

# A Review on Application of Big Data in China Retail Industry

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## Abstract

The retail industry has evolved from Retail 1.0 to Retail 4.0 in response to the advancements brought about by the industrial revolution. After the COVID-19 epidemic, the customer had formed the habit of online shopping. The retail enterprise business model change from traditional retail to new retail and omni-channel retail. Artificial intelligence (AI), big data, Internet of Things (IoT), and other technologies make this change an inevitable trend in the era of Retail 4.0. The present study provides an overview of the current state of China's retail industry in the post-epidemic era. It explores how retail enterprises are transitioning their business models from traditional retail to new retail and omni-channel retail within the framework of Retail 4.0. In conjunction with an analysis of the development and research status of big data, this paper explores the application of big data in China's retail industry across five key areas, namely risk management, category management, customer relationship management, logistics management, and market analysis, then summarizes its challenges, limitations and future trends. The purpose of this paper is to provide enterprises with a clear understanding of their current stage and offer guidance for decision-making in the application of big data.

**Keywords:** Big Data, Retail industry, Retail 4.0, New retail, China retail industry.

## 1. THE DEVELOPMENT STATUS OF CHINA RETAIL INDUSTRY

The retail industry pertains to the domain of commercial exchanges involving goods produced by industrial and agricultural manufacturers, which are directly retailed to individuals for personal use or supplied to social institutions for public utilization. The retail industry, as a vital component of China's tertiary sector, encompasses essential aspects of people's livelihoods such as clothing, food, housing, and transportation. Moreover, being a significant player in the private economy landscape, its development is intricately linked to national economic progress and the stability of social security. The retail trade sector comprises not only brick-and-mortar retailers but also online and other non-store retailers, as stated in the classification of retail formats (GB/T 18106-2021) of China [1]. The

brick-and-mortar retailers, such as Wal-Mart in China, Sears and Costco in the USA, Tsutaya Books in Japan, Globus in Germany, etc., are widely recognized. On the other hand, e-commerce giants like Alibaba, Amazon, Meituan, eBay, and Zalando have become ubiquitous and integral parts of our daily lives.

The year 2021 witnessed the country's baptism of the epidemic stage, during which the retail industry has demonstrated a positive development trend. Consumers have adapted to both online and offline shopping experiences, thereby facilitating the advancement and implementation of new retail practices. In 2021, the added value of the wholesale and retail industries was 11,049.3 billion yuan, experiencing a growth of 11.3% compared to the previous year. The total revenue from the sales of consumer goods in retail amounted to 44,082.3 billion yuan, reflecting a growth rate of 12.5% compared to the previous year. According to the different types of consumption, the retail sales of goods amounted to 39,392.8 billion yuan, experiencing a growth rate of 11.8%. Furthermore, emerging industries and innovative business models demonstrated rapid expansion. The annual online retail sales achieved a remarkable milestone at 13,088.4 billion yuan, indicating a year-on-year increase of 14.1%. Notably, online retail sales specifically for physical goods reached an impressive figure of 10,804.2 billion yuan with a growth rate of 12%, accounting for approximately one-fourth (24.5%) of the total retail sales volume for social consumer goods [2].

In general, the retail industry, as a significant component of the tertiary sector, continues to demonstrate resilience in its macro environment and development trajectory, despite the impact of COVID-19, accompanied by a concurrent high level of consumer purchasing power.

## **2. THE EFFECT OF THE COVID-19 EPIDEMIC ON CHINA RETAIL INDUSTRY**

The COVID-19 pandemic has significantly disrupted the retail industry. In China, epidemic measures reduced foot traffic and store performance, leading to notable closures across various retail formats and forcing many brick-and-mortar stores to close. According to incomplete statistics provided by One View Commerce [3], during the first half of 2022, a significant number of offline stores in different physical retail formats, including supermarkets, department stores, catering establishments, beauty and makeup shops, clothing retailers, etc., announced closures. This includes renowned brands such as Wal-Mart, IKEA, Hema, RT-Mart, and others. Surviving stores adapted by implementing reforms like online-offline integration, live marketing, and innovative promotions to enhance customer experience [4].

