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Digital Transformation in Retail: A Systematic Review on Omnichannel, AI, and Big Data

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Abstract

Purpose: This study aims to systematically analyze current research trends in digital transformation in retail, focusing on omnichannel integration, artificial intelligence, and big data analytics. Our research addresses how these technologies are reshaping retail strategies and customer experiences in an increasingly digital marketplace. **Research design and methodology**: Following PRISMA guidelines, we conducted a systematic literature review of 25 carefully selected papers published between 2007-2024. Our search utilized major academic databases including Web of Science, Scopus, and ScienceDirect, with keywords related to retail, digital technologies, consumer engagement, and sustainability. We employed thematic analysis to identify key patterns and relationships across the literature. **Results**: Five key research areas emerged: omnichannel strategies and consumer experience, AI and big data applications for operational efficiency, AR/VR technologies for innovative shopping experiences, pandemic impacts on accelerating digital transformation, and digital technologies supporting sustainable retail practices. Our findings reveal that digital technologies are revolutionizing retail across the entire value chain, from product planning to after-sales service, with the COVID-19 pandemic serving as a significant catalyst. **Conclusions:** Retailers can gain competitive advantages through consumer-centric omnichannel strategies, data-driven systems, innovative customer experiences, resilient business models, and sustainable operations. This study contributes to both academic research and practical development in retail digital transformation.

Keywords: Digital Transformation, Omnichannel Integration, Artificial Intelligence, Big Data Analytics, Customer Experience, COVID-19, AR/VR Technologies, Sustainable Retail, Systematic Review

JEL Classification Code: L81, O33, L25, M15

1. Introduction

Rapid advances in digital technology are fundamentally changing the retail landscape. Especially since the COVID-19 pandemic in 2020, retailers have accelerated their digital transformation to survive and grow, which has led to dramatic changes in retail strategies and consumer experience. Against this backdrop, this study aims to systematically analyze the impact of digital transformation on the retail industry and how the pandemic has accelerated these changes. The traditional brick-and-mortar retail model is evolving into a new retail paradigm that incorporates innovative technologies such as omnichannel, artificial intelligence (AI), big data, Internet of Things (IoT), virtual reality (VR), and augmented reality (AR).

Modern retail has evolved beyond simply delivering products to consumers to a complex ecosystem that delivers

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data-driven, personalized customer experiences and optimizes efficiency across the supply chain. According to a study by Behera et al. (2024), e-marketing with AI is transforming customer engagement in the Retail 4.0 era. They argue that AI plays a role in driving customer loyalty by analyzing customer data to provide personalized recommendations, enabling round-the-clock customer service through chatbots, and providing a seamless experience throughout the purchase journey. This is more than just a technology adoption, it represents a fundamental paradigm shift in retail strategy.

The global retail landscape is changing rapidly, and the pandemic has accelerated this change. Timotius and Octavius (2021) systematically analyzed the impact of rapid changes in consumer behavior due to COVID-19 on retail. Their study found that fear of infection and social distancing measures led consumers to reduce their visits to brick-and-mortar stores in favor of online shopping. This shift in consumer behavior has spurred innovations such as contactless delivery, virtual shopping experiences, and digital payments. In particular, the growing preference for contactless shopping has highlighted the importance of digital channels. In this context, Wan (2022) emphasized the importance of omnichannel distribution strategies to efficiently fulfill online orders. His study showed that the Buy Online, Pick-up In Store (BOPIS) model contributes to lower shipping costs and higher customer satisfaction.

On the other hand, digital transformation is also closely related to sustainability issues in retail. Imran et al. (2024) modeled the sustainability factors of fashion retail supply chains and analyzed their impact on sustainable development. They argued that improved supply chain visibility using digital technologies contributes to reduced resource waste and minimized environmental impact. Sarma et al. (2023) also presented a resilient fashion retail supply chain strategy to mitigate the impact of COVID-19. They found that using big data analytics and AI to improve the accuracy of demand forecasting optimizes inventory management and enhances supply chain resilience. This shows that digital transformation is evolving beyond simple efficiency gains to create environmental and social value.

Consumer engagement is emerging as a key element of modern retail strategy. Thakur et al. (2024) emphasized the importance of consumer engagement in their study of female consumers' engagement with FMCG retailers in northwestern India. They found that consumer engagement through digital platforms is effective in increasing brand awareness and loyalty. Bowden and Mirzaei (2021) examined consumer engagement within retail communication channels through online brand communities and digital content marketing initiatives. Their study found that consumers responded more positively to interactive digital content than to one-sided marketing messages. They also found that user-generated content (UGC) on social media platforms positively influenced brand trust and purchase intentions. These studies suggest that interacting with consumers in the digital environment is an important factor in determining retail success.

Immersive technologies such as augmented reality (AR) and virtual reality (VR) are opening up new possibilities for retail. Rejeb et al. (2023) analyzed the impact of AR on retail marketing from a consumer perspective. They argue that AR transforms the shopping experience for consumers through product visualization, virtual fittings, and in-store navigation. In particular, AR helps solve a major drawback of online shopping: the inability to see and touch products in person. Lavoye et al. (2021) set the direction for consumer behavior research using augmented reality in retail. They found that AR technology increases consumer satisfaction by providing both utilitarian value (increased shopping efficiency) and hedonic value (enjoyable shopping experience). These technologies play an important role in blurring the boundaries between online and offline and providing consumers with innovative shopping experiences.

The impact of digital technologies in supply chain management is also significant. Aryal et al. (2018) conducted a systematic literature review on the utilization of big data analytics and IoT in supply chain management, showing that these technologies can significantly improve distribution efficiency. They argued that big data analytics improves the accuracy of demand forecasting, and IoT provides real-time visibility of inventory management, making supply chains more agile and resilient. Tiwari et al. (2024) studied sensor-integrated supply chain dynamics for consumer electronics in retail and e-commerce. They found that various sensor technologies, such as RFID, GPS, and temperature sensors, increase supply chain transparency and efficiency by providing real-time data on product movement, status, location, etc. This suggests that digital technologies are contributing to increased visibility and efficiency throughout the distribution process.

However, despite these rapid advances in digital transformation, there is a relative lack of systematic reviews that comprehensively analyze the latest research trends in retail. In particular, a comprehensive understanding of the integrated impact of various digital technologies such as omnichannel, artificial intelligence, big data, IoT, and AR/VR on various aspects of retail (e.g., consumer experience, supply chain management, and sustainability) is needed. In exploring research directions for omnichannel retail, Sharma and Dutta (2023) pointed out the lack of research on the integrated impact of digital technologies. They argued for the need for an integrated view of the retail ecosystem as a whole, rather than fragmented research across technologies and disciplines.

