ỨNG DỤNG DỮ LIỆU LỚN TRONG QUẢN LÝ CHUỖI CUNG ỨNG: TRƯỜNG HỢP CỦA WALMART VÀ KHUYẾN NGHỊ CHO VIỆT NAM

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Tóm tắt

Nghiên cứu này khám phá việc Walmart ứng dụng Dữ liệu lớn (Big Data) trong Quản lý Chuỗi Cung Ứng (SCM) và những tác động của nó đối với ngành bán lẻ tại Việt Nam. Nghiên cứu xem xét phân tích dữ liệu theo thời gian thực của Walmart, dự báo nhu cầu dựa trên trí tuệ nhân tạo (AI) và tối ưu hóa logistics bằng Internet vạn vật (IoT) nhằm nâng cao hiệu quả và giảm chi phí. Bằng cách phân tích quản lý hàng tồn kho, logistics và hợp tác với nhà cung cấp của Walmart, nghiên cứu làm rõ các tiến bộ công nghệ quan trọng. Ngoài ra, nghiên cứu đánh giá mức độ ứng

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dụng Dữ liệu lớn trong ngành bán lẻ tại Việt Nam, tập trung vào các chuỗi WinMart và Bách Hóa Xanh. Những thách thức như tích hợp dữ liệu còn hạn chế, logistics kém hiệu quả và tốc độ tự động hóa chậm được xác định. Thông qua phân tích so sánh, kết quả cho thấy mặc dù các nhà bán lẻ Việt Nam đang có những bước tiến trong chuyển đổi số, nhưng vẫn cần cải thiện phân tích dự báo, tự động hóa quản lý hàng tồn kho và tích hợp dữ liệu nhà cung cấp. Nghiên cứu đưa ra các khuyến nghị nhằm nâng cao hiệu quả chuỗi cung ứng và khả năng cạnh tranh của ngành bán lẻ tại Việt Nam.

Từ khóa: dữ liệu lớn, ứng dụng, Walmart, WinMart, Bách Hóa Xanh, Việt Nam, khuyến nghị

APPLICATION OF BIG DATA IN SUPPLY CHAIN MANAGEMENT: CASE OF WALMART AND RECOMMENDATIONS FOR VIETNAM

Abstract

This study explores Walmart's use of Big Data in Supply Chain Management (SCM) and its implications for Vietnam's retail sector. It examines Walmart's real-time data analytics, AI-driven demand forecasting, and IoT-based logistics optimization to enhance efficiency and reduce costs. By analyzing Walmart's inventory management, logistics, and supplier collaboration, the research highlights key technological advancements. It also assesses Big Data adoption in Vietnam's retail sector, focusing on WinMart and Bach Hoa Xanh. Challenges such as limited data integration, inefficient logistics, and slow automation adoption are identified. Through comparative analysis, the findings suggest that while Vietnamese retailers are progressing in digital transformation, improvements in predictive analytics, inventory automation, and supplier data integration are needed. The study offers recommendations for enhancing supply chain efficiency and competitiveness in Vietnam's retail industry.

Keywords: big data, application, Walmart, Winmart, Bach Hoa Xanh, Vietnam, recommendations

Introduction

The evolution of information technology, increased customer expectations, economic globalization, and other modern competitive priorities have caused firms to adjust in today's

competitive environment. Therefore, the rivalry between businesses is replaced by competition between businesses and their supply chains. Supply chain experts are straining in today's competitive market to handle massive amounts of data to achieve an integrated, efficient, effective, and agile supply chain. As a result, the rapid expansion in volume and variety of data types throughout the supply chain has necessitated the development of systems that can intelligently and quickly evaluate enormous amounts of data (Bhumika Dutta, 2021). To improve supply chain management, big data analytics is becoming increasingly important. It addresses several issues at the strategic, operational, and tactical levels. Big data is affecting every aspect of the supply chain. It includes anything from reducing the communication gap between manufacturers and suppliers to boosting delivery times. Decision-makers can use analytics reports to increase operational efficiency and monitor performance to boost productivity. To cut costs and improve service levels, supply chain analytics supplement data-driven decisions.

Among major global retailers, Walmart is a leader in Big Data adoption for SCM. Big data analytics are widely used by Walmart to enhance its supply chain and consumer experience. To decrease out-of-stock items and make sure that its stores are well stocked, it leverages real-time data from its pharmacies, distribution facilities, stores, and e-commerce channels. In order to simplify its delivery procedure and lower transportation expenses, it has also made investments in technology. The organization has been able to decrease expenses, boost customer satisfaction, and considerably increase supply chain efficiency thanks to this strategy (Britney Osuala, 2023). On the other hand, Vietnam's retail sector, while experiencing rapid growth, is still in the early stages of adopting Big Data in SCM (Hoang, P., Nguyen, M. and Pham, M. 2019). Companies have begun implementing data analytics and warehouse automation, yet challenges remain. The lack of real-time data sharing, inefficient supplier collaboration, and insufficient investment in advanced logistics technologies continue to limit the effectiveness of Vietnam's supply chains.

1. Theoretical Framework

1.1. Supply Chain Management

Supply chain: According to (Islam, 2023), supply chains are the synchronized systems of all related entities, processes, resources, information, and technology involved, from the delivery of

the source materials of products to the products' ultimate delivery to the customer. In the book Principles of Supply Chain Management by (Wisner et al.,2022), the concept of supply chain is explained in a clearer and more accessible way through a diagram. According to the diagram, the supply chain begins with companies extracting raw materials from natural resources, such as iron ore, oil, wood, and food products. These raw materials are then sold to suppliers, including lumber companies, steel mills, and raw food distributors. These suppliers process the raw materials into usable materials based on purchase orders and specifications provided by component manufacturers.
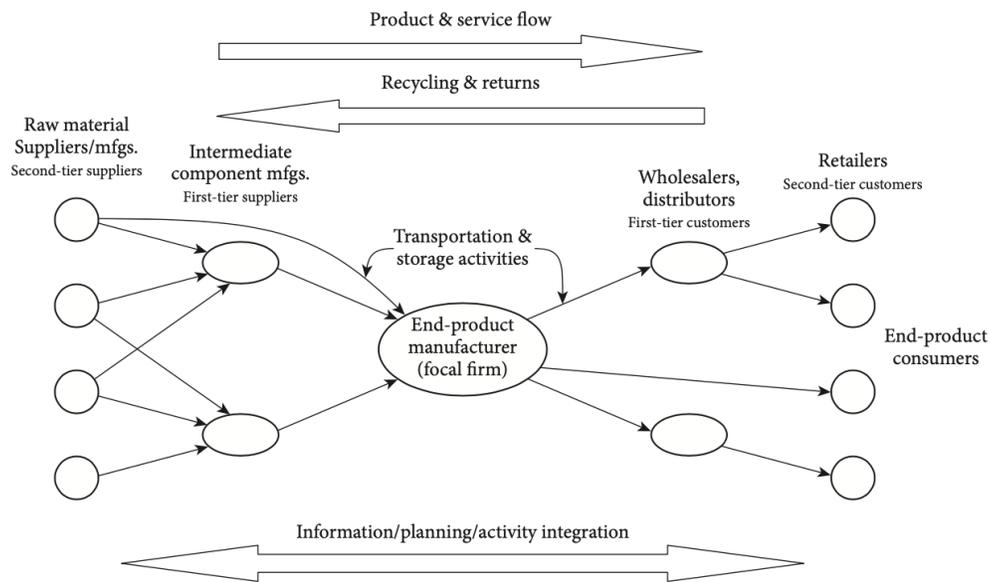

Figure 1: *The Generic Supply Chain*

Source: *Wisner, J.D., Tan, K.-C. and Leong, G.K. (2022) Principles of Supply Chain Management a balanced approach. Mason, OH: Cengage.*

Supply Chain Management (SCM): The Council of Supply Chain Management Professionals (CSCMP) defines supply chain management as:"The planning and management of all activities involved in sourcing, procurement, conversion and all logistics management activities. Importantly, it also includes coordination and collaboration with channel partners, which can be suppliers, intermediaries, third-party service providers and customers".