As offline stores close and traditional retail faces challenges such as a declining scale, high costs, and inadequate supply chain management, the proliferation of the Internet and rapid technological advancements have prompted many retailers to embrace online retailing. However, online retail also has drawbacks in terms of customer experience, quality assurance, after-sales service, and logistics efficiency. Moreover, the popularity of the Internet has led to a gradual decrease in user growth and traffic dividends for online retail, creating a bottleneck for its growth. [5].

Regardless of whether it is an online or offline retail enterprise, they are integrating their online and offline businesses, which is known as the new retail model. The main focus lies in technological advancements, including big data, artificial intelligence, mobile Internet, and cloud computing. Sec-

ondly, there has been a shift in consumer behavior and preferences towards quality and experience rather than price. Thirdly, national policies have provided support for this transformation with the issuance of the Opinions on Promoting Innovation and Transformation of Physical Retail by the State Council [6]. During the “two sessions” in 2018, efforts were made to merge traditional brick-and-mortar retail with internet-based platforms and innovative technologies to revitalize the established retail industry [7]. Alibaba has established Hema as an offline store while JD.com has launched 7-fresh. Walmart has initiated online sales and delivery services on JD’s platform, while China Resources Vanguard introduced similar services on Meituan’s platform [8].

In conclusion, in the post-pandemic era, an increasing number of customers have developed a habit of engaging in both online shopping and offline experiences. Although some offline stores have been closed by retail enterprises, this has not impacted sales growth. Consequently, these enterprises have had to innovate additional channels for expanding sales, provide more services to enhance consumer satisfaction, and introduce new formats to increase their scale.

### **3. RETAIL 4.0**

#### **3.1 Retail 1.0 To 4.0**

The retail industry is transitioning from Retail 1.0 to Retail 4.0 in response to the industrial revolution [9]. In the mechanized era of Industry 1.0, manual labor was gradually replaced by machines. During Retail 1.0, employees relied on their physical abilities to provide comprehensive services in grocery stores, and the introduction of cash registers increased the popularity of department stores. In the era of mass production of electric products during Industry 2.0, which corresponds to Retail 2.0, product costs were reduced, and various payment methods, including credit cards and membership cards, made shopping more convenient and provided valuable data for the decision-making process. The automation technologies of Industry 3.0, such as three-dimensional warehouses, advanced sorting systems, and the Internet, enabled Retail 3.0, allowing customers to easily buy and pay online while enjoying the vast array of affordable consumption options brought about by high-speed Internet.

Industry 4.0 involves leveraging IoT (Internet of Things) information systems to digitize and enhance intelligence within production processes for rapid, efficient, and personalized product delivery. The emergence of Retail 4.0 has promoted the integrated application of artificial intelligence, machine learning, and data analysis platforms [9], leading to the automation of various workflows in the retail industry, including purchasing, inventory management, customer service, accounts, and supply chain management. Simultaneously, by leveraging diverse technical support, various retail entities have enhanced their linkage platforms, pioneered consumer-centric business models, and harnessed big data to drive the transformation and advancement of the digital retail industry. The use of big data helps identify issues in logistics, transportation, distribution, and other operations, provides customers with personalized precision marketing, and changes consumers’ shopping behavior [10]. For example, people’s preference for online shopping has increased; it is now easier to compare prices between online and offline platforms, and there is a demand for faster delivery speeds [11].

