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A Case Study on AI-Enabled Lean Supply Chain Cost Management: Evidence from Haier Smart Home

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Abstract: Against the backdrop of the digital economy, traditional cost management approaches have become increasingly inadequate in addressing the pressures arising from intensified competition in the home appliance industry and fluctuations in raw material prices. Taking Haier Smart Home as the research case, this study systematically investigates the mechanisms and effects of artificial intelligence (AI)-enabled lean supply chain cost management by employing a case study approach that integrates both qualitative and quantitative analyses, grounded in lean cost management theory and transaction cost theory.

The findings indicate that Haier Smart Home has leveraged AI platforms such as COSMOPlat and HYZEN to break down data silos and realize end-to-end collaboration across procurement, production, logistics, sales, and green operational processes. Through the precise management of direct costs, activity-based costs, transaction costs, and environmental costs, the company has significantly reduced procurement cost ratios while improving inventory turnover efficiency and profitability. In response to existing challenges related to global coordination, the integration of business and financial systems, and data security governance, this study further proposes several optimization strategies, including deepening the analysis of AI-driven operational mechanisms, establishing a globally unified intelligent control platform, and strengthening intelligent risk management systems.

This research enriches the interdisciplinary literature at the intersection of AI and accounting cost management, while also providing practical insights for manufacturing enterprises seeking to achieve cost reduction, operational efficiency enhancement, and greater supply chain resilience through digital and intelligent technologies.

Keywords: Artificial Intelligence; Supply Chain Cost; Lean Cost Management; Haier Smart Home; Manufacturing Industry

1. Introduction

At present, the convergence of the global digital economy and the transformation toward "new quality productive forces" in manufacturing is accelerating the transition of traditional supply chains toward intelligent and lean-oriented development. According to research released by the China Household Electrical Appliances Association, the home appliance industry has entered a stage characterized by the diminishing dividends of incremental market growth. Meanwhile, fluctuations in raw material prices and mismatches between supply and demand have led to a "high-cost, low-redundancy" operational structure, which has become a critical constraint on industrial resilience. Against this backdrop, national policies such as the "14th Five-Year Plan for Digital Economy Development" have explicitly positioned digital and intelligent empowerment as a strategic priority for supply chain modernization. Existing studies have established a solid foundation for this research from the perspectives of macro-level trends, theoretical evolution, technological pathways, and empirical case analysis.

First, the academic community has gradually reached a consensus regarding the expansion of supply chain cost management boundaries and the evolution of management approaches. Ai Baojun (2006) was among the earliest scholars to establish a target cost management framework from a supply chain perspective[1], while Yin Junming et al. (2006) further identified the integration of quality, cost, and time dimensions as a defining characteristic of comprehensive cost management[2]. Subsequent studies shifted

toward technology-driven precision governance, such as Xu Kun's (2016) in-depth analysis of activity-based costing (ABC) and Zheng Tingting et al.'s (2025) forward-looking proposition of integrating big data analytics with ABC to enhance the real-time accuracy of cost allocation[3]. These studies provide important methodological support for AI-enabled cost management.

Second, research on the intrinsic mechanisms through which artificial intelligence (AI) enhances supply chain cost reduction and efficiency improvement has become increasingly empirical. Fitzgerald (2014) and Chen Jian (2020), respectively from the perspectives of value creation tools and managerial paradigm transformation, demonstrated how digital technologies reshape corporate competitiveness[4]. Building upon this foundation, the focus of existing research has gradually shifted from "process-driven" management toward "data-driven" governance. Through empirical analysis, Zhang Jianqi (2024) confirmed the cost-reduction effects of big data on inventory management, while Zhao Ling (2022) employed machine learning models to reveal the positive role of digital investment in mitigating cost stickiness[5]. These micro-level empirical findings provide important theoretical support for AI-enabled lean cost management across the entire supply chain.

Third, the integration of multidimensional theories provides strong theoretical underpinnings for this study. Coase's (1937) transaction cost theory established the fundamental objective of reducing information asymmetry, whereas lean cost management theory emphasizes the elimination of non-value-added activities as a core managerial principle[6]. Within this analytical framework, Wang Yijun's (2017) study on information-sharing mechanisms between suppliers and purchasers, together with Tu Xiwei's (2024) exploration of environmental cost measurement within green supply chains, further expanded the connotation of supply chain governance from the perspectives of transaction cost reduction and environmental cost internalization[7].

Finally, case analyses of digital transformation among leading enterprises have become a crucial pathway for extracting broadly applicable managerial insights. Xiao Hongjun and Li Shantong (2024) developed the theoretical paradigm of the "digital-intelligent supply chain," while Ding Guoning et al. (2025), through observations of leading manufacturing firms, demonstrated the driving role of intelligent scheduling in enhancing operational resilience. As a global leader in the home appliance industry, Haier Smart Home has implemented extensive AI practices in demand forecasting, smart logistics, and business-finance integration. Its experience represents not merely an individual corporate case, but also a representative example of how AI reconstructs supply chain processes and generates spillover effects through supply chain reengineering.

In summary, existing studies have confirmed the positive effects of digital transformation on supply chain cost optimization. However, insufficient attention has been paid to how AI technologies can be deeply embedded into accounting-based cost accounting systems and lean management practices at the granular level of business-finance integration. Accordingly, this study systematically examines the case of Haier Smart Home and constructs an AI-enabled lean cost management framework covering the entire supply chain and full operational lifecycle based on a four-dimensional cost structure encompassing direct costs, activity-based costs, transaction costs, and environmental costs. By doing so, this study seeks to address the limitations of existing research regarding the integration of AI-specific empowerment mechanisms with professional accounting dimensions.

2. Case Background

2.1 Overview of Haier Smart Home

Haier Smart Home was established in 1984 and is headquartered in Qingdao, Shandong Province. The company was listed on the Shanghai Stock Exchange in 1993 and has maintained the world's largest retail sales volume among major home appliance brands for 15 consecutive years. In 2023, it ranked 405th on the Fortune Global 500 list. The company operates in more than 200 countries and regions worldwide and owns multiple global brands, including Haier, Casarte, Leader, GE Appliances, and Fisher & Paykel. Its product portfolio covers a full range of household appliances, including refrigerators, washing machines, air conditioners, water heaters, and kitchen appliances.

