1)$ in the entire market to receive subsidies and other incentives. The purchase probability of selected customers (i.e. seed customers) has increased to $p^+ (0 \leq p^+ \leq 1)$, indicating a significant increase in $p^- < p^+$. After the enterprise makes marketing decisions and before WOM begins to spread, the expected purchase probability of the entire market is

$$\mu = \rho p^+ + (1-\rho) p^-$$

(5)

Obviously, $0 \leq \mu \leq 1$. Subsequently, WOM spreads through social fission.

Among numerous diffusion models, the exposure model is the most suitable for the research context of this article. When the exposure $E_{i,t}$ of individual i at the t moment is no less than τ_i, the individual will adopt innovation. The adoption threshold of an individual and their exposure in the network will jointly affect their final adoption behavior. The basic expression form of $E_{i,t}$ is shown in equation (6).

$$E_{i,t} = \frac{\sum_{j \neq i} x_{ij} A_j}{\sum_{j \neq 1} x_{ij}}$$

(6)

$x_{ij} \in X_t$ is an element of the adjacency matrix, reflecting the direct relationship between nodes. A_j takes a value of 0 or 1. If j adopts innovative products at the t moment, then $A_j = 1$. In equation (6), exposure is measured by the direct relationship between nodes, which can reflect the influence of informational mechanisms that transmit information through direct contact and persuasive mechanisms that transmit information through direct pressure.

To describe its impact, it is necessary to distinguish the reasons for the purchase behavior of each node. For node v_i, the Bernoulli variables ϕ_i and Y_i are first introduced to represent their random purchasing behavior before and after the influence of WOM. $Y_i = 1$ indicates that v_i chooses to purchase due to the successful influence of any neighboring WOM; $Y_i = \phi_i$ indicates that all impacts have been unsuccessful, and v_i will consider whether to purchase based on its own wishes.

$$1 - Y_i = \left(1 - \phi_i\right) \prod_{j=1}^{\deg(i)} \left(1 - e_{ji} Y_j\right) \tag{7}$$

Equation (7) provides the interaction process between non root nodes. Similarly, for the root node v_r, the Bernoulli variable X that defines whether it is affected by WOM to purchase is:

$$1 - X = \left(1 - \phi_r\right) \prod_{j=1}^{\deg(r)} \left(1 - e_{jr} Y_j\right) \tag{8}$$

Equation (8) provides the WOM influence process that propagates from non root nodes to root nodes.

3. Result analysis and discussion

Analyze the contribution of each latent variable and the degree of model interpretation by determining the coefficient through endogenous latent variables. According to the analysis criteria in general research, the coefficient of determination (variance interpretability) of endogenous latent variables is greater than or equal to 0.67, which is better; 0.33, medium; Less than 0.19 indicates a lower difference. Using smartPLS3.0 software as a data analysis tool, the quality criteria for the endogenous latent variables in the model were obtained as shown in Table 1, with variance interpretability greater than 0.67, proving that the model has good explanatory power and high goodness of fit.

Table 1 Model goodness of fit analysis results

	R Square	R Square adjusted
Adoption intention	0.768	0.739
Perceived usefulness	0.727	0.715
Perceived credibility	0.683	0.702

Through simulation experiments, study the impact of factors such as network connectivity range and impact probability, marketing costs and product profits, and willingness to buy on WoM decision-making and market outcomes, and extract management suggestions. Identify seed users using individual and group strategies, and conduct 100 network diffusion experiments. Figure 2 shows the comparison of diffusion performance between individual strategy and group strategy.
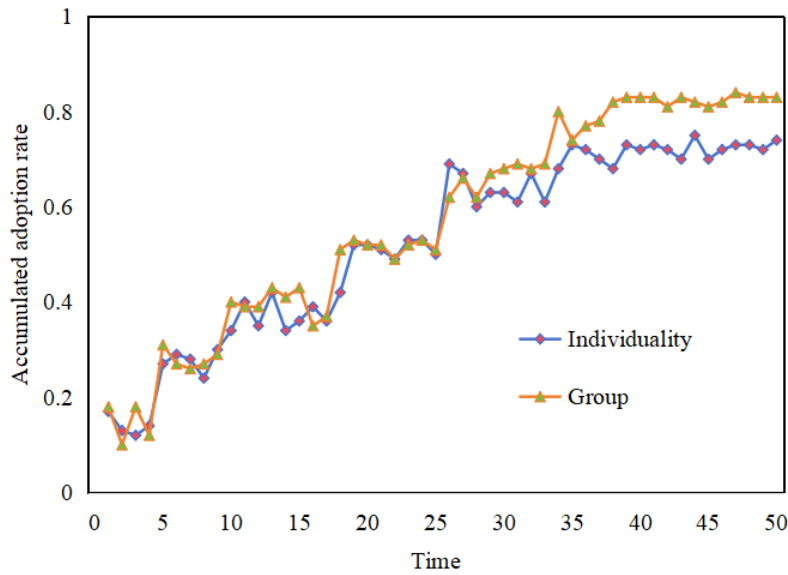
Figure 2 Comparison of diffusion performance under individual and group strategies

The diffusion rate of seed users identified by individual and group strategies remained generally stable in the early stages. Since the 28th period, the advantages of group strategies began to emerge, and the cumulative adoption rate under the influence of group strategies ultimately exceeded 80%, which was better than the performance of individual strategies. This is related to the larger scope of influence of seed users identified by group strategies.