Table 1: Important Elements of Supply Chain Management (SCM)

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Supply Chain Management Elements	Key Issues
Supply	Supply base reduction, supplier alliances, SRM, global sourcing, ethical and sustainable sourcing
Operations	Demand management, CPFR, inventory management, MRP, ERP, lean systems, Six Sigma quality
Logistics	Logistics management, CRM, network design, RFID, global supply chains, sustainability, service response logistics
Integration	Barriers to integration, risk and security management, performance measurement, green supply chains

Source: Wisner, J.D., Tan, K.-C. and Leong, G.K. (2022) Principles of Supply Chain Management a balanced approach. Mason, OH: Cengage

Importance of Supply Chain Management (SCM): According to (Kleab, K., 2017), supply chain management (SCM) enables organizations to concentrate on their core competencies by outsourcing certain functions to specialized firms that can handle these tasks more cost-effectively, ultimately boosting competitiveness. SCM plays a vital role in enhancing organizational competitiveness, optimizing customer service, and maintaining a balance between costs and service quality. It encompasses the coordination of goods, services, and information flow from raw material acquisition to final product delivery, ensuring seamless integration of business processes across different organizations.

1.2. Big Data

Big Data: The concept of "Big Data" first appeared in an article published in October 1997 (GilPress, 2012). In this article, Big Data refers to extremely large datasets that exceed the storage and processing capabilities of traditional memory and disk systems, requiring scalable computing resources to efficiently manage and analyze them. Today, Big data refers to large, diverse sets of information that grow at ever-increasing rates (Segal, T., 2024). It has emerged in the digital age,

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driven by the rapid growth of data generation. Big Data is characterized by its five Vs, which are massive volume, variety, velocity, veracity, and significant value.

Table 2. Five Vs of Big Data

Name	Meaning
Volume	The vast and ever-growing amount of data in each sector, which is extensive and enhances future predictions.
Variety	The speed at which data can be analyzed to support decision-making. As data volumes grow rapidly, it becomes crucial to extract valuable insights in real time.
Velocity	The highly diverse data sources, varying in structure, including structured, unstructured, and semi-structured formats such as text, sensor data, audio, video, graphs, and more.
Veracity	The quality or trustworthiness of the collected data. Considering the accuracy of the collected data and analyzing it is important.
Value	The ability of individuals or organizations to transform big data into meaningful benefits by collecting and utilizing it effectively to accomplish specific objectives.

Source: Author's compilation.

Source of Big Data: According to the synthesis of information from 52 mainstream sources of Big Data across the Supply Chain by (Awwad, M. et al., 2018), data is categorized into three types: Structured, Semi-Structured, and Unstructured, in relation to the Velocity and Volume of data generation. The statistics show that data collected from Transactions, Social Media, Sensors, and RFID scans or POS (Point of Sale) were recorded at 88%, 43%, 43%, 42%, and 41%, respectively. This information is visualized in the following figure.
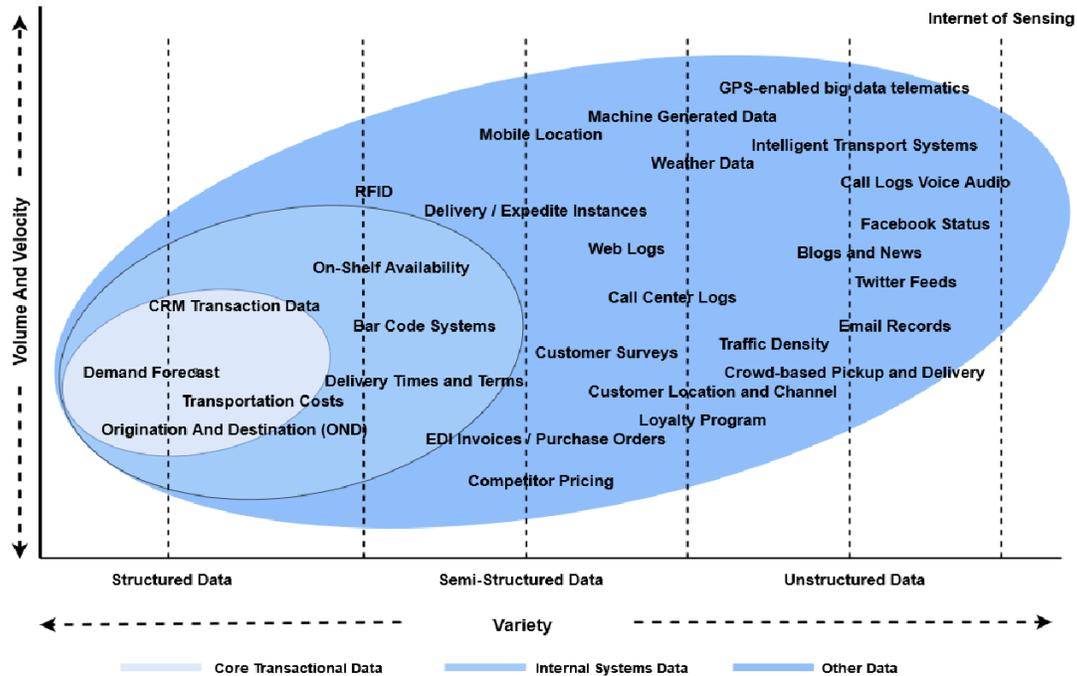
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Figure 2: Classification and Source of Data

Source: Awwad, M. et al. (2018) 'Big Data Analytics in Supply Chain: A Literature Review', Proceedings of the International Conference on Industrial Engineering and Operations Management Washington DC, USA [Preprint]. doi:https://ieomsociety.org/dc2018/papers/149.pdf.

2. Literature review

2.1. About the application of Big Data in their SCM

(Iheukwumere et al., 2024) stated that Big Data Analytics (BDA) is applied in various stages, including Demand Management, Logistics and Transport Optimization, Supplier Relationship Management, Predictive Maintenance, Inventory Management, and Quality Control. Additionally, (Vu & Nguyen, 2023) pointed out that Big Data can also be applied in logistics. In demand forecasting, (CİĞERCİ, 2023) pointed that analyzing large datasets on consumer behavior, sales, and market trends allows businesses to accurately predict demand. This helps optimize production schedules, reduce storage costs, minimize stockouts, and improve operational efficiency. An example in this case is Amazon, who employs big data analytics to predict the demand for its products and make appropriate inventory adjustments. According to (Yan et al., 2019), big data also played a key role in logistics optimization within supply chain management. By leveraging

real-time data on traffic, weather, and delivery schedules, companies can optimize routes, reduce delivery times, and cut fuel costs. For example, United Parcel Services (UPS) uses advanced data analysis to refine delivery routes, leading to substantial fuel savings and lower carbon emissions. In inventory management, (Liu, X., 2022) further illustrated how Big Data is specifically implemented in the case of Walmart. Specifically, they use barcodes and RFID systems to manage inventory, the HDFS system to track the locations of stores worldwide, and the Polaris engine to analyze consumer social data to predict demand. Last but not least, in supply chain risk management, (Araz et al., 2020) stated that examining supplier performance, geopolitical risks, and natural disasters helps organizations identify potential supply chain threats and implement proactive strategies to mitigate them.