Haier Smart Home has undergone six major

stages of strategic evolution: the brand-building strategy stage (1984–1991), diversification strategy stage (1991–1998), internationalization strategy stage (1998–2005), global branding strategy stage (2005–2012), networking strategy stage (2012–2019), and ecosystem branding strategy stage (2019–present). Since the launch of its networking strategy, the company has taken the lead in advancing the digitalization and intelligent transformation of supply chain management by deeply integrating artificial intelligence (AI) technologies into the entire supply chain process. As a result, Haier Smart Home has become a benchmark enterprise for digital transformation and lean supply chain cost management within the home appliance industry.

2.2 Pain Points in Haier Smart Home's Supply Chain Cost Management

In the process of supply chain cost management, Haier Smart Home has faced dual challenges arising from insufficient internal coordination and inefficient external integration. These issues have reduced the efficiency and precision of cost control, thereby limiting the company's ability to achieve comprehensive cost reduction and operational efficiency enhancement across the entire supply chain network. Specifically, these challenges can be categorized into two major dimensions: internal supply chain pain points and external supply chain pain points, both of which constituted the primary causes of the company's initially high supply chain costs.

(1) Internal Supply Chain Pain Points in Table 1

Table 1. Analysis of Internal Supply Chain Pain Points

Pain Point	Analysis of the Pain Point
Severe information silos	Traditional functional organizational structures resulted in fragmented data across procurement, production, logistics, sales, and finance departments, leading to low cross-departmental coordination efficiency and the absence of a holistic perspective in cost management.
Insufficient production leanization	Large-scale standardized production models exhibited limited flexible manufacturing capabilities, resulting in serious resource waste and relatively extensive production cost management practices.
Slow inventory turnover	The coexistence of multiple brands and a nationwide product distribution network led to inventory accumulation, low inventory turnover efficiency, and persistently high warehousing and logistics costs.
Extensive marketing model	Traditional offline sales channels dominated the marketing model, resulting in high customer acquisition costs, low conversion efficiency, and continuously rising selling expenses.
Lagging financial accounting systems	Manual financial accounting processes and the low precision of cost allocation made it difficult to achieve real-time cost monitoring and refined cost analysis.

(2) External Supply Chain Pain Points in Table 2

Table 2. Analysis of External Supply Chain Pain Points

Pain Point	Analysis of the Pain Point
High supplier concentration	Between 2003 and 2012, supplier concentration exceeded 40%, and in certain years surpassed 90%, weakening the firm's bargaining power and increasing difficulties in procurement cost management.
Supply-demand information asymmetry	Delayed and distorted transmission of customer demand information resulted in supply-demand mismatches, product overstocking, and high product return and exchange costs.
Weak environmental cost management	Enterprises lacked the capability to accurately quantify energy consumption and carbon emissions across production and logistics processes, leading to deficiencies in environmental cost management.
Insufficient upstream and downstream supply chain coordination	Inefficient information communication with suppliers and customers, combined with high transaction costs, weakened overall supply chain resilience.

2.3 AI Deployment in Haier Smart Home's Supply Chain

Haier Smart Home has experienced three stages in exploring AI-enabled supply chain transformation: the exploratory stage (2005–2014), the acceleration stage (2014–2020), and the deep integration stage (2020–present). Through these stages, the company has gradually established a full-process AI-enabled supply

chain system. The core architecture is summarized in Figure 1.

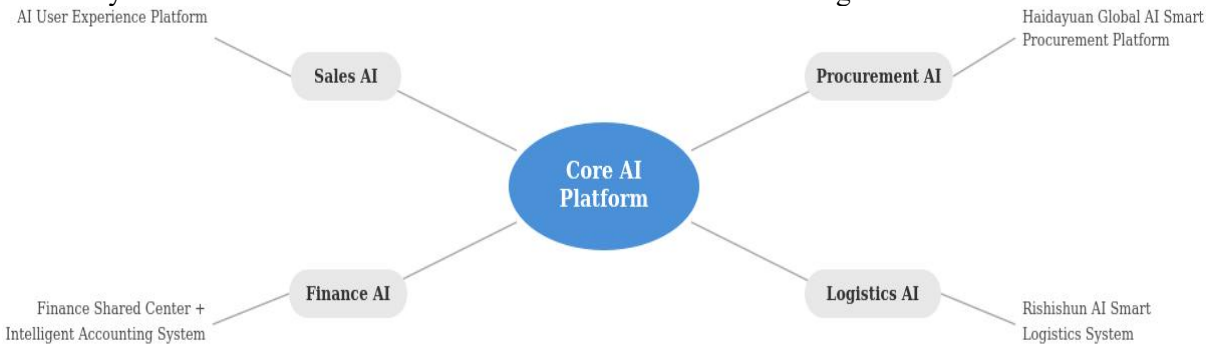

Figure 1. Core Layout of a Full-Process AI Supply Chain System

Core AI Platform

The COSMOPlat industrial internet platform serves as the company's core AI platform, enabling intelligent manufacturing, end-to-end process coordination, and refined cost analysis through AI technologies.

Procurement-side AI

The HYZEN Global AI Intelligent Procurement Platform enables intelligent sourcing, automated price comparison, supplier evaluation, and automated order processing.

Logistics-side AI

The RRS Smart Logistics System supports intelligent inventory forecasting, smart warehouse allocation, and end-to-end logistics visualization.

Sales-side AI

AI-enabled user experience cloud platforms, precision marketing systems, and intelligent customer service systems facilitate user profiling, precise customer acquisition, and efficient after-sales services.

Finance-side AI

The integration of financial shared service centers with AI-enabled accounting and refined cost analysis systems enables automated cost accounting, real-time monitoring, and driver-based cost analysis.

3. Mechanisms Through Which Artificial Intelligence Enables Lean Supply Chain Cost Management

3.1 Logical Framework of AI-Enabled Lean Supply Chain Cost Management

The core logic underlying lean cost management can be conceptualized as a closed-loop system characterized by "data-driven operations → process optimization→collaborative cost reduction → refined cost management." Specifically, as shown in Table 3, this framework can be divided into four hierarchical layers.