### **3.2 The Development Progress of China Retail Model Based On Retail 4.0**

Traditional retail refers to physical stores where products are displayed and sold, requiring in-store purchases. Its sales growth relies on the advantage of location and has maintained a high rate despite market competition. The introduction of Taobao in 2003 marked the beginning of the online retail era, and by 2006 it had quickly become Asia's largest e-commerce platform due to the popularity of the Internet. In 2016, Jack Ma first proposed the concept of "new retail" during his speech at the Alibaba Cloud Conference, emphasizing that true new retail integrates online and offline channels as well as logistics.[12]. New retail is a transformative phenomenon brought about by progress in information technology, encompassing mobile payment, internet technology, and intelligent terminals. Retail 4.0 has reshaped the traditional retail sales model [13]. The growth of new retail sales depends on cost control and efficiency improvement. Based on the new retail model, consumers now have a wide range of shopping options, including offline stores and various online platforms such as Taobao, Meituan, Douyin, Kuaituantuan, and WeChat. The 2020-2025 edition of the Retail Industry Government Strategic Management and Regional Development Strategy Research Advisory report highlights the new retail trend, indicating that digitization will extend to upstream sectors within the industry, starting from consumers and reaching brand manufacturers [14].

COVID-19 control measures have led to the rise of social, local, and mobile consumer groups [15]. Omni-channel retailing has become popular among retailers as it seamlessly integrates offline, online, and mobile channels. Its characteristics include transcending channel boundaries for seamless integration; comprehensive tracking of consumer purchasing data for accurate forecasting and understanding of buying patterns; and prioritizing diverse personalized shopping needs [16]. Furthermore, Kang argues that the ultimate goal of omni-channel retail is to offer consumers multiple channel options while delivering exceptional shopping experiences through systematic management across all channels and actively engaging with customers [15].

In the era of Retail 4.0, characterized by the integration of smart technologies and digitization, the incorporation of technology and big data has facilitated the transformation of retail business models. From traditional brick-and-mortar stores to online platforms and emerging omni-channel strategies, there has been a significant enhancement in consumer convenience while enterprises have achieved notable performance improvements.

## **4. THE OVERVIEW OF BIG DATA**

Big data is extensively utilized in the retail industry, enabling retailers to gain valuable insights into consumer behavior and their needs, thereby facilitating informed purchasing decisions.

### **4.1 The Development Status of Big Data**

The advent of Retail 4.0 has led to the transformation of traditional retail enterprises into new retail enterprises, which are established in the era of the internet and possess digital DNA. These encompass not only pure online e-commerce companies but also innovative retail enterprises that leverage advanced technologies to deeply cultivate offline retail or achieve seamless integration

between online and offline channels [17]. In July 2023, the National Development and Reform Commission promulgated the Measures to Restore and Expand Consumption [18]. The proposal includes 20 specific policies and measures across six areas: expanding the utilization of services, diversifying new forms of consumption, optimizing the overall consumer environment, and so on. Regarding the expansion of new types of consumption, emphasis will be placed on strengthening digitalized spending patterns. Embracing digital consumption and management emerges as one of the pivotal directions for advancing the new retail industry.

Since 2015, Chinese physical retail enterprises have embarked on digital transformation and omnichannel strategies to effectively cater to the dynamic consumer demands. The digital management priorities vary among different enterprises and stores, encompassing strategy formulation, staff management, business process optimization, overall budget allocation, and technology empowerment. The China Chain-Store & Franchise Association and EY Company have proposed the 5P framework of store digital management elements and its corresponding application scenarios, encompassing user interaction (people), product display (product), employee empowerment (personnel), optimal facilities (premise), and supply chain efficiency (process) [19]. For example, in 2015, Yintai Business Group and Alibaba Group began to lay out the omnichannel retail system, focusing on the digitization of membership and payment, and then continued to deepen cooperation in big data in the follow-up [20].

Under the new retail model, big data technology is widely employed in the retail industry, leading to an exponential growth in big data encompassing customer, supplier, order, logistics, and purchase data [21]. The types of big data are becoming increasingly complex due to changes in the diversified retail market, leading to a corresponding increase in management difficulty. Big data is not only the datasets but also comprises the content reflected behind the data. We should combine the data with the specific context of the enterprise to help enterprises track their operations through data management and analysis, thereby realizing the value of the data to the enterprise [22].

