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Research and Analysis of Precision Marketing Strategy in the Era of Big Data

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Abstract: In the era of big data, precision marketing has become a research focus in today's academic and business circles. With the increasingly fierce market competition and the increasing demand of consumers for personalized products and services, the traditional marketing model has been unable to meet the needs of modern market. In the realm of contemporary business, precision marketing strategy has increasingly emerged as a vital tool for enterprises to bolster their competitive edge, by using the keywords "big data" and "precision marketing" in EBSCO, CNKI and other databases, the target research literature related to the subject was selected. Through a comprehensive review and analysis of these documents, this paper delves deeply into the core technologies of big data application in precision marketing, and elaborates on how it significantly enhances marketing efficiency and effectiveness by precisely targeting customers, customizing marketing content, and optimizing marketing channels. The study found that with the support of big data, precision marketing can realize the efficient allocation of marketing resources and the precise push of personalized services. However, big data precision marketing also faces many challenges in the development process, such as data security, privacy protection and algorithm bias. To encourage the long-term growth of big data precision marketing, future research should focus more on the cross-industry application of technology and the feasibility of long-term implementation of marketing strategies, and further improve technical ethics.

Keywords: Big Data, Precision Marketing, Marketing Effectiveness, Consumer Behavior, Individuation.

1. Introduction

With the rapid advancement of information technology and the widespread adoption of the Internet, Big Data has become a central focus of societal attention. It not only refers to the vast amounts of data generated in the era of information explosion, but also represents the technological developments and innovations associated with it. This data encompasses user behavior, consumption preferences, social interactions, and other multidimensional information, offering significant advantages in areas such as e-commerce, O2O (Online to Offline), and logistics distribution. Through big data analytics, businesses can accurately assess consumer behavior, predict product sales, optimize marketing efforts, and enhance supply chain efficiency, thereby achieving more refined market insights and driving business innovation, all while adhering to the profit-maximization principle of MR=MC (marginal revenue = marginal cost).

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This study aims to systematically examine the theoretical foundations, technical methodologies, and practical applications of marketing with accuracy strategies in the big data era. It explores how big data enables businesses to achieve precise and personalized marketing, and delves into the challenges and future trends in this field. The literature reviewed in this study primarily focuses on the application of big data, artificial intelligence, and other technologies in precision marketing. It investigates how big data, machine learning algorithms (such as XGBoost, decision trees, clustering algorithms, etc.), the Internet of Things, and artificial neural networks can be employed to analyze consumer behavior, assess marketing effectiveness, and develop precision marketing models. This research aims to improve marketing accuracy and effectiveness in various business contexts, providing a theoretical and technical foundation for companies to develop more efficient marketing strategies.

These studies have contributed to the theoretical development of precision marketing, offering practical guidance for diverse stakeholders. It ranges from small and medium-sized enterprises to e-commerce platforms, in implementing precision marketing in the big data era. They have also fueled advancements in precision marketing technologies. By integrating cross-disciplinary research on big data and precision marketing, this study constructs a systematic analysis framework and synthesizes practical experiences from different industries. It not only addresses gaps in existing theories and provides strategic operational guidelines for businesses, but also offers recommendations for balancing commercial interests with social responsibility, particularly regarding data privacy and security concerns. This study provides both theoretical depth and practical value, serving as a valuable reference for both academic research and practical applications. The rapid development of big data technologies has presented unprecedented opportunities for precision marketing. Through a comprehensive review and in-depth analysis, this study aims to promote the continuous optimization and innovative application of precision marketing strategies, helping businesses better meet the individual needs of consumers in a competitive market, while improving marketing efficiency and economic outcomes.

2. Literature review

2.1. The concept and theoretical basis of precision marketing

Precision marketing is a marketing approach that relies on the analysis of consumer data and behavior, the core of which is to realize the accurate push of marketing information through in-depth understanding of consumer needs. Contemporary precision marketing has developed into an "intelligent marketing system based on consumer omnichannel behavior data, building user profiles through machine learning algorithms to achieve accurate time-space access to marketing information", that is, precision marketing needs to mine and analyze consumer behavior data, preference data, etc., and realize personalized recommendation with the help of big data technology. Develop precision marketing strategies [1]. The definition highlights three key elements: Data-driven, Algorithm-enabled, and Context-aware. In terms of theoretical construction, precision marketing integrates traditional 4P marketing theory, customer relationship management (CRM) theory and long tail theory. It is proposed the "data-insight-reach" triad model, which shows that big data technology has reestablished the implementation path of traditional marketing theory, especially emphasizing the importance of big data in precision marketing, arguing that big data can help enterprises better understand consumer needs. Through the cloud computing platform, small and medium - sized enterprises are now able to achieve the precision marketing capability that was previously only accessible to large enterprises [2].