Table 3. Hierarchical Framework of AI-Enabled Supply Chain Management

Layer	Conceptual Description
Data perception layer	Internet of Things (IoT) and big data technologies are utilized to collect internal and external data throughout the supply chain process, thereby eliminating information silos.
Intelligent analytics layer	AI algorithms and machine learning technologies are employed to accurately identify cost drivers, forecast demand and prices, and detect cost anomalies.
Decision execution layer	Intelligent decision-making systems, robotic process automation (RPA), and digital twin technologies are applied to optimize operational processes, automate execution, and dynamically schedule resources.
Lean management layer	Enterprises achieve comprehensive reductions in direct costs, activity-based costs, transaction costs, and environmental costs, thereby realizing lean cost management objectives.

Overall Logical Framework

Artificial intelligence technologies → elimination of information asymmetry → reconstruction of supply chain processes → optimization of resource allocation → reduction of four categories of costs → realization of lean supply chain cost management

3.2 Technological Support for AI-Enabled Lean Supply Chain Cost Management

The core AI technologies involved in this study can be broadly categorized into several major types, each playing a crucial role in supply chain cost management, including big data analytics, machine learning technologies, and Internet of Things (IoT) technologies, see Table 4.

Table 4. Technological Support for AI-Enabled Supply Chain Cost Management

Technology	Function
Big data analytics technologies	Integrate multidimensional data from procurement, production, logistics, sales, finance, suppliers, and customers across the supply chain, enabling comprehensive cost data collection, cleansing, and analysis, as well as the accurate identification of cost drivers and anomalies.
AI-enabled forecasting technologies	Based on machine learning algorithms, these technologies accurately forecast market demand, raw material prices, inventory demand, and logistics transportation requirements, thereby mitigating overproduction, inventory backlogs, and procurement overflow risks.
IoT and sensing technologies	Real-time collection of production equipment energy consumption data, logistics transportation status, inventory quantities, and environmental emission data enables dynamic cost monitoring and real-time early warning systems.
RPA-based process automation technologies	Replace manual operations in procurement order processing, financial accounting, invoice verification, and inventory counting, thereby reducing labor costs and operational errors.
Industrial internet platforms	Break down data barriers among internal departments and external upstream and downstream enterprises, enabling end-to-end collaborative management across the supply chain.
Digital twin technologies	Construct digital simulation models of the supply chain to simulate process optimization, cost fluctuations, and risk scenarios, thereby supporting refined decision-making and risk prevention.

3.3 Cost Reduction Pathways of AI-Enabled Lean Supply Chain Cost Management

Driven by core technologies such as big data analytics, machine learning, intelligent forecasting, Internet of Things (IoT)-based sensing, robotic process automation (RPA), and digital twin technologies, artificial intelligence (AI) enables a lean cost reduction framework that spans six key supply chain dimensions: procurement, production, warehousing and logistics, sales, cross-entity coordination, and green low-carbon operations. Through end-to-end process penetration, multidimensional coordination, and full-cost coverage, this framework establishes an integrated pathway for lean cost management.

Specifically, AI-enabled supply chain management targets the reduction of four major categories of costs-direct costs, activity-based costs, transaction costs, and environmental costs-thereby facilitating the transformation from traditional "single-point passive cost reduction" toward an intelligent and proactive model of enterprise-wide lean cost management. Ultimately, this transformation contributes to the optimization of overall supply chain costs,see Figure 2.

(1) Procurement Stage: AI-Enabled Intelligent Sourcing and Full-Cycle Supplier Management for Reducing Direct Costs and Transaction Costs

The procurement stage represents the primary source of direct costs within the supply chain. Through multidimensional data integration, intelligent decision-making, and automated execution, artificial intelligence (AI) enables enterprises to manage procurement costs at the source. On the one hand, AI leverages big data technologies to capture and analyze global supplier data in real time, thereby breaking down traditional procurement information barriers, mitigating monopoly pricing by dominant suppliers, accurately identifying cost-effective suppliers, and reducing direct procurement costs. On the other hand, AI algorithms can forecast fluctuations in raw material prices and assist firms in determining optimal procurement quantities and purchasing timing, thereby minimizing cost losses associated with price volatility.

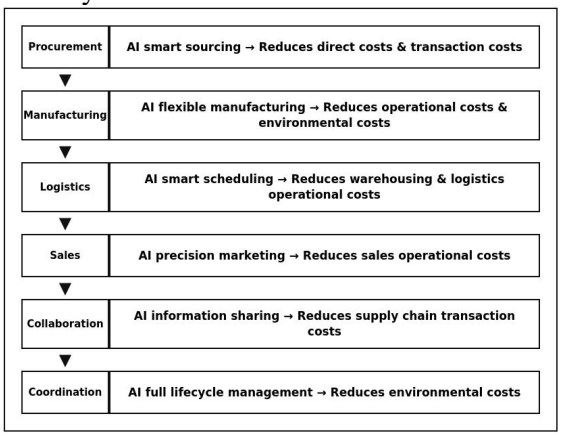

Figure 2. AI-Enabled Supply Chain Cost Reduction Pathway

Meanwhile, robotic process automation (RPA)

technologies enable the full-process automation of procurement orders, inspection reporting, and settlement procedures, substantially reducing supply chain transaction costs related to information searching, contract negotiation, and contract performance supervision.

(2) Production Stage: AI-Enabled Flexible Intelligent Manufacturing and Energy Consumption Management for Reducing Activity-Based Costs and Environmental Costs

The production stage constitutes the primary source of activity-based costs and environmental costs within the supply chain. Artificial intelligence (AI) facilitates cost reduction through data-driven production management, lean manufacturing, and green operational optimization. By conducting intelligent analyses of order demand, AI enables flexible production scheduling, thereby avoiding excessive production, raw material waste, and idle production capacity, while reducing manufacturing costs and labor-related operational costs.

In addition, IoT sensors continuously collect real-time operational data from production equipment, while AI algorithms dynamically optimize production parameters to improve production efficiency and resource utilization.

(3) Warehousing and Logistics Stage: AI-Enabled Inventory Forecasting and Intelligent Scheduling for Reducing Warehousing and Logistics Operating Costs

The warehousing and logistics stage constitutes an important component of supply chain operating costs. Artificial intelligence (AI) facilitates cost reduction through accurate demand forecasting, optimal resource allocation, and streamlined process optimization. Based on historical sales data, market trends, seasonal fluctuations, and other influencing factors, AI establishes inventory demand forecasting models to accurately determine optimal inventory levels, thereby mitigating the risks of inventory overstocking and stockouts while reducing inventory holding costs and warehousing occupancy costs.

