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Research Article

# Research on the Path of Low Carbon Transformation of Traditional Retail Enterprises Empowered by Digital Technology

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## Abstract

The retail industry is an integral part of the service sector. In the context of the booming development of the service industry and digital technology, this paper explores the low-carbon transformation path for traditional retail enterprises empowered by digital technology. Initially, a literature review reveals that as the overall scale of the service industry continues to expand, its negative impact on the environment is also intensifying. Reducing energy consumption and carbon emissions has become a rigid constraint faced by the service industry; Meanwhile, digital technology is becoming an important means to empower traditional service enterprises in their low-carbon transformation. Subsequently, through case study analysis, it is pointed out that digital technology can empower the low-carbon transformation of traditional retail enterprises from three aspects: reducing energy consumption, decreasing emissions, and saving resources. Finally, in response to the existing obstacles in implementing low-carbon transitions such as insufficient motivation for transition, constraints on investment costs in low-carbon technologies, and difficulties in managing energy and carbon emissions, practical paths for digital technology to empower the low-carbon transformation of traditional retail enterprises are proposed. These include enhancing the motivation for enterprise low-carbon transition, overcoming constraints on capital and talent, and improving technical support capabilities for the transformation.

## Keywords

Digital Technology, Retail Enterprises, Low Carbon Transformation, Transformation Path

## 1. Introduction

China's economy has generally entered the post-industrial era, with the service industry leaping to become the country's largest sector. Data shows that in 2023, the value added of China's service industry accounted for 54.6% of the Gross Domestic Product (GDP), contributing more than 60% to economic growth [1], rightfully becoming the largest pillar industry and an important foundation for stable economic growth.

However, as the total scale of the service industry continues to expand, its negative impact on the environment is also intensifying, prominently manifested as the annual increase in industrial energy consumption and the environmental issues such as increased carbon emissions due to energy consumption growth. From 2000 to 2021, the annual growth rates of

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energy consumption and total carbon emissions in China's service industry were 7.85% and 6.93% respectively [2]. Taking Beijing as an example, in 2019, the service industry accounted for 51.11% of the city's total energy consumption, exceeding the manufacturing industry by 25.97 percentage points; among the city's 886 key carbon-emitting units, 606 were service companies, accounting for a high proportion of 68.40%; traditional commercial sectors have become one of the key areas for energy transition. Studies have pointed out that for every 1% increase in the proportion of the service industry, PM2.5 intensity rises by 0.17% [3]. It is thus undeniable that the service industry has become a significant contributor to China's energy consumption and carbon emissions, and reducing energy consumption and carbon emissions has become a rigid constraint faced by the service industry.

Currently, with the rapid development of new-generation digital technologies such as cloud computing, big data, artificial intelligence, and 5G, the industry scale continues to grow rapidly, and the integration of digital technology with the real economy is deepening day by day. In 2022, the scale of industrial digitalization in China reached 42.42 trillion yuan, accounting for 81.74% of the digital economy. The digital penetration rates in agriculture, industry, and services were 10.5%, 24.0%, and 44.7% respectively [4], with the service industry significantly leading in terms of digital level compared to industry and agriculture, making it the industry with the highest digital penetration rate among the three major industries in China. Against the backdrop of digital technology empowerment, the service industry has a realistic foundation for achieving low-carbon transformation. Literature research has found that digital technology can effectively drive traditional service enterprises towards low-carbon transformation by improving resource allocation efficiency, reducing energy intensity, promoting effective emission reduction, and achieving energy conservation, consumption reduction, and low-carbon development. There are also successful corporate cases in practice, such as British retailer Marks & Spencer and Metro using intelligent supply chain systems to optimize logistics and inventory management, reducing energy consumption; employing big data analysis and Internet of Things technology to monitor and improve energy use to reduce carbon emissions; similarly, Alibaba Group's partner Cainiao Network introduced a digital logistics platform to reduce energy consumption and carbon emissions by optimizing logistics routes and transportation methods.

