Digitalizing Manufacturing: Midea Group's Industrial Evolution Case Study

Zebin Liang

[1] Shenzhen Audencia Financial Technology Institute, Shenzhen University, Shenzhen, Guangdong, 518060, China
2024362044@mails.szu.edu.cn

Abstract. This study presents a comprehensive analysis of Midea Group's digital transformation as a paradigmatic case of manufacturing industry evolution in the Industry 4.0 era. Grounded in China's "Made in China 2025" strategic framework, the research systematically investigates three transformative pillars: the innovative "T+3" customer-order-driven supply chain model that reduced production cycles by 75%, the proprietary M.IoT industrial internet platform achieving cross-system integration of over 100,000 manufacturing assets, and the establishment of multiple Lighthouse Factories demonstrating breakthrough operational improvements (notably Nansha plant's 300% productivity surge). Through longitudinal case analysis, this paper identifies critical success factors including early-mover strategic positioning (initiated in 2011), synergistic technology-business integration, and ecosystem expansion through strategic acquisitions. However, the transformation faces persistent challenges including geopolitical data governance constraints, core technology dependencies in robotics and AI, and organizational silos between B2B/B2C divisions. The study contributes both theoretical insights into digital transformation pathways and practical frameworks for manufacturing enterprises, while highlighting the imperative for technological sovereignty and adaptive organizational structures in globalized operations.

Keywords: Midea Group, AI, Digital Transformation.

1 Introduction

In recent years, the globe has been changing rapidly as new technologies emerged one after another. Cloud computing enabling vast data storage and processing, 5G networks facilitating reliable connectivity, artificial intelligence (AI) driving intelligent decision-making, and advanced robotics transforming physical production lines.

In March 2015, the Third Session of the 12th National People's Congress explicitly proposed the "Made in China 2025" strategy. This initiative emphasizes the integration of new-generation information technology with traditional manufacturing to promote innovation and development within the manufacturing sector.

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The digital economy has become a crucial driver in transforming the global economic structure [1]. Within the tide of digital economic development, digital transformation has become an inevitable stage for enterprise growth [2]. The digital changes brought by the digital economy endow enterprises with new momentum and reconfigure their development models. Digital transformation represents the continuation and iterative upgrade of modern enterprise development strategies [3].

Rooted in the Fourth Industrial Revolution, also known as Industry 4.0, digital transformation refers to the process of triggering significant changes in the attributes of physical entities through the combination of information technology, computing technology, communication technology, and connectivity technology, thereby improving those entities. Digital transformation enables enterprises to achieve greater flexibility and efficiency, optimize production processes, form value propositions for innovation ecosystems, and respond promptly to market demands. It is crucial for enterprises to maintain market competitiveness and technological innovation.

In terms of economic benefits, digital transformation enhances internal efficiency within enterprises. Investments in related projects can optimize the input-output ratio, drive high-quality development, leverage digital technology to innovate value creation models, select solutions based on their own characteristics, and build competitive advantages [4]. Simultaneously, it enhances enterprises' ability to perceive the external environment. Based on accurately identifying and analyzing market demands, it pushes information to investors, bridges information gaps, and balances information asymmetries.

Currently, mainstream literature on digital transformation research primarily focuses on its key aspects, models, and economic consequences. However, case studies on digital transformation remain relatively scarce.

In 2011, Midea Group began exploring reforms oriented toward intelligent manufacturing. Through strategic implementation, Midea Group's digital transformation has steadily matured.

This study seeks to examine the implementation outcomes of digital transformation strategies. Using Midea as a representative case study, this paper analyzes its transformation process to reveal multidimensional impacts on business operations and growth.

2 Midea’s Expansion and Technological Transformation

2.1 Profile of Midea Group

Founded in 1968 and headquartered in Foshan, Guangdong, Midea Group has grown into a global technology leader with significant presence in smart home appliances, new energy, industrial technologies, building automation, robotics, automation, and other innovative fields. The group offers a diverse portfolio of products and services to customers worldwide. As a top-tier global manufacturer, Midea operates multiple R&D centers and production bases across the globe, with its products distributed in over 200 countries and regions.

