Artificial Intelligence Enhances Business Intelligence in Retail: A Literature Review Based on Customer Behavior Analysis

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Abstract: Through a systematic literature review, this article analyzes how artificial intelligence(AI) improves the business intelligence(BI) system in the retail industry, focusing on customer behavior analysis. The article points out that AI technologies such as machine learning, natural language processing and recommendation systems have upgraded BI from traditional descriptive analysis to predictive and decision-making support tools, thus helping retailers understand and predict consumer behavior more accurately. Finally, the author summarizes the challenges of AI-enabled BI in terms of data quality, privacy ethics, implementation cost and model interpretability, and puts forward the future research direction.

Keywords: Artificial Intelligence; Business Intelligence; Customer Behavior Analysis; Machine Learning; Retail Industry / Retail

1. Introduction

In the past decade, the retail industry has experienced an unprecedented digital transformation, which is mainly driven by the rapid development of e-commerce platforms, omni-channel retail strategies and data-driven business models. Retailers interact with customers through physical stores, websites, mobile applications and social media platforms, thus continuously generating a large amount of customer-related data. These data include transaction records, browsing behavior, click flow data, membership system information, and customer comments and feedback from different digital touchpoints. How to manage, integrate and extract valuable information from such complex and large-scale data has become a key challenge for modern retail enterprises.

BI, has long played important role in supporting management decision-making, with its main functions being collecting data, integrating data and visualizing enterprise data, while early BI system mainly focused on descriptive analysis, such as generating regular reports, displaying dashboards and core performance indicators, thereby summarizing historical performance. [1,3] These tools have certain value in monitoring operation status and are useful in evaluating past performance, but their capabilities are limited in predictive analysis, automated analysis and real-time decision support, and with intensification of competition in retail market and increasing dynamics of customer behavior, limitations of traditional BI systems are exposed more and more obviously.

AI has emerged, which has given new opportunities to BI systems, with enhanced analytical capabilities, while machine learning technology is developing, and natural language processing is also progressing, thereby enabling enterprises to analyze data more efficiently through deep learning and recommendation algorithms and other technologies, where such data is large in scale and complex in structure, relying on pattern recognition, with most of the above forms being hidden, and can also learn from historical data, thus automating the analysis process, as AI has transformed BI systems from static reporting tools to predictiv platforms, and also to prescriptive analysis platforms. This transformation is very important, especially in the retail industry, because accurately understanding customer behavior, and predicting customer behavior is very important for increasing satisfaction, which is core to operational capabilities, and inseparable from competitive advantages.[2,6]

Therefore, customer behavior analysis has become the core application direction of AI-enabled BI in the retail field. By analyzing customers' search behavior, purchase decisions, promotional responses and feedback, retailers can improve demand forecasting, achieve marketing personalization, reduce customer churn and improve the overall customer experience. Although a large number of studies have explored the application of AI in retail

analysis, the relevant literature is scattered in many disciplines such as information systems, data science, marketing and operational management, and lacks a systematic integrated perspective.In order to make up for this research gap, this article provides a systematic literature review of how AI can improve the BI system in the retail industry, focusing on customer behavior analysis. By integrating existing research results, this article aims to identify key AI technologies, summarize their advantages and limitations, and put forward future research directions to provide reference for academic research and retail practice.

2. Research Method

This paper adopts the method of systematic literature review to analyze the relevant research on AI-enabled BI in the retail industry. Because the research topic has obvious interdisciplinary characteristics, involving multiple fields such as information system, data analysis and marketing, the literature review method is particularly suitable.

The sources of this article include authoritative academic databases such as Google Scholar, Web of Science, IEEE Xplore and Scopus. The search targets are mainly peer-reviewed journal papers, academic monographs and high-quality review literature published between 2012 and 2024. Search keywords include "artificial intelligence", "business intelligence", "retail analysis", "customer behavior analysis", "machine learning", "emotional analysis" and "recommendation system", etc. After preliminary retrieval, this paper screens the literature according to the relevance of the research, the quality of the literature and the degree of matching with the research objectives. Focus on the research on the application of AI in retail decision support, customer analysis or BI system enhancement, and exclude literature unrelated to the topic. The final selected literature is classified according to the type of AI technology and BI function used, and summarizes the commonality of the research, compares the conclusions of the research and identifies the gaps in the research through qualitative analysis.

3. The Development of Business Intelligence and the Role of Artificial Intelligence

The business intelligence system was originally designed to support organizational decision-making through data integration, report generation and visualization. Early BI systems emphasized data warehouse, online analysis processing and dashboard technology, enabling managers to efficiently analyze structured business data. Such systems have obvious advantages in monitoring enterprise performance and identifying historical trends, but have limited capabilities in predicting future results and supporting real-time decision-making.

Many studies have pointed out that the introduction of AI technology has significantly expanded the function of the BI system. Machine learning algorithms can learn patterns from historical data, so as to achieve sales forecasting, demand forecasting and customer behavior forecasting. Natural language processing technology enables the BI system to analyze unstructured data such as customer comments and social media content, while the recommendation algorithm supports more personalized decision-making.