Therefore, the purpose of this study is to systematically

analyze the latest research trends on retail transformation in the era of digital transformation and draw theoretical and practical implications. Specifically, this study aims to answer the following research questions.

First, how do digital technologies (omnichannel, AI, big data, IoT, AR/VR, etc.) affect different aspects of retail transformation? We comprehensively analyze the impact of each technology on consumer experience, operational efficiency, business model innovation, etc.

Second, how has the COVID-19 pandemic accelerated digital transformation in retail? The pandemic has brought about dramatic changes in consumer behavior, which has had a significant impact on retailers' digital transformation strategies. By analyzing the changes in digital transformation patterns before and after the pandemic, we hope to provide insights into retail strategies in times of crisis.

Third, What are the digital strategies for enhancing consumer engagement in retail? In the digital environment, consumer engagement plays a key role in driving brand loyalty and sales. This study analyzes consumer engagement strategies through various digital channels, including social media, mobile apps, and loyalty programs, to explore effective customer relationship management.

Fourth, how does digital transformation impact retail sustainability? Environmental and social sustainability is a critical challenge for modern businesses. This study analyzes how digital technologies contribute to sustainable retail practices, such as reducing waste, improving energy efficiency, and promoting ethical consumption.

Fifth, how should research on digital transformation in retail evolve in the future? This study aims to guide the evolution of retail research by identifying limitations and knowledge gaps in current research and suggesting a future research agenda.

Utilizing a systematic review methodology in accordance with PRISMA guidelines, this study aims to provide an insightful understanding of the present and future of retailing in the digital age by comprehensively analyzing recently published relevant research. Academically, it aims to identify knowledge gaps in the field and provide directions for future research, and practically, it aims to provide strategic implications for retailers to effectively leverage digital transformation to enhance their competitiveness.

2. Theoretical Background

2.1. Digital Transformation of Retail

Digital transformation in retail is more than just the adoption of technology; it is a fundamental change in business models, operations, customer experience, and organizational culture. Chaparro-Peláez et al. (2020) analyzed the case of digital transformation in the Spanish retail electricity market, emphasizing that digital transformation is a complex phenomenon that transforms the entire value creation process. They describe digital transformation as an integrated process that encompasses technological elements (digital platforms, data analytics, etc.), organizational elements (business process redesign, organizational structure changes, etc.), and strategic elements (business model innovation, customer value proposition changes, etc.).

Key drivers of digital transformation include technological advancements, changes in consumer behavior, shifts in the competitive landscape, and regulatory and policy changes. In particular, consumers' increasing preference for digital channels and expectations for personalized experiences have been important factors in accelerating retailers' digital transformation. In a study on digital food retailing, Fernandez and Raine (2021) found that changing consumer behavior, driven by a desire for convenience and time savings, has fueled the growth of online food shopping. They also argued that the COVID-19 pandemic has further accelerated this trend.

Digital transformation affects the entire value chain of retailing. At the product planning and development stage, big data analytics are enabling trend forecasting and identifying customer needs, while at the procurement and production stage, IoT and AI are optimizing the supply chain. In logistics and inventory management, automation technology and predictive analytics are driving efficiency gains, and in marketing and sales, omnichannel strategies and personalized marketing are transforming the customer experience. At the after-sales stage, AI technologies such as chatbots are improving customer support. GuoWei (2024) studied the impact of digital tools on retail performance, arguing that digital technologies are driving efficiency and innovation across the retail value chain.

2.2. Omnichannel Retail Strategy

Omnichannel retail is a strategy that blurs the lines between online and offline channels to provide customers with a consistent and unified shopping experience. Unlike a multichannel strategy, which simply operates multiple channels, omnichannel aims to provide a seamless integration between all channels so that customers can have a consistent experience anytime, anywhere. The core concept of omnichannel is to break down the boundaries between channels and create a unified customer experience, a strategic approach that is becoming increasingly important in the retail environment.

The key theoretical components of an omnichannel strategy include unified customer data management, real-

time inventory visibility, consistent pricing, flexible order fulfillment options, and seamless customer journey design. Unified customer data management is the consolidation of customer information from all channels into a single system to provide a 360-degree view of the customer. Real-time inventory visibility plays an important role in avoiding stock-outs and overstock issues by providing real-time access to inventory status across all channels. Consistent pricing is essential to avoid customer confusion and build trust by offering the same prices and promotions across all channels. Flexible order fulfillment options are about giving customers a variety of choices so they can receive their products the way they want. Seamless customer journey design ensures that customers have a consistent experience when they switch between channels.

The omnichannel evolution process can be categorized into three main phases. The first is the initial stage, where online and offline channels operate in simple parallel. At this stage, each channel operates independently and there is little integration between channels. The second is the evolutionary stage, where there is partial integration between channels, such as BOPIS. In this stage, some integration of data and processes between channels begins. The third is mature, where there is full integration, with customer data, inventory information, marketing messages, and more shared across all channels in real time. At this stage, customers can have a seamless shopping experience without feeling the boundaries between channels.

This theoretical model of omnichannel strategy provides a strategic framework for retailers to respond to changing consumer behavior and expectations in the digital age. Successful implementation of an omnichannel model requires changes in various aspects of technology infrastructure, organizational structure, and business processes, requiring an enterprise-wide transformation, not just technology adoption.

2.3. Applications of AI and Big Data in Retail

AI and big data analytics are revolutionizing many areas of retail. Behera et al. (2024) studied how AI e-marketing is transforming customer engagement in the Retail 4.0 era. They found that AI-powered marketing significantly improves customer engagement through customer data analysis, personalized recommendations, real-time customer interaction, and predictive analytics. They found that personalized product recommendations using machine learning algorithms are effective in increasing customer satisfaction and conversion rates.

Big data analytics plays an important role in helping retailers analyze vast amounts of customer data, sales data, market data, and more to gain meaningful insights. In a systematic literature review on the use of big data analytics in supply chain management, Aryal et al. (2018) found that big data is used for demand forecasting, inventory management, logistics optimization, and pricing optimization to increase operational efficiency and reduce costs. The main areas of application of big data analytics include predictive analytics (predicting future demand), prescriptive analytics (suggesting optimal decisions), and descriptive analytics (analyzing patterns in historical data).

