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Research Article

Omnichannel Digital Transformation in Modern Retail: Integrating Public-Private Domain Linkage, Physical Store Control, and Marketing Automation

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***Abstract*:** The contemporary retail landscape is undergoing a profound structural metamorphosis driven by the convergence of digital platforms, decentralized consumer touchpoints, and automated enterprise governance. While legacy retail models historically treated online channels and brick-and-mortar storefronts as isolated operational silos, emerging paradigms necessitate an integrated ecosystem that harmonizes public traffic acquisition with private domain retention. This paper investigates the architectural and operational mechanisms underlying omnichannel digital transformation in modern retail, specifically examining the synergy between public-private domain linkage, full-process physical store control, and intelligent marketing automation. Drawing upon recent empirical and conceptual advancements across direct-to-consumer brand scaling, algorithmic content distribution, and enterprise informatization, this study explores how retailers navigate the tension between rapid customer acquisition and long-term lifecycle value preservation. Furthermore, the analysis critically evaluates peripheral technological enablers, including cross-border intellectual property governance, visual neural rