

The Reconstructive Effects of C2M Reverse Customization on Manufacturing Supply Chains: A Case Study of Midea Group

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Abstract: Driven by the digital economy and industrial internet, the manufacturing industry is transitioning from "mass production competition" to "flexible response competition." Among these changes, the C2M reverse customization model, which connects users directly to factories, plays a significant role in supply chain restructuring. This study aims to analyse the achievements and challenges of Midea Group, a home appliance company, in implementing this model, and to explore how this model transforms traditional manufacturing supply chain relationships, operational processes, and management strategies. This study adopts a case study method, using Midea Group's "T+3" model as an example. This model relies on an independently developed industrial internet platform to achieve the entire process from order placement to logistics delivery within 12 days. The study found that the C2M model reshapes the node relationships and operational methods of the supply chain by shortening supply chain links, using data to guide production, and promoting flexible collaboration among all parties. Theoretically, this study extends the "static resource ownership" emphasized in the "resource-based view" to "dynamic resource co-creation," enriching the interdisciplinary research on reverse customization and supply chain restructuring. Practically, it provides referenceable experience for the transformation of manufacturing. However, the study also points out that while this model reduces the amplification effect of demand fluctuations, it faces challenges such as high technical investment costs and risk to supply chain stability.

Keywords: C2M reverse customization, supply chain restructuring, industrial internet, "T+3" model, Midea Group

1. Introduction

With the development of the economy and the arrival of the industrial internet era, the global manufacturing industry is undergoing a transition from "scale competition" to "flexible competition." Technologies such as 5G, artificial intelligence, and digital twins enable manufacturing systems to achieve real-time sensing, dynamic optimization, and intelligent decision-making capabilities, driving the evolution of traditional "push-based" supply chains toward "pull-based" supply chains [1]; At the same time, China's 14th Five-Year Plan explicitly proposes a dual-drive strategy of "smart manufacturing + supply chain collaboration," identifying reverse

customization C2M as a key driver for high-quality development in manufacturing. C2M (Customer-to-Manufacturer) refers to "demand data directly reaching the factory," which features reduced bullwhip effects and enables production based on sales and flexible supply [2].

Midea Group, a leading home appliance manufacturer that has been listed in the Fortune Global 500 for five consecutive years, proposed a "T+3" model strategy centred on C2M reverse customisation in 2021. Relying on its self-developed industrial Internet platform M.IoT, it has achieved a 12-day delivery cycle from user orders (T0) to smart logistics (T3), providing a benchmark for C2M flexible production. This paper explores how C2M can redefine the manufacturing supply chain by addressing the following questions: At the organisational, technological, and process levels, what mechanisms does C2M employ to reshape traditional supply chain node relationships, information structures, and inventory strategies? What achievements has Midea made in implementing C2M, and what challenges does it face? This paper adopts a case study method, using a research case, "T+3" C2M model Midea's C2M supply chain restructuring in manufacturing to explore the direction of intelligent upgrading and transformation in manufacturing.

2. Literature review

The effect" refers to the phenomenon "bullwhip, where minor fluctuations in demand at the downstream end of a supply chain are amplified at each successive level, leading to significant distortions in inventory and production capacity decisions at the upstream end. In traditional supply chains, which consist of multiple node enterprises, the supply chain management and integration capabilities of core enterprises are insufficient, resulting in information delays and distortions, thereby generating the "bullwhip effect" [3]. Li Bingxue further pointed out that traditional supply chains rely on distributors to aggregate demand, leading to a significant "bullwhip effect" [1]. C2M (Customer-to-Manufacturer) is a large-scale reverse customization paradigm that starts with user orders and leverages digital platforms to enable demand to reach factories directly, compressing the traditional multi-tiered channels into a short, direct "user-platform-factory" chain. Lin et al. pointed out that this model is data-driven, enabling dynamic matching between flexible production and personalized demand. One of the foundational theories of supply chain restructuring—the resource-based view—holds that a company's sustained competitive advantage stems from its internal "scarce, difficult-to-imitate, and irreplaceable strategic resources." [4] Companies emphasize identifying and statically allocating key resources (such as patents, brands, channels, and data) to achieve excess profits [5,6]. In contrast, the C2M model transforms the "static resource ownership" of RBV into dynamic resource action"co-creation."Through real-time order triggers, user data, modular production capacity, and supplier capabilities are dynamically reorganized enabling resources to no longer be exclusively owned by the enterprise but instead involving users,continuously co-created within a multi-party network suppliers, thereby overcoming the scarcity and path dependence inherent in RBV., platforms, factories, and Meanwhile, the industrial Internet of Things (IIoT) provides technical empowerment for the C2M model through real-time mapping of "demand data-production resources" [7]. Realizing data empowerment in the C2M model has become a current research hotspot, with existing scholars constructing models based on existing C2M practice cases [8]. The C2M model has been widely applied in manufacturing, such as Tesla, Siemens, and Whirlpool. However, there are still shortcomings in the intersection of C2M and supply chains, and there is a lack of cross-case comparisons and critical analysis. For example, the C2M models of Midea and Haier have significant differences in organizational structure and technical paths. Midea focuses on the "T+3" process and uses the M.IoT platform to achieve linear collaboration, while Haier uses the "1+7+N" experience cloud ecosystem as a framework to build a