At the same time, AI-enabled end-to-end logistics visualization and real-time monitoring reduce additional costs arising from cargo damage and delivery delays, while further improving inventory turnover efficiency.

(4) Sales Stage: AI-Enabled Precision Marketing and Intelligent Customer Service for Reducing Sales Operating Costs

Marketing expenditures and after-sales service costs constitute major components of operating costs within the sales stage. Artificial intelligence (AI) enables cost reduction in sales operations through precision targeting, efficient service delivery, and demand forecasting. By utilizing user profiling and consumer behavior analytics, AI facilitates precision advertising and personalized product recommendations, thereby improving marketing conversion efficiency.

In addition, intelligent customer service systems and automated after-sales response systems shorten service response times, reduce labor-intensive after-sales service costs, and lower the probability of product returns and exchanges. Meanwhile, AI captures changes in end-market demand in real time and transmits such information back to the production stage, thereby reducing inventory backlogs and rework costs caused by supply-demand mismatches and further lowering operating costs in the sales process.

(5) Supply Chain Collaboration Stage: AI-Enabled Information Sharing and Process Integration for Reducing Interorganizational Transaction Costs

Information asymmetry across upstream and downstream supply chain participants constitutes a primary driver of elevated transaction costs. Artificial intelligence (AI) mitigates coordination frictions through end-to-end data sharing and cross-entity process integration. By leveraging AI-enabled supply chain platforms, focal firms can substantially reduce communication costs, negotiation costs, and contract enforcement costs between suppliers and customers.

Meanwhile, AI technologies enable the early identification and warning of supply chain collaboration risks, thereby reducing additional losses caused by supply disruptions, contract breaches, and other operational uncertainties. As a result, enterprises can achieve lean management of interorganizational transaction costs across the supply chain network.

3.4 Transmission Mechanisms of AI-Enabled Lean Supply Chain Cost Management

The transmission mechanism underlying AI-enabled lean supply chain cost management refers to the integrated pathway through which digital technologies and supply chain coordination logic enable the cost reduction and efficiency enhancement capabilities of AI to

extend from isolated internal business functions to the broader interorganizational supply chain network. Specifically, this mechanism can be categorized into two major dimensions: internal transmission mechanisms and external transmission mechanisms.

3.4.1 Internal transmission mechanism

The core logic underlying the internal transmission mechanism is that artificial intelligence (AI), with data serving as the central connecting element, integrates the information flows and operational processes across five key internal business functions-procurement, production, warehousing and logistics, sales, and finance. Through a closed-loop transmission pathway characterized by "data integration → process coordination → resource optimization → cost reduction," AI enables enterprise-wide lean management of internal supply chain costs.

First, at the data layer, AI eliminates internal information asymmetry by enabling integrated data connectivity. Through big data platforms and Internet of Things (IoT)-based sensing technologies, AI continuously collects real-time data regarding raw material prices and inventory levels in procurement, equipment energy consumption and work order data in production, inventory turnover and scheduling information in warehousing and logistics, customer orders and demand information in sales, as well as cost accounting and expense data in finance. By integrating previously fragmented and isolated departmental data into unified, real-time, and traceable enterprise-wide data assets, AI fundamentally resolves the problem of information silos under traditional management models. Consequently, cost drivers, waste points, and resource gaps become clearly identifiable, thereby establishing a robust data foundation for lean cost management.

Second, at the process layer, AI reconstructs internal operational processes by connecting fragmented business procedures. AI technologies eliminate process segmentation among procurement, production, logistics, sales, and finance, thereby enabling automated end-to-end process integration and dynamic operational coordination. For example, intelligent sourcing data generated during procurement can be directly synchronized with production planning systems; production completion data can automatically trigger warehousing and logistics scheduling; sales-side demand forecasting can reversely drive procurement decisions and production scheduling; and AI-enabled financial accounting systems can seamlessly integrate real-time cost data from each operational stage. In doing so, enterprises eliminate non-value-added activities such as manual coordination, repetitive approval procedures, and information delays, thereby reducing redundant costs at the process source.

Third, at the resource layer, AI enables the precise allocation of internal resources through intelligent decision-making based on enterprise-wide data. Specifically, AI dynamically allocates key organizational resources-including labor, equipment, inventory, and capital-across internal operations. On the production side, intelligent production scheduling reduces equipment idleness and raw material waste; within logistics operations, intelligent scheduling minimizes inventory backlogs and warehousing occupancy; on the sales side, precision marketing improves the input-output efficiency of resource investments; and within finance functions, intelligent capital management enhances capital utilization efficiency. As a result, enterprises achieve resource utilization objectives characterized by "zero waste, high efficiency, and optimal allocation."

Fourth, at the cost layer, AI establishes a closed-loop mechanism for continuously reducing internal costs. Building upon data integration, process coordination, and resource optimization, AI directly reduces direct costs such as raw materials, direct labor, and manufacturing overhead, while simultaneously optimizing operating costs related to warehousing, logistics, marketing, and administrative activities. Moreover, through real-time monitoring, anomaly detection, and iterative optimization, AI forms a closed-loop lean cost management system that transforms cost management from traditional ex post accounting into proactive ex ante forecasting and real-time in-process control, thereby enabling the continuous optimization of internal supply chain costs.

3.4.2 External transmission mechanism

The external transmission mechanism is grounded in the theory of supply chain spillover effects. With the AI-enabled supply chain platform of the focal firm serving as the central transmission hub, intelligent management models, data standards, and cost management philosophies are transmitted bidirectionally to

upstream suppliers and downstream customers. By breaking through organizational boundaries, AI enables cross-entity collaborative cost reduction across the entire supply chain, with a particular emphasis on reducing transaction costs and external environmental costs.

First, the transmission mechanism extends upstream to suppliers, thereby reducing supply chain transaction costs and promoting green collaboration. Through AI-enabled supply chain platforms, focal firms transmit order demand, quality standards, cost management requirements, and green production specifications to upstream suppliers in real time, enabling end-to-end data sharing throughout the supply chain process. On the one hand, AI replaces traditional manual negotiations, thereby reducing transaction costs associated with information searching, contract negotiation, and contract enforcement. On the other hand, focal firms diffuse intelligent manufacturing standards and energy consumption management technologies to suppliers, thereby reducing upstream raw material energy consumption and environmental costs at the source.

