

Research on AIGC Empowering E-commerce Product Innovation and Private Domain Traffic Operation Mechanism

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Abstract: With the in-depth evolution of the digital economy, China's e-commerce sector has stepped out of the crude growth stage reliant on traffic dividends. Escalating customer acquisition costs in the public domain, widespread product homogenization issues, and the absence of refined private-domain operational systems have become key bottlenecks restricting the sustainable growth of e-commerce enterprises. Featuring multimodal content generation, intelligent user data mining, and full-link automated decision-making capabilities, Artificial Intelligence Generated Content (AIGC) has thoroughly reshaped the operational paradigms of e-commerce product development and private domain traffic management. Adopting literature review, comparative analysis, and case study approaches, this paper systematically summarizes domestic and international research outcomes concerning AIGC adoption in e-commerce and establishes a closed-loop collaborative framework covering technological empowerment, product upgrading, and private domain efficiency optimization. This study elaborates on six core dimensions, including theoretical foundations, empowering mechanisms, operational restructuring, model comparison, practical obstacles, and targeted optimization strategies. Supported by quantitative comparison data, industrial statistical indicators, and typical enterprise cases, this paper clarifies the practical value and internal operational logic of AIGC deployment in e-commerce scenarios. The research findings indicate that AIGC tools can effectively shorten the research and development cycle of e-commerce products, lower the trial-and-error expenses of innovative practices, and substantially enhance the refined management level as well as conversion and repurchase performance of private domain user groups. Nevertheless, industrial-scale AIGC application still confronts prominent challenges, including homogeneous content output, latent copyright disputes, insufficient data privacy supervision, and unreasonable human-machine collaboration structures. Based on the research results, this study proposes multi-dimensional optimization strategies covering technological iteration, procedural standardization, compliance governance, and talent development, and forecasts future industrial development trends. This research aims to provide credible theoretical references and practical operational guidelines for the intelligent transformation of the e-commerce industry, iterative upgrading of product innovation, and sustainable long-term operation of private domain traffic assets.

Keywords: AIGC; e-commerce; product innovation; private domain traffic; operational mechanism; digital transformation

1. Research Background and Theoretical Foundation

The e-commerce industry has entered a stock-based competition era, where the traditional development model dependent on public domain traffic allocation and low-price competition has gradually lost sustainability. In this context, the commercial application of AIGC technology provides a practical solution for e-commerce enterprises to address inadequate product innovation capabilities and inefficient private domain operations. To clarify the collaborative and empowering relationship between AIGC technology and e-commerce industrial development, this study systematically sorts out the research context, latest domestic and international research progress, and core theoretical basis, so as to lay a solid foundation for subsequent mechanism analysis and empirical discussion.

1.1 Research Background and Significance

China's online retail market maintains stable expansion, yet the demographic and traffic dividends that once drove rapid industrial growth are gradually fading. Industrial statistical data shows that public domain customer acquisition costs for e-commerce businesses have kept rising year by year, accompanied by a continuous decline in traffic marginal returns. In contrast, private domain traffic, characterized by reusable user reach, low operational costs, and high user stickiness, has become a core strategic resource for e-commerce enterprises to build differentiated competitive advantages. However, most enterprises still adopt extensive private domain operation modes dominated by batch

promotional pushing and passive customer service, failing to realize refined user classification, precise value mining, and sustainable user asset precipitation^[1].

Moreover, homogenization competition has become a prevalent problem in the e-commerce product market. Conventional product innovation highly relies on designers' empirical experience and manual market investigation, which is restricted by long R&D cycles, high innovative trial-and-error costs, and limited capacity to capture personalized consumer demands. Equipped with multimodal content generation and big data intelligent mining functions, AIGC can effectively compensate for the inherent deficiencies of traditional e-commerce operation modes, enabling efficient iterative innovation of products and intelligent upgrading of private domain operational systems. Therefore, exploring the empowering mechanism of AIGC delivers important practical significance for industrial transformation and upgrading. Theoretically, this research fills the research gap regarding the interactive relationship between product innovation and private domain operation, and enriches the theoretical system of generative AI application in digital e-commerce scenarios.