## **4.2 The Research Status Of Big Data**

The research on big data encompasses two main aspects: big data management and big data analysis. In the context of the retail industry, big data management is applied to investigate the impact of customer satisfaction on organizational performance and to contribute to predicting trends in the retail industry [23]. Effective and efficient big data management can ensure that companies make more accurate and reliable choices. Big data analysis pertains to the gathering and examination of information, extracting valuable insights and patterns within the dataset, to provide a decision-making basis for enterprise operations, optimize business models and market strategies, and thus improve performance [24].

The field of big data analytics (BDA) has emerged as a prominent research area for both retail enterprises and scholars [25]. Studies based on BDA have primarily focused on technical or system development, as well as customer relationships and experiences. Big data analysis affects the decision-making processes of enterprises, such as new product development or product differentiation strategies, thereby influencing organizational performance [26]. Youssef mentioned that the adoption of big data analytics in the retail industry is influenced by technological, environmental,

organizational, and human factors, with cross-national differences playing a moderating role among them [25].

In the view of Lutfi [27], the adoption of big data analytics is influenced by top management support, government support, data quality, and organizational readiness, which have the potential to enhance firm performance. Big data will also be used in conjunction with other technologies to boost business performance. Awini [28] mentioned that IoT sensors can assist firms in obtaining substantial consumer data, and this real-time data can reflect product shortage conditions and predict the time between purchases. In the study of Atal [29], he integrated big data with Six Sigma to analyze online product reviews and customer ratings, identify customer issues, and propose improvement strategies for optimizing the customer experience.

All in all, big data management and analytics frequently appear in papers concerning customer management, goods management, and the impact of integrating big data with various technologies on businesses.

## **5. THE APPLICATION OF BIG DATA IN CHINA RETAIL INDUSTRY BASED ON RETAIL 4.0**

Under the concept of Retail 4.0, big data technology finds extensive applications in retail enterprise risk management, category management, customer relationship management, logistics management, and market analysis.

### **5.1 Retail Risk Management**

The data risk management of new retail enterprises is well-established, with a comprehensive big data warehouse construction. These enterprises possess abundant high-quality data resources and are equipped with a dedicated data analysis department and staff. Additionally, there is a wide range of market-available tools for data management and analytics visualization, such as Fine-BI or Quick BI. The “Retail Risk Big Data Application Status Research Report” mentions that new retail enterprises will prioritize the application of risk big data. Given that many retail enterprises have numerous stores and operate in diverse market areas, conducting risk assessments becomes essential when deciding whether to open or close stores. Over 45% of Chinese enterprises employ at least one visualization tool for risk big data, such as a “risk control screen” or “risk management cockpit.” These data visualization tools effectively demonstrate the application outcomes of risk big data, facilitating users’ quick comprehension of the information. Consequently, enterprises can promptly and comprehensively understand their business situations across different locations, enabling them to implement business monitoring, operational command, and operation and maintenance management effectively while serving as an internal motivator and detecting abnormalities [30].

## 5.2 Retail Category Management

The category management is the most prominent sector of big data application, and it is also the field where big data application involves a wide range of employees, including commodity procurement, display, sales, promotion, and loss control. Through big data analysis, we can directly observe the impact on sales and costs. In the report “Research and Implementation of Category Analysis of Chinese Retail Enterprises (2023)” [31], it emphasizes that retail enterprises need to shift from traditional data analysis concepts in category management to focusing more on category analysis. This should begin with scientific digital planning, selecting professional systems, gradually improving data availability, and establishing a targeted analysis system.

Under the influence of Retail 4.0, driven by the widespread implementation of new retail and omnichannel retail, the channels through which goods reach consumers are diversifying. Therefore, for retail enterprises, it is imperative to support commodity management decisions through the analysis of commodity circulation data and strategically allocate appropriate merchandise to suitable nodes at optimal times. However, current challenges faced by retail enterprises in establishing a category management system include insufficient data integration, a scarcity of specialized talents, and a lack of management tools. In order to achieve sustainable development in new retail and omnichannel environments, enterprises must effectively optimize internal resources.

