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Article

Research on the Application of Big Data in Precision Marketing of the Big Health Industry in the Guangdong-Hong Kong-Macao Greater Bay Area

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Abstract: As a strategic emerging industry, the big health industry faces the challenge that traditional marketing models struggle to meet increasingly diverse and personalized consumer needs. This study investigates the application of big data in precision marketing within the big health industry in the Guangdong-Hong Kong-Macao Greater Bay Area. Drawing on literature research, case analysis, and data mining, it systematically examines the current stage of industrial development, the characteristics of regional integration, and the main marketing bottlenecks. The findings indicate that, despite rapid expansion and distinctive cross-regional advantages, enterprises still lack deep user insight, effective customer segmentation, and efficient marketing channels. Through the analysis of representative enterprise cases, the study clarifies the operating logic of big data-driven precision marketing: multi-channel data collection, integration, and cleaning; in-depth analysis to construct user portraits; and subsequent implementation of market segmentation, personalized product and service design, and targeted channel delivery. Empirical evidence suggests that the adoption of big data tools significantly improves user activity, sales performance, and customer retention. Nevertheless, the application of big data is constrained by data security and privacy risks, shortages of technical talent, and difficulties in cross-platform data integration. In response, the paper proposes a coordinated promotion strategy involving government optimization of laws and regulations, enterprise investment in technology and talent, and industry associations' support for standardized data sharing, thereby providing theoretical and practical guidance for enhancing precision marketing and promoting high-quality development of the big health industry in the Greater Bay Area.

Keywords: big data; precision marketing; health industry; regional development; data mining; user behavior

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1. Introduction

As the digital economy continues to expand globally and the development of the Guangdong-Hong Kong-Macao Greater Bay Area accelerates, the big health industry—a strategic emerging sector encompassing medical services, pharmaceutical manufacturing, health management, and healthcare—has entered a phase of unprecedented growth. With consumers' health needs becoming increasingly diverse and personalized, traditional marketing models are no longer sufficient to address the demands of market competition. Precision marketing has emerged as a critical approach to enhancing the competitiveness of the big health industry [1]. Big data technology, with its capabilities in massive data processing, deep information analysis, and accurate prediction, offers new opportunities for precision marketing within this sector. Despite existing research on big data and

precision marketing in the healthcare industry both domestically and internationally, studies focusing on the Guangdong-Hong Kong-Macao Greater Bay Area—a unique economic region—remain limited. This study seeks to explore the application of big data in precision marketing for the big health industry in this region, identify challenges encountered during implementation, and propose targeted solutions. The research employs literature analysis to establish a theoretical foundation, utilizes case studies to examine corporate practices in detail, and applies data mining methods to evaluate the outcomes of these applications. The findings have significant theoretical and practical implications for advancing the development of the healthcare industry in the Guangdong-Hong Kong-Macao Greater Bay Area.

2. Theoretical Basis and Industry Status

2.1. Core Concepts and Theories

Big data, characterized by its "4V" attributes of massive data volume (Volume), diverse data types (Variety), high-speed processing requirements (Velocity), and low-value density with significant potential for deep analysis (Value), holds a pivotal role in the current digital era. Through various channels, such as Internet platforms, sensor devices, and medical information systems, big data technology enables the extensive collection of vast datasets. Advanced algorithms for data mining, cleaning, and analysis transform these seemingly disorganized datasets into valuable information. In the precision marketing domain of the health industry, big data is instrumental in analyzing consumers' past health-related behaviors, treatment histories, and daily health management practices [2]. This analysis provides profound insights into consumers' potential health needs and behavioral trends, offering critical data to support the formulation of effective marketing strategies.