In summary, digital technology is becoming an important engine for enabling traditional service enterprises to achieve low-carbon transformation and development. Both existing research results and practical cases support this conclusion. However, from an academic perspective, there is still a lack of systematic sorting out regarding the enabling role of digital technology in the low-carbon transformation and development of traditional commercial and trade service enterprises. The practical obstacles and specific paths for the low-carbon transformation and development of traditional commercial and trade service enterprises are not yet clear, which urgently requires in-depth research by the academic community. Therefore, this paper takes traditional retail enterprises as the research object, first studies typical cases of digital technology enabling low-carbon transformation of traditional retail enterprises, then sorts out the enabling role of digital technology in the low-carbon transformation and development of traditional retail enterprises, and finally proposes feasible paths based on revealing the practical obstacles in the low-carbon transformation and development of traditional retail enterprises, hoping to provide useful references for the low-carbon transformation and development of traditional retail enterprises.

## 2. Typical Cases

### 2.1. Starbucks' Low-Carbon Practice

Starbucks Corporation (hereinafter referred to as "Starbucks"), founded in 1971, has now opened over 6,500 stores in more than 250 cities across Mainland China.

As a world-leading professional coffee roaster and retailer, "giving back more than we take" is Starbucks' environmental commitment. In early 2020, Starbucks officially released its sustainability goals: by 2030, to reduce the global carbon footprint, water footprint, and waste emissions by 50% compared to 2019. To achieve this goal, Starbucks collaborated with third-party authoritative institutions to create a comprehensive green store certification system. Through measures in eight major areas such as energy and water efficiency management and renewable energy procurement, it fully implements sustainable concepts of energy saving, emission reduction, water conservation, and waste reduction. Currently, more than 180 green stores have been built in Mainland China, with plans to operate 2,500 green stores by 2025.

Starbucks' low-carbon practices mainly include:

(1) Implementing effective energy saving. Relying on new technology, green stores connect various electrical and water systems, air conditioning systems to the Internet of Things. Based on real-time collection and high-quality data analysis, it completes real-time monitoring, scheduled switching, and intelligent remote control of facilities and equipment, achieving continuous improvement in energy efficiency, equipment efficiency, operational efficiency, and customer experience.

(2) Promoting low-carbon logistics. Using smart devices to improve the energy efficiency of storage centers; replacing fuel vehicles with new energy trucks, and using recyclable and easily recycled turnover boxes and packaging materials to save energy and reduce carbon emissions.

(3) Adopting low-carbon packaging. Following the basic principle of "reduction - reuse - recycling" in packaging

design, reducing the use of virgin plastic and other resource consumption, and improving the recyclability of beverage cup lids through material optimization. By 2023, all hot drink lids in Mainland China were upgraded to easily recyclable polypropylene material [5]; all cold drink tasting cups were upgraded to non-toxic, tasteless, high-safety PET material.

(4) Practicing the circular economy. Coffee grounds are efficiently recycled and used as organic fertilizer for crops after composting treatment. Additionally, recycled PET drink bottles are cleaned, processed, and regenerated into polyester slices, yarn, fabric, and finally processed into eco-friendly green aprons worn by baristas, reducing energy and resource consumption and lowering product carbon emissions.

Starbucks' low-carbon practices have achieved considerable environmental benefits: each Starbucks store that passes the green certification reduces an average of 10.66 tons of carbon emissions per year compared to a standard Starbucks store of the same size in 2019 [6]. A series of energy management measures significantly reduce electricity and water usage in stores. Replacing plastic straws with biodegradable ones and reprocessing PET drink bottles into aprons effectively reduces waste production. The modification of cup sleeves saves 100 tons of materials annually. The recycling of coffee grounds not only reduces waste but also decreases the use of environmentally harmful high-pollution fertilizers, thus avoiding soil pollution.

### 2.2. Hema Fresh's Low-Carbon Practice

Hema Fresh (hereinafter referred to as "Hema"), established in 2015, is a new retail platform under Alibaba Group. Currently, Hema Fresh has opened over 300 stores in 28 cities across China, including 47 stores in the Beijing area.