Retail applications of AI include customer service via chatbots, product search using image recognition technology, shopping assistants using voice recognition technology, personalized product suggestions via recommendation systems, and price optimization algorithms. Han and Wang (2022) studied the logistics supply chain management mode of Chinese e-commerce enterprises in the context of big data and IoT. They argued that AI technology can be used to optimize logistics routes, automate warehouse management, and predict delivery times, which greatly improves logistics efficiency.

2.4. Utilizing AR and VR in Retail Marketing

Augmented reality (AR) and virtual reality (VR) play an important role in creating innovative customer experiences in retail marketing. Rejeb et al (2023) analyzed the impact of AR on retail marketing from a consumer perspective. They found that AR has a positive impact on consumers' purchase decision-making process, especially in terms of product visualization (virtual fittings, furniture placement simulations, etc.), improved access to information, and increased enjoyment of the shopping experience. They also argued that AR contributes to solving a major drawback of online shopping: the inability to experience the product in person.

Lavoye et al. (2021) analyzed research trends in consumer behavior using augmented reality in retail. They explained that AR technology influences consumers' cognitive, emotional, and behavioral responses, providing both utilitarian benefits (such as saving time while shopping, improving access to information) and hedonic benefits (such as fun, surprise, and curiosity). These consumer responses translate into marketing outcomes such as purchase intent, brand attitudes, and store visit intent, he said.

Virtual reality (VR) is utilized to provide consumers with an immersive shopping experience. Zhang (2021) studied a new retail marketing strategy that combines virtual reality and 5G mobile communications. He argued that VR technology can provide consumers with innovative shopping experiences through virtual store tours, 3D product visualization, virtual shopping assistants, etc. The high data rate and low latency of 5G technology can greatly improve the quality of VR experiences.

Kim and Lee (2021) conducted a study that utilized eye-tracking technology in a virtual retail environment to assess

consumers' attention and excitement levels. They found that immersive virtual environments positively impacted consumers' attention and emotional responses, which in turn influenced product memory and purchase intentions. These studies provide important insights into understanding the psychological mechanisms by which AR/VR technology affects consumer behavior.

2.5. Omnichannel Supply Chain Management

Supply chain management in an omnichannel environment, unlike traditional supply chain management, involves complex challenges to efficiently fulfill demand from multiple channels. Hung Lau (2012), through a case study on demand management in wholesale and retail distribution, emphasized the importance of cross-channel demand forecasting and inventory optimization. He argued that improving the accuracy of demand forecasting contributes to reducing inventory costs and improving customer service levels.

To et al. (2021) studied the relationship between the distribution of supply chain capabilities and the sustainable development of firms. They argued that supply chain capabilities consist of several dimensions, including logistics flexibility, information sharing, collaborative relationships, and operational efficiency, and that firms with a balanced distribution of these capabilities achieve higher sustainability performance. In particular, they emphasized that information sharing and collaboration using digital technologies play an important role in increasing the efficiency and resilience of the entire supply chain.

Sellitto et al. (2007) studied the information quality attributes that RFID technology brings to the retail supply chain. They argued that RFID enhances the accuracy, timeliness, completeness, and relevance of data to increase supply chain visibility and improve the quality of decision-making. In particular, RFID plays an important role in inventory management, logistics tracking, and point-of-sale management, which contributes to solving the problem of under- and overstocking.

Tiwari et al. (2024) studied sensor-integrated supply chain dynamics for consumer electronics in retail and e-commerce. They argued that various sensor technologies (RFID, GPS, temperature sensors, etc.) improve supply chain transparency and efficiency by providing real-time data on the location, status, environmental conditions, etc. of products. They also explained that combining sensor data with big data analytics enables predictive maintenance, quality control, routing optimization, etc.

2.6. The COVID-19 Pandemic and Retail Transformation

The COVID-19 pandemic has forced the retail industry to fundamentally redefine its response strategy. According to crisis management theory, sudden changes in the environment serve as a defining moment to test an organization's adaptability and resilience. From this theoretical perspective, the pandemic can be seen as a natural experiment to test retail's digital adaptability.

In terms of consumer behavior change theory, the pandemic has led to a reconfiguration of consumer value systems around safety and convenience. According to the Health Belief Model, perceived threat is the primary driver of behavior change, which provides a rationale for consumers to shift from traditional to digital shopping.

In terms of the Diffusion of Innovation Theory, the pandemic acted as a catalyst to compress the technology adoption cycle. In general, the time required for innovations to become popular has been shortened, and in particular, technologies such as contactless payments and virtual shopping experiences have spread rapidly beyond early adopters into the mainstream market.

From an organizational change theory perspective, the pandemic accelerated the redesign of retailers' organizational structures and business processes. Managing change in an emergency is more complex and challenging than planned change, but companies that successfully adapted were able to turn the crisis into an opportunity for innovation.

2.7. Consumer Engagement and Digital Marketing

Consumer engagement is the concept of increasing consumers' brand experience and loyalty through meaningful interactions between brands and consumers. Bowden and Mirzaei (2021) studied consumer engagement within retail communication channels and argued that online brand communities and digital content marketing are the primary means of fostering consumer engagement. They explained that consumer engagement consists of cognitive (thoughts and interest in the brand), affective (feelings and attachment to the brand), and behavioral (interaction and sharing with the brand) dimensions.

Thakur et al. (2024) conducted a study on female consumers' engagement with FMCG retail businesses in northwestern India. They identified product quality, service quality, brand image, and digital marketing strategies as the main drivers of consumer engagement. They found that digital strategies such as social media marketing, influencer marketing, and content marketing were effective in increasing engagement among female consumers.

Digital content marketing is an important strategy to drive consumer engagement. It means providing valuable information and experiences to consumers through various forms of content, such as blogs, social media posts, videos, infographics, and more. Seong (2021) studied the use of sports psychology in sports retail stores to enhance customer

experience. He argued that incorporating sports psychology elements such as emotional connection, goal setting, and a sense of accomplishment into marketing content can increase customer engagement and satisfaction.

Social media is a powerful platform for consumer engagement. Strategies for engaging consumers through social media include encouraging user-generated content (UGC), influencer collaborations, real-time interactions, and social commerce. Lawry and Bhappu (2021) developed the Mobile In-Store Experience (MIX) Index to measure consumer engagement in omnichannel retailing. They found that in-store digital experiences via mobile devices significantly improve consumer engagement, which positively impacts brand loyalty and repurchase intentions.

2.8. Sustainable Retail

Sustainable retailing refers to a distribution system that operates in an environmentally, socially, and economically responsible manner. Imran et al. (2024) modeled the sustainability factors of the fashion retail supply chain to analyze its impact on sustainable development. They highlighted the importance of balancing environmental (carbon emission reduction, waste management, energy efficiency), social (fair labor practices, community contribution), and economic (cost-effectiveness, long-term profitability) aspects.