mesh-like collaborative network among users, micro-enterprises, and resource providers. It is necessary to further explore organizational changes and ecosystem collaboration mechanisms in conjunction with supply chain restructuring, and explain the differences in model adaptability among different enterprises.

Supply chain restructuring is manifested in the following four dimensions: (1) Data-driven demand response. Yang Jinzhen used the Stackelberg game model to prove that when the commission ratio is below the threshold, the C2M pre-sale strategy can simultaneously increase the profits of manufacturers and platforms [9]. Wang et al. further pointed out that integrating text mining and QFD methods can convert user comments into product specification weights, assisting enterprises in achieving "hourly" demand response [10]; (2) Flexible production modes. Traditional rigid production lines struggle to adapt to the "high variety, small batch" characteristics of C2M. By leveraging industrial internet platforms to collect real-time data on equipment status, order priorities, and energy consumption, and using reinforcement learning algorithms to dynamically generate optimal production schedules, it is possible to achieve seamless switching between single-piece flow and batch production [4]; (3) Logistics coordination: In the C2M model, logistics must align with the synchronization of production and delivery. VMI (supplier-managed inventory) and blockchain technology can enhance cross-enterprise inventory transparency [2]; (4) Value chain integration: In users' transition from recipients to "prosumers," and suppliers evolve from transactional partners to collaborative innovation partners. The C2M model proposed the strategy "chain-leading enterprise + specialized SMEs" to drive the transformation of user and supplier roles and jointly enhance supply chain resilience [11]. Current research still lacks sufficient quantitative data support for supply chains, with most analyses being qualitative.

3. Analysis of midea's C2M practice

3.1. Background of C2M implementation

The fragmentation of the demand market and information silos on the supply side have led to inefficient chains, constraining their response speed in traditional supply. Gao Xinru pointed out that around 2016, the widespread adoption of mobile internet led to home appliance consumption exhibiting characteristics of "high frequency, small batches, and personalization," while the traditional "production-driven sales" model resulted in inventory buildup and prolonged delivery cycles [12]; Additionally, the division-based structure of Midea's business units created information silos: each division had independently developed ERP, MES, and other systems, resulting in inconsistent data standards and low cross-departmental collaboration efficiency [13].

Meanwhile, Midea is also facing dual pressures from policy and competition. The "14th Five-Year Plan for the Development of Intelligent Manufacturing" clearly states that "by 2025, the numerical control rate of key processes in large-scale manufacturing enterprises should reach 68%," in the home appliance industry [14]. At the same time, competition is forcing companies to seek new efficiency curves.

3.2. The specific process of midea's and T+3 model

Midea's "T+3" model is a localised implementation of C2M. C2M provides a demand entry point, while the T+3 model quantifies the response time for each stage." The two are integrated through Midea's industrial internet platform M.IoT, forming an end-to-end closed-loop collaboration mechanism that connects user demand, production scheduling and logistics delivery. This model

divides the order fulfillment cycle into four phases compressed to three days or less, with the entire customer order delivered within 12 days. The specific process is divided into T0~T4:

T0 (Smart Marketing): When a customer places an order, the demand data is synchronised in real time to Midea's DTC digital platform AI algorithms generate dynamic demand forecasts based on historical behaviour and industry analysis, completing inventory-available sales matching Unmet demand is immediately converted into production orders and funds are locked in to ensure zero distortion of demand signals.

T1 (Smart Supply Chain): Suppliers share real-time inventory data via the EDI system. Once inventory levels trigger pre-set conditions, VMI automatic replenishment is triggered; blockchain-based evidence technology enhances the reliability and security of the procurement process, thereby reducing procurement cycles.