## 5.3 Retail Customer Relationship Management

Utilizing big data in customer analytics can enhance sales growth and subsequently optimize customer relationship management (CRM) performance. The transformation of a firm’s big data and artificial intelligence (BDAI) into superior CRM performance is contingent upon the marketing and mass-customization capabilities. According to Han [32], the value of customer data relies on data mining, which benefits the effectiveness of CRM. CRM is an important system in retail enterprises for collecting customer data, in addition to other data collection methods, such as questionnaires. Given the vast amount of customer data, retail enterprises need to mine useful information from this massive dataset and analyze it to provide a basis for business decision-making. For example, Meiyijia, a well-known convenience store in China, monitored RFM metrics and found in October 2018 that the activity of some high-value members had declined, posing a significant risk of churn. Therefore, it decided to implement a proactive customer engagement and reactivation strategy based on RFM [33].

At the same time, big data is widely used to improve the online customer experience. Retail enterprises utilize big data for comparing consumers and products, subsequently forecasting trends in commodity prices, as well as reducing marketing expenses [34]. Customer relationship management plays a pivotal role in enabling enterprises to attain a competitive edge, and big data integrates data into the CRM process, analyzes customer behavior and buying patterns, and optimizes and maintains customer relationships. The BDA tools for customer relationship management include Apache Hadoop, Apache Spark, MapReduce, and Apache HBase. Besides the tools of BDA, Alida Magakam Tchamekwen et al. propose two kinds of digital capabilities and study the relationship between them [35]. Employee skills and data-based decision-making, as well as decision-making based on data from different customer groups, are conducive to improving sales and thus enter-

prise performance. Meanwhile, Elisabeta evaluated the retail employee performance by building a software model considering big data [36].

#### **5.4 Retail Logistics Management**

Big data is usually used in supply chain optimization. In the study of Feng [37], he believed that the data-driven collaborative model would take the supply chain system model as the main framework, and the integration of data resources and sharing of information depend on the systemic relationships among supply chain members. Only by maintaining a good collaborative mechanism can enterprises improve their performance comprehensively. Wu [38] examined the impact of big data capability on enterprise performance and the mediating role of supply chain flexibility. The study revealed that the fundamental resource capability, technological application capability, and management application capability of big data have significant positive effects on all five dimensions of supply chain flexibility. Moreover, big data analysis technology positively influences enterprise performance by effectively enhancing operational, financial, and market performance. Additionally, supply chain collaboration partially mediates the relationship between big data analysis ability and operational, financial, and market performance [39].

Under Retail 4.0, automatic sorting, unmanned distribution, artificial intelligence, and big data, etc., have not been well popularized in rural areas, so we focus on the terminal distribution of urban retail enterprises. For example, Yuntong Logistics, which provides logistics services for BBK Group, a well-known retail enterprise in China, makes business changes in internal management processes and operational nodes through the use of big data to improve service efficiency and reduce costs [40].

Firstly, big data management for distribution personnel is crucial. The pace of urban life is accelerating, and consumers are placing very high demands on delivery timeliness. Urban residents are increasingly scattered, leading to a large and dispersed distribution range, which increases the demand for distribution personnel. Therefore, the routes in the urban community terminal distribution network have strong crossover characteristics, and enterprises need many distribution staff to satisfy customer demand [41]. Secondly, big data management is also important for optimizing distribution efficiency. In the urban community terminal distribution network, the last distribution node is often the community convenience store, community owner, property management company, intelligent express cabinet, community chain supermarket, or self-run community service station. In some special communities, such as colleges (e.g., Guangdong Baiyun University), they have developed big data + Internet crowdsourcing platforms to solve problems like inefficiency and difficult supervision [42].