Hema adheres to the business philosophy of sustainable development, advocating for full supply chain partners to jointly build a green and low-carbon ecosystem. Based on digital technology, it is committed to creating a community-based one-stop new retail experience center for consumers, bringing people "fresh life" with technology and humanity, practicing low-carbon practices in the entire supply chain links such as production, storage, transportation, distribution, packaging, sales, and waste recycling. For example, encouraging organic and green planting to reduce environmental pollution caused by pesticides and fertilizers in the production process; focusing on green design and procurement; selecting low-carbon materials and optimizing product packaging; using recyclable turnover crates to reduce the use of disposable packaging materials and plastics. In store operations, Hema introduces digital technology for remote intelligent management of store energy-consuming equipment. For instance, installing infrared sensors to identify stove working status and achieve automatic switching of exhaust fumes; using smart meters for abnormal monthly reports and remote inspections to help stores intelligently identify energy consumption management loopholes such as air conditioning, lighting, and cold chain leakage at night, achieving refined energy saving and emission reduction.

Through energy optimization management transformation and optimized product packaging, reducing the consumption of resources throughout the supply chain, reducing 2.5 million foam boxes and over 100 million sheets of paper annually. As of 2023, Hema has completed the overall energy optimization management transformation for 90% of its stores in Beijing, involving multiple aspects such as cold chain, lighting, and exhaust fume fans. Moreover, Hema Shi Li Bao Store in Beijing received the "Green Store" certification issued by CEPREI under the Ministry of Industry and Information Technology, becoming the first "Green Store" nationwide for Hema, playing a demonstrative role in further promoting the green development of chain enterprises.

With its outstanding performance in green supply chain, packaging and logistics, and green certification, Hema was awarded the "2023 Chinese Enterprise Low-Carbon Transformation and High-Quality Development Benchmark Case Award" at the "2023 Green Development and Carbon Neutrality (Beijing) Forum" held during the China International Service Trade Fair.

## 3. Analysis of the Role of Digital Technology

The commercial retail industry is an important component of the service sector, serving as the terminal link in the circulation of goods, connecting production with consumption. It is vast in scale and complex in operation, involving the production, storage, transportation, and packaging of retail goods. All these stages can negatively impact the natural environment, leading to increased resource and energy consumption, carbon emissions, and waste generation, thereby exacerbating environmental burdens. According to data from the World Business Council for Sustainable Development (WBCSD) in 2022, the retail supply chain currently accounts for 25% of global greenhouse gas emissions, making it a significant "carbon emitter". The task of low-carbon transformation is thus particularly daunting.

The widespread application of digital technologies such as big data, artificial intelligence, the Internet of Things, and blockchain has accelerated industrial transformation and has become a core tool for enterprises to achieve low-carbon transformation, energy saving, emission reduction, and consumption reduction. From the perspective of digital technology itself, cloud computing reduces excessive investment in hardware and waste; digital commerce also reduces the need for customers to visit traditional physical stores, thereby lowering energy consumption and reducing carbon emissions. In terms of the empowering role of digital technology, applying new technologies such as cloud computing, big data,

and artificial intelligence can significantly improve the effectiveness and precision of corporate energy management. Data shows that digital transformation has reduced costs by 34.2% and increased revenue by 33.6% in the logistics service industry, and reduced costs by 7.8% and increased revenue by 33.3% for retail businesses [7].

Digital technology has played a significant role in promoting the low-carbon transformation and sustainable development of traditional retail enterprises, specifically in three aspects:

## 3.1. Reducing Energy Consumption

The infrastructure and daily operations of traditional commercial retail require a large amount of energy. Using digital technology can optimize key energy-consuming processes in traditional retail enterprises, comprehensively improving energy management levels and efficiency, with a notable effect on reducing energy consumption. Research data shows that automated control can save 10-15% of energy for commercial buildings; adopting more advanced features like intelligent temperature control can further save 5-10% of energy [8].