2.2. About the importance of Big Data in Supply Chain Management (SCM)

According to (Hader et al., 2022), one significant benefit of utilizing big data in supply chain management is the improvement of forecasting accuracy. Precise demand forecasting is essential for businesses to ensure they maintain the right stock levels at the right time. By leveraging big data analytics, companies can examine historical sales data, customer behaviors, and market trends to identify patterns and anticipate future demand. This allows organizations to optimize inventory management, minimize stock shortages, and improve customer satisfaction. Furthermore, big data enables businesses to detect and respond to shifts in customer demand in real time, allowing them to adjust production schedules and logistics operations as needed. According to (Nguyen, T. et al., 2018), using the systematic literature review method, the author pointed out that big data is also applied in other areas of supply chain management, such as manufacturing, procurement, warehousing, and logistics/transportation. Among these, logistics/transportation was the most prevalent area where big data analytics (BDA) was used to support decision-making. (Bag et al., 2020) stated that by examining data on supplier performance, quality, and delivery reliability, organizations can identify supplier strengths and weaknesses. This helps businesses pinpoint areas for improvement and negotiate better terms. Additionally, big data enables companies to detect and address supply chain risks by identifying potential disruptions and developing contingency plans. Ultimately, big data analytics enhances supply chain efficiency and supports strategic objectives.

2.3. About the challenges of Big Data in SCM:

However, during the application of Big Data in SCM, many challenges must also be faced. (Awwad, M. et al., 2018) stated that the issues and challenges in adopting Big Data Analytics for Supply Chain can be broadly categorized into two main categories: Organizational Challenges, which include six issues, and Technical Challenges, which include three issues. (Zhong et al., 2016) also predicted several challenges that firms might face when adopting Big Data. A major issue of Big Data storage was the limitation of media, which refers to the hardware used to store large amounts of physical data. Current tools are not capable of processing storage operations within seconds when dealing with an immense volume of data. Additionally, processing time was also a significant obstacle to the adoption of Big Data in SCM at that time. Specifically, it was estimated that approximately 635 years would be required to process 1K Petabytes, assuming a processor executes 100 instructions per block at 5 GHz. In Bangladesh, (Moktadir et al., 2019) stated that the biggest barrier to the manufacturing supply chain was the lack of infrastructural facilities, highlighting it as the greatest sub-barrier to adopting BDA in Bangladesh manufacturing industries.

2.3. Research gap

Previous papers have primarily used qualitative methods to define concepts and outline the processes of Big Data application in SCM. Most studies confirmed the positive impact of Big Data Analytics (BDA) on SCM. However, there is still a lack of research providing detailed insights into how BDA is specifically applied in a company's supply chain management process. Our study will synthesize findings from previous studies and relevant information on the application of Big Data in Walmart's SCM. Based on this, we will summarize lessons learned and provide recommendations for Winmart and Bach Hoa Xanh in Vietnam.

3. Application of Big Data in Walmart

3.1 Overview of Walmart

Walmart Inc. is an American multinational retail corporation that operates a chain of hypermarkets (also called supercenters), discount department stores and grocery stores in the United States and 23 other countries, serving millions of customers worldwide.

As of 2016, Walmart's operations are organized into four divisions: Walmart U.S., Walmart International, Sam's Club and Global eCommerce (Walmart, 2016). In the United States, Walmart's stores operate in four formats: discount, supercenters, neighborhood markets and Sam's

Club stores (Boland, Michael A., 2022). Walmart International stores include additional formats such as supermarkets, hypermarkets, cash-and-carry stores, home improvement, specialty electronics, restaurants, apparel stores, drugstores, and convenience stores.

In 2024, Walmart reported robust financial performance, with total revenue reaching approximately $648 million, marking a 6% increase from the previous year (Statista, 2024). In the third quarter of fiscal 2024, the company continued its upward trajectory, achieving a 5.5% growth in revenue to $168 billion and an 8.2% increase in operating income. (Walmart reports, 2024)

Walmart's mission is "to save people money so they can live better" (Save Money. Live better), reflecting its commitment to providing affordable products and services. The company's vision is "to be the destination for customers to save money, no matter how they want to shop," emphasizing a seamless shopping experience across various platforms.

In alignment with its mission and vision, Walmart is dedicated to fostering opportunity, sustainability, and community development. The company strives to create a culture of inclusivity, aiming for every associate to feel valued and respected. Additionally, Walmart focuses on building a sustainable future by collaborating with partners to drive positive environmental and social impact across global supply chains.

3.1.1. Logistic strategy

Walmart's logistics operations are one of the most advanced in the world, ensuring efficiency and cost reduction. Key elements include:

Cross-docking system: Goods are transferred directly from suppliers to Walmart's distribution centers (DCs) and then immediately shipped to stores, reducing storage costs.

Automated warehouses: Walmart uses AI and robotics for inventory management and warehouse automation.

Private truck fleet: The company owns one of the largest private trucking fleets in the U.S., ensuring reliable and cost-effective transportation.

Real-time data analytics: Walmart employs IoT and big data analytics to track inventory in real-time, optimizing stock levels and reducing wastage.

Sustainability efforts: Walmart is investing in electric trucks, solar energy, and other green initiatives to reduce its carbon footprint. (Walmart IoT-Enabled inventory management)
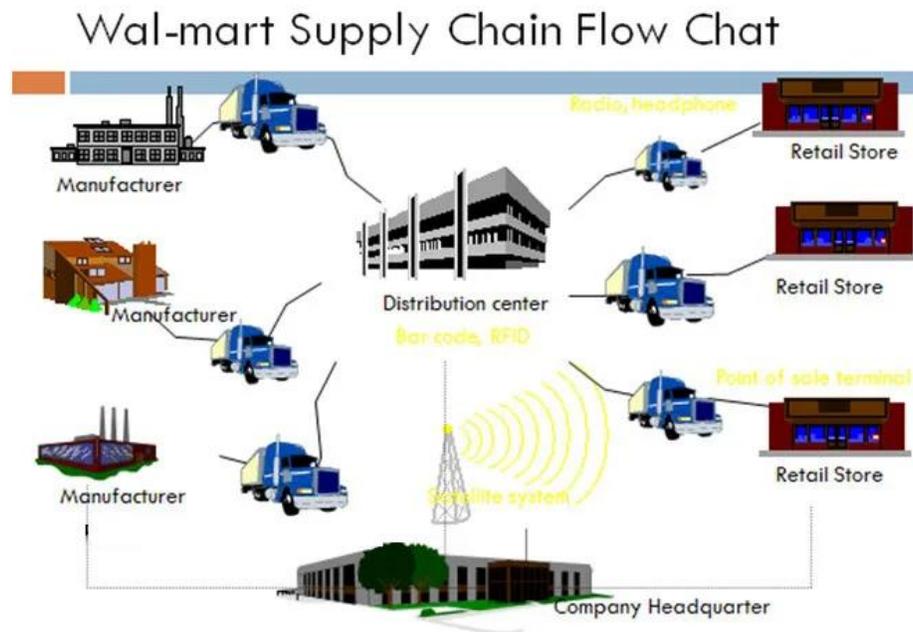

Figure 3*: Walmart logistic system flow chart*

Source: *Francis, A. (2011). Case Study: Wal-Mart's Distribution and Logistics System. MBA Knowledge Base.*

3.1.2. Supply chain management

Walmart's supply chain is a key factor in its competitive advantage. It integrates suppliers, distributors, and retail operations efficiently through:

Vendor - managed inventory (VMI): Suppliers monitor inventory levels at Walmart and restock products as needed.