T2 (Smart Manufacturing): After receiving orders, the MES system uses intelligent scheduling algorithms to integrate variables such as equipment status and energy consumption costs to generate the optimal production sequence. Modular design supports rapid switching of functional components, significantly enhancing production flexibility. Additionally, in the T2 phase, digital twin technology is innovatively adopted, significantly reducing trial production cycles and costs, laying a solid foundation for rapid product market launch.

T3 (Smart Logistics): IoT tracks the entire process from finished product outbound to customer receipt, based on real-time traffic conditions and other factors, dynamic route planning algorithms optimizing multimodal transport. Through enhanced management, warehouse logistics and direct delivery offline, it provides accurate data for nationwide inventory adjustments, support, and improves overall logistics and delivery efficiency.

However, Midea's "T+3" model also faces some major obstacles during implementation, and the company has taken targeted measures to address them. Technologically, the model relies heavily on digital technologies. Any failure of the Midea Industrial Internet M.IoT platform or IoT technologies could disrupt the entire supply chain process. To address this, Midea's technical team monitors and maintains the system 24/7, promptly identifying and resolving technical issues. Additionally, a technical backup mechanism has been established to ensure the continuity of supply chain operations. There are also obstacles in terms of supplier collaboration: some suppliers have low levels of informatization and are unable to meet the requirements of the "T+3" model, such as real-time sharing of inventory data and rapid response to replenishment requests. Some suppliers also have low levels of acceptance and cooperation with the model. In response, Midea provides technical support to suppliers to help them build data sharing systems, while also allowing suppliers to enjoy participating in the "T+3" model the mutual benefits, thereby improving supplier cooperation.

3.3. Specific tools for technological empowerment

Midea's C2M practice heavily relies on the technical foundation provided by the M.IoT industrial internet platform developed by Midea. This foundation, through a layered and collaborative architecture design, enables end-to-end empowerment from data integration to intelligent decision-making, providing core support for the efficient operation of the C2M model. The data governance layer platform establishes a comprehensive data integration system, using digital twin technology to simulate the entire lifecycle of an order: the PLM (Product Lifecycle Management) system covers product lifecycle data; the ERP (Enterprise Resource Planning) system covers enterprise operational data; and the MES (Manufacturing Execution System) system collects real-time data on equipment operating parameters and production progress from the production process. The intelligent decision-

making layer focuses on dynamic response and global optimization, using dynamic production scheduling algorithms and supply chain collaboration modules to achieve minute-level scheduling. At the same time, the platform has built an open ecosystem through standardized API interfaces, providing lightweight interface adaptation solutions for suppliers of different sizes and with varying levels of information technology. This ensures that even small suppliers can connect at a low cost. Through API interfaces, it connects with 470,000 supply chain enterprises, providing micro-services such as order management and supply chain finance, and improving inventory turnover by 38% [13].

4. C2M's reconstruction of the supply chain

4.1. Positive effects

4.1.1. Demand response

Under the C2M model, user orders are transmitted in real time from e-commerce platforms directly to factories. Demand data is captured in real time by the DTC platform, personalised, and converted into production instructions, reducing prediction errors from 15% in traditional models to 6% or less [13]. Yang Jinzhen confirmed through a game theory model that C2M can simultaneously increase the profits of manufacturers and platforms by controlling commission thresholds, verifying the economic feasibility of direct demand connection [9]. Wang et al. further pointed out that integrating text mining with QFD can convert user reviews into product specification weights, enabling "hourly" demand response, significantly outperforming the traditional weekly response cycle [10].

4.1.2. Production modes

Traditional rigid production lines are difficult to adapt to small-batch customization due to high changeover costs. Midea has deployed edge computing gateways through an industrial Internet platform to collect real-time data on equipment status, order priority, and energy consumption. Using reinforcement learning algorithms, it dynamically generates optimal production schedules. At the same time, modular production lines enable SKU switching within 48 hours, increasing flexibility by 2.3 times [4]. Furthermore, digital twin technology is used to simulate the entire order lifecycle, validate the feasibility of personalized demands, and enable seamless switching between "single-piece flow" and "mass production."

4.1.3. Logistics coordination

Under the C2M model, logistics must align with "production-delivery" synchronisation. Through VMI (supplier-managed inventory) blockchain-based inventory data sharing, cross-enterprise inventory transparency is achieved, improving inventory turnover rates (e.g., Midea increased by 38% by 2025). Regional shared logistics hubs integrate the transportation capacity of multiple enterprises to reduce empty runs and duplicate transportation. During the 2023 custom air conditioner order event, Midea activated shared spray coating centres in Foshan and Wuxi, synchronizing order data through the M.IoT open interface, and increased custom casing production capacity from 3,000 units per day to 8,000 units per day, validating the emergency response value of the shared logistics network.