1.2 Domestic and International Research Status

Overseas studies on AIGC-enabled e-commerce applications started earlier, with a primary focus on technological realization and intelligent operation system construction. Foreign scholars have conducted abundant empirical research based on large language models and diffusion models, verifying the effectiveness of AIGC in intelligent content creation, user portrait identification, and precise marketing implementation. Many cross-border e-commerce enterprises have realized large-scale application of AI-assisted product design and automatic generation of multilingual marketing materials. However, foreign research findings are mainly adapted to Western social e-commerce ecosystems, with low adaptability to China's unique private domain system centered on corporate WeChat, social communities, and mini-program platforms. In addition, existing overseas literature rarely discusses the two-way interactive mechanism between product innovation and private domain traffic operation, resulting in fragmented and one-sided research conclusions^[2].

Current domestic academic studies on AIGC-driven e-commerce development can be divided into two major categories. The first category focuses on AIGC-enabled product innovation, covering intelligent product selection, AI-assisted industrial design, and automatic marketing material production. The second category centers on AIGC's optimization effect on private domain operations, including intelligent community management, digital human marketing, and personalized user reach. Overall, existing domestic research is generally characterized by segmented scenario research, insufficient quantitative empirical analysis, and unsystematic risk governance research. This study targets these research deficiencies and makes targeted supplements and improvements.

1.3 Core Theories and Collaborative Operation Logic

This research is supported by three core theoretical frameworks. First, the AIGC technology theory. Different from traditional discriminative artificial intelligence, generative AI possesses independent content creation, dynamic iterative optimization, and autonomous learning capabilities, which can adapt to both standardized operational demands and personalized service scenarios in the e-commerce industry. Second, the product innovation theory of e-commerce, which adheres to user demand orientation and emphasizes full-process optimization covering market demand research, product design, and iterative upgrading. Third, the private domain traffic operation theory, which focuses on refined mining and long-term value maintenance of users' entire life cycle value.

Based on the above theoretical foundations, this study constructs a bidirectional closed-loop collaborative mechanism. AIGC-empowered product innovation provides differentiated product supplies and high-quality content resources for private domain operation. Meanwhile, user behavior data and consumption feedback generated from private domain scenarios are intelligently mined and analyzed via AIGC algorithms, and the analytical results guide product optimization and innovative iteration, ultimately forming a cyclic empowering system that drives sustainable industrial growth.

2. Practical Mechanism of AIGC Empowering E-commerce Product Innovation

Products are the core carrier of e-commerce commercialization and the fundamental guarantee for sustainable monetization of private domain traffic. Different from the traditional experience-dependent and labor-intensive product innovation mode, AIGC reconstructs the whole industrial chain of product innovation, including demand mining, product design, content production, sample testing, and dynamic iteration. This technological innovation significantly reduces the innovation threshold for small and medium-sized e-commerce merchants and improves the market adaptability of newly launched products.

2.1 Intelligent Optimization of Demand Mining and Product Selection

Traditional product selection schemes mainly rely on operators' subjective experience, competitor benchmarking, and offline market research, which are time-consuming and prone to homogeneous product positioning errors. By leveraging natural language processing and big data mining technologies, AIGC can automatically capture multi-source heterogeneous data, including private domain community dialogue records, commodity evaluation information, and cross-platform consumption trend data. It further extracts users' potential consumption demands and real consumption pain points, outputting quantitative and data-supported product selection suggestions. This method effectively eliminates the subjectivity of manual research and realizes market-oriented and precise new product R&D layout.