Just-in-Time (JIT) inventory: Reduces storage costs by delivering goods as needed.

RFID (radio-frequency identification) technology: Monitor inventory across supply chain networks in real-time, improving accuracy, minimizing stockouts and enhancing overall inventory accuracy (Vietnam Logistics Review, 2020).

Strategic supplier relationships: Walmart pressures suppliers for lower costs but also works closely with them to improve efficiency. Walmart implements the direct sourcing strategy with

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their suppliers, which allows Walmart to negotiate favorable terms, reduce procurement costs, and maintain stringent quality control over its merchandise.

E-commerce fulfillment centers: Walmart has built specialized fulfillment centers for online orders, enhancing its e-commerce operations.

Big data analytics: Walmart utilizes predictive analytics to assess historical sales data, seasonal trends, and external factors, allowing for accurate anticipation of customer demand, optimal inventory levels, reducing instances of overstocking or stockouts. (Parvez Musani, 2023)

In summary, Walmart's logistics strategy and supply chain management are characterized by a combination of innovative practices, technological integration, and a commitment to efficiency and sustainability. By continuously refining these areas, Walmart maintains its position as a leader in the global retail market, delivering value to customers while effectively managing operational costs.

3.2. Application of Big Data in Walmart

Walmart has strategically integrated big data technology into its supply chain management to enhance efficiency, reduce costs, and improve customer satisfaction. Walmart's journey with big data began in the early 2000s (Admin, 2024), they began gathering vast amounts of data from their stores, including transaction histories, stock levels, and customer demographic details. As of 2025, Walmart operates a total of 10,660 stores worldwide, attracting approximately 255 million customer visits weekly (Kumar, 2024). Additionally, Walmart generates nearly 300,000 social media mentions each week aggregated from platforms such as YouTube, Reddit, Facebook, and Twitter (Statista, 2024). This vast data ecosystem is powered by advanced data centers, primarily located in the United States.

About Data Analyst Capabilities: Walmart has developed one of the most advanced data analytics ecosystems in global retail. Every hour, it collects around 2.5 petabytes of data from over 1 million transactions, including unstructured data from both online and offline sources (Dasca.org, 2022). Its proprietary Data Cloud and the Data Café in Arkansas allow real-time analysis of up to 40 petabytes of transactional data (Dasca.org, 2022). Through in-memory analytics and data mining, Walmart identifies consumption trends and quickly adjusts operations. A famous example is the sevenfold increase in Pop-Tarts sales before hurricanes, which led the company to place the

product at checkout counters in affected areas (Projectpro.io, 2024). Moreover, Walmart monitors over 145 million customers, analyzing everything from purchases and browsing habits to social media and weather patterns, enabling hyper-personalized experiences (Projectpro.io, 2024). These real-time, multi-layered insights give Walmart a significant competitive edge in the retail industry.

About Supply Chain Automation: Walmart is a global pioneer in using Big Data to automate and optimize supply chains. As early as the 1990s, the company introduced Retail Link, a system that connects real-time sales data with suppliers, enabling automatic restocking (Projectpro.io, 2024). With a robust Big Data infrastructure, Walmart monitors all segments of its supply chain—from demand forecasting to warehouse and logistics operations. For example, the system once detected poor cookie sales in two stores during Halloween despite chain-wide success. A display error was quickly identified and fixed, preventing revenue loss (Projectpro, 2024). Walmart's analytics also automates operational decisions: when inventory levels or sales patterns deviate, the system issues real-time alerts and triggers actions like stock transfers or pricing adjustments (Dasca.org, 2022). It also integrates IoT and logistics tracking—even counting how far products move from warehouse to shelf—to optimize routing and performance (Dasca.org, 2022). The result is a highly responsive, data-driven supply chain that reduces inventory, cuts costs, and ensures seamless product flow.

About Customer Service Optimization: Walmart extensively uses Big Data to enhance customer experience by analyzing shopping behaviors and offering personalized recommendations. It collects data from credit card transactions, loyalty programs, app/web activity, and in-store Wi-Fi tracking to create 360° customer profiles, predicting demand and optimizing engagement. For example, Walmart detected the rising trend of "cake pops" on social media and quickly stocked them in stores (Projectpro, 2024). Walmart also uses Big Data to improve in-store service: analyzing wait times at checkout, customer traffic, and applying machine learning to manage inventory, ensuring that popular products are always available. Thanks to this customer-centric data strategy, Walmart not only increases sales but also retains customers. Every shopper—whether online or offline—receives a personalized experience from promotions to store layouts, powered by insights drawn from the behavior of millions of customers.

By applying certain big data and IoT technologies, systems and models, Walmart is making a real difference to increase sales and revenue, and to be the market leader in retailing industry:

Inventory optimization: Walmart utilizes big data analytics, especially RFID (Radio - frequency identification) technology to optimize inventory levels across its vast network of stores. RFID tags attached to products transmit data about their location, condition, and other details, allowing Walmart to track inventory in real time and determine when restocking is necessary. This predictive approach ensures that each store maintains optimal stock levels, reducing instances of overstocking or stockouts. For example, Walmart's real-time data analytics have improved supply chain efficiency, leading to a 10% reduction in logistics costs through better demand forecasting and streamlined inventory management (Transights, 2024).

Logistics optimization and demand forecasting by utilizing social media analytics for retail insights. Walmart leverages social media data from platforms like Facebook, Twitter, and Pinterest to gain insights into consumer preferences and market trends. Through Social Genome - a big data analytics solution powered by WalmartLabs, the company analyzes billions of social interactions to track customer sentiment, identify trending products, and offer personalized promotions. This helps Walmart align inventory with demand more accurately and improve logistics efficiency. One key initiative was a crowdsourcing contest, where over 5,000 entrepreneurs submitted products for Walmart shelves, receiving more than 1 million public votes. This initiative provided valuable data on consumer interests while also bringing innovative products into Walmart stores.

Consumer personalization and demand planning by applying AI - powered gift recommendation. The Shopycat Gift Recommendation Engine, developed by WalmartLabs, analyzes users' Facebook activity to suggest personalized gifts available at Walmart. The app integrates social media trends, search behavior, and customer purchasing data to enhance product discovery and drive sales. This system also improves Walmart's inventory planning, ensuring that high-demand gift items are well-stocked during holiday seasons.

Improving customer experience and workforce planning: To enhance customer experience, Walmart applies big data analytics to determine the best checkout method (self-checkout or

assisted checkout) based on customer behavior. Predictive analytics also helps Walmart forecast peak hours, ensuring that the right number of employees are allocated to checkout counters at specific times. This reduces wait times, improves customer flow, and optimizes workforce efficiency.