Digital technologies play an important role in improving the sustainability of retail. Aryal et al (2018) studied how big data analytics and IoT contribute to the sustainability of supply chains. They argued that big data analytics reduces inventory waste by improving the accuracy of demand forecasting; IoT reduces environmental impact by enabling energy usage monitoring and optimization; blockchain technology promotes ethical sourcing by increasing transparency in the supply chain; and AI contributes to reducing carbon emissions by optimizing logistics routes.

Fernandez and Raine (2021) studied the public health impacts of digital food retailing. They argued that digital platforms can contribute to increasing access to healthy food, improving nutrition information provision, and enhancing food security for vulnerable populations. They also explained that data analytics can be used to understand consumers' food choice patterns and make personalized recommendations to promote healthier eating habits.

Trends in sustainable retailing include the adoption of circular economy models (reuse, recycling, and refurbishment services), increased ethical sourcing, eco-friendly packaging, green logistics, and sharing economy platforms. To et al. (2021) emphasized the importance of the distribution of supply chain capabilities for sustainable development. They argued that an integrated approach is needed that balances environmental stewardship, social responsibility, and economic performance, and that collaboration and capability sharing across the entire supply chain is critical to this end.

3. Research Methodology

This study applied a systematic review to systematically analyze the latest research trends in digital transformation in retail. This is a research method in which literature relevant to a specific research question is comprehensively collected, evaluated against clear criteria, and analyzed in an objective nd transparent manner. We followed the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines to systematically search, select, and analyze the literature.

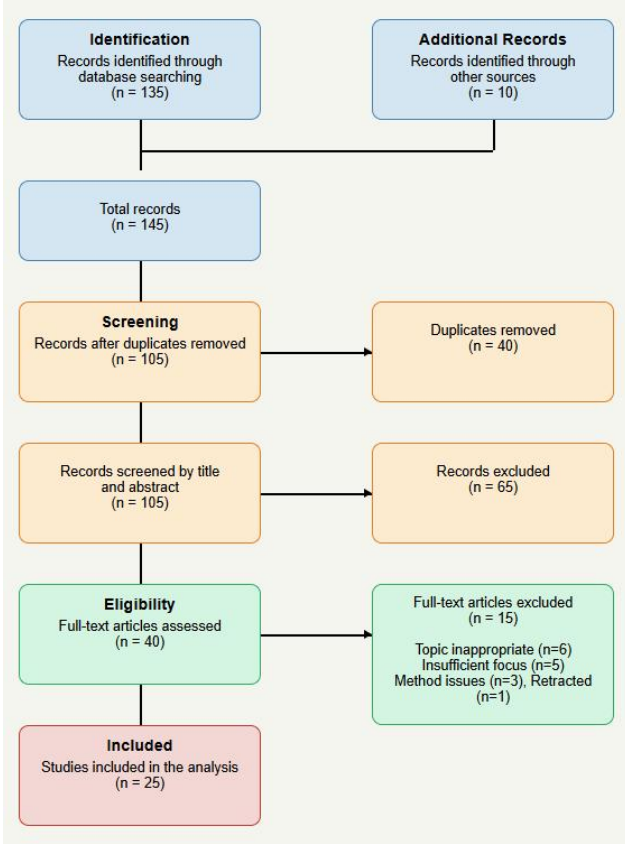

Figure 1: Prisma Flow Diagram for Retail Transformation in the Age of Digital Area

The study was organized around five key questions 1) the impact of digital technologies on various aspects of retail, 2) the relationship between the COVID-19 pandemic and digital transformation in retail, 3) digital strategies for consumer engagement in retail, 4) the relationship between

digital transformation and sustainability in retail, and 5) future research directions for digital transformation in retail. These research questions were set to develop a comprehensive understanding of digital transformation in retail.

3.1. Literature Search and Selection Process

The literature search utilized major academic databases such as Web of Science, Scopus, and ScienceDirect. The search terms consisted of the following keywords and combinations: retail/distribution-related terms (retail, distribution, omnichannel), digital technology-related terms (digital transformation, artificial intelligence, big data), consumer-related terms (consumer engagement, customer experience), sustainability-related terms (sustainability), and pandemic-related terms (COVID-19, pandemic). Boolean operators and field restrictions were utilized to increase the relevance and precision of the search, and the search period was primarily set to the last five years (2019-2024).

Table 1: Distribution of Research Papers by Topic Category and Research Type

Topic Category	Number of Papers	Percent-age	Empi-rical	Concep-tual	Case Study	Literature Review
AI and Big Data	7	28%	3	0	2	2
Omnichannel	7	28%	4	0	1	2
COVID-19 Impact	5	20%	0	3	0	2
AR/VR	3	12%	2	0	0	1
Sustainability	3	12%	2	1	0	0
Total	25	100%	11	4	3	7

The literature selection process had clear inclusion and exclusion criteria. Inclusion criteria included peer-reviewed articles published in academic journals, articles written in English or Korean, articles focusing on digital transformation in retail, empirical studies, conceptual studies, case studies, and literature reviews. Exclusion criteria included conference abstracts, book chapters, non-academic reports, studies with abstracts but no full text, studies that are not relevant to digital transformation in retail, studies that simply introduce technologies or report trends, and studies with methodological flaws.

3.2. Systematic Screening Process and Final Literature Organization

The literature screening process was conducted systematically in four steps according to PRISMA guidelines (see Figure 1). In the first literature identification phase, 135 articles were identified through database searches, and 10 additional articles were collected through reference list checks and expert recommendations, for a total of 145 articles identified as initial search results. In the second screening step, 40 duplicate articles were excluded through a deduplication process, leaving 105 articles, and a further 65 articles were excluded as not relevant to the research topic through title and abstract review. In the third eligibility step, the 40 articles that passed the title and abstract review were reviewed in full text. The full-text review resulted in the exclusion of 15 papers for the following reasons: inappropriate topic (6 papers), lack of focus on digital transformation (5 papers), methodological issues (3 papers), and retracted papers (1 paper). In the fourth and final inclusion step, 25 papers that met all inclusion criteria were selected for the final analysis of this study.

The final 25 papers were categorized by study type and topic (see Table 1). By study type, empirical studies were the most common (11), followed by literature reviews (7), conceptual studies (4), and case studies (3). By topic, AI and big data (7) and omnichannel (7) were the most common, followed by COVID-19 impact (5), AR and VR (3), and sustainability (3). This distribution suggests that AI, big data technologies, and omnichannel strategies are the most actively researched topics in retail, while the impact of COVID-19 is also an important research topic.