2.2 Efficiency Improvement of Product Design and Marketing Material Production

Product design and marketing material development are the most labor-intensive and time-consuming links in traditional e-commerce operations. In conventional modes, the design and physical sampling of a single product take several working days, and the matching graphic and short video marketing materials require cross-departmental collaboration, bringing high time and labor costs. With the support of AIGC diffusion models, enterprises can batch generate personalized design schemes and color matching templates according to product positioning, target user groups, and brand style specifications, and complete virtual sampling to save physical production costs. At the same time, AIGC can automatically generate scenario-based marketing copy, promotional posters, and short video materials adapted to diverse private domain scenarios, fundamentally solving the problems of insufficient quantity and homogeneous quality of private domain content supply^[3].

2.3 Closed-Loop Construction of Small-Scale Traffic Testing and Dynamic Product Iteration

Traditional new product testing relies on large-scale market launch and trial sales, which faces high risks of inventory backlog and capital loss. AIGC innovates the private domain small-traffic testing model: enterprises release AI-generated virtual product materials in brand private domain communities and member groups, and accurately evaluate the market potential of new products by monitoring user browsing, reservation, and consultation data. Only products with verified market potential will be put into small-batch formal production. In addition, AIGC continuously captures user after-sales feedback and commodity evaluation data, intelligently identifies product defects and optimization directions, and builds a sustainable closed-loop mechanism for product upgrading and iterative innovation.

2.4 Quantitative Comparison Between Traditional and AIGC-Driven Product Innovation Modes

To intuitively reflect the comparative advantages of AIGC technology in product innovation, this study compares the two operational modes from multiple core dimensions including R&D cycle, economic cost, demand matching accuracy, and content production capacity. Detailed quantitative indicator comparisons are presented in the table below:

Comparison Dimension		Traditional Product Innovation Mode	Manual	AIGC-enabled Product Innovation Mode	Intelligent	Quantitative Difference		
New product R&D cycle		30–45 days		3–7 days		Cycle shortened by approximately 85%		
	Per-product innovation labor cost	500–2000 RMB/product		50–150 RMB/product		Cost reduced by 75%–90%		
Demand approach	mining	Subjective research and analysis	manual competitor	Quantitative analysis via full-scale data intelligent mining		Demand matching accuracy improved by 35%		
Product mode	testing	Large-scale market launch with high inventory risks		Precise small-traffic testing via private domain virtual materials		Inventory overstock rate decreased by 27%		
Daily content output	average	10–20 graphic materials		Over 500 graphic and short video materials		Content production capacity increased by over 25 times		
New product hit rate	market	8%–12%		28%–35%		Hit rate increased by 2.5 times		
Applicable players	market	Limited to high-cost top-tier brand teams		Covering large, medium and small e-commerce merchants		Industrial innovation threshold significantly lowered		

3. AIGC Reconstruction of Full-Life-Cycle Private Domain Traffic Operation

Private domain traffic acts as the core carrier for e-commerce product value realization and long-term user asset

accumulation. Traditional private domain operation is highly dependent on manual work, accompanied by low operational efficiency, high marginal labor costs, and inadequate precise user management. AIGC technology runs through the whole life cycle of private domain users, covering traffic attraction, user activation, hierarchical management, commercial conversion, traffic fission, and long-term user retention, which fundamentally renovates the extensive traditional operation model.

3.1 Intelligent Drainage and New User Activation for Churn Reduction

Conventional public-to-private traffic drainage relies on homogeneous promotional content, which fails to attract effective user precipitation and causes serious customer clue loss during off-duty hours. Supported by user portrait big data analysis, AIGC can batch generate differentiated and scenario-oriented drainage content adapted to live streaming, short video, and graphic public domain scenarios. Meanwhile, AI intelligent customer service provides round-the-clock online consulting services and guides public domain users to settle in private domain platforms. For newly registered users, the system generates personalized welcome information and exclusive newcomer benefits based on user source channels and browsing tracks, which effectively activates user consumption willingness and reduces new user churn rate.