Second, the transmission mechanism extends downstream to customers, thereby reducing supply-demand mismatch costs and optimizing environmental costs throughout the product lifecycle. AI platforms continuously collect and analyze downstream customer preferences, consumption habits, product usage feedback, and recycling demands, while transmitting precise demand information back to the production stage. This process substantially reduces costs arising from supply-demand mismatches. Meanwhile, product energy consumption data and end-of-life recycling information from the customer side are incorporated into full-lifecycle supply chain management, thereby promoting green consumption and recycling practices while optimizing environmental costs throughout the product lifecycle. As a result, downstream customers and focal firms achieve collaborative environmental cost management.

Third, supply chain-wide collaboration facilitated by AI enables the formation of an intelligent ecosystem and enhances overall cost competitiveness. Through the positive spillover effects of AI, focal firms extend their internal lean cost management capabilities across the broader supply chain network, thereby establishing an intelligent collaborative ecosystem composed of focal firms, suppliers, and customers. Consequently, the supply chain evolves from an isolated model of firm-level cost reduction toward an integrated model of supply chain-wide efficiency enhancement, ultimately strengthening overall supply chain resilience and cost competitiveness.

4. Implementation and Effectiveness Analysis of AI-Enabled Lean Supply Chain Cost Management at Haier Smart Home

4.1 Internal Supply Chain: Implementation Pathways of AI-Enabled Lean Cost Management

(1) Procurement Stage: AI-Enabled Intelligent Procurement for Reducing Direct Costs

Haier Smart Home has established an intelligent procurement system based on the HYZEN AI Intelligent Procurement Platform, featuring a three-tier architecture composed of "front-end role differentiation, middle-platform nine-node coordination, and back-end big data empowerment." AI algorithms continuously capture and analyze global supplier information in real time, automatically comparing supplier prices, product quality, and credit ratings to achieve intelligent sourcing and optimal supplier matching, see Table 5.

Table 5 Haier Smart Home – Procurement Cost as Percentage of Main Business Cost

Year	Haier Smart Home Procurement Cost as Percentage of Main Business Cost
2016	88.9%
2017	85.9%
2018	83.9%
2019	83.2%
2020	83.1%
2021	85.7%
2022	85.4%
2023	85.7%
2024	82.5%
2025	84.3%

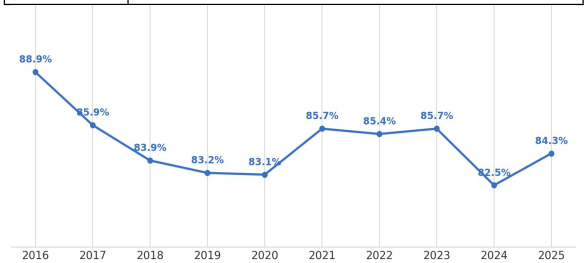

Figure 3. Changes in Haier Smart Home's Procurement Cost as a Percentage of Main Business Cost

Meanwhile, AI monitors fluctuations in raw

material prices and, in combination with production demand forecasting, formulates precise procurement plans to avoid excessive purchasing and price premiums. In addition, robotic process automation (RPA) technologies automate procurement orders, inspection reporting, and settlement procedures, thereby reducing labor-intensive operational costs associated with manual processing.

As shown in Figure 3,through AI-enabled procurement management, the proportion of procurement costs to the cost of main business operations at Haier Smart Home declined from 88.9% in 2016 to a low of 82.5% in 2024. As a result, direct procurement costs were substantially reduced, while the company's bargaining power was significantly strengthened.

(2) Production Stage: AI-Enabled Intelligent Manufacturing for Reducing Operating Costs

Leveraging the COSMOPlat Industrial Internet Platform, Haier Smart Home established an AI-driven flexible manufacturing system that enables intelligent production scheduling, real-time equipment energy consumption monitoring, and AI-powered quality inspection. AI algorithms dynamically adjust production rhythms based on customer order demand, thereby facilitating mass customization and shifting production logic from "production for inventory" to "production for users," effectively avoiding overproduction.

Meanwhile, IoT sensors continuously collect real-time equipment energy consumption data, while AI analytics optimize energy consumption structures to reduce energy waste. In addition, computer vision technologies enable automated product quality inspection, thereby reducing losses associated with defective products.

As illustrated in Figure 4,AI-enabled intelligent manufacturing contributed to an increase in the gross profit margin of Haier Smart Home from 27.6% in 2016 to 31.5% in 2025. These improvements indicate significant achievements in production operating cost management, including a 16% increase in labor productivity and a 4% optimization in manufacturing expense ratios across domestic factories, see Table 6.

Table 6. Haier Smart Home – Gross Margin by Year

Year	Haier Smart Home Gross Margin
2016	27.6%
2017	27.9%
2018	29.1%
2019	29.8%
2020	29.7%
2021	31.3%
2022	31.3%
2023	31.5%
2024	30.7%
2025	31.5%

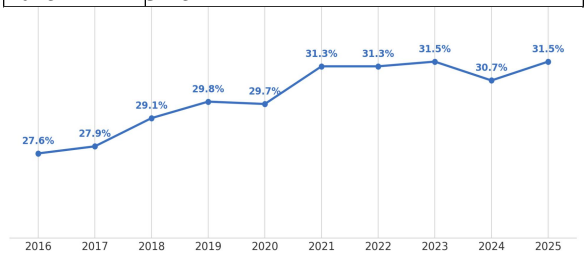

Figure 4. Changes in Haier Smart Home's Gross Margin

(3) Warehousing and Logistics Stage: AI-Enabled Intelligent Scheduling for Optimizing Inventory Costs

The RRS AI Smart Logistics System utilizes machine learning algorithms to accurately forecast inventory demand across different product categories and geographic regions. By establishing a distributed "cloud warehouse" network, the system enables inventory sharing and intelligent scheduling. Meanwhile, AI optimizes logistics distribution routes and reduces intermediate circulation links, thereby facilitating direct delivery from factories to consolidation warehouses and from consolidation warehouses to end customers, ultimately shortening delivery cycles.