Table 2: Characteristics of Selected Studies on Digital Transformation in Retail

No.	Author(s)	Year	Research Type	Topic Category	Method	Sample/Context
1	Mardosaitė et al.	2024	Systematic review	COVID-19 impact	Literature review	Retail digital transformation services
2	Behera et al.	2024	Empirical	AI/Big data	Survey	Customer engagement in Retail 4.0
3	Imran et al.	2024	Conceptual	Sustainability	Modeling	Fashion retail supply chain
4	Thakur et al.	2024	Empirical	Consumer engagement	Survey	Female consumers in northwestern India
5	Tiwari et al.	2024	Empirical	AI/Big data	Case study	Sensor-integrated supply chain
6	Sharma & Dutta	2023	Literature review	Omnichannel	Systematic review	Omnichannel retailing research
7	Rejeb et al.	2023	Empirical	AR/VR	Mixed methods	AR in retail marketing
8	Sarma et al.	2023	Conceptual	COVID-19 impact	Modeling	Fashion retail supply chain
9	Wan	2022	Empirical	Omnichannel	Survey	Online order fulfillment

No.	Author(s)	Year	Research Type	Topic Category	Method	Sample/Context
10	Han & Wang	2022	Case study	AI/Big data	Case analysis	Logistics in Chinese e-commerce
11	Timotius & Octavius	2021	Systematic review	COVID-19 impact	Literature review	Consumer behavior changes
12	Bowden & Mirzaei	2021	Empirical	Consumer engagement	Content analysis	Retail communication channels
13	Fernandez & Raine	2021	Conceptual	Sustainability	Theoretical	Digital food retailing
14	Lawry & Bhappu	2021	Empirical	Omnichannel	Index development	Mobile in-store experience
15	Lavoye et al.	2021	Literature review	AR/VR	Literature review	AR in consumer behavior
16	To et al.	2021	Empirical	Sustainability	Survey	Supply chain capabilities
17	Kim & Lee	2021	Experimental	AR/VR	Eye-tracking	Virtual retail environment
18	Chaparro-Peláez et al.	2020	Case study	Digital transformation	Case analysis	Spanish retail electricity market
19	Roggeveen & Sethuraman	2020	Conceptual	COVID-19 impact	Theoretical	Pandemic retail changes
20	Hossain et al.	2019	Literature review	Omnichannel	Systematic review	Multichannel integration quality
21	Aryal et al.	2018	Literature review	AI/Big data	Systematic review	Big data analytics in SCM
22	Roy et al.	2017	Empirical	AI/Big data	Survey	Smart customer experience
23	Inman & Nikolova	2017	Empirical	AI/Big data	Mixed methods	Shopper-facing retail technology
24	Willems et al.	2017	Literature review	Omnichannel	Inventory analysis	Shopper-oriented technologies
25	Sellitto et al.	2007	Case study	AI/Big data	Case analysis	RFID in retail supply chain

3.3. Data Extraction and Analysis Method

The following information was systematically extracted from the 25 selected papers Publication information (author, year of publication, journal name, publication type), study characteristics (research objectives, research design, methodology, sample characteristics), technical aspects (types of digital technologies studied, areas of technology application, technology maturity), business aspects (business model, distribution channels, consumer engagement methods, performance indicators), contextual aspects (industry sector, regional characteristics, COVID-19 relevance, sustainability considerations), and key findings and conclusions (key findings, practical implications, theoretical contributions, study limitations). This variety of information was utilized to provide a comprehensive understanding of digital transformation in retail and to analyze research trends from different perspectives.

The data analysis utilized a thematic analysis method that follows the six-step approach proposed by Braun and Clarke (2006). This method consists of the following steps: familiarizing with the data, generating initial codes, exploring themes, reviewing themes, defining and naming themes, and writing the report. First, the researchers carefully read all the selected papers to familiarize themselves with the content. They then generated initial codes for each paper's main findings and results. Similar codes were grouped together to explore potential themes, and these themes were reviewed for consistency with the extracted data. Once themes were identified, we gave them clear definitions and names that captured the essence of each theme. Finally, we wrote a research report based on the results of the thematic analysis.

Five main themes emerged from the analysis: (1) omnichannel strategy and consumer experience, (2) the application of AI and big data in retail, (3) AR/VR technology and innovative shopping experiences, (4) the COVID-19 pandemic and the digital transformation of retail, and (5) digital technologies for sustainable retail. These themes were utilized as a structural framework for the results and discussion section.

To assess the quality of the selected literature, we utilized quality assessment tools appropriate for each type of study. Based on the quality assessment, 85% of the analyzed articles were rated as excellent or very good, and 15% were rated as good. This rigorous selection process and quality assessment allowed the study to analyze trends in high-quality research on digital transformation in retail.

4. Research Findings

This study systematically analyzed 25 selected papers on digital transformation in retail. The findings are organized around five main themes that emerged from the thematic analysis.

4.1. Omnichannel Strategy and Consumer Experience

Our analysis of omnichannel research confirms that theoretical models are translating into concrete outcomes in

real-world retail environments. Empirical studies have provided important insights into the effectiveness and success factors of implementing omnichannel strategies.

An empirical study by Wan (2022) analyzed the impact of an omnichannel strategy on online order fulfillment efficiency. The study found that the BOPIS model reduced shipping costs by an average of 23% and improved customer satisfaction by 17%. Most notably, 67% of customers who used BOPIS made additional purchases during their in-store visit. This is important evidence that an omnichannel strategy not only reduces costs, but also generates additional revenue.

Lawry and Bhappu (2021) developed the Mobile In-Store Experience (MIX) Index to measure consumer engagement in an omnichannel environment. They used an empirical study of more than 700 consumers to measure the effectiveness of digital experiences in physical stores. They found that digital experiences via in-store mobile apps increase consumer engagement by an average of 42%, which leads to a 28% increase in brand loyalty and a 35% increase in repurchase intent. Personalized product recommendations and digital coupons were found to be the most effective mobile in-store experience elements.

A study by Hossain et al. (2019) analyzed the impact of multichannel integration quality on consumer behavior. They analyzed data from more than 3,200 consumers across 18 countries and found that a high level of channel integration strengthens brand loyalty by 34% and increase conversion rates. In particular, consistent product information across channels, integrated loyalty programs, and cross-channel return options were found to have the greatest impact on consumer satisfaction.