Midea adheres to its "Technology Leadership, User-Centric Approach, Digital & Intelligent Transformation, and Global Breakthrough" strategy. By focusing on smart and digital transformation, the company drives synergy between its ToC (consumer) and ToB (business) operations, leveraging its diversified industrial layout to achieve cyclical stability. While ToC innovations enhance profitability, they also support ToB business upgrades [5].

Additionally, Midea continuously strengthens its global capabilities, transitioning from a domestic leader to an international powerhouse. Through operational efficiency, technological innovation, and product excellence, the company has enhanced its global presence.

Midea began as a fan manufacturer before expanding into air conditioners and home appliances. Its early diversification focused on broadening product lines within the appliance industry, later accelerating growth through strategic acquisitions.2016, acquiring Germany's KUKA, entering robotics and automation. 2018, acquiring Italy's Clivet and strengthening its European market presence. 2021, acquiring Thailand's GMCC & Welling, boosting competitiveness in global refrigeration compressors.

Through both M&A and in-house R&D, Midea has expanded into industrial technology and building systems, offering solutions in smart manufacturing, building automation, and energy management. This diversification strategy has solidified its competitive edge in a rapidly evolving market.

2.2 Current Situation

After years of development, Midea Group has evolved into a technology conglomerate integrating consumer appliances, HVAC systems, robotics and automation systems, smart supply chains, semiconductor industry, and elevator industry. The group operates approximately 200 subsidiaries, 35 R&D centers, and 35 major production bases worldwide, with its business covering over 200 countries and regions. In 2021, Midea Group achieved revenue of 343.4 billion yuan, representing a year-on-year increase of 20.2%, and ranked 288th on the Fortune Global 500 list.

2.3 Strategy

Today, Midea's strategy crystallizes around three interconnected pillars, globalization, efficiency optimization, and digital transformation. Globalization focuses on deepening market penetration, optimizing global supply chains and expanding its own-brand presence in international markets. Efficiency Optimization entails reducing costs and enhancing productivity across the entire value chain, ensuring lean and competitive operations. Digital Transformation serves as the overarching enabler, leveraging advanced technologies to drive globalization and efficiency goals while unlocking new value streams and business opportunities. This DX is increasingly permeating not just its traditional B2C (Business-to-Consumer) home appliance business but also its rapidly expanding ToB (Business-to-Business) segments, including industrial technology (e.g., components, robotics via KUKA), Building Technologies (e.g., HVAC solutions for commercial buildings via Clivet, Italy), and Automation & Digital Solutions.

3 The Specific Implementation of Midea's Digital Transformation

Prior to 2012, Midea Group primarily relied on large-scale manufacturing, with its domestic home appliance market share rising from 5% in the 1980s to 30% in 2010. However, as consumption patterns upgraded and market demands underwent dramatic shifts, the original extensive expansion strategy—which prioritized scale and price as core advantages—became ineffective. Issues like inventory overstock and slow-moving products grew increasingly prominent, demanding urgent transformation and upgrading.

Meanwhile, digital technology enables enterprises to perceive and capture heterogeneous resources from consumers, allowing them to more accurately align with shifting demand preferences and thereby increase market share. Based on this, in 2011, Midea Group began exploring reforms oriented toward intelligent manufacturing.

3.1 T+3 Model

The T+3 production-sales model is a customer demand-driven approach that revolutionizes traditional manufacturing by aligning production with real-time orders. The term "T+3" refers to the four key cycles in the production process as shown in figure 1. T+0 Cycle is order collection and processing, which involves receiving and analyzing customer orders. T+1 Cycle is component supply, which focuses on rapid, cost-efficient preparation of raw materials and production inputs. T+2 Cycle is product manufacturing, which ensures quality and efficiency. T+3 Cycle is logistics and delivery, which covers shipping finished products to customers [6].

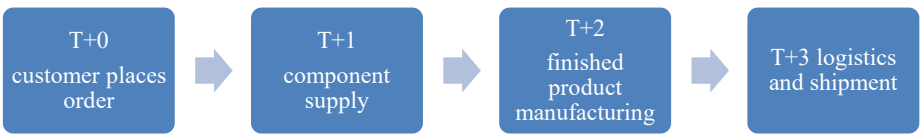

Fig. 1. T+3 production-sales model.