As shown in Figure 5,following AI implementation, the inventory turnover ratio of Haier Smart Home improved from 5.98 in 2019 to 4.52 in 2023. Since 2020, the company has achieved accelerated cost reduction, substantially lowering inventory backlog costs while continuously reducing warehousing and logistics operating costs, see Table 7.

Table 7. Haier Smart Home – Inventory Turnover Ratio by Year

Year	Haier Smart Home Inventory Turnover Ratio
2016	8.82
2017	7.36
2018	6.89
2019	5.98
2020	5.93
2021	5.57
2022	5.11
2023	4.52
2024	4.11
2025	4.42

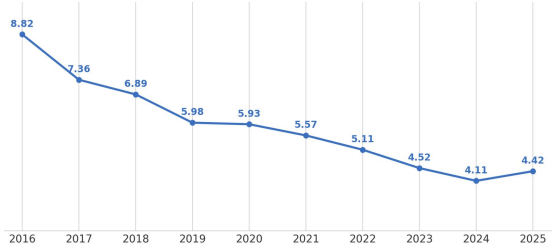

Figure 5. Haier Smart Home – Inventory Turnover Ratio Trend

(4) Sales Stage: AI-Enabled Precision Marketing for Reducing Selling Expenses

The AI-driven user profiling system at Haier Smart Home accurately analyzes consumer demand, preferences, and purchasing power, thereby enabling precision advertising and personalized product recommendations to improve marketing conversion efficiency. In addition, AI-powered intelligent customer service reduced response times by 38%, significantly lowering labor-intensive after-sales service costs. Furthermore, the AI-enabled integrated online-to-offline (O2O) marketing model mitigated channel conflicts and reduced channel-related costs.

From 2016 to 2023, the selling expense ratio of Haier Smart Home declined from 17.85% to 15.67%, reflecting a substantial reduction in marketing-related operating costs. Meanwhile, home appliance sales continued to grow, reaching 119.78 million units/sets in 2023.

(5) Financial Stage: AI-Enabled Financial Shared Services for Lean Cost Accounting

The financial shared service center of Haier Smart Home is equipped with an AI-enabled intelligent accounting system. Through robotic process automation (RPA), the system automatically processes expense reimbursement, invoice verification, cost allocation, and financial statement preparation, thereby enabling real-time cost data collection, precise cost accounting, and dynamic cost analysis. In addition, the AI-driven cost driver analysis module accurately identifies abnormal cost fluctuations and provides data support for lean cost management.

AI-enabled financial shared services have facilitated the transformation of financial personnel from routine accounting functions toward management accounting roles. Cost accounting efficiency increased by 80%, while the financial closing cycle was shortened from 10 days to 3 days, substantially improving the precision of cost management.

4.2 External Supply Chain: Implementation Pathways of AI-Enabled Lean Cost Management

(1) Supplier Collaboration: AI-Enabled Information Sharing for Reducing Transaction Costs

The HYZEN AI Platform enables real-time sharing of order, fulfillment, quality inspection, and settlement information between suppliers and Haier Smart Home, while automatically integrating operational processes to reduce transaction costs associated with negotiation, supervision, and communication. Meanwhile, the AI-driven supplier evaluation system dynamically monitors suppliers' fulfillment capabilities, quality performance, and green operational performance, thereby optimizing the supplier structure and reducing supplier dependence.

The supplier concentration ratio of Haier Smart Home declined from over 40% in 2013 to 23.60% in 2023, while the proportion of related-party procurement decreased from 18.80% to 10.60%. Consequently, supply chain transaction costs were substantially reduced, and the company's bargaining power was significantly enhanced.

(2) Customer Collaboration: AI-Driven Demand Forecasting for Reducing Supply-Demand Mismatch Costs

The AI-powered user experience cloud platform continuously collects customer demand, product usage feedback, and satisfaction data in real time, thereby enabling accurate market demand forecasting and facilitating demand-driven production. As a result, costs associated with product overstocking, returns, and exchanges are significantly reduced. In addition, AI-enabled precision services improve customer satisfaction while lowering customer retention costs.

In 2023, the customer satisfaction rate of Haier Smart Home reached 99.87%. Multiple product categories-including refrigerators, washing machines, and televisions-ranked first in industry customer satisfaction surveys. Meanwhile, customer concentration continued to decline, substantially reducing costs associated with supply-demand mismatches.

(3) Green Collaboration: AI-Enabled Full-Lifecycle Management for Reducing Environmental Costs

AI-enabled energy consumption monitoring systems continuously collect real-time energy consumption and emissions data from

production and logistics operations, thereby enabling precise measurement of environmental costs. Meanwhile, the AI-driven "Whale Recycling" digital platform facilitates intelligent recycling and resource reutilization of discarded household appliances, effectively reducing environmental governance costs.

In 2023, the total greenhouse gas emissions of Haier Smart Home decreased by 23.86% year-on-year, total water consumption declined by 12.55%, and hazardous waste emissions fell by 42.44%. These results demonstrate significant achievements in environmental cost management, with the company's green supply chain index ranking among the industry leaders.

4.3 Effectiveness Analysis of AI-Enabled Lean Supply Chain Cost Management

(1) Financial Performance Effects

The company's cost structure has been continuously optimized, as reflected by sustained declines in procurement costs, selling expense ratios, and warehousing and logistics cost proportions. Meanwhile, the cost-to-profit ratio improved from 6.78% in 2018 to 8.46% in 2023. Profitability also steadily increased, with gross profit margins rising continuously over multiple years and outperforming industry averages, thereby strengthening the firm's ability to withstand risks associated with raw material price fluctuations.

Operational efficiency improved significantly, as evidenced by continuous optimization in inventory turnover and accounts receivable turnover ratios, enhanced capital utilization efficiency, and reduced financial risks. Furthermore, expense management performance was remarkable: the administrative expense ratio continuously declined, labor productivity improved substantially, and the combined effects of economies of scale and AI-enabled cost reduction further strengthened operational efficiency.

(2) Non-Financial Performance Effects

Supply chain collaboration capabilities were significantly strengthened, as reflected in declining supplier and customer concentration ratios, enhanced supply chain resilience, and improved risk resistance capabilities. Customer satisfaction remained industry-leading, with multiple home appliance categories ranking first in customer satisfaction evaluations, thereby continuously strengthening brand influence.