4.1.4. Value chain integration

C2M is restructuring the power dynamics of the value chain, transforming users from passive recipients into "prosumers" and suppliers from transactional partners into collaborative innovation partners. Midea has partnered with 470,000 supply chain enterprises to build API interfaces, providing microservices such as order management and supply chain finance [13]. This includes tiered floating price contracts to achieve profit sharing and alleviate cost pressures from small-batch orders. Additionally, by 2025, Midea plans to reduce customization options to three categories—colour, engraving, and packaging—to minimize impact on the core supply chain.

4.2. Risks and challenges

In terms of cost risks associated with the " , " the development of industrial internet platform interfaces, digital twins, and edge computing deployment increases the renovation costs per production line, significantly extending the investment payback period. As evidenced in Midea's 2023 financial report, the washing machine division first listed "C2M digital operations and maintenance fees" separately, accounting for 3.6% of total manufacturing costs, primarily covering cloud-edge-end computing power leasing, AI model retraining, and block chain node energy consumption; Zhao et al. developed a "supply chain restructuring-resilience quantification" model targeting the special scenario of "manufacturers' factories losing production capacity for an extended period," and solved it using an improved NSGA-II algorithm [15]. One of the core conclusions is that when production capacity gaps are irreversible, relying solely on "emergency procurement + line expansion" cannot eliminate default costs. These findings fully reflect the significant cost pressures inherent in the C2M model.

Additionally, due to high dependence on ecosystems platform and information sharing, of reactions a series chain occur, significantly increasing supply chain disruption. Moreover, capacity gaps amplify along the supply chain, creating a ripple effect [15]. In other words, while C2M's short supply chains reduce the bullwhip effect, the amplification of node failures is more concentrated. C2M supply chains heavily rely on the resource integration capabilities of core platforms. If the stability of the platform ecosystem is insufficient, it may trigger chain risks. For example, in Haier's "1+7+N" ecosystem, although the Kaos platform was used to integrate internal and external resources to achieve large-scale customization, discrepancies in resource sharing between external suppliers and the platform company can lead to a decline in supply chain response efficiency [8] .

5. Recommendations

First, at the enterprise level, companies can establish enterprise-level DTC digital platforms to directly connect with user touch points such as e-commerce communities. By using AI algorithms to capture personalized demands, they can form a closed-loop response system from "user order" to "demand analysis" to "production instructions." Industrial Internet transformation should be promoted in stages, with MES systems and modular production lines first piloted in core product lines such as air conditioners and refrigerators, and then gradually expanded to all product categories. A joint data middle platform should be built with core suppliers to share real-time inventory and production capacity data and alleviate the cost pressure of small-batch production.

Second, at the government level, a special fund for C2M transformation can be established to subsidize the construction of industrial Internet platforms and the research and development of digital twin technology for enterprises; industry associations can be brought together to formulate

standards and unify the format of key indicators; regional-level intelligent logistics hubs can be built to integrate warehousing and transportation resources, and logistics subsidies can be provided to participating enterprises; and an industry supply chain reconfigurability index monitoring centre can be established to provide optimization recommendations to enterprises.

6. Conclusion

This study examines the systemic restructuring of the supply chain through the case study of Midea's C2M model, revealing its significance at both theoretical and practical levels. Theoretically, from a multi-level network perspective of "user-platform-factory-supplier," it elucidates the C2M-enabled supply chain empowerment pathway, enriching cross-disciplinary research on reverse customization and supply chain restructuring. Practically, it summarizes the implementation measures, qualitative analysis, and potential risks of Midea's "T+3" C2M model. C2M is not only a production model innovation, but also the core engine driving the transformation of manufacturing supply chains from "scale efficiency" to "flexible value." This path provides a benchmark model for the intelligent upgrade of manufacturing towards a "user-centric" approach. Balancing innovation and cost, coordination and risk will be key challenges for manufacturing enterprises in their C2M transformation.

The limitations of this study mainly lie in the single case selection. As a leading company in the home appliance manufacturing industry, Midea's resource endowment may be higher than that of small and medium-sized manufacturing enterprises, and the universality of the conclusions needs to be further verified in other industries (such as automobiles and 3C electronics). Future research can be expanded in two directions: first, conducting cross-industry comparative studies to analyse the impact of different product characteristics (such as standardization levels and customization complexity) on the restructuring effects of C2M; second, exploring the deep integration of digital twins and artificial intelligence to enhance the supply chain's real-time response accuracy to personalized demands.

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