On the other hand, the Walmart map software HDFS (Hadoop distributed file system) uses Hadoop to track the most recent locations of more than 1000 Walmart stores throughout the world (Liu, X., 2022). It can even provide the precise position of an item in a Walmart store, therefore customers can easily find the best location to purchase their favoured items, saving time and enhancing shopping experience.

Logistics optimization: In logistics, Walmart employs big data to enhance route planning and distribution efficiency. By analyzing data on traffic patterns, weather conditions, and delivery schedules, the company optimizes its transportation routes, reducing fuel consumption and delivery times. Additionally, Walmart has invested in automation and robotics within its distribution centers. For instance, the company has opened new automated distribution centers that utilize advanced software and robotics to streamline the handling of refrigerated and frozen foods, effectively doubling the capacity of existing facilities. Furthermore, in 2023, this technology eliminated 30 million unnecessary miles, avoiding 94 million pounds of CO_2 emissions (Food & Wine).

Collaborative planning: Big data facilitates enhanced collaboration between Walmart and its suppliers. Through the Retail Link platform, Walmart shares real-time sales and inventory data with suppliers, enabling them to monitor product performance and manage replenishment effectively. This transparency fosters a proactive supply chain, where suppliers can anticipate demand fluctuations and adjust their production schedules accordingly. This collaborative approach has been instrumental in maintaining product availability and reducing lead times.

By integrating big data technologies across its supply chain, Walmart has transformed its operations, achieving greater efficiency and capable of adapting to market dynamics and meeting customer expectations effectively.

3.3. Lessons learned

3.3.1. Benefits of Walmart's Application of Big Data in Supply Chain Management (SCM)

The case study of Walmart's integration of Big Data into its supply chain management offers several critical insights for organizations about the benefits that Big Data can bring to their Supply Chain Management (SCM):

In Demand Forecasting: Walmart's utilization of historical sales data, seasonal trends, and real-time market analytics facilitates precise demand forecasting. This data-driven approach optimizes inventory levels, mitigating the risks of overstocking and stockouts. Consequently, Walmart has significantly improved supply chain efficiency, leading to a measurable reduction in logistics costs. Organizations should leverage predictive analytics to enhance demand forecasting, thereby improving inventory management and overall supply chain performance.

In Inventory Management: By implementing Internet of Things (IoT)-enabled sensors across its retail infrastructure, Walmart achieves continuous inventory tracking. This real-time monitoring system enables immediate restocking decisions and minimizes product waste, ensuring optimal stock availability and reducing inefficiencies. The integration of real-time data collection and monitoring systems enhances supply chain responsiveness, enabling firms to promptly address fluctuations in inventory levels and mitigate operational disruptions.

In Logistics and Transport: Walmart applies advanced data analytics to optimize transportation routes by incorporating factors such as traffic patterns, weather conditions, and delivery schedules. Additionally, the company has invested in automation and robotics within its distribution centers, effectively doubling warehouse capacity while reducing reliance on manual labor. In 2023 alone, these optimizations eliminated 30 million unnecessary transportation miles and reduced carbon emissions by 94 million pounds. Data-driven logistics optimization contributes not only to cost reduction but also to environmental sustainability, emphasizing the importance of integrating efficiency-focused and eco-conscious strategies in supply chain management.

In Supplier Relationship Management: Walmart fosters a data-driven collaborative approach with its suppliers through its Retail Link platform, which provides real-time sales and inventory data.

This transparency enables suppliers to anticipate demand fluctuations, adjust production schedules accordingly, and streamline replenishment processes. The enhanced coordination reduces lead times and ensures a steady supply of goods. Strengthening data transparency and collaboration with suppliers enhances supply chain resilience, minimizes disruptions, and facilitates proactive decision-making.

3.3.2. Challenges Walmart Faced in Applying Big Data to Supply Chain Management (SCM)

However, in implementing Big Data into its supply chain management, Walmart has also encountered certain challenges:

Data Management and Governance: Walmart has a massive volume of data from various sources like POS systems, IoT devices, and online transactions. Ensuring data accuracy, transparency, and consistency across its global supply chain remains a complex task, alongside storage, processing, and real-time analysis issues. To handle its massive volume of data, Walmart uses cloud computing and edge computing to efficiently store, process, and analyze real-time data.

Data Security and Privacy: Protecting customer and supplier data from cyber threats while complying with global data protection regulations (e.g., GDPR, CCPA) is a constant challenge. A significant example of this challenge occurred in 2015 when Walmart Canada (Tencer, D., 2015) suffered a possible data breach, possibly exposing the personal credit information of 60,000 customers due to a hacker attack. However, Walmart took several measures to secure its systems and prevent future hacking incidents. These actions included launching investigations into the breaches, securing affected associate accounts, and reporting the former employee involved in the payroll fraud to law enforcement.

Technology Integration and Infrastructure: Integrating Big Data solutions with existing IT infrastructure is both costly and complex, requiring a transition from traditional supply chain models to cloud-based and AI-powered analytics systems. To address this challenge, Walmart invested heavily in employee training programs to equip its workforce with the necessary skills to operate Big Data tools and analytics platforms.

4. Current situation and Recommendations for Vietnam:

4.1. Overview of retail industry in Vietnam

Regarding the structure of grocery retail channels (Figure 4), the traditional sales channel still holds the majority of the market share, while modern retail models account for only 12%. However, over the past seven years, especially following the impact of the COVID-19 pandemic, modern retailers have been gradually increasing their market share in Vietnam, expanding their network by more than 700 new stores per year and achieving a compound annual growth rate (CAGR) of 11% during the 2016-2023 period (Vietcap, 2024).
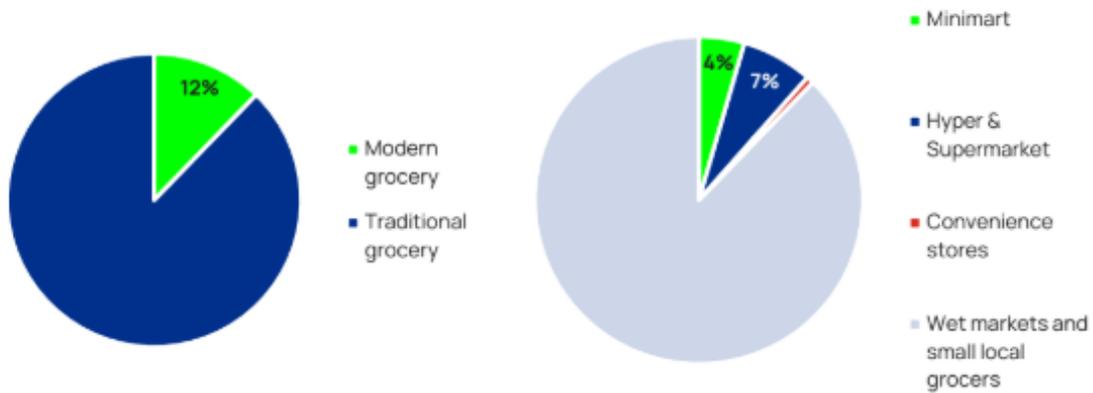

Figure 4. *Grocery retail market share by channel*

Source: Euromonitor, Vietcap, 2024.

Figure 5. *Market value of modern grocery retail formats in Vietnam*

Source: Euromonitor, Vietcap, 2024.