In addition, green development performance improved substantially, with continuous reductions in energy consumption and emissions, effective environmental cost control, and strong alignment with China's "Dual Carbon" policy objectives. Moreover, the company maintained industry-leading digital capabilities through full-chain AI deployment, positioning its supply chain intelligence level at the forefront of the industry.

4.4 Summary of Implementation Effectiveness

Artificial intelligence technologies have comprehensively empowered both the internal full-process operations and external collaborative activities of the supply chain at Haier Smart Home, enabling enterprise-wide lean cost management characterized by precise reductions in direct costs, lean optimization of operating costs, substantial reductions in transaction costs, and controllable environmental costs. AI technologies have broken through the information barriers, process barriers, and collaboration barriers inherent in traditional supply chain cost management, thereby facilitating the transformation of the company's supply chain from traditional extensive management toward intelligent, lean, green, and collaborative management. Consequently, the company's core competitiveness, supply chain resilience, and sustainable development capabilities have been substantially enhanced.

5. Problems and Optimization Recommendations for AI-Enabled Lean Supply Chain Cost Management

5.1 Existing Problems

Although Haier Smart Home has achieved phased progress in lean supply chain cost management through artificial intelligence technologies, shortcomings remain in areas including the depth of technological integration, global collaborative governance, business-finance data integration, refined inventory management, and risk governance. These issues constrain the full realization of AI-enabled value creation.

First, the integration depth between AI technologies and lean supply chain cost management remains insufficient. In many operational stages, AI applications remain limited to basic-level process automation and data visualization, without being deeply embedded into advanced application scenarios

such as cost driver analysis and end-to-end lean decision-making. Consequently, AI's capabilities in value mining and forward-looking forecasting based on cost data have not been fully leveraged, and supply chain cost management still exhibits substantial lagging characteristics.

Second, under the globalized supply chain layout, the collaborative governance effectiveness of AI systems has not been fully realized. Although the company's supply chain network spans extensive geographic regions, problems including inconsistent data standards, inadequate system compatibility, and significant data barriers across regional AI systems hinder unified global supply chain cost management and coordinated scheduling. Furthermore, the level of AI application within overseas supply chains remains significantly lower than that within domestic operations, limiting the realization of cross-regional economies of scale in collaborative cost reduction.

Third, from the perspective of business-finance integration, the coordination capability of AI-enabled cost data remains inadequate. Data barriers between supply chain business operations and financial cost management have not been fully eliminated, preventing AI technologies from supporting real-time data sharing, precise cost accounting, and integrated analytical linkage between operational data and financial cost data. In addition, an integrated AI-driven business-finance cost management platform has not yet been fully established, and data fragmentation continues to hinder enterprise-wide lean cost management implementation.

Finally, the AI data security governance system and supply chain risk management mechanisms remain underdeveloped. As supply chain digitalization advances, risks such as data leakage and system failures continue to increase, while the company has yet to establish a comprehensive data security governance framework. At the same time, AI-driven supply chain risk early-warning mechanisms remain inadequate, resulting in insufficient forecasting and prevention capabilities regarding risks such as raw material price fluctuations, supply chain disruptions, and international logistics bottlenecks.

5.2 Optimization Recommendations

In response to the above challenges, and in consideration of evolving AI technology application trends and the requirements of lean supply chain cost management, this study proposes optimization recommendations across five dimensions: technological integration, global governance, business-finance collaboration, refined inventory management, and risk governance, as illustrated in Figure 6.

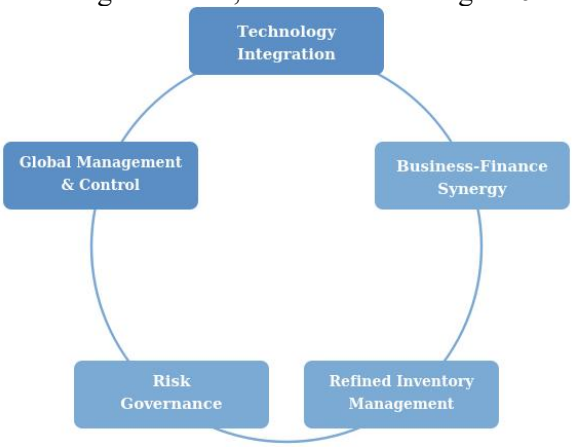

Figure 6. Core Layout of Full-Process AI Supply Chain System

First, enterprises should deepen the integration between AI technologies and end-to-end lean supply chain cost management by increasing investment in the research, development, and practical deployment of advanced AI technologies. Technologies such as deep learning, digital twins, and large language model (LLM)-based analytics should be embedded into core cost management processes to establish AI-driven intelligent cost decision-making systems. This transformation would shift cost management from traditional ex post accounting toward ex ante forecasting and real-time in-process control, thereby fully unlocking the value of AI-enabled cost reduction and efficiency enhancement[8].

Second, enterprises should establish a unified global AI-enabled supply chain governance platform to eliminate data barriers among regional supply chain systems. By developing unified data standards, accounting criteria, and management procedures, firms can achieve real-time monitoring, collaborative governance, and intelligent scheduling of global supply chain costs. At the same time, enterprises should accelerate the upgrading of AI applications within overseas supply chains and replicate mature domestic management models internationally, thereby fully leveraging the economies of scale generated by AI technologies.

Third, enterprises should strengthen AI-enabled collaborative governance mechanisms for cost data from the perspective of business-finance integration. Specifically, firms should establish AI-driven integrated business-finance cost management platforms that fully connect operational and financial data chains, enabling real-time data sharing, integrated analytical linkage, and bidirectional feedback mechanisms. In addition, financial personnel should participate more deeply in business operations, thereby establishing a closed-loop governance model characterized by integrated business-finance collaboration[9].

Fourth, enterprises should optimize refined AI-enabled inventory management models by upgrading inventory forecasting algorithms in accordance with firm-specific operational characteristics. Companies should establish refined management models differentiated by product category, geographic region, and distribution channel, while simultaneously developing a global intelligent inventory scheduling system to facilitate dynamic inventory resource allocation, reduce warehousing costs, and improve inventory turnover efficiency.