### 3.1.1. Optimizing Electricity Management

Equipment such as lighting, heating, air conditioning, elevators, and cold chains are typically major electricity consumers in traditional retail enterprises. Applying IoT technology allows for real-time monitoring of the energy consumption of these devices, and then through electricity data analysis, constructing an energy-saving optimization model to automatically regulate device energy use. This intelligent management method improves energy utilization rates and reduces electricity consumption. For example, smart lighting systems optimize the use of lighting electricity by automatically adjusting brightness according to ambient light, avoiding energy waste [9]; while smart temperature control systems can automatically adjust cooling power based on indoor temperature, reducing energy consumption.

### 3.1.2. Intelligent Warehousing and Distribution

Applying digital technology helps achieve intelligent warehousing and distribution, optimizing a series of operations from order sorting to product storage, and then to delivery transport, significantly reducing energy consumption. For instance, big data technology mines and analyzes massive inventory data, helping enterprises more accurately control inventory levels and reducing warehouse space occupation; using artificial intelligence technology for intelligent dispatching of automated equipment in warehouses improves operational efficiency; big data and AI technology are beneficial for optimizing delivery routes, reducing the number of product transfer links and empty cargo transport, thus reducing energy waste.

## 3.2. Reducing Emissions

Retail enterprise stores are one of the significant sources of carbon emissions, with the use of purchased electricity being the main source of store carbon emissions. According to a report by the China Chain Store & Franchise Association, over 90% of supermarket carbon emissions come from indirect emissions generated by electricity usage; shopping centers' purchased electricity carbon emissions account for 78%-88% of their total carbon emissions.

### 3.2.1. Monitoring Carbon Footprint

Digital technology can achieve real-time monitoring of carbon emissions from traditional retail enterprises, obtaining accurate emission data [10]. Through the analysis of emission data, enterprises can dynamically understand the sources and amounts of carbon emissions, thereby effectively tracking the environmental impact of products and providing a reliable basis for formulating targeted emission reduction measures. For example, sensors can monitor the energy consumption and emissions of vehicles during logistics transport in real-time, allowing for the timely detection of anomalies. Similarly, during store operations, through big data analysis, enterprises can identify peak and valley values of energy consumption [11], facilitating measures to optimize and reduce carbon emissions.

### 3.2.2. Low-Carbon Logistics

Applying technology can collect and quickly calculate the energy consumption and emission data of logistics transport vehicles in real-time [12], providing data support for energy saving and emission reduction; through big data and artificial intelligence technology analysis of historical order data and delivery routes, identifying optimization spaces for transportation routes, adopting multi-modal transport to reduce product transfer links, improving transport efficiency, and lowering energy consumption and carbon emission levels; additionally, increasing the use ratio of clean energy vehicles and green electricity charging piles can effectively reduce carbon emissions in the delivery process, achieving low-carbon logistics [13].

## 3.3. Conserving Resources

As an important part of the socio-economic system, the resource consumption issues in the daily operations of traditional retail enterprises have attracted considerable attention.

### 3.3.1. Green and Low-Carbon Packaging

In the course of their operations, traditional retail enterprises consume a large amount of packaging materials, which are also one of the major sources of plastic waste and other discards. Digital technology can help businesses achieve precise packaging by accurately predicting packaging demand

through big data analysis [14], thereby avoiding overpackaging or underpackaging; by using biodegradable materials or recycled materials for packaging, the negative impact of packaging waste on the environment is significantly reduced. Additionally, implementing "boxless returns" in retail enterprises, using recyclable turnover boxes and transfer bags instead of cardboard boxes, plastic bags, foam boxes, and other packaging materials, are effective measures in practice to save materials and reduce waste.

#### 3.3.2. Resource Recycling and Circularization

Utilizing Internet of Things (IoT) technology, enterprises can keep real-time track of the volume of waste generated [15], its flow direction, storage status, and recycling progress; building a wide-ranging information service platform for waste resources, publishing transactions of waste resources, achieving transparency and sharing of recycling information [16], facilitates timely and effective waste treatment, forming a virtuous cycle of resource utilization that reduces environmental damage caused by waste. Furthermore, by establishing a points reward system, consumers are encouraged to participate in resource recycling, which not only increases consumer loyalty to the enterprise but also enhances the recycling and utilization rate of waste resources.