The healthcare industry encompasses a broad scope, with its primary objective being the maintenance, improvement, and promotion of health throughout the entire human life cycle, from birth to old age. Traditional medical services, including diagnosis, treatment, and rehabilitation provided by hospitals at various levels, as well as the research, development, production, and sales of pharmaceutical products, form the foundational elements of the healthcare sector [3]. Concurrently, with societal development and heightened health awareness, areas such as personalized health examinations, chronic disease management, traditional Chinese medicine health care, nutritional dietary guidance, and the operation of elderly health care communities have emerged as significant components of the expanding health industry. These interconnected sectors collectively contribute to a robust and dynamic industrial ecosystem.

Precision marketing theory leverages modern information technology to implement a consumer-centric approach. By utilizing big data and artificial intelligence, it enables precise market positioning [4]. Through comprehensive analysis of multidimensional consumer data, individuals with similar needs, behavioral patterns, and consumption preferences are grouped into distinct market segments. This segmentation allows for the accurate identification of target customer groups. For these segments, companies can design customized and personalized products and services, aligning closely with specific consumer needs. Additionally, the most suitable marketing channels, such as social media platforms and professional health information websites, can be employed to deliver targeted marketing messages. This approach significantly enhances the accuracy and efficiency of marketing activities, reduces costs, strengthens customer recognition and loyalty toward corporate products and services, and maximizes both economic and social benefits for businesses.

2.2. Development Trend of the Big Health Industry in the Guangdong-Hong Kong-Macao Greater Bay Area

In recent years, the scale of the big health industry in the Guangdong-Hong Kong-Macao Greater Bay Area has shown a trend of rapid growth. From the perspective of industry scale data, the overall output value of the big health industry in the Greater Bay Area has continued to rise in the past few years, with a growth rate significantly higher than the national average, and its share in the national big health industry pattern is increasing. In terms of industrial layout, the region has distinct characteristics. Guangzhou has many well-known medical institutions, including a range of affiliated hospitals of major universities. It has rich medical education resources and has provided a large number of professional talents for the medical service industry. Its comprehensive strength in the field of medical services ranks among the top in the Greater Bay Area [5]. Figure 1 shows GDP of key cities in Greater Bay Area.

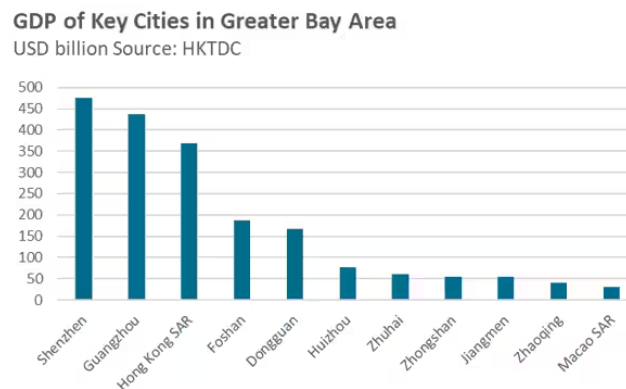


Figure 1. GDP of key cities in Greater Bay Area.

Shenzhen has made continuous breakthroughs in the biopharmaceutical field with its strong foundation in scientific and technological innovation. The city is home to global leaders in the research and development and application of gene sequencing technology [6]. Many innovative biopharmaceutical companies benefit from Shenzhen's robust innovation and entrepreneurship ecosystem and strong financial support to actively pursue innovative drug research and development. Significant progress has been made in areas such as biological vaccines. In terms of intelligent medical devices, high-end medical device products produced by companies in Shenzhen are not only widely used domestically but are also exported internationally, enhancing the global competitiveness of the medical device industry in the Greater Bay Area.

With its international medical service standards and advanced medical technology, Hong Kong attracts numerous mainland and international customers seeking high-end medical services, including premium physical examinations, international referrals, and precision medicine. Macau leverages its unique tourism resources and cultural characteristics to actively develop the health tourism industry. By integrating traditional Chinese medicine health care with tourism and vacation, Macau has introduced a variety of distinctive health tourism products, such as traditional Chinese medicine therapy tourism packages and cultural experience tours [4].