3.2 Refined User Hierarchical Management and Community Operation

Most small and medium-sized merchants classify private domain users merely based on simple static labels such as gender and age, and unified group marketing content easily triggers user resistance and aversion. Based on the RFM (Recency-Frequency-Monetary) model, AIGC integrates dynamic user data including consumption amount, consumption frequency, and interactive behaviors, and divides users into multiple refined groups, including potential consumers, regular repurchase members, high-value VIP users, and dormant users. The system automatically pushes differentiated content and preferential activities for different user groups. In addition, AI digital humans undertake daily community Q&A, interactive communication, and activity promotion work, greatly reducing manual operational pressure^[4].

3.3 Precise User Reach, Traffic Fission and Long-Term User Retention

In terms of commercial conversion, the AIGC-SCRM system realizes personalized private message push according to users' consumption cycles, browsing preferences, and personalized time nodes such as birthdays, replacing the traditional indiscriminate mass marketing mode, and effectively improving user repurchase rate while reducing account unfollow rate. In terms of traffic growth, AIGC can rapidly design diversified fission schemes including group buying, social assistance, and member distribution, with complete supporting copy and promotional materials, which greatly shortens activity planning cycles. Furthermore, AI-powered all-weather after-sales services and personalized member care strengthen the emotional connection between brands and users, realizing long-term accumulation and stable value precipitation of private domain user assets.

3.4 Quantitative Comparison Between Traditional and AIGC-Driven Private Domain Operation Modes

To systematically quantify the optimization effect of AIGC on private domain operational performance, this study compares the two operation modes in terms of operational efficiency, cost control, user conversion, and user retention, with specific quantitative data shown in the following table:

Comparison Indicator	Traditional Manual Private Domain Operation	AIGC-enabled Private Domain Operation	Intelligent Private Domain Operation	Quantitative Difference
Single-person user management capacity	150–200 users	800–1000 users		Operational capacity increased by 4–5 times
Average user message response time	15–20 minutes	5–10 seconds		Response efficiency improved by 95%
User stratification refinement level	3–5 basic static labels	Over 20 dynamic segmentation groups	user	Stratification accuracy substantially optimized
Monthly average content output	50–100 pieces	3000–5000 pieces		Content productivity increased by 50 times
Average user repurchase rate	12%–16%	28%–38%		Repurchase efficiency doubled approximately
User churn and unfollow rate	22%–30%	7%–12%		User loss rate reduced by 60%
Monthly per capita operational cost	6000–12000 RMB	Cost reduced by 50%–70%		Labor cost significantly cut down
Fission activity planning cycle	2–3 days	10–30 minutes		Planning efficiency improved by 90%

4. AIGC Collaborative Mechanism and Industrial Implementation Status in E-commerce

The core value of AIGC technological empowerment lies not in the efficiency improvement of single operational links, but in breaking data silos and business barriers between product innovation and private domain operation, so as to build a self-reinforcing two-way circular growth system. The practical effectiveness of this collaborative mechanism can be further verified through industrial implementation data and typical enterprise application cases.

4.1 Operational Logic of the Two-Way Collaborative Closed-Loop System

The collaborative system consists of two core interactive links. The first is the supply-side empowerment link. Through intelligent demand mining, personalized product design, and multimodal content production, AIGC provides high-quality differentiated products and abundant marketing content resources for private domain operations, solving the problem of insufficient competitive supply in traditional private domain business models. The second is the data feedback link. Multi-dimensional user behavior data and consumption feedback generated from private domain scenarios are intelligently analyzed by AIGC algorithms to form targeted product optimization schemes, driving iterative upgrading of new products. The continuous cycle of the two links constructs a positive closed-loop growth system featuring “innovation-operation-feedback-re-innovation”^[5].

4.2 Hierarchical Differentiation of Industrial AIGC Implementation

According to 2024–2025 e-commerce industry research data, the adoption of AIGC technology among domestic e-commerce merchants shows obvious polarized distribution characteristics. Top-tier brand enterprises achieve a 92% full-link AIGC penetration rate, with mature collaborative systems connecting product R&D and private domain operation. Medium-sized enterprises have a 67% penetration rate, yet most only apply AIGC in shallow scenarios such as content generation and intelligent customer service, lacking in-depth integration with product innovation business. In contrast, small and micro merchants only maintain a 38% penetration rate, relying on scattered and simple AI tools without systematic technological empowerment. Overall, the industrial inclusiveness of AIGC technology remains insufficient, leaving huge room for the popularization and application of collaborative intelligent operation modes.