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3. Strategies and methods of precision marketing

3.1. Data mining and analysis technology

Precision marketing relies on data mining as its foundation, with the primary objective of extracting valuable insights from extensive datasets to underpin the creation of effective marketing strategies. Huijun Chen proposed an enterprise marketing strategy combining big data mining technology and XGBoost model [3]. XGBoost (eXtreme Gradient Boosting) is an efficient machine learning algorithm mainly used for regression and classification tasks. It serves as an extension of the Gradient Boosting algorithm,which is widely used in data science competitions and actual projects by optimizing calculation speed and model performance, and has the characteristics of high efficiency and flexibility. XGBoost iteratively generates decision trees, and each tree corrects the errors of the previous tree. The specific steps are as follows: 1. Initialize the model: Make initial predictions with a simple model (such as a constant). 2. Calculate residual: Calculate the residual difference between the current predicted value and the true value. 3. Train new trees: Train new decision trees with residuals. 4. Update the model: Add the predicted result of the new tree to the model and update the predicted value. 5. Repeat iteration: Repeat the above steps until the specified number of trees is reached or the error is no longer significantly reduced. The strategy obtains consumer data through data mining technology, and then uses XGBoost model to analyze and predict the data, so as to achieve precision marketing. Mengmeng Zhang also emphasized the importance of data mining in precision marketing [4]. The research collects consumer behavior data via the Internet of Things (IoT) platform, and subsequently employs data mining techniques to analyze consumer behavior patterns, thereby offering support for the precision marketing strategy in the fresh e-commerce sector.

3.2. Application of models and algorithms

Machine learning and artificial intelligence models are widely used in precision marketing. Jianfeng Cheng proposed a commercial precision marketing evaluation strategy based on artificial neural networks [5]. The strategy uses artificial neural network model to analyze and predict consumer data, so as to realize the evaluation of precision marketing effect.El Koufi and Belangour proposed a precision marketing response system based on RFM model, deep learning and feature importance ranking [6].

The RFM model is a marketing tool for customer value analysis that assesses customer value through three key metrics: Recency, Frequency, and Monetary. Recency is used to measure when a customer last made a purchase. Customers who have recently spent are more likely to buy again, so the smaller the Recency value, the higher the customer value. Frequency is used to measure the number of purchases made by a customer in a certain period of time. The higher the frequency of consumption, the higher the customer loyalty and the greater the value. Monetary is a measure of the total amount of money a customer has spent in a given period of time.The higher the amount spent, the greater the customer's contribution to the business. Deep learning is a subfield of machine learning that focuses on using multi-layered neural networks (called deep neural networks) to model and solve complex problems. It processes data by simulating a network of neurons in the human brain, capable of automatically extracting features from large amounts of data and making predictions or classifications. This paper mainly shows the use of artificial neural network in precision marketing. Artificial Neural Network (ANN) consists of interconnected neurons (nodes) and is divided into three layers: Input Layer: used to receive raw data (such as image pixels, text features, etc.). Hidden Layer: Responsible for processing data (there can be multiple layers, and "depth" in deep learning refers to the number of hidden layers). Output Layer: Generates final prediction results (e.g. category labels, numerical values, etc.).Each neuron receives an input signal, generates an output through weighted

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summation and applies an activation function. Artificial neural network has strong learning and generalization ability, can handle high-dimensional data but needs a lot of data and computing resources, long training time, and poor model interpretation. The system classifies consumers through the RFM model, then uses the deep learning model to predict consumer behavior, and finally determines key characteristics through the feature importance ranking, thus helping enterprises to identify high-value customers, optimize marketing strategies, improve customer retention and conversion rates, and achieve precision marketing.

It proposed a precision marketing method of e-commerce platform based on clustering algorithm [7]. A clustering algorithm is an unsupervised learning technique that partitions samples within a dataset into distinct groups known as "clusters". Within each cluster, samples exhibit high similarity, whereas samples from different clusters show lower similarity.

Clustering algorithm is widely used in data mining, pattern recognition, image analysis, market segmentation and other fields.This literature mainly introduces the K-means method, which divides the data into K clusters through iteration, and each cluster is represented by its centroid (the mean of samples within the cluster). The algorithm optimizes cluster partitioning by minimizing the distance from the sample to the center of mass. Its steps are divided into four steps: 1. Randomly initialize K centers of mass. 2. Assign each sample to the cluster with the nearest center of mass. 3. Update the centroid of each cluster to the mean of the samples in the cluster. 4. Repeat steps 2 and 3 until the center of mass no longer changes or the maximum number of iterations is reached. This method is simple, efficient and suitable for large-scale data sets like precision marketing. In this method, consumers are grouped by clustering algorithm, and then different marketing strategies are formulated for different groups to achieve precision marketing.