The changes in the population structure and the improvement of residents' living standards in the Greater Bay Area have profoundly influenced the demand for the big health market. The aging population continues to grow, with the proportion of individuals aged 60 and above increasing annually. This has driven a steady rise in demand for elderly chronic disease management, rehabilitation care, and elderly health care services. Simultaneously, as residents' income levels have risen, consumption preferences have shifted from traditional disease treatment to disease prevention and health management [7]. The demand for high-quality, personalized health products and services, such as customized health check-up packages, precision nutritional supplements,

and one-to-one health management services, has grown significantly, creating a broad market space for the development of the big health industry in the Greater Bay Area.

2.3. Dilemma of Traditional Marketing Model

In the process of the vigorous development of the big health industry in the Guangdong-Hong Kong-Macao Greater Bay Area, the drawbacks of the traditional marketing model have gradually become apparent [6]. For user insights, traditional methods mainly rely on limited market research approaches such as questionnaires and focus group interviews. The number of samples is relatively small, and the selection range is restricted. It is challenging to fully cover the vast consumer groups of different ages, regions, and consumption levels in the Greater Bay Area. Additionally, the research cycle is lengthy, and the information collected often lags behind market changes, making it difficult for companies to grasp consumers' increasingly diverse and rapidly evolving health needs in a timely and accurate manner. For instance, emerging young consumer groups exhibit a growing demand for digital health products and sports health services, yet traditional research methods may fail to capture these subtle changes promptly. This can lead to deviations in product development and marketing strategies, making it difficult to accurately target customers.

In terms of marketing channels, traditional marketing relies heavily on offline physical stores and traditional media advertising. Offline physical stores are constrained by geographical location and have limited coverage, making it difficult to reach potential customers widely distributed across the Greater Bay Area. Although traditional media advertising, such as television, newspapers, and magazines, once played a significant role in information dissemination, its effectiveness has significantly diminished with the rise of new media. On one hand, traditional media advertising incurs high costs and lacks precision in delivery, making it challenging to accurately convey advertising information to target customer groups, thereby wasting marketing resources. On the other hand, traditional media advertising lacks interactivity with consumers, leaving them in a passive state of receiving information without providing timely feedback on opinions and needs. This makes it difficult for companies to adjust their marketing strategies promptly based on market feedback [2].

Marketing effectiveness evaluation is crucial for companies to optimize their marketing strategies and improve the return on marketing investment [2]. In the traditional marketing model, the evaluation indicators are relatively simplistic, primarily focusing on financial metrics such as sales and market share, which fail to comprehensively measure the impact of marketing activities on brand awareness, customer loyalty, and user word-of-mouth communication. Furthermore, traditional evaluation methods often rely on manual statistics and basic data aggregation, lacking scientific and systematic data analysis models. This makes it difficult to deeply explore the inherent relationship between marketing activities and sales performance. As a result, it becomes impossible to accurately assess the actual effects of different marketing channels and strategies, leaving companies without robust data support when adjusting their marketing approaches. This hinders scientific decision-making and restricts market expansion and sustainable development.

2.4. Comparison of Aging Status: Japan, South Korea, Northeast China and Nantong

Due to global demographic changes, aging has become a significant challenge for many countries and regions, with distinct characteristics observed in different areas. Comparing the aging situations in Japan, South Korea, Northeast China, and Nantong provides valuable insights for the development of the big health industry in Guangdong, Hong Kong, and Macao [8].

Japan is one of the countries with the most advanced aging population globally. Its population aged 65 and over reached 7.06% as early as 1970, marking its entry into an aging society. Within 24 years, this proportion rose to 14%, and by 2005, Japan had become

a super-aged society [6]. As of September 15, 2024, the number of individuals aged 65 and over in Japan reached 36.25 million, accounting for 29.3% of the total population. The aging of nursing staff and a shortage of caregivers have placed significant pressure on the pension system, exacerbated by a declining number of contributors and an increasing number of recipients.