In 2016, Midea Group embarked on its Digital Transformation 2.0 initiative to support business model innovation [7]. During this phase, the company leveraged digital technologies to upgrade its supply chain, addressing chronic manufacturing challenges like high inventory and low efficiency. This enabled a "make-to-order" production model that significantly reduced order fulfillment times by basing production directly on customer demand.

Midea underwent a fundamental shift in its business model - transitioning from traditional multitier distribution and "make-to-stock" practices to a demand-driven, fragmented-order approach. This transformation demanded unprecedented levels of delivery flexibility and operational efficiency.

After completing comprehensive integration of systems, processes, tools, data and IT infrastructure, Midea achieved remarkable operational improvements. To further strengthen market competitiveness, the company fully implemented its innovative "T+3 Customer Order System" business model. Under this framework, Midea restructured four critical processes -order receipt, procurement, production and logistics -into discrete yet interconnected cycles. This created seamless alignment between orders, production planning and scheduling, ensuring highly coordinated manufacturing, supply and sales operations.

The transformation not only streamlined sales processes but dramatically shortened supply cycles from 28 days to just 7 days, achieving break-through supply chain efficiency.

3.2 M.IoT Platform

Beginning in 2018 with advancements in loT technology, Midea started transforming conventional standalone appliances into connected smart devices. In October that year, the company launched its self-developed M.loT industrial internet platform, becoming China's first manufacturer with comprehensive capabilities in proprietary industrial knowledge, software and hardware, demonstrating formidable strength in industrial internet applications.

Evolving alongside the changing needs of manufacturing enterprises, Midea M.loT dynamically advances through iterative upgrades to its platform, consulting, hardware, and ecosystem integration capabilities. It has progressed from single-product applications to suite-based software solutions, now comprehensively upgrading toward integrated solutions.

3.3 Lighthouse Factories

The achievements of Midea Group's digital transformation are most visibly demonstrated in its Lighthouse Factories.

Empowered by Al, they not only achieve flexible production and personalized manufacturing but also establish an end-to-end intelligent manufacturing closed loop. From Al-driven market demand forecasting and smart order processing to automated supply chain matching, optimized production scheduling, intelligent logistics dispatch, and Al-

powered after-sales service, Midea has reshaped the entire manufacturing process with Al.

Midea's Lighthouse Factories each have their own strengths. The Guangzhou air conditioner factory increased labor efficiency by 28%, reduced unit costs by 14%, and shortened order delivery time by 56%.The Shunde microwave oven factory improved overall internal efficiency by 28%, enhanced product quality metrics by 15%, reduced order lead time by 53%, and decreased end-to-end channel inventory by 40%.The Jingzhou refrigerator factory boosted labor productivity by 52%, shortened delivery time by 25%, reduced quality defects by 64%, and increased customer satisfaction by 11%.The Hefei washing machine factory cut delivery cycles by 56%, raised finished goods inventory turnover by 125%, improved direct shipping rates by 50%, enhanced per capita efficiency by 51.6%, and saved nearly 10 million yuan annually in logistics costs [8].

At Midea's air conditioner smart factory in Nansha, by 2019, raw material and semi-finished goods inventory was reduced by 80%, overall manufacturing efficiency improved by 44%, and the export delivery cycle was shortened to 24 days.

In 2020, the Nansha smart factory averaged production of over 900,000 units per month with 3,000 employees, far exceeding the original design of 300,000 units per month with 4,000employees. The factory's net profit also increased by nearly 20% compared to pre-transformation levels.

Midea's microwave oven factory in Shunde utilizes "5G+Al+cloud technology" for intelligent identification and start/stop control of key quality elements like panels, labels, and screws. Its Al quality inspection system completes all steps-capturing 5 photos, uploading to the cloud platform, analyzing, and outputting results-within 1.3 seconds of the production cycle time, achieving machine vision-based quality inspection and deep learning.

At Midea's refrigerator factory in Jingzhou, through the application of technologies like the industrial internet and big data, major financial indicators significantly improved: labor productivity increased by 52%, the delivery cycle shortened by 25%, and quality defects decreased by 64%.

3.4 Green Digital Transformation

In the context of economic globalization, the logistics industry, as a key link connecting production and consumption, is facing many challenges, and at the same time, ESG scores are gradually becoming a key indicator of the ability to measure the sustainable development of enterprises [9].

Midea Group actively responds to China's "Dual Carbon" goals (carbon peak and neutrality), strictly aligning its management and business structures with the national "3060" carbon reduction roadmap [10]. The company has launched intelligent green building retrofits and energy management programs, leveraging digital transformation and green upgrades to reduce carbon emissions. By optimizing elevators, air conditioners, and other appliances, Midea effectively controls carbon output while improving energy efficiency. Beyond operational improvements, Midea contributes to industry-

wide carbon standards development and advances green technology innovation in home appliances.

On the product side, the factory employs digital simulation models, intelligent algorithms, and big data analytics, shortening the product development cycle by 25% while enabling lightweight, low-carbon product designs. This ensures full lifecycle carbon footprint traceability and control. In manufacturing, the factory leverages big data, AI, industrial IoT, and 5G-powered microgrid solutions to optimize energy collection, storage, and utilization, boosting production efficiency and product quality—resulting in a 36% drop in defect rates.

In logistics, technologies like AI, IoT, cloud computing, and block-chain enable multi-scenario dynamic balancing and intelligent scheduling, reducing production energy consumption by 37.6%. The system enhances logistics coordination, ensuring seamless data sharing across personnel, vehicles, and goods from warehousing to delivery, thereby improving efficiency, cutting costs, and lowering carbon emissions.

Nearly all Midea's major appliance lines have undergone green upgrades, with environmentally friendly products spanning its entire business chain. These sustainable offerings enjoy strong consumer adoption, with Midea maintaining leading market shares across core product categories.

Midea commits to developing eco-friendly products, using digital innovation and technological empowerment to achieve its "Dual Carbon" objectives. The company has introduced multiple ultra-energy-efficient appliance models, with breakthrough technologies like refrigerant variable frequency systems and heat pump solutions significantly enhancing product performance while reducing energy consumption. While leading in green air conditioner innovation, Midea's other product lines have also gained wide-spread recognition for their environmental performance.

From being recognized as an "End-to-End Lighthouse Factory" in 2022 to its upgrade to a "Sustainable Lighthouse Factory" in 2024, Midea's Hefei washing machine factory has focused on end-to-end smart manufacturing and energy-saving carbon reduction. By integrating multiple digital and intelligent technologies and deploying 24 Industry 4.0 use cases, the factory has established a green ecosystem spanning "product-manufacturing-logistics", achieving a 36.4% reduction in Scope 1 & 2 carbon emissions and a 26.0% reduction in Scope 3 emissions.

Midea proactively shapes green product standards, applying stricter technical and energy efficiency benchmarks that transform the entire industry. By establishing and participating in standard-setting initiatives, the company accelerates the home appliance sector's transition toward energy-saving and sustainable innovation.

3.5 Path Summary

Midea's transformation, while successful, is an ongoing journey. The digital landscape evolves rapidly, presenting both new avenues and enduring challenges.

Midea Group's digital transformation presents three empirically validated strategic opportunities.

Firstly Al-driven manufacturing optimization demonstrates significant efficiency gains, with documented savings of 3.96 million labor hours in 2024 through proprietary

"factory agent" systems. The company's committed ¥50 billion R&D investment in industrial Al and embodied intelligence suggests continued productivity enhancement potential, evidenced by JA Solar's Lighthouse Factory metrics showing 68% reduction in material delivery cycles post-implementation.

Secondly, structural growth in ToB segments manifests in financial performance: Energy & Industrial Technologies recorded 45% YoY revenue growth (¥11.1 billion) in Q12025, while Smart Building Solutions achieved 18% HVAc energy reduction at UHealth Shunde Hospital through integrated logistics-energy-information flows.

Thirdly, global supply chain localization mitigates trade risks while expanding market penetration, with 22 overseas factories (of 43 total) enabling region-specific product development(e.g., modular North American heat pumps) and driving over 40% overseas revenue contribution progress to-ward the 70% local production target by 2025 These opportunities collectively indicate transformation beyond operational efficiency toward technology-enabled business model diversification.

4 Potential Challenges in the Future

4.1 Geopolitical & Data Compliance Risks

Political & Legal Compliance Costs. Midea operates 19 manufacturing bases across 21 countries, but differing data regulations (e.g., EU's GDPR) may hinder its AI model training (relying on 1 billion+ real-world data points) and global supply chain coordination. Strict industrial data rules in Europe could delay "digital twin factory" deployments, weakening real-time supply chain synchronization. Midea's goal of 50% overseas revenue by 2025 faces geopolitical risks, including trade restrictions and localization mandates.

Privacy Concerns & Consumer Trust Erosion. Smart home devices collect vast behavioral/environmental data; any breach could damage brand trust. According to a 2025 Ipsos report, 56% of consumers are willing to pay a premium for trusted brands—but this hinges on robust data security. Weak governance may undermine Midea's "Direct-to-Consumer (DTC)" strategy, reducing digital marketing effectiveness.

4.2 Technology Iteration & R&D Fragmentation

Rapid Tech Evolution & Talent Shortages. AI advancements outpace Midea's in-house capabilities; its Central Research Institute still relies on external hires for humanoid robotics (key components like sensors/reducers remain imported). R&D spending on ToB segments (robotics, healthcare, new energy) is only 3.2%, far below tech leaders like Huawei (15%), limiting deep-tech competitiveness.

Low R&D Synergy & Subpar Commercialization. Midea's industrial robotics division (KUKA) has an 18% gross margin, lagging behind FANUC (35%), signaling weak tech-to-profit conversion. Despite selling 100,000+ industrial robots annually, its industrial IoT platform penetration in external manufacturing is just 14.7%, indicating limited scalability.

4.3 Economic Cycles & Market Imbalances

Price Wars in Stagnant Markets. China's air conditioner ownership has reached 171.7 units per 100 urban households, forcing Midea into price cuts for floor cleaners/robotic vacuums (2023 average prices fell, squeezing margins despite 40% cost reductions in digital factories).

Rising Global Supply Chain Costs. Midea's "Local-for-Local" strategy (targeting 70% overseas production by 2025) increases capital expenditures, raising long-term debt ratios from 1.11% (2015) to 25.78% (2019). Interest payments may offset digital cash flow gains (total assets up 319% in 10 years).

4.4 Organizational & Operational Bottlenecks

"T+3" Model's Limitations in Seasonal Products. Air conditioner demand peaks in summer (70%+ sales), but T+3's "produce-to-order" approach struggles with volatility, risking delays or idle capacity.

ToB & ToC Data Silos. Despite rapid growth in building tech (33.1% YoY) and robotics (42.4% YoY), disjointed data systems hinder knowledge-sharing (e.g., medical imaging R&D not applied to home CT scanners).

5 Conclusion

This study provides an in-depth analysis of Midea Group's digital transformation journey, systematically summarizing its pathways, achievements, and challenges. The research reveals that Midea implemented digital transformation through three core initiatives: First, the innovative "T+3" flexible supply chain model reduced order fulfillment cycles from 28 to 7 days; second, the independently developed M.IoT industrial internet platform achieved interconnection of over 100,000 devices; third, the establishment of multiple lighthouse factories. These transformation measures significantly enhanced operational efficiency, product quality, and market responsiveness.

Midea's successful digital transformation primarily stems from three key factors: forward-looking strategic planning with smart manufacturing exploration dating back to 2011; deep integration of technology and business to address operational pain points;

and synergistic technology and resource acquisition through mergers and acquisitions. However, the study also identifies several challenges in Midea's ongoing transformation, including geopolitical and data compliance risks, insufficient core technology independence, pricing pressures from market saturation, and organizational coordination inefficiencies.

Based on the findings, this study proposes the following recommendations: strengthen independent R&D of core components to enhance supply chain security; establish a global data governance framework to address regional compliance requirements; optimize the T+3 model for better seasonal fluctuation adaptability; and break down data silos between ToB and ToC businesses to facilitate knowledge sharing and technology reuse.

The primary contribution of this research lies in systematically documenting typical digital transformation pathways for manufacturing enterprises, providing empirical case studies for related theoretical research. However, the study has certain limitations, including insufficient quantitative analysis of transformation cost-benefits and lack of comparative studies with peer companies. Future research could further explore differentiated transformation paths for companies of different scales and innovation in transformation models amid rapid digital technology evolution.

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