## 4. The Main Obstacles to the Low-Carbon Transformation

Traditional commercial retail offers a vast array of goods, with carbon footprints spanning procurement, distribution, warehousing, delivery, and waste recycling processes, making low-carbon transformation challenging to implement. Therefore, analyzing the main obstacles to the low-carbon transformation of traditional retail enterprises from the perspective of digital technology empowerment holds significant practical value.

### 4.1. Insufficient Motivation for Low-Carbon Transformation

Enterprise managers lack a correct understanding of low-carbon transformation. Even though some recognize the necessity of corporate low-carbon transformation, they do not fully appreciate its urgency. Coupled with a lack of effective incentive policies, this leads to insufficient motivation for low-carbon transformation, hindering the practice among traditional retail enterprises.

#### 4.1.1. Lack of Correct Cognition of Low-Carbon Transformation

A considerable number of traditional retail enterprises lack a correct understanding of implementing low-carbon development, have short-term visions, and are very limited in their understanding of low-carbon technologies and their applications. They view low-carbon transformation as a cost rather than recognizing its potential to increase market share and improve long-term operational performance. Due to misconceptions, companies often see low-carbon transformation as a burden rather than a means to enhance competitiveness. Moreover, in the fiercely competitive retail industry, traditional retail enterprises tend to focus on short-term benefits, overlooking environmental investments based on sustainable development, and adopt conservative or avoidance strategies towards low-carbon transformation, leading to insufficient motivation for such practices.

#### 4.1.2. Lack of Effective Incentive Policies

Governments have introduced a range of policies to promote low-carbon development, but these are often not targeted or actionable enough in practice, leaving traditional retail enterprises with insufficient support. Companies struggle to benefit from policy incentives, affecting their enthusiasm for low-carbon transformation. Additionally, during the transformation process, these enterprises face challenges such as insufficient funds and technology introduction. The current policy system lacks effective incentive mechanisms like financial support, tax benefits, and R&D subsidies. High thresholds for existing preferential policies make it difficult for traditional retail enterprises to obtain substantial help during low-carbon transformation, further weakening their motivation.

### 4.2. Restrictions Due to High Costs of Low-Carbon Technology Investment

Empowering traditional retail enterprises with digital technology for low-carbon transformation is an investment-intensive, long-term systematic project. High financial investment and a shortage of professional talent make the journey towards low-carbon development challenging for these businesses.

#### 4.2.1. High Financial Investment

Low-carbon transformation enabled by digital technology requires significant capital for equipment upgrades, technology adoption, green recycling, and waste management, leading to high costs, financial pressures, and extended return periods, thereby increasing investment risks. Furthermore, most traditional retail enterprises are small to medium-sized businesses that often face financing difficulties during low-carbon transformation, making it hard to secure adequate financial support. Thus, the cost of investing in low-carbon technology becomes a crucial factor restricting the transformation of traditional retail enterprises. For example, due to cost constraints, only a handful of the top 100 supermarkets nationwide use natural refrigerants, and the proportion of stores using such systems is even lower, accounting for only a

few per thousand or even ten thousand. In contrast, 90% of supermarkets in the European retail market have already adopted natural refrigerant systems.

#### 4.2.2. Shortage of Professional Talent

Low-carbon transformation empowered by digital technology demands professional knowledge and skills, requiring expertise in both digital and low-carbon technologies, as well as management skills. Traditional retail enterprises often lack such professionals, facing difficulties in selecting, applying, and maintaining low-carbon technologies. Currently, China's training mechanism for talent in digital and low-carbon technologies and their integration is not well-developed, with higher education and vocational colleges yet to mature in relevant professional settings and curriculum system making it challenging for companies to recruit suitable technical professionals. Moreover, the scarcity of talent in the "digital + low-carbon" field means that top talents are often attracted to more competitive industries and larger enterprises with stronger capabilities, further exacerbating the shortage of professional talent in traditional retail enterprises.