This competition has witnessed the dominance of the top seven leading companies in the industry, accounting for up to 86% of total retail sales as of early 2024 (Figure 6). Among them, two companies are leading the national market, particularly in the minimart segment: Bach Hoa Xanh (abbreviated as BHX in the figure) and Winmart/WinCommerce (abbreviated as WCM/WMP in the figure). While Bach Hoa Xanh, with its strategy focused on the Vietnamese market, has expanded to 1,735 stores and captured 54% of the market share, Winmart has prioritized broad coverage with over 3,600 stores nationwide to date, securing the top position in retail network size (VietnamBiz, 2024).

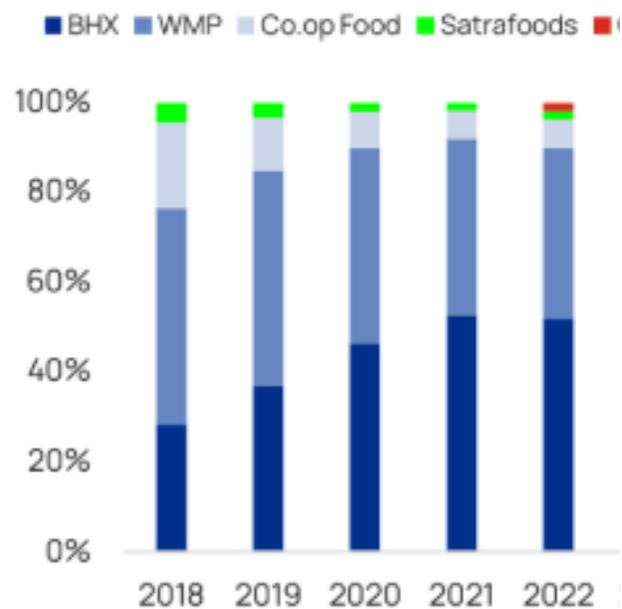**Figure 6.** *Total modern retail market share*

Figure 7. *Market share of minimart value*

Source: Euromonitor, Vietcap, 2024.

Additionally, the chart shows that 4 out of the 7 largest retail companies in Vietnam are domestic enterprises, accounting for approximately 60-65% of the market share, indicating that the retail sector in Vietnam is still dominated by local businesses (CafeF, 2023). Foreign retailers are gradually losing momentum in the grocery retail race, despite the market's optimistic growth rate (The Leader, 2018).

4.2. The current application of Big Data in the modern retail industry

Of course, it is difficult to compare Vietnam's advanced technology applications with those of a major power like the United States. However, according to Mordor Intelligence (2024), the application of modern technology in the retail sector, particularly Big Data, in the Asia region, including Vietnam, remains at a Medium level and holds strong potential for development (Figure 8).
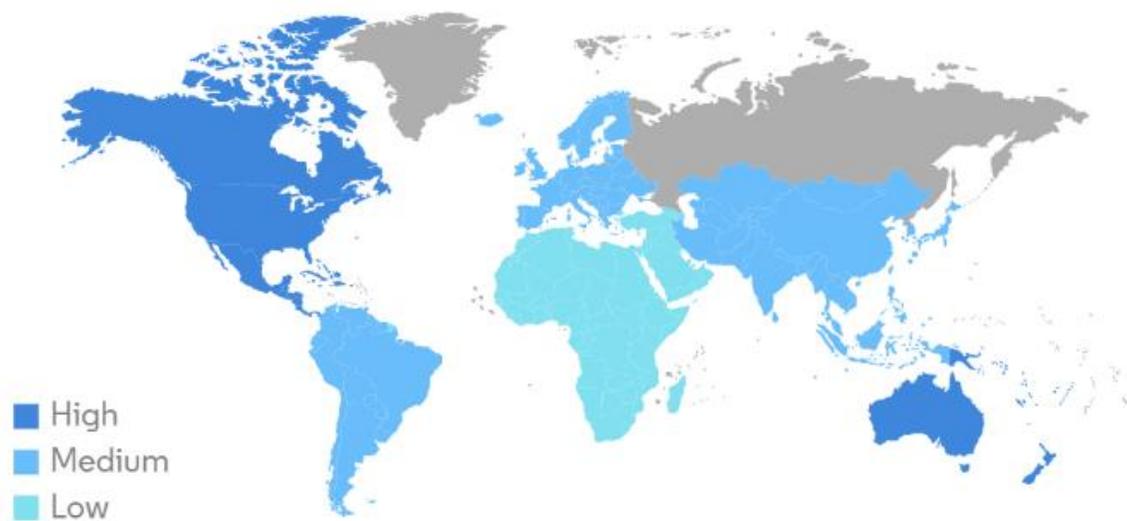

Figure 8. *Big Data Analytics in the Retail Market*

Source: *Mordor Intelligence, 2024.*

To gain a more specific perspective, the authors will analyze the Big Data applications of major retail players in Vietnam, especially with a particular focus on the WinMart retail system.

4.2.1. Big Data application of WinMart

WinMart and WinMart+ are the supermarket and minimart systems under WinCommerce JSC, a subsidiary of Masan Group (hereinafter referred to as WinMart). Since 2021, the company has taken bold steps toward transforming into a consumer-technology giant. Danny Le, CEO of Masan Group, stated: "Masan views its retail consumer platform as a place where we can leverage the best technologies to address major unmet needs and deliver superior benefits to consumers" (Masan Group, 2022).

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The first step in realizing this goal was Masan's focus on implementing a supply chain model integrated with AI and Big Data. In fact, even before Masan acquired the retail chain, VinCommerce had already laid the foundation with a strategic partnership agreement with XAct Solutions Company to implement the "Supply Chain Transformation Project" using the most advanced solutions (Tạp chí Công thương, 2019). VinCommerce developed a system of six nationwide distribution centers, categorized into dry, chilled, frozen, and cold storage warehouses to enhance product preservation quality. The company also adopted the Just-in-Time (JIT) delivery model to ensure optimal product distribution coverage while minimizing inventory levels. This approach allows for efficient, timely, and cost-effective product distribution across its 3,600 retail locations nationwide.

After being acquired by Masan, the company enhanced its system by establishing its own domestic logistics company, Supra, in March 2022. Although Supra has only been in operation for nearly two years, it has helped WinCommerce reduce logistics costs by up to 13% for goods delivered through its distribution center (DC) system. The Supra Transportation Technology (STT) system has been implemented to optimize transportation, automate route management, and track shipments, thereby improving logistics efficiency (CafeF, 2023). Additionally, Supra has developed 10 distribution centers, ensuring that 60% of the total volume of goods is transported through this system (Người Lao động, 2024). Thanks to Supra, Masan has finally started to "turn losses into profit" (Lao động, 2024) and increased product availability from 65% to 80% (Tạp chí Công thương, 2025).

Following this, Masan also prioritized partnerships with suppliers by establishing a strategic collaboration with Lazada, a major e-commerce platform in Southeast Asia under Alibaba (Masan Group, 2022). This partnership enables WinMart to supply goods for online orders at offline retail locations, optimizing the supply chain and providing a seamless shopping experience for customers. By leveraging the synergies between their supply and logistics platforms, both companies have optimized operations, reduced costs, and enhanced service quality for consumers. Subsequently, Masan invested $65 million to acquire a 25% stake in Trusting Social, a fintech company specializing in artificial intelligence (AI) and machine learning (ML), to develop the EVO credit card (Masan Group, 2022). This product not only provides credit limits but also

integrates the WIN membership card function from WinMart, helping personalize the shopping experience and strengthen customer engagement.