Analyze the impact of profits and costs on marketing decisions and market outcomes: Select $p = 5$ and introduce the parameter cost-benefit ratio $l = c / p$ to reflect the relationship between marketing costs and profits. The results of the optimal WoM decision variable ρ are shown in Figure 3.
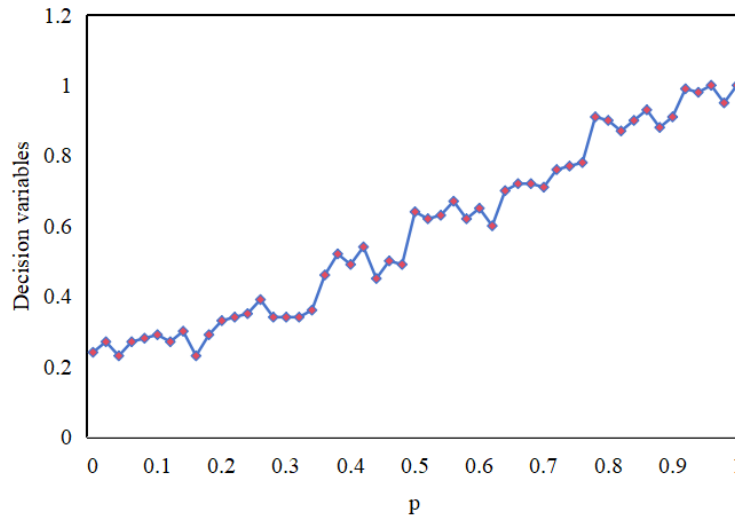

Figure 3 WoM decision variables

From Figure 3, it can be seen that when $l > 1$ (i.e. $c > p$), ρ is relatively small, but it is not without marketing, especially when q is large. As l decreases, ρ significantly increases, and the larger q, the more significant the increase in ρ. It can be seen that the cost-benefit ratio l has a significant impact on the marketing decision variable ρ, and excessive marketing expenses will limit WoM. This in turn explains the rapid development of social e-commerce, which utilizes acquaintances to engage in low-cost social fission and gain greater market share.

Observe the diffusion effect of seed strategy implementation by changing the size of seed users. Figure 4 shows the results of 100 simulation experiments.
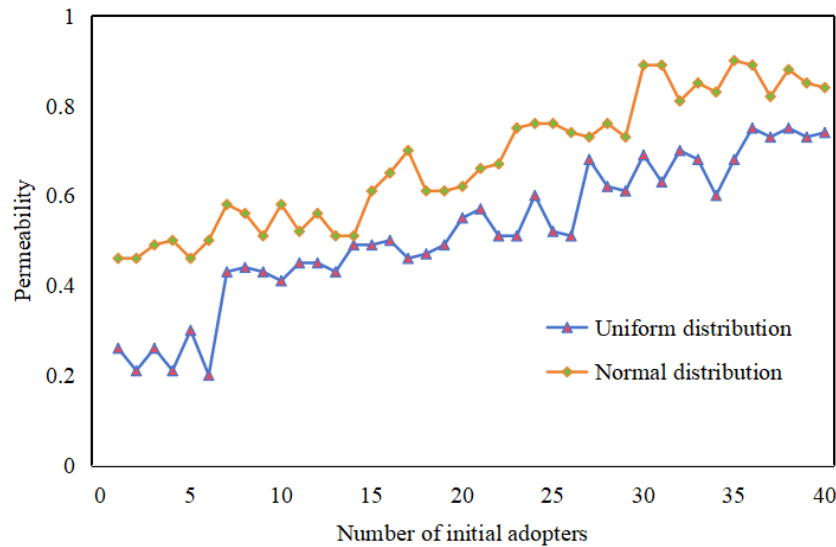
Figure 4 Seed user scale and cumulative penetration rate of new products

As shown in Figure 4, with the expansion of the scale of seed users, the cumulative adoption rate of new products in social networks is gradually increasing, and the overall penetration rate curve shows an upward trend. From the distribution of individual adoption thresholds, compared to when the adoption threshold follows a uniform distribution, when the adoption threshold follows a normal distribution, the penetration rate of different seed user sizes is higher. When deciding how many seeds to choose, marketers need to comprehensively consider costs and benefits, and select the seed user with the highest "cost performance" after weighing.

4. Conclusion

As the main mode of transmitting, promoting, and exchanging product information in the Internet era, the importance of IWOM is self-evident. While the mobile Internet era has brought many conveniences, it has also brought many changes to the dissemination and marketing model of IWOM. In today's highly developed social media era, the quality of products and WOM are evident in the spread of online public opinion, and their impact on product distribution is also significant. WoM based on social media platforms has advantages that traditional marketing models cannot match, but it also brings challenges to enterprises. This article constructs an e-commerce WoM strategy optimization model based on social media and demonstrates the existence of the optimal solution. The experimental results indicate that the model constructed in this article has a certain positive impact on WoM. The sudden demand triggered by WoM cannot be separated from the support of supply. In future research, the impact of the supply side on WoM and operations can be further considered, and the joint optimization of WoM and supply operations can be explored.

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