Fifth, enterprises should improve AI data security governance systems and intelligent supply chain risk prevention mechanisms by establishing end-to-end data security control frameworks and strengthening data encryption, access authorization management, and vulnerability detection capabilities. Meanwhile, firms should develop intelligent supply chain risk early-warning platforms that leverage AI technologies to achieve real-time risk identification, accurate forecasting, and proactive risk prevention and control, thereby comprehensively enhancing supply chain resilience and security.

6. Research Conclusions and Implications

6.1 Research Conclusions

Taking Haier Smart Home as a case study, this study systematically examines the mechanisms, implementation pathways, and practical effects of AI-enabled lean supply chain cost management, leading to three major conclusions.

First, artificial intelligence constitutes the core technological foundation for achieving lean supply chain cost management. Through four core functions-intelligent data analytics, process automation, precise supply-demand matching, and upstream-downstream collaboration-AI technologies effectively alleviate information asymmetry, eliminate non-value-added activities, and optimize resource allocation. Consequently, AI can comprehensively reduce direct costs, operating costs, transaction costs, and environmental costs throughout the supply chain, thereby aligning closely with the fundamental objectives of lean cost management.

Second, the AI-enabled lean supply chain cost management practices of Haier Smart Home have achieved remarkable results. Across internal operational stages-including procurement, production, warehousing and logistics, sales, and finance-as well as external collaborative dimensions involving suppliers, customers, and green low-carbon initiatives, the company has extensively applied AI technologies in multiple scenarios. These practices have generated significant outcomes, including optimized cost structures, enhanced profitability, improved operational efficiency, strengthened supply chain collaboration, and upgraded green development performance, thereby validating both the effectiveness and feasibility of AI-enabled cost management.

Finally, there remains considerable room for improvement in the company's AI-enabled cost management practices. Limitations persist in areas such as the depth of AI integration, global collaboration, business-finance data connectivity, lean inventory management, and risk prevention and control. Future optimization should therefore focus on deepening technological applications, establishing unified governance platforms, strengthening data collaboration, upgrading management models, and improving risk governance systems.

6.2 Research Implications

Using Haier Smart Home as a representative case, this study explores AI-enabled lean supply chain cost management and, based on analyses of both practical outcomes and existing challenges, provides targeted and actionable implications for manufacturing enterprises, accounting practitioners, industry development, and policymakers. These findings offer important practical reference value for promoting intelligent supply chain transformation, lean cost management, and high-quality development within the manufacturing industry.

For manufacturing enterprises, AI technologies should be regarded as a strategic instrument for achieving lean supply chain cost management and enhancing core competitiveness. Firms should accelerate the deep integration of AI technologies across the entire supply chain process, including procurement, production, warehousing and logistics, sales, and green low-carbon operations, with the primary objectives of eliminating non-value-added waste, reducing multidimensional costs, and enhancing supply chain resilience.

For accounting practitioners, it is essential to proactively adapt to the development trends of the digital economy and enterprise intelligent transformation by transcending the traditional functional boundaries of financial accounting and transitioning from conventional accounting roles toward intelligent management accounting roles. Accounting professionals should actively develop expertise in AI-enabled cost accounting, intelligent cost driver analysis, integrated business-finance data management, and lean supply chain cost management. By leveraging AI technologies, they can achieve real-time cost data collection, precise accounting, and dynamic analytical capabilities, thereby participating deeply in the full process of enterprise supply chain cost governance.

At the industry level, core supply chain enterprises should fully leverage their technological, resource, and scale advantages to assume industry leadership responsibilities. Relying on the technological spillover effects of their AI-enabled supply chain platforms, these firms should promote the widespread adoption of AI technologies among upstream and downstream small and medium-sized enterprises (SMEs), thereby addressing industry-wide challenges related to insufficient digital transformation capabilities and weak cost management practices among SMEs. Core enterprises may draw upon the collaborative governance model of Haier Smart Home by transmitting AI cost management standards, data systems, and operational experience to suppliers and distributors, thereby constructing a supply chain ecosystem characterized by core enterprise leadership, upstream-downstream collaboration, and full-chain cost reduction. This approach can facilitate the transformation of the industry from isolated enterprise-level cost reduction toward integrated lean management across the entire industrial chain.

From a policy perspective, governments should continue strengthening policy guidance and resource support by increasing fiscal subsidies and tax incentives for AI core technology research and development, as well as for supply chain digital transformation within the manufacturing industry. Policymakers should also accelerate the establishment of standard systems and data governance frameworks for intelligent supply chain transformation in manufacturing, while promoting the secure circulation and collaborative sharing of cross-regional and cross-enterprise supply chain data. Such institutional arrangements would provide critical support for global AI-enabled supply chain governance and integrated business-finance collaboration.

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References

[1] Ai, B. J. (2006). *Theory of competitive cost.* Beijing: China Social Sciences Press, pp. 156–159.

[2] Yin, J. M., Wang, P. X., & Wang, C. J. (2006). Supply chain cost management: Development process and theoretical structure. *Accounting Research, 10*, 44–49, 95–96.

[3] Zheng, T. T., & Zhang, R. M. (2025). Cost control and performance evaluation of e-commerce logistics enterprises under the digital economy. *Friends of Accounting, S1*, 45–48.

[4] Chen, J., Huang, S., & Liu, Y. H. (2020). From empowerment to enablement: Enterprise operations management in the digital environment. *Management World, 36*(2), 117–128, 222.

[5] Zhao, L., & Huang, H. (2022). Enterprise digital transformation, supply chain collaboration, and cost stickiness. *Contemporary Finance & Economics, 5*, 124–136.

[6] Coase, R. H. (1937). The nature of the firm. *Economica, 4*(16), 386–405.

[7] Tu, X. W., & Zhang, P. D. (2024). Enterprise digital transformation, carbon emissions, and supply chain spillover effects. *China Industrial Economics, 4,*

133–151.

[8] Guan, Y. P. (1999). A discussion on the information paradigm in economics. *Economic Research Journal, 6*, 72–79.

[9] Huang, H. B., Zhang, Y. Y., & Xu, C. H. (2023). Can supply chain digitalization promote collaborative innovation among enterprises? A quasi-natural experiment based on smart supply chain policies. *Contemporary Finance & Economics, 8*, 134–145.