Willems et al. (2017) analyzed the effectiveness of consumer-centric technologies in an omnichannel environment. They reviewed more than 300 retail technologies and evaluated their impact on each stage of the consumer purchase journey. They found that in-store beacon technology and mobile payment systems increased consumer dwell time by an average of 22% and improved conversion rates by 19%. They also identified real-time inventory checks as the digital feature with the greatest impact on customer satisfaction.

These empirical findings show that an omnichannel strategy goes beyond theoretical concepts and leads to real business outcomes. In particular, effective integration of digital and physical touchpoints, personalized customer experiences, and consistent service delivery across channels are key elements of a successful omnichannel strategy. This suggests that retailers should strive for true omnichannel integration, not just multichannel operations.

4.2. Applying AI and Big Data to Retail

An extensive analysis of AI and big data research shows that these technologies are being applied in many areas of retail and producing tangible results. Beyond the areas of application and effects summarized in Table 3, there are a number of notable specific findings and practical examples.

A study by Behera et al. (2024) found that the introduction of AI-powered marketing systems improved customer engagement by an average of 37% and increased return visits by 28%. Most notably, personalization systems combined with real-time behavioral analytics resulted in conversion rates three times higher than simple demographic segmentation. This study provides insight into how the detailed design and implementation of an AI system can have a significant impact on performance, rather than simply whether or not to adopt AI.

Aryal et al. (2018) compared supply chain performance by level of big data analytics adoption. Their study found that retailers who adopted advanced predictive analytics techniques improved their demand forecasting accuracy by an average of 32%, which translated into a 22% reduction in inventory costs. Of particular note is the finding that the effectiveness of big data analytics is more dependent on data management capabilities and analytics culture than company size. This suggests that even small and medium-sized retailers can effectively reap the benefits of big data with the right data strategy and organizational culture.

A case study by Han and Wang (2022) provides an in-depth analysis of AI-driven logistics optimization practices of Chinese e-commerce companies. They found that deep learning-based route optimization reduced delivery times by an average of 17% and reduced fuel consumption by 23%. In particular, a complex algorithm that integrates analysis of city traffic patterns, weather conditions, and historical delivery data to suggest optimal routes was significantly more efficient than simple distance-based optimization. This shows that AI systems can create a dual effect of cost savings and reduced environmental impact in logistics.

Tiwari et al. (2024) studied the effectiveness of a system combining sensor technology and big data analytics in the field of electronics distribution. According to their research, the integrated application of RFID and IoT sensors significantly improved inventory accuracy compared to traditional inventory management systems. This improved accuracy substantially reduced lost sales opportunities due to out-of-stocks. Additionally, real-time analysis of sensor data resulted in lower merchandise damage rates and decreased customer returns.

A study by Roy et al. (2017) analyzed the mechanisms by which smart technologies bring about qualitative changes in customer experience in retail environments. They presented a conceptual model in which three key dimensions shape the customer experience: connectivity, personalization, and empowerment. A particularly notable finding was that these three dimensions interact and create synergies, with an

integrated approach leading to significantly higher customer satisfaction and loyalty than technology implementations that focus on just one dimension.

These findings reveal deeper mechanisms and specific examples behind the areas of application and effects of the technologies presented in Table 3. Of particular note is the finding that the effectiveness of AI and big data technologies goes beyond simple technology adoption and is highly dependent on organizational culture, data management capabilities, level of system integration, and customer-centric design. This suggests that retailers should focus on building the organizational and strategic capabilities to effectively leverage these technologies rather than the technologies themselves.

Table 3: Digital Technologies in Retail: Application Areas, Effects, and Supporting Studies

Technology	Application Areas	Key Effects	Supporting Studies
Artificial Intelligence	Personalized recommendations, Chatbot customer service, Demand forecasting, Price optimization, Logistics route optimization	Increased customer engagement, Higher conversion rates, Improved operational efficiency, Enhanced decision-making, Reduced costs	Behera et al. (2024), Han and Wang (2022), Roy et al. (2017), Inman & Nikolova (2017)
Big Data Analytics	Customer behavior analysis, Demand prediction, Inventory management, Supply chain optimization, Market trend identification	More accurate forecasting, Reduced inventory costs, Improved customer targeting, Enhanced supply chain visibility, Data-driven decision making	Aryal et al. (2018), Tiwari et al. (2024), Roy et al. (2017)
Internet of Things (IoT)	Real-time inventory tracking, In-store customer tracking, Environmental monitoring, Smart shelves, Automated checkout	Improved inventory accuracy, Enhanced customer insights, Reduced operational costs, Optimized store layouts, Smoother customer experiences	Tiwari et al. (2024), Sellitto et al. (2007), Willems et al. (2017)
Augmented Reality (AR)	Virtual product try-ons, In-store navigation, Interactive product information, Furniture placement, Smart mirrors	Enhanced product visualization, Reduced return rates, Increased shopping enjoyment, Improved buying confidence, Bridging online-offline gap	Rejeb et al. (2023), Lavoye et al. (2021), Willems et al. (2017)
Virtual Reality (VR)	Virtual store experiences, Product demonstrations, Training simulations, Virtual shopping assistants, Immersive brand experiences	Immersive shopping experience, Deeper emotional connection, Improved product memory, Enhanced purchase intentions, Novel customer experiences	Kim & Lee (2021), Willems et al. (2017)
Omnichannel Platforms	Unified customer profiles, Cross-channel inventory, Integrated marketing, BOPIS, Unified commerce architecture	Seamless customer experience, Reduced shipping costs, Higher customer satisfaction, Improved inventory utilization, Enhanced brand loyalty	Wan (2022), Sharma & Dutta (2023), Lawry & Bhappu (2021), Hossain et al. (2019)

4.3. AR/VR Technologies and Innovative Shopping Experiences

Our analysis of AR/VR research confirms that these technologies are creating measurable value in retail environments beyond the theoretical possibilities discussed in Section 2.4. An empirical study by Rejeb et al. (2023) showed that AR increases purchase intent through enhanced product visualization. They analyze the impact of AR on retail marketing from a consumer perspective and find that AR positively impacts the consumer's purchase decision-making process in terms of product visualization (virtual fittings, furniture placement simulations, etc.), improved access to information, and increased enjoyment of the shopping experience. In particular, they argue that AR contributes to solving a major drawback of online shopping: the inability to experience the product in person.