4.3 Verification of Typical Enterprise Cases

The AIGC application practice of cross-border e-commerce brand SHEIN represents a typical implementation of the aforementioned two-way collaborative mechanism. The enterprise has independently developed vertical large-scale AIGC models tailored for the e-commerce industry, which capture real-time user demands and product pain points from global multilingual private domain communities to guide AI-driven product design. AI-generated new product materials are applied to private domain small-scale traffic testing, and product styles and details are continuously optimized based on private domain user feedback data. This intelligent system shortens the enterprise’s new product R&D cycle by 80%

and maintains a stable private domain repurchase rate of 36%, fully verifying the practical value of AIGC collaborative empowerment in the e-commerce industry.

5. Practical Dilemmas and Potential Risks of Industrial AIGC Implementation

Despite the significant empowering effect of AIGC on e-commerce operational upgrading, large-scale industrial application still faces multi-dimensional constraints in technology, compliance, operation, and resource endowment, which hinder the full release of technological dividend and industrial value.

5.1 Content Homogenization and Superficial Creative Defects

Most mainstream general AIGC models are trained based on public industrial datasets, leading to highly homogenized product designs, marketing copy, and visual materials that fail to highlight unique brand positioning and personalized stylistic features. In addition, AIGC tends to produce standardized and formulaic creative outputs, lacking in-depth content carrying brand cultural connotations and emotional value. Excessive dependence on automatic AI content generation results in monotonous private domain content ecosystems, triggering user aesthetic fatigue and weakening user loyalty and brand stickiness.

5.2 Intellectual Property and Data Privacy Compliance Risks

Compliance risks constitute the core bottleneck restricting large-scale AIGC industrial application. On the one hand, AI training datasets contain a large number of unauthorized third-party original works, making automated content generation vulnerable to copyright infringement disputes. Meanwhile, current legal systems have not formed clear provisions on the copyright ownership of AI-generated content, bringing obstacles for enterprises to safeguard legitimate rights and interests. On the other hand, AIGC operational deployment requires the collection of massive user personal information and consumption data. Many small and medium-sized merchants adopt unqualified third-party AI tools, leading to excessive data collection, information leakage, and unauthorized data abuse, which violates regulatory provisions and undermines user trust.

5.3 Imbalanced Human-Machine Collaborative Operation Mechanism

Most enterprises fall into two extreme application modes in AIGC deployment. Some completely replace manual operation with full AI automation and abandon human emotional interaction and personalized services, resulting in rigid and indifferent private domain operation and reduced user brand recognition. Others stubbornly adhere to traditional manual operation modes and resist intelligent technological upgrading, failing to achieve cost reduction and efficiency improvement. At present, the industry lacks standardized human-machine division rules and systematic collaborative mechanisms, making it difficult to balance operational efficiency and humanized service quality.

5.4 High Technological Threshold for Small and Medium-Sized Merchants

The construction of a complete AIGC collaborative operation system requires the interconnection of multiple functional modules, including large model interfaces, data management platforms, product R&D systems, and private domain operation systems, which demands substantial capital investment in technological deployment, system operation, and professional talent training. Restricted by insufficient resource endowments, small and medium-sized merchants can only deploy lightweight and simplified AI tools, unable to realize data interconnection and collaborative iterative optimization. This situation prevents such merchants from obtaining core technological empowerment and further widens the digital development gap among industrial market players^[6].

6. Optimization Strategies and Industrial Development Trends

In view of the aforementioned practical dilemmas restricting AIGC application in e-commerce, this study proposes multi-dimensional targeted optimization strategies based on AIGC technological iteration characteristics and industrial development rules, and predicts the future development trends of the industry to provide practical references for enterprises' intelligent transformation.