Big Data also enables WinMart to forecast customer purchasing demand. Additionally, Masan has made significant investments in developing a "spending power map" based on Big Data and AI, dividing Vietnam into approximately 33 million 100m x 100m grid squares (Masan Group, 2022). This system analyzes income levels, purchasing power, and other key criteria to determine optimal store locations, suitable product assortments, and the required inventory levels for each outlet. By leveraging this data-driven approach, Masan optimizes operating costs while ensuring that each store meets the specific demands of its surrounding area.

4.2.2. Big Data application of other retailers

WinMart has made successful strides, serving as a driving force for other domestic retail chains in adopting technology, particularly Big Data. One notable example is Saigon Co.op (including Co.opmart, Co.opXtra, and Co.op Food), a major retail chain primarily operating in the supermarket segment. In 2021, Saigon Co.op decided to implement various enterprise software solutions, such as the MMS retail system, ERP applications, OMNI channel sales platform, loyal customer management, and data management systems. Notably, the company partnered with Oracle Cloud, a leading cloud computing service provider, with implementation consultancy from KPMG, to develop a self-operating data warehouse project. This initiative enables advanced analytics, demand forecasting, and improved customer experience, thereby enhancing the brand's competitiveness (Tuổi trẻ, 2022). However, Saigon Co.op's operational model still relies on a traditional supply chain and inventory management system. Additionally, the company's *digital transformation process has been relatively slow*, unable to keep pace with the rapid evolution of technology (CafeF, 2023).

For *Bach Hoa Xanh*, a retail chain once expected to become the "Walmart of Vietnam," its biggest challenge has stemmed from its *inability to integrate technology into logistics*. At least twice, senior executives of The Gioi Di Dong have expressed concerns about the application of technology in grocery logistics, stating that "while the monthly product circulation volume for The Gioi Di Dong and Dien May Xanh is only 1.5 – 2.5 million products, at Bach Hoa Xanh, this figure reaches up to 150 million products. Increasing revenue through store space optimization is

meaningless if inventory cannot be delivered in full and managed effectively" (VietnamBiz, 2023). Furthermore, Bach Hoa Xanh's overly aggressive expansion strategy - without adequate technological development - led to poor management, excessive inventory, high logistics costs, and severe profit declines (CafeBiz, 2019). As a result, the company was forced to shut down multiple stores and is currently undergoing a complete restructuring of its system (Dân Việt, 2023).

For foreign retail systems, including Central Retail (BigC/GO!), Aeon Mall, and Lotte Mart, although they hold a smaller market share compared to domestic competitors, their large financial resources and prior experience in other markets have enabled them to implement AI and Big Data technologies earlier and more rapidly. For BigC/GO! (formerly part of France's Casino Group), it has been one of the longest-established supermarket chains in Vietnam, operating since 1998. Thanks to its early presence, BigC was able to build strong relationships with suppliers and gain high brand recognition among consumers (Dân trí, 2016). Central Retail, its later parent company, leveraged its extensive experience in the retail industry in Thailand and other Southeast Asian countries to drive BigC's digital transformation strategy. The company successfully integrated CRM systems to analyze consumer behavior across multiple sales channels and implemented an omnichannel sales platform (Central Retail). Additionally, Central Retail has developed Robotic Process Automation (RPA) solutions to handle various tasks, including accounting and auditing, reducing errors and operational costs (Akabot, 2021). BigC has also introduced an online grocery shopping feature via the Chopp app, allowing customers to place online orders and receive home delivery, meeting the growing demand for convenient shopping in modern retail (Central Retail, 2021). Similarly, Aeon Mall and Lotte Mart have also applied Big Data to their systems, such as customer data analytics platforms (The Saigon Times, 2019) and online shopping apps (LOTTE Mart Vietnam, 2023).

4.3. Comparision between the application of Big Data in Vietnamese retail enterprises and Walmart

Walmart has long been considered a pioneering model in applying Big Data in retail, while Vietnamese retailers are still in the early stages of this journey. The comparison below outlines key criteria:

4.3.1. Data Analytics Capabilities

Vietnamese retailers are gradually improving their analytics capabilities, but they still lag significantly behind Walmart. Currently, most Big Data projects in Vietnam focus on inventory and sales analysis to optimize operations. Big Data is used to forecast product trends, helping retailers manage inventory efficiently and minimize under- or overstocking (*Vietbiz.jp, 2023*). Some leading retailers are also leveraging customer data for basic personalization—for example, using chatbots on e-commerce platforms to collect feedback or recommend products based on previous purchases (*Vietbiz.jp, 2023*). However, overall data analysis is still limited to descriptive and simple predictive models, lacking the real-time, advanced forecasting capabilities seen at Walmart. The main reason is that most Vietnamese retailers only have moderate-sized data warehouses, and the process of integrating data from multiple sources (omnichannel, IoT, social media, etc.) is still ongoing.

Big Data in Vietnam is mainly used by large enterprises, while SMEs struggle due to limited resources and technical capacity (Vietbiz.jp, 2023). As a result, Vietnam's data analytics remains at a medium level, requiring time and investment to match Walmart's expertise. Retailers like Bach Hoa Xanh (BHX), Saigon Co.op, and foreign chains are still catching up, facing key challenges. BHX, despite high transaction volumes, lacked a strong data foundation during rapid expansion, leading to supply-chain inefficiencies, overstocking, and financial losses, forcing store closures in 2022 (CafeF.vn, 2022; VnExpress, 2023). Saigon Co.op has adopted ERP and CRM via Oracle Cloud for better customer and supply management, but its analytics remain basic, focusing on sales reporting rather than real-time demand prediction (Vietnam Investment Review, 2022).

Foreign retailers like Central Retail (GO!/BigC), Aeon Mall, and Lotte Mart leverage advanced global data platforms (CRM, AI, omnichannel), but struggle with localized consumer behavior and algorithm adaptation. Their insights are often centralized, limiting flexibility at the store level in Vietnam (Nikkei Asia, 2022).

4.3.2. Supply Chain Automation

Vietnamese retailers have recently begun integrating Big Data into supply chain management, showing progress but on a smaller scale. WinCommerce (WinMart) stands out with its Supply Chain Transformation Project, launched in 2019. By 2022, it established Supra, a logistics company with 10 distribution centers (DCs) nationwide, handling 60% of goods daily

(Baochinhphu.vn, 2023). AI-powered order planning, warehouse sorting, and route optimization helped reduce logistics costs by 13% and improve product availability. Real-time data from DCs enables Just-in-Time inventory, enhancing efficiency.

Outside WinCommerce, most domestic retailers still operate with semi-manual logistics systems. Bach Hoa Xanh (BHX) struggled with inventory planning during rapid expansion, leading to overstocking, spoilage, and high costs, which contributed to financial setbacks and store closures in 2022. While restructuring, BHX's logistics remain under redevelopment and lack full data integration (CafeF.vn, 2022). Saigon Co.op, despite adopting ERP and Oracle Cloud, still relies on periodic reports rather than real-time analytics, limiting its responsiveness (Vietnam Investment Review, 2022).

Foreign retailers like Aeon, Central Retail (GO!/BigC), and Lotte Mart have advanced global logistics systems but face challenges adapting to Vietnam. Their centralized models lack localized real-time control, slowing inventory and demand response. While investing in digital logistics, adoption at the local level remains inconsistent (Nikkei Asia, 2022; VIR, 2023).