South Korea has also rapidly entered the aging process. In 2024, individuals aged 65 and over accounted for 20% of the population, officially classifying the country as a super-aging nation. A low fertility rate is a major factor contributing to this demographic shift. The rapid change in population structure has created substantial pressure on the social welfare system, labor market, and economic development [9]. This is evident in the sharp rise in pension expenditures and the decline in the working-age population, which negatively impacts national innovation capacity and industrial competitiveness.

In China, the northeastern region is experiencing a pronounced aging phenomenon. According to data from the seventh national census, the proportion of individuals aged 65 and above in Northeast China is 16.39%, exceeding the national average. The natural population growth rate in this region has been consistently lower than the national average for an extended period. Limited population growth is influenced by changing fertility concepts, while economic disparities drive many young people to migrate to developed coastal areas, resulting in labor shortages and hindering economic development. Similarly, Nantong is one of the most aging prefecture-level cities in China [7]. Aging in Nantong is closely linked to its economic development model and population outflow. Despite ongoing economic development, the city struggles to attract young people amid industrial restructuring. Additionally, rising childbearing costs, shifting childbearing concepts, and slow population growth have exacerbated the aging issue.

In contrast, while the overall aging level in the Guangdong-Hong Kong-Macao Greater Bay Area has not yet reached the extent observed in Northeast China, Nantong, or parts of Japan and South Korea, the aging trend is accelerating due to economic development, improved healthcare, and declining fertility rates. Therefore, when developing a large-scale health industry in the Greater Bay Area, it is crucial to establish a comprehensive health service system for older adults and enhance the training of elderly care professionals in advance.

3. Big Data Application Mechanism and Practical Cases

3.1. The Operating Logic of Big Data-Driven Precision Marketing

The operation of precision marketing in the health industry driven by big data is a systematic, multi-link collaborative process. First, the data collection phase is crucial. Enterprises gather data through various online and offline channels. Online data includes transaction records from e-commerce platforms, discussions on health topics on social media, and user behavior data from health apps. Offline data encompasses information from medical institution visits, test reports from physical examination centers, and consumption records from physical stores. For instance, a chain physical examination institution in the Greater Bay Area collects not only basic physical examination data from users but also obtains data such as daily exercise steps and sleep quality through cooperative health management apps, forming a comprehensive original data set.

The next step is the data processing stage, which involves using data cleaning techniques to eliminate duplicate and erroneous data and integrating data from different sources into a unified format [10]. On this basis, data mining algorithms, such as cluster analysis and association rule mining, are applied to extract valuable insights from the vast data. For example, cluster analysis can classify users based on health risk levels, consumption capacity, and other dimensions, while association rule mining can uncover potential connections between users' purchases of specific health products and their medical history or lifestyle habits.

Subsequently, accurate user profiles are constructed based on the processed data. These user profiles are not merely collections of information but are detailed virtual models that provide an in-depth depiction of consumer health needs, consumption preferences, purchase frequency, and decision-making patterns [11]. These profiles clearly outline the personalized requirements of different user groups and offer a focused direction for precision marketing.

Finally, during the execution phase, companies perform market segmentation and positioning based on user profiles, developing tailored product strategies, pricing strategies, channel strategies, and promotional strategies for distinct market segments. By leveraging appropriate marketing channels, customized product and service information is precisely delivered to target users, ensuring efficient allocation of marketing resources and maximizing the effectiveness of marketing efforts.

3.2. Typical Enterprise Application Cases

Take a well-known Internet medical platform company in the Greater Bay Area as an example. The company integrates data such as online consultation records, drug purchase orders, and user health records. It utilizes big data analysis technology to construct user profiles across multiple dimensions, including age, gender, region, health status, and consumption habits. For young people, it was found that they generally have sub-health problems and fragmented time. Hence, the company launched convenient services, including online quick consultations, electronic prescriptions, and drug delivery. For middle-aged and elderly individuals with chronic diseases, customized health management plans and medication reminder services are provided based on their specific disease types and medication histories. In addition, by analyzing the user's search keywords, browsing pages, and other behavioral data on the platform, relevant health science articles and product recommendations are accurately displayed, allowing users to obtain valuable information while increasing their attention to and willingness to purchase platform products and services.