#### **5.5 Retail Market Analysis**

Retail market analysis refers to the analysis of market industry data, market sales data, market competition data, etc., so that enterprises can better understand the market environment and develop better market strategies to improve firm performance [43]. The enterprise application of big data in market analysis may include market prediction, pricing decisions, promotional decisions, and so on. Regarding market prediction, Dama Qian analyzes a large amount of “Daily inventory clearance”



sales data to make sales forecasts and procurement forecasts, helping retail stores rationally allocate inventory, reduce excess and shortage, and improve sales efficiency and profits. For market pricing, Amazon understands users' purchase preferences and price sensitivity by analyzing big data such as product sales, costs, and competitors' prices, displaying different prices for different user groups, and developing more reasonable pricing strategies. In terms of market promotion, Walmart and Starbucks subdivide the consumer market through the analysis of consumers' purchase history, giving different discounts and coupons to customers in different segments, carrying out precision marketing by matching the most appropriate channels, improving marketing effectiveness, and increasing user engagement and loyalty [44].

## **6. CHALLENGES, LIMITATIONS AND FUTURE TRENDS**

Applications of big data are becoming more common, but they often fail to achieve their intended goals, and businesses and academics are still struggling to figure out how to derive value from big data.

### **6.1 Challenges and Limitations**

Chinese retail enterprises serve the people's livelihood. Based on China's huge population, the big data generated by retail enterprises constitutes a massive amount of real-time consumer consumption data. Therefore, the challenges faced by retail enterprises include whether the enterprise has a sufficient budget, whether the hardware and software systems can meet the needs of data storage and processing, how to ensure the accuracy of the collected data, and whether it is actually needed by the enterprise, as well as whether the relevant technical personnel of the enterprise possess the necessary professional skills [45].

In addition, big data is like a double-edged sword: consumers benefit from its use, but privacy is also vulnerable to infringement. Data security and privacy require joint efforts to protect [46]. At the national level, a series of laws have been formulated to protect personal data and data security, such as *the Data Security Law of the People's Republic of China*, *the Cybersecurity Law of the People's Republic of China*, and *the E-commerce Law*. At the enterprise level, it is essential for retail enterprises to ensure data compliance and security and to ensure that the personal information authorized by customers is used only to serve them in a safe and reliable manner. From the consumer level, there is a need to continuously improve awareness of personal data security and protection and put it into practice in daily life [22].

### **6.2 Future Trends**

Retail big data is in a stage of rapid development, with huge market potential and rapid expansion of application fields. Chinese retail enterprises' investment in big data is also increasing. In the context of retail 4.0, retail enterprises are deepening the integration of big data and other emerging technologies (AI, Internet of Things, etc.). Multi-point intelligence enterprise provide digital technical support for enterprises like Metro, Wumart, and Fat east. Meanwhile, the integration of

technology promotes continuous innovation in retail models, such as omnichannel retail and instant retail [47].

Regardless of the size of retail enterprises, in the omni-channel retail model, they are more concerned about the problem of data security and privacy protection, and relevant technologies will become more mature. The application of big data in the retail industry will further promote the coordinated development of the retail industry and other related industries, such as finance, logistics, and technology. This industrial coordination will also promote the development of cross-border retail and accelerate the international expansion of retail enterprises [48].

## 7. SUMMARY

In the realm of big data application, it is widely acknowledged that big data serves as a pivotal scientific and technological tool, which is widely used in logistics management, customer management, category management, market analysis, and so on. The process encompasses the comprehensive acquisition, processing, and analysis of extensive data across all facets of enterprise operations to establish a foundation for informed business decision-making and enhance overall organizational performance. In the context of the emerging retail and omni-channel retail model, it is imperative for retail enterprises to consider various aspects when utilizing big data; there are challenges in terms of data security and privacy, talent, funding, etc. Exploring the extent of big data application, striking a balance between cost and utilization of big data, enhancing the efficiency of its application, and leveraging big data to optimize resource effectiveness will remain a hot field of academic research in the future.

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