4.3.3. Customer Experience Optimization

The application of Big Data to enhance customer experience in Vietnam's retail sector is still in its early stages, though some promising pilots have emerged. WinCommerce integrates its WIN membership card with AI/ML from Trusting Social to analyze shopping behavior and offer personalized promotions. Its EVO credit card combines loyalty and credit features for a seamless shopping experience. Some retailers are also testing IoT and facial recognition to identify VIP customers, notify staff, and provide tailored recommendations in real time (CafeF.vn, 2022).

Many supermarkets use mobile apps and kiosks for price checks, points, and personalized deals. Bach Ha Xanh has improved store layouts and service but lacks advanced CRM and targeted promotions. Saigon Co.op's Co.opSmile loyalty program captures purchase data but is mainly used for reporting rather than real-time AI-driven targeting.

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Overall, Vietnam's customer data systems remain fragmented, with limited advanced analytics. Retailers are still building foundational data platforms, and achieving Walmart-level hyper-personalization will require significant investment in technology and analytics.

4.3.4. Limitations of Vietnam Compared to Walmart in Applying Big Data

Despite recent progress, Vietnam's retail sector still faces several limitations compared to Walmart in the application of Big Data:

In Technology: Vietnam's Big Data infrastructure is still far behind that of Walmart. Most Vietnamese retailers lack real-time analytics systems or large-scale integrated data platforms. Data synchronization from sources like IoT, POS systems, and websites remains slow and suffers from high latency, leading to a less seamless "hyper-aware" shopping experience (*cafef.vn, 2022*). In contrast, Walmart operates a powerful SAP HANA in-memory supercomputer at its Data Café, capable of processing petabytes of data instantly, along with an internally developed and well-established IT infrastructure. The gap in analytics capabilities—especially in AI, machine learning, and private cloud computing—between Walmart and Vietnamese retailers remains substantial.

In Data Infrastructure: Vietnam lacks large, integrated data centers and warehouses like those of Walmart. Many Vietnamese retail companies still rely on third-party cloud services or traditional servers with limited scalability. Although Vietnam has seen rapid development in data center infrastructure in recent years (*Vietbiz.jp, 2023*), the domestic retail sector's capacity for storing and processing Big Data remains small in scale. By contrast, Walmart has built one of the largest private data infrastructures in the global retail industry, capable of storing tens of petabytes and integrating hundreds of real-time data streams. This disparity limits the speed and scale at which Big Data solutions can be deployed in Vietnam.

In Investment: Compared to Walmart—a financially powerful company willing to invest billions of USD in data technology—Vietnamese retailers still invest modestly in Big Data. Even the country's largest retail corporations have only invested a few million USD in IT and digital transformation. In 2021, global investment in retail store technology reached $2.2 billion in Q1 alone, a fourfold increase year-over-year (*cafef.vn, 2022*), reflecting the global push for technology in retail. While Vietnam has increased investments post-pandemic (especially in e-commerce), Big

Data budgets remain tight. This is partly due to concerns over ROI, a shortage of skilled personnel, and the low profit margins in Vietnam's retail market, which make large-scale tech investments difficult. As a result, the investment gap between Vietnam and Walmart remains significant—Walmart has even acquired data analytics startups (e.g., Inkiru) to strengthen predictive capabilities (*Projectpro.io, 2024*), something that very few Vietnamese companies have attempted.

In Human Resources and Analytical Skills: Vietnam faces a severe shortage of data science and Big Data analytics professionals, leading to underutilization in the retail sector. Many employees lack formal training, and SMEs struggle with limited resources, often relying on overworked, underqualified IT staff (Onesme.vn, 2024). In contrast, Walmart Labs attracts global talent and invests heavily in training, embedding data-driven decision-making at all levels. Additionally, language and tool barriers hinder adoption, as many Big Data platforms require deep technical expertise in English. This talent gap remains a major obstacle to fully leveraging Big Data in Vietnam, highlighting the urgent need for greater investment in training and talent acquisition.

4.4. Recommendations

To enhance operational efficiency and increase competitiveness in the retail industry, Vietnamese enterprises must focus on applying Big Data and AI to optimize supply chain management and inventory control. Investing in smart warehouses, IoT sensors, and real-time data systems will help minimize surplus or stock shortages, optimize product flow, and reduce operational costs.

Additionally, strengthening data connectivity with suppliers is essential to ensure stable supply sources, shorten replenishment times, and improve supply chain flexibility. Enterprises should develop a shared data platform that allows suppliers to track sales in real time, enabling more efficient production and distribution planning.

Personalizing the shopping experience based on customer data is also a key strategy for increasing competitiveness. Instead of applying generic promotions, businesses should leverage AI and consumer behavior analysis to recommend suitable products, personalize offers, and create more effective loyalty programs.

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Furthermore, optimizing logistics through technology will significantly reduce transportation costs and improve delivery speed. Retailers should invest in transport management systems (TMS), automate route coordination, and develop flexible delivery models to better meet customer demands in the rapidly growing e-commerce landscape.

Another crucial factor is developing an omni-channel retail model that integrates in-store sales with e-commerce. Establishing an efficient online sales system and synchronizing offline and online shopping data will help businesses maximize revenue and provide a seamless shopping experience.

Finally, retailers need to adjust pricing and operational strategies to maintain competitiveness, especially as the market sees increasing numbers of strong competitors. Optimizing procurement costs, developing private-label product lines, and leveraging technological advantages to cut operating expenses will help businesses achieve sustainable growth.

By effectively implementing these strategies, Vietnamese retail enterprises can improve operational performance, optimize costs, and expand market share, creating a solid foundation to compete in an increasingly dynamic market.

Conclusion

In conclusion, this study has explored the application of Big Data in Supply Chain Management (SCM), focusing on Walmart's innovative strategies and their implications for Vietnam's retail sector. Through an analysis of real-time data analytics, predictive inventory management, and AI-driven logistics, the research highlights how Big Data can optimize supply chain efficiency, reduce costs, and improve customer satisfaction. Walmart's ability to integrate data-driven decision-making, automation, and supplier collaboration has solidified its position as a global leader in retail logistics.

The study also examined the current state of Big Data adoption in Vietnam's retail industry, with a particular focus on WinMart and Bach Ha Xanh. While these companies have made notable advancements in digital transformation, challenges such as fragmented data systems, limited

automation, and inefficient logistics networks continue to hinder the full potential of Big Data in Vietnam's retail supply chains. The comparison between Walmart and Vietnamese retailers underscores the urgent need for enhanced technological investment and data-driven strategies to remain competitive in the evolving market landscape. Moreover, this research underscores the broader significance of Big Data in modern supply chain operations, demonstrating its role in enhancing operational resilience, improving demand forecasting, and fostering a more adaptive retail ecosystem. As the global retail industry continues to evolve, Vietnamese retailers must accelerate their adoption of advanced data analytics, IoT-based logistics, and AI-driven inventory management to remain competitive. By implementing automated supply chain solutions, real-time data integration, and predictive analytics, businesses in Vietnam can enhance efficiency, reduce costs, and build more sustainable and competitive supply chains.

The insights presented in this study contribute to both theoretical understanding and practical applications of Big Data in SCM. As technological advancements continue to reshape global commerce, future research should explore emerging innovations, case studies in diverse retail environments, and the long-term impact of Big Data-driven supply chain transformation. By continuously evolving and embracing data-driven strategies, Vietnam's retail industry can achieve a more dynamic, efficient, and customer-centric supply chain ecosystem.

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