Another company that focuses on smart wearable devices uses real-time health data such as heart rate, blood pressure, and movement trajectory collected by users through devices worn by users, combined with users' purchase records on e-commerce platforms and discussions on health topics on social platforms, to conduct in-depth analysis of users' health needs and sports preferences. For users who love outdoor sports, the company has launched smart watches that are waterproof, have long battery life, and support outdoor navigation, and has carried out targeted advertising in outdoor sports forums, social media sports groups, and other channels [12]. For middle-aged and elderly users who are concerned about health monitoring, the main products are smart bracelets with abnormal heart rate warning and fall detection functions, and they are promoted through community health lectures and public accounts for elderly health. Through big data precision marketing, the market share of the company's products has increased by 25% within a year, and the new product development cycle has been shortened by 30%, effectively reducing market risks and improving corporate competitiveness.

4. Application Challenges and Optimization Suggestions

4.1. Challenges of Big Data Applications

In the process of big data application, issues related to data security and privacy protection have emerged as primary challenges. The big health industry involves substantial amounts of sensitive health information and personal privacy data of consumers, which, if leaked, could pose significant risks to users. Additionally, the development of data security technologies has not kept pace with the rapid advancement of data applications, leading to occasional data leakage incidents. The application of big data technology also demands multidisciplinary professionals who possess expertise in both the big health industry and big data analysis. However, the current talent pool in the Greater Bay Area is insufficient, creating challenges for enterprises in recruiting qualified

personnel and managing high training costs. Furthermore, the diverse range of data sources in the big health industry, including medical institutions, health management organizations, and e-commerce platforms, results in inconsistent data standards and varied data formats. This lack of standardization complicates data integration and analysis, hindering the ability to fully realize the comprehensive value of big data.

4.2. Collaborative Promotion Strategy

The government should enhance policy guidance and regulatory frameworks, establish stringent data security and privacy protection regulations, and oversee the collection, usage, and storage of data by enterprises [3]. Additionally, financial support for the advancement of big data technology and talent development should be increased, with the creation of dedicated funds to encourage universities and research institutions to undertake relevant projects. Efforts should also focus on promoting the establishment of a data-sharing platform for the big health industry in the Greater Bay Area, developing unified data standards and exchange protocols to eliminate data silos. Enterprises must prioritize raising awareness of data security, invest in advanced data security technologies, and implement robust data security management systems. Furthermore, collaboration with universities and research institutions for joint training and talent acquisition is essential to enhance big data application capabilities. Internal business processes should be optimized, with a focus on strengthening data governance and improving data quality and utilization efficiency. Industry associations should act as intermediaries, facilitating the exchange of big data application experiences among enterprises, fostering technical cooperation, establishing industry self-regulation standards, and promoting data sharing and collaboration to advance precision marketing in the healthcare sector within the Guangdong-Hong Kong-Macao Greater Bay Area.

5. Conclusion

This study highlights the significant application value of big data in precision marketing within the healthcare industry in the Guangdong-Hong Kong-Macao Greater Bay Area. By leveraging accurate user profiling, personalized marketing strategies, and optimized channels, enterprises can enhance their marketing effectiveness and strengthen their market competitiveness. Nonetheless, challenges such as data security, technical expertise, and data integration persist in the implementation process. Collaborative efforts among government entities, enterprises, and industry associations, alongside improvements in policies and regulations, advancements in technological innovation, talent development, and the promotion of data sharing, can foster a supportive environment for the application of big data in precision marketing within the healthcare sector. However, this study is limited by its case selection and depth of data analysis. Future research could broaden the scope of case samples, enhance quantitative analysis, and explore innovative approaches and models for integrating big data with precision marketing in the healthcare industry, thereby contributing to the sustainable development of the Guangdong-Hong Kong-Macao Greater Bay Area.

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