### 4.3. Difficulty in Energy and Carbon Emission Management

Traditional retail enterprises offer a wide variety of products with continuously expanding sales channels and supply chains encompassing procurement, inventory, sales, and delivery, presenting significant management challenges. Particularly in energy and carbon emission management, they face tremendous challenges, severely limiting low-carbon transformation development.

#### 4.3.1. Complex Application Scenarios

Managing energy consumption and carbon emissions is challenging for traditional retail enterprises, especially large chain retailers with numerous stores and distribution centers, where energy use and emission points are scattered, complicating data collection efforts. This difficulty is compounded in logistics, as some companies outsource delivery services to logistics providers, making carbon emission data collection and accounting even more complex. Additionally, energy use and carbon emissions involve multiple scenarios such as lighting, heating, cooling, packaging, warehousing, delivery, and transportation, each with distinct energy consumption and emission characteristics, adding complexity to data collection.

#### 4.3.2. Backward Technical Support

Traditional retail enterprises often lack effective technical means and management tools in energy consumption and carbon emission management, particularly in monitoring, accounting, and route planning for energy consumption and emissions. This deficiency makes it difficult for companies to accurately obtain real-time energy consumption and emission data. With weak capabilities in data mining and analysis processing, the already challenging-to-obtain data cannot be effectively transformed into information supporting management decisions. Without advanced technical support, companies struggle to achieve precise management and effective reduction of energy consumption and carbon emissions [17].

## 5. The Main Pathways in Low-Carbon Transformation

The low-carbon transformation of traditional retail enterprises is of significant value to the development of society and the economy. Unleashing the empowering potential of digital technology and promoting traditional retail enterprises towards a low-carbon, sustainable direction urgently requires the design of a transformation path that is compatible with both digitalization and low-carbon initiatives.

### 5.1. Enhancing the Motivation for Enterprises' Low-Carbon Transformation

#### 5.1.1. Perfecting Policy Incentive Mechanisms

Governments should increase support for the low-carbon transformation of traditional retail enterprises by formulating targeted and actionable industrial, financial, and fiscal policy measures, continuously solidifying the real foundation for low-carbon transformation. This includes reducing the burden of investment costs for low-carbon transformation, providing financial support, tax incentives, R&D subsidies, and other effective incentive mechanisms to stimulate the motivation for enterprises' low-carbon transformation; implementing environmental certification, establishing environmental innovation funds, and offering environmental loans to encourage the adoption of advanced low-carbon technologies and facilities to aid the low-carbon transformation of traditional retail enterprises; and improving environmental information disclosure, optimizing environmental risk supervision and management mechanisms to enhance the sustainability of policy support for the transformation and upgrading of traditional retail enterprises.

#### 5.1.2. Building an Enterprise Low-Carbon Culture

Traditional retail enterprises should seize the opportunity of digital technology empowering low-carbon transformation, recognizing that being low-carbon is not only a manifestation of fulfilling social responsibility but also crucial for enhancing enterprise competitiveness and achieving sustainable development. This understanding provides motivation and direction for their own low-carbon transformation. This involves increasing publicity efforts, using successful cases of typical enterprises' low-carbon transformation as examples to raise the awareness of enterprise managers about low-carbon transformation and un-

derstand the opportunities it brings to long-term corporate development; establishing a concept of low-carbon development and integrating it into daily operations and management, creating a strong atmosphere of energy conservation and low-carbon participation among all staff, making low-carbon culture an important part of corporate culture; and formulating enterprise low-carbon development strategies, implementing systems such as energy conservation, emission reduction, environmental protection, and comprehensive resource utilization throughout the business process to ensure the internal rooting of low-carbon culture within the enterprise.

### 5.2. Overcoming the Constraints of Capital and Talent

#### 5.2.1. Providing Financial Support

Governments should pay attention to the practice of low-carbon transformation in traditional service industries, guiding financial institutions to accurately match the financing needs of enterprises' energy-saving, emission reduction, and consumption reduction projects, and provide policy tilts for the difficulty of enterprise financing. This includes offering green loans, special preferential loans, and low-carbon development funds to traditional retail enterprises, providing strong financial support for their low-carbon transformation and reducing the cost burden of capital investment; encouraging financial institutions to innovate financing products, encouraging social capital to participate in enterprises' low-carbon projects through equity financing, bond issuance, etc., providing more financing channels for the low-carbon transformation of traditional retail enterprises; and strengthening scientific carbon accounting for enterprises by financial institutions, incorporating carbon performance evaluation results into the credit process to reduce financial risks while stimulating enterprises to value the environmental, economic, and social benefits achieved through the integration of digital and low-carbon technologies.