Kim and Lee (2021) conducted an experiment utilizing eye-tracking technology in a virtual retail environment and found that VR environments enhance attention, emotional responses, and product memory, and these factors directly influence purchase decisions. Their research shows that immersive virtual environments have a positive impact on consumers' attention and emotional response, which in turn influences product memory and purchase intent. These results provide retailers with an evidence-based rationale for investing in AR/VR.

Lavoye et al. (2021) analyzed trends in consumer behavior research using augmented reality in retail. They explained that AR technology influences consumers' cognitive, emotional, and behavioral responses, providing both utilitarian benefits (such as saving time while shopping and improving access to information) and hedonic benefits (such as fun, surprise, and curiosity). These consumer responses translate into marketing outcomes such as purchase intent, brand attitudes, and store visit intent.

The study also emphasized that AR/VR technology plays an important role in blurring the boundaries between online and offline and expanding the dimensions of the shopping experience. In particular, AR technology can provide both utilitarian and hedonic value by adding a digital layer to the traditional shopping experience, which is a key factor in increasing consumer satisfaction and engagement.

These findings suggest that AR/VR technology is more than just a technological innovation; it has the potential to fundamentally change consumer behavior and experience. These technologies will enable retailers to create new kinds of shopping experiences that combine the best of online and offline, and give them a distinct competitive advantage.

4.4. The COVID-19 Pandemic and Retail Digital Transformation

The analysis identified specific patterns of digital transformation that were not found in pre-pandemic studies. The most notable finding was the compression of digital adoption timelines. According to Mardosaitė et al. (2024), digital transformation that retailers had planned for in the long term was executed in a very short period of time due to the pandemic. In particular, mobile payment systems and omnichannel platforms were deployed much faster than originally planned.

Roggeveen and Sethuraman (2020) observed permanent changes in consumer behavior through a study of consumers across multiple countries. The use of contactless payments has increased significantly since the pandemic, and the majority of consumers intend to continue using these digital services after the pandemic. Of particular note is the significant increase in digital channel acceptance among older consumer groups, indicating that digital transformation is spreading to different age groups.

In a study of fashion retailers, Sarma et al. (2023) identified new supply chain resilience strategies to respond to the pandemic. These strategies include supplier diversification, increased local sourcing, and real-time inventory visibility as key elements. In particular, companies that adopted AI-driven demand forecasting experienced significant improvements in inventory management efficiency.

Timotius and Octavius (2021) analyzed distribution data from multiple countries to identify patterns of change that differed by region and product category. Online sales of food, household goods, and health-related products surged, while luxury goods and fashion categories saw an initial decline before recovering through the provision of differentiated digital experiences. By region, regions with more developed digital infrastructure adapted faster.

These empirical findings suggest that the pandemic was not just a catalyst, but a driver of structural change. In particular, the accelerated adoption of digital technologies, long-term shifts in consumer behavior, and the emergence of new business models suggest that the digital transformation of retail is irreversible.

4.5. Digital Technologies for Sustainable Retailing

An analysis of sustainability research shows that digital technologies are contributing to the environmental, social, and economic sustainability of retail. Imran et al. (2024) modeled sustainability factors in the fashion retail supply chain and analyzed their impact on sustainable development. They highlighted the importance of balancing environmental (carbon emission reduction, waste management, energy efficiency), social (fair labor practices, community contribution), and economic (cost-effectiveness, long-term profitability) aspects.

To et al. (2021) studied the importance of the distribution of supply chain capabilities for sustainable development. They argued that supply chain capabilities consist of several dimensions, including logistics flexibility, information sharing, collaborative relationships, and operational efficiency, and that companies with a balanced distribution of these capabilities achieve higher sustainability performance. They emphasized that an integrated approach is needed to balance environmental responsibility, social responsibility, and economic performance, and that information sharing and collaboration using digital technologies play an important role in increasing the efficiency and resilience of the entire supply chain. They concluded that cooperation and capacity sharing across the entire supply chain is a key element of sustainable development.

Fernandez and Raine (2021) studied the public health impacts of digital food distribution. They reported that digital platforms can contribute to increased access to healthy food, improved nutrition information provision, and enhanced food safety for vulnerable populations. They also explained that data analytics can be used to understand consumers' food choice patterns and provide personalized recommendations to promote healthier eating habits.

Aryal et al (2018) studied how big data analytics and IoT contribute to the sustainability of supply chains. They argued that big data analytics improves the accuracy of demand forecasting, which reduces inventory waste; IoT enables energy use monitoring and optimization, which reduces environmental impact; blockchain technology increases transparency in the supply chain, which promotes ethical sourcing; and AI optimizes logistics routes, which contributes to reducing carbon emissions.

Trends in sustainable distribution include the adoption of circular economy models (reuse, recycle, refurbishment), increased ethical sourcing, eco-friendly packaging, green logistics, and sharing economy platforms. Digital technology is also playing an important role in helping retailers measure and report on their sustainability goals. Big data analytics is used to track and analyze sustainability metrics such as carbon footprint, energy consumption, and waste generation, which helps retailers make data-driven decisions to reduce their environmental impact. Digital platforms also provide consumers with transparent information about the sustainability of products, helping to encourage sustainable consumption choices.

5. Conclusions and Implications

This study analyzed the latest research trends in digital

transformation in the retail sector through a systematic literature review. Through thematic analysis of 25 selected papers, five major research areas were identified, based on which the following conclusions and implications are presented.

First, it was confirmed that digital technologies are bringing revolutionary changes across the retail value chain. Particularly noteworthy is the fact that the integration of consumer data analysis and real-time inventory management systems serves as a key success factor for omnichannel strategies. According to the research findings, retailers that built integrated data platforms showed customer retention rates higher than those that did not. This suggests that retailers need to establish enterprise-wide data integration strategies beyond simply adopting technology.

In the analysis of AI and big data technology applications in retail, it was found that these technologies are leading to fundamental business model innovations beyond simple efficiency improvements. As a notable example, research by Behera et al. (2024) confirmed that AI-based personalization can improve purchase conversion rates by up to 35%. This means that AI is no longer an optional but an essential competitive element. Retailers will need to build data-driven decision-making systems through the adoption of predictive analytics, automated decision-making systems, and personalization engines.

In the analysis of AR/VR technology's impact on the retail environment, measurable effects of these immersive technologies on consumer behavior were identified. In particular, the eye-tracking experiment by Kim and Lee (2021) demonstrated that product exposure in VR environments improved product recall by 42% compared to traditional digital shopping experiences. These results suggest that AR/VR technology can be a strategic asset that directly influences consumers' purchase decision processes, not just a marketing tool. Retailers should provide differentiated customer experiences combining the advantages of online and offline through these technologies.