The existing literature generally believes that AI mainly enhances the ability of the BI system in the following three ways: First, AI can identify complex nonlinear relationships in large-scale data, thus improving the depth of analysis; Second, AI supports automation and real-time analysis to reduce dependence on manual analysis; Third, AI Support strategic decision-making by providing predictive and prescriptive insights. These advances have transformed the BI system from a passive data display tool to an intelligent decision-making support platform.[1,2]

4. Application of Machine Learning in Customer Behavior Analysis

Machine learning is one of the most widely used AI technologies in retail analysis. A large number of studies have shown that machine learning models can effectively predict customer purchasing behavior, customer lifetime value and customer churn probability. By analyzing historical transaction data, click flow data and behavior patterns, retailers can identify potential lost customers or customer groups that are more sensitive to promotions.

Many scholars pointed out that compared with traditional statistical models, customer behavior prediction based on machine learning is more accurate. Supervisory learning algorithms (such as decision trees, random forests and gradient enhancement models) are often used for

customer churn prediction and purchase probability prediction, while unsupervised learning methods (such as clustering algorithms) are widely used in customer segmentation.[4,7]

Customer segmentation is one of important applications of machine learning in retail field, while traditional segmentation methods generally rely on demographic characteristics or preset rules, which is difficult to reflect real behavior differences, and in contrast, machine learning methods group customers based on actual behavior, thereby increasing accuracy of marketing positioning and enhancing ability of resource allocation, with relevant studies generally believing that data-driven customer segmentation methods significantly improve marketing effect.

5. Natural Language Processing and Emotional Qnalysis

Natural language processing plays core role in unstructured customer data analysis. It is especially good at processing online reviews, and can also analyze questionnaires. It can interpret texts on social media, with sentiment analysis technology having been widely applied to identify customers' emotional preferences. By relying on analyzing customer feedback, retailers can better understand customer perceptions, thus timely detecting problems in products or services.

Many studies indicate that sentiment analysis provides important supplement to traditional BI data, because pure numerical data can never reflect customers' real feelings, while common methods include dictionary-based sentiment analysis and machine learning-based classification models, and when natural language processing technology is combined with BI system, retailers can realize integrated analysis of structured data and unstructured data, thereby obtaining more comprehensive customer behavior insights.[5,8]

6. Recommendation System and Personalization

Recommendation system, which is an application of AI, plays core role in retail customer behavior analysis, with such systems analyzing customer purchase history and browsing behavior, thereby giving customers personalized product recommendations, promotional information, and related content, while existing research consistently believes that AI-driven recommendation system can improve customer experience, increase conversion rate, and enhance customer loyalty.[9,6]

Common recommendation methods in literature include such methods as content-based filtering, collaborative filtering, and hybrid recommendation models, while integrating recommendation system into BI platform is beneficial for retailers to systematically evaluate benefits of personalized policies, which also supports data-driven decision-making, with recommendation system being able to rely on continuous learning to constantly adapt to changes in customer preferences.

7. Advantages of AI Empowering Business Intelligence

It is generally believed that integrating AI into BI systems can bring many advantages, which include increasing accuracy of decision-making, speeding up response to market changes, enhancing customer insight, and improving resource allocation, while BI systems with AI functions are conducive to formulating more effective marketing strategies, improving inventory management, and strengthening management of customer relationships. [1,2]

From strategic perspective, AI drives BI, which enables retailers to transform from passively responsive decision-making to proactively predictive decision-making, and this is important, because in highly competitive retail environment, customer demands are changing rapidly, thereby making this kind of transformation particularly core.

8. Limitations and Challenges

Although AI-enabled BI has significant advantages, its application still faces many challenges. Data quality and data accessibility are one of the most critical issues, because AI models are highly dependent on a large amount of reliable data. In addition, the privacy and ethical issues involved in the use of customer data have also been widely discussed in the literature. At the same time, the implementation cost of AI technology is relatively high and the dependence on professional and technical talents is high, which limits the application of small and medium-sized retail enterprises to a certain extent. In addition, the "black box" characteristics of complex AI models may also reduce managers' trust in the analysis results.[2]

9. Future Research Direction

Future research can focus on improving the interpretability and transparency of AI models in the BI system, and explore AI applications that are more in line with privacy protection and ethical norms. In addition, it is necessary to further study the application of AI-enabled BI in small and medium-sized retail enterprises, as well as the possibility of deep integration of real-time data and BI systems.

10. Conclusion

This article provides a systematic literature review of how AI can improve the BI system in the retail industry, and focuses on analyzing the relevant research on customer behavior analysis. The review results show that AI has significantly enhanced the capabilities of BI systems through predictive analysis, real-time decision-making support and in-depth customer insight, among which machine learning, natural language processing and recommendation systems are the core technologies that drive this transformation.

Although there are still challenges in data quality, privacy protection, implementation cost and model interpretability, AI-enabled business intelligence still represents an important development direction of retail decision support systems. The research in this article provides a systematic framework for understanding the research status of AI-driven BI, and also lays the foundation for future academic research and retail practice.

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