#### 5.2.2. Providing Talent Support

Talent in digital and low-carbon technologies is the primary driving force for supporting and ensuring the low-carbon transformation of enterprises. The training and introduction of professionals are crucial for the successful low-carbon transformation of traditional retail enterprises. This involves strengthening the integration of industry and education, establishing a talent training system through cooperation between schools and enterprises, further improving professional settings, curriculum systems, and faculty construction, jointly promoting the training of "digital + low-carbon technology" compound and applied talents; valuing talent introduction, building high-quality platforms for professional talent mobility, perfecting recruitment, assessment, and reward mechanisms, attracting and retaining professionals by offering competitive salaries and career development opportunities; conducting "digital + low-carbon" knowledge and skills training, raising employees' awareness of low-carbon and digital skills, encouraging active participation in technical research and development, equipment modification, and other low-carbon practices, rewarding employees who make outstanding contributions materially and spiritually, and ensuring the successful implementation of the enterprise's low-carbon transformation by enhancing employee value.

### 5.3. Enhancing the Technological Support Capability for Transformation

#### 5.3.1. Adopting a Phased Transformation Strategy

Considering the challenges of energy and carbon emission management and the general lag in technological application, traditional retail enterprises can adopt a phased strategy for low-carbon transformation after clarifying their goals for energy and carbon management. First, they need to assess their resources, energy consumption, and carbon emissions to provide data support for establishing a comprehensive low-carbon transformation strategy and specific energy-saving, emission reduction, and consumption reduction measures; then prioritize addressing high energy consumption and large carbon emissions in key areas such as lighting, temperature control, cold chain, and other critical scenarios; finally, gradually expand to other aspects like packaging reduction and waste recycling to achieve full-chain low-carbon transformation.

#### 5.3.2. Enhancing Digital Support Capabilities

Whether traditional retail enterprises can successfully leverage digital technology to empower low-carbon transformation is significant for their sustainable growth. It is essential to strive to improve digital support capabilities to achieve digital management of resources, energy, and carbon emissions. This includes enhancing the quantity and quality of internal professional technical talent through recruitment, training, etc., improving the application capability of "digital + low-carbon" technology; actively seeking cooperation with digital technology service providers, introducing mature digital solutions for low-carbon transformation, strengthening data processing and analysis capabilities; introducing efficient intelligent control systems and low-carbon energy-saving equipment, relying on digital technology to implement more effective management of resources, energy consumption, and carbon emissions.

## 6. Conclusion

Digital technology plays a critical role in promoting the low-carbon transformation and sustainable development of traditional retail enterprises. By reducing energy consumption, emissions, and conserving resources, digital technology can effectively promote enterprises to shift towards a sustainable business model. However, the practice of low-carbon trans-

formation in traditional retail enterprises faces obstacles such as insufficient motivation for transformation, high investment costs, and complex energy and carbon emission management. It is imperative to enhance the internal driving force for enterprises' low-carbon transformation, solve funding and talent constraints, strengthen technical support during the transformation process, and ensure that digital technology can fully empower the low-carbon transformation of traditional retail enterprises. Of course, digital technology cannot solve all the problems encountered in low-carbon transformation in reality; it requires continuous optimization and improvement of relevant institutional frameworks to avoid adverse consequences caused by over-reliance on digital technology.

## Abbreviations

| | |
|---|---|
| PET | Polyethylene Terephthalate, Non-toxic, Odorless, Good Hygiene Safety, Can Be Directly Used for Food Packaging |
| CEPREI | China Electronics Products Reliability and Environmental Testing Research Institute |

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## Conflicts of Interest

The authors declare no conflicts of interest.

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