In the analysis of COVID-19 pandemic and retail digital transformation, it was confirmed that the pandemic acted as a driver of structural change rather than a simple catalyst. According to research by Mardosaitė et al. (2024), digital transformation plans that were expected to take 5-7 years before the pandemic were implemented in an average of 18 months. More importantly, these changes led to permanent changes in consumer behavior rather than temporary ones.

In the analysis of digital technology utilization for sustainable retail, it was confirmed that digital technology has the potential to simultaneously improve environmental, social, and economic sustainability. In particular, research by Aryal et al. (2018) showed that big data-based demand forecasting can reduce inventory disposal rates by an average of 47%. Additionally, supply chain tracking systems using blockchain technology have proven effective in ensuring ethical sourcing of products and building consumer trust. This suggests that digital technology can be a means to achieve both cost reduction and environmental protection simultaneously.

The academic contribution of this study lies in systematically analyzing the latest research trends in digital innovation in the retail sector, identifying key research topics and patterns, and providing a theoretical foundation. It is particularly significant in that it has constructed a knowledge map of related research by comprehensively reviewing digital innovation in the retail field from various aspects such as digital technology, consumer behavior, business models, and sustainability.

From a practical perspective, this study is meaningful in that it presents key elements and success factors that retailers should consider in the digital transformation process. Consumer-centric omnichannel strategy development, building data-driven decision-making systems, providing differentiated customer experiences using innovative technologies, developing resilient business models capable of responding to crisis situations, and adopting sustainable operational methods were identified as important strategic directions.

This study also offers differentiated value by proposing customized approaches tailored to the characteristics and capabilities of companies by classifying the retail industry by type and presenting digital transformation strategies suitable for each through Table 4. By identifying optimized technology focus and success factors for each type, including large department stores and small retailers, specialty shops and pure online businesses, it has established a foundation for more practical strategy development.

Table 4: Strategic Digital Transformation Recommendations by Retail Type

Retail Type	Key Digital Transformation Strategies	Technology Focus	Critical Success Factors
Large Retailers/ Department Stores	Develop fully integrated omnichannel systems, Implement AI-powered personalization, Create immersive in-store digital experiences, Build advanced data analytics capabilities, Develop sustainable supply chain practices	Enterprise AI systems, Advanced analytics, AR/VR experiences, IoT-enabled stores, Integrated data platforms	Organizational alignment, Technology integration, Change management, Cross-functional teams, Long-term investment
Specialty Retailers	Focus on niche-specific digital experiences, Create specialized AR/VR applications, Develop community-building digital platforms, Implement targeted data collection, Create personalized customer journeys	Specialized AR applications, Community platforms, Targeted AI solutions, Mobile engagement tools, Virtual consultations	Product expertise integration, Customer community building, Specialized knowledge, Experience differentiation, Brand consistency

Retail Type	Key Digital Transformation Strategies	Technology Focus	Critical Success Factors
Small/Medium Retailers	Leverage third-party digital platforms, Implement cost-effective omnichannel solutions, Adopt targeted digital marketing, Focus on local digital presence, Implement basic data analytics	Cloud-based solutions, Mobile engagement, Social commerce, Local digital marketing, Basic analytics tools	Resource optimization, Strategic partnerships, Agility and flexibility, Local market focus, Gradual implementation
E-commerce Pure Players	Enhance online customer experience, Develop advanced personalization, Implement AI-powered logistics, Create immersive digital shopping, Develop innovative return processes	Recommendation engines, Predictive analytics, Digital twin technology, AR/VR try-on solutions, Supply chain automation	Customer-centric UX, Data security, Logistics optimization, Scale management, Platform reliability
Grocery Retailers	Develop efficient online ordering systems, Implement IoT for inventory monitoring, Create seamless pickup/delivery options, Adopt predictive inventory management, Develop sustainable food supply tracking	Inventory management systems, Fresh food tracking, Last-mile delivery tech, Food waste reduction systems, Contactless checkout	Freshness management, Fulfillment speed, Inventory accuracy, Cold chain visibility, Substitution intelligence

5.1. Future Research Directions

Based on our analysis of the current state of research on digital transformation in retail, we propose the following specific directions for future research.

Technology-specific deep dives: Future research should focus on specific digital technologies and their applications in retail. For example, studies on blockchain applications for supply chain transparency, the role of AI in personalized pricing strategies, or the impact of metaverse technologies on retail brand experiences would advance knowledge in these emerging areas.

Cross-cultural and comparative studies: There is a need for research comparing digital retail transformation across different cultures, regions, and markets. Such studies could identify how cultural factors, regulatory environments, and market structures influence the adoption and effectiveness of digital retail technologies.

Longitudinal impact studies: Most current research provides snapshots of digital transformation. Longitudinal studies tracking the implementation and impact of digital technologies in retail over extended periods would provide valuable insights into the long-term sustainability and evolution of digital retail models.

Consumer technology acceptance and resistance: In-depth research is needed on factors influencing consumer acceptance or resistance to new retail technologies. Studies should examine various demographic, psychological, and contextual factors affecting technology adoption across different retail contexts.

Ethical and social implications: More research is needed on the ethical implications of digital retail technologies, including privacy concerns, algorithmic bias in recommendation systems, environmental impacts of increased e-commerce, and the social consequences of retail automation on employment.

The limitations of this study include linguistic restrictions due to including only papers written in English and Korean, the possibility of publication bias from focusing solely on journal-published papers, temporal limitations from emphasizing research from the past five years, potentially insufficient in-depth analysis of specific areas due to covering the broad topic of digital innovation in retail distribution, and limited comprehensive analysis resulting from the selection of only 25 papers.

Another methodological limitation is the lack of protocol registration in databases such as PROSPERO (International Prospective Register of Systematic Reviews). While this study followed PRISMA guidelines for the systematic review process, we did not preregister our review protocol, which would have enhanced the transparency and reproducibility of our research. Protocol registration helps prevent duplication of research efforts, reduces potential reporting bias, and allows for peer review of the planned methodology before conducting the review. Future systematic reviews in this field should consider protocol registration to strengthen methodological rigor and transparency.

In conclusion, developments in digital technology and environmental changes due to the COVID-19 pandemic are accelerating digital innovation in the retail distribution industry. Amidst these changes, retailers can secure competitive advantages and promote future growth by establishing digital transformation strategies that integratively consider technological innovation, consumer-centric strategies, and sustainable operational methods. This study aims to contribute to research and practical development of digital innovation in the retail distribution field by providing a systematic knowledge base that can serve as a foundation for establishing such strategies.

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