3.3. Cross-platform and multi-channel integration

In the era of big data, consumer behavioral data is scattered across different platforms and channels. Therefore, cross-platform and multi-channel data integration is essential for precision marketing. It studied platform supply chain model selection and pricing, and considered the impact of precision marketing. They pointed out that in a multi-platform environment, enterprises need to optimize and coordinate the supply chain through precision marketing, so as to improve their competitiveness [8]. Fadil Indra Sanjaya and Anna Dina Kalifia took Orebae.com as an example to study the application of precision marketing model based on decision tree in e-commerce platform. By integrating multi-channel data from e-commerce platforms, this study uses decision tree model to classify and predict consumers, thus achieving precision marketing [9].

4. Application and practice of precision marketing

4.1. E-commerce field

E-commerce is one of the most widely used areas of precision marketing. It took Orebae.com as an example to study the application of precision marketing model based on decision tree in e-commerce platform. By analyzing consumer data on e-commerce platforms, they use decision tree models to classify and predict consumers, thus achieving precision marketing [9]. It took fresh e-commerce as an example to study consumer behavior analysis and precision marketing strategies based on the Internet of Things platform. This research leverages the Internet of Things platform to gather data on consumer behavior. Subsequently, it employs data analytics techniques to examine patterns in consumer behavior, thereby offering insights to bolster the precision marketing initiatives in the fresh food e-commerce domain.

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4.2. Traditional enterprise domain

Traditional enterprises are also actively exploring the combination of big data and precision marketing. It proposed an enterprise marketing strategy combining big data mining technology and XGBoost model. This strategy obtains consumer data through data mining technology, and then uses XGBoost model to analyze and predict the data, thus achieving precision marketing. It also pointed out that traditional enterprises can realize precision marketing through big data technology, and formulate marketing strategies that are more in line with consumer needs through in-depth understanding of consumer needs.

4.3. Problems and challenges of precision marketing

In the era of big data, data privacy and security are major challenges for precision marketing. Nouhaila El Koufi, Abdessamad Belangour and Mounir Sadik pointed out that in precision marketing, enterprises need to collect and analyze a large amount of consumer data, which may lead to consumer privacy disclosure and data security problems [10]. Therefore, when enterprises conduct precision marketing, they need to strengthen data privacy and security protection to ensure the legal use of consumer data.

Data quality is also one of the key factors in precision marketing. El Koufi and Belangour pointed out that in precision marketing, data quality directly affects the accuracy and effectiveness of marketing strategies. Therefore, enterprises need to strengthen data quality management to ensure the accuracy and integrity of data.

Although machine learning and artificial intelligence models are widely used in precision marketing, these models and algorithms also have certain limitations. Jianfeng Cheng pointed out that the artificial neural network model may have overfitting problems when dealing with complex data, resulting in the decline of model prediction accuracy. Bei Zhang, Luquan Wang and Yuanyuan Li have also pointed out that clustering algorithms may have efficiency problems when processing large-scale data, which affects the implementation efficiency of precision marketing.

5. Conclusion

This paper systematically examines and analyzes the relevant literature on precision marketing strategies in the era of big data. The findings indicate that, with the support of big data, precision marketing can efficiently allocate marketing resources and deliver personalized services through data mining, model application, and cross-platform integration. Although this study provides a comprehensive review of the theoretical foundations, technical applications, and practical cases of precision marketing in the big data era, certain limitations remain.

First, existing literature predominantly focuses on the e-commerce and retail sectors, with limited cross-industry studies, particularly in traditional manufacturing, services, and other fields, which may restrict the generalizability of the findings. Second, discussions on data privacy and security are mostly theoretical, with a lack of empirical research verifying the actual effects and tradeoff mechanisms of various privacy protection technologies, such as federated learning and differential privacy in precision marketing. Furthermore, the optimization of current algorithm models (e.g., XGBoost, neural networks) often overlooks real-time requirements and computing costs, making them less adaptable to the dynamic market environment.

Future research can be expanded in several key areas. First, there is a need to strengthen cross-industry applications, particularly focusing on the ethical framework and compliance strategies for precision marketing in data-sensitive sectors such as healthcare and education. Second, new technologies that balance data utility with privacy protection should be developed, such as transparent data-sharing mechanisms based on blockchain. Third, improving the real-time

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capabilities and interpretability of optimization algorithms, in combination with dynamic adaptation techniques like reinforcement learning, could enhance the long-term stability of marketing strategies. Fourth, emerging technologies—such as generative AI and the metaverse—should be explored for their potential to reconstruct the precision marketing paradigm. The impact of multi-modal data fusion and immersive interaction on consumer behavior analysis also warrants further investigation. Additionally, interdisciplinary collaboration mechanisms should be established to integrate technical research with sociological and legal perspectives, ensuring that precision marketing evolves in a balanced way, addressing both commercial value and social responsibility.

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