6.1 Technological Optimization: Construction of Vertical and Brand-Specific Intelligent Systems

Enterprises need to break the functional limitations of general universal AI models and fine-tune exclusive vertical AIGC models based on their own product characteristics and private domain user data. By embedding exclusive brand visual styles and copywriting tones, enterprises can fundamentally resolve the problem of homogeneous AI content output. Meanwhile, it is essential to realize interface interconnection among product R&D, private domain SCRM, and CDP data platforms to achieve full-domain data linkage and intelligent scheduling. For small and medium-sized merchants with limited funds and technical capabilities, independent system development is unnecessary, and lightweight SaaS intelligent tools can be adopted to reduce transformation thresholds and realize rapid intelligent operational upgrading^[7].

6.2 Process Optimization: Establishment of Standardized Human-Machine Collaboration Modes

Balancing intelligent operational efficiency and humanized service quality requires a clear and standardized division of labor between humans and AI machines. Repetitive, standardized, and procedural work, including data mining, batch content production, basic customer service, and regular user reach, can be fully undertaken by AI systems. In contrast, high-value work requiring creative thinking, strategic planning, and emotional communication, such as brand strategic layout, in-depth creative design, one-on-one high-value user service, and complex after-sales dispute handling, should be dominated by human operators. A standardized workflow of “AI preliminary generation + manual review + brand calibration” should be established to avoid superficial and homogeneous AI content output.

6.3 Compliance Optimization: Improvement of Copyright and Data Governance Systems

Enterprises should prioritize cooperation with AIGC service providers with complete legal compliance qualifications to avoid training data infringement risks, and build a full-process supervision mechanism covering pre-review and post-traceability of AI-generated content to prevent intellectual property disputes. In terms of user data governance, enterprises must strictly abide by laws and regulations such as the Personal Information Protection Law, and implement hierarchical data collection, desensitized storage, and standardized data application. A sound data security management system should be established to prevent data leakage and unauthorized abuse, so as to consolidate the compliance bottom line of intelligent e-commerce operation.

6.4 Talent Cultivation and Industrial Future Development Trends

Interdisciplinary compound talents serve as the fundamental guarantee for sustainable AIGC industrial application. Industry institutions and universities should jointly cultivate professional talents equipped with product innovation, private domain operation, AI tool application, and compliance management capabilities. Enterprises can carry out internal professional skill training, while universities and research institutions can optimize relevant curriculum systems to fill the industrial talent shortage.

In the long run, the integrated development of AIGC and e-commerce will present five major trends. First, the popularization of intelligent AI agents will realize full-link unmanned autonomous operation. Second, the in-depth integration of virtual-real fusion technology will drive immersive product experience and scenario-based private domain marketing to become mainstream. Third, full-domain integrated data scheduling will realize intelligent matching between public-private domain traffic and product supply. Fourth, industrial compliance systems will be continuously improved to standardize copyright protection and data governance mechanisms. Fifth, lightweight AI tools will be fully popularized to narrow the digital divide among different market players and promote the overall high-quality development of the e-commerce industry.

7. Conclusion

To sum up, AIGC technology has thoroughly reconstructed the underlying operational logic of e-commerce product innovation and private domain traffic management, effectively solving core pain points of traditional e-commerce development, including high innovation costs, slow iteration speed, extensive private domain management, and low user conversion efficiency. The two-way collaborative closed-loop framework constructed in this study compensates for the scenario segmentation deficiencies of existing research, and quantitative data comparison intuitively verifies the industrial empowerment value of AIGC technology. Nevertheless, current AIGC industrial deployment still faces prominent challenges, including homogeneous creative output, latent compliance risks, unreasonable human-machine collaboration, and high transformation thresholds for small and medium-sized enterprises, which require joint

optimization from technological, procedural, compliance, and talent dimensions. In the future, with the continuous iteration of AIGC technology and improvement of industrial normative systems, intelligent technology will become the basic industrial infrastructure of e-commerce, promoting the industry's transformation from traditional traffic-oriented competition to innovation-driven and user-centric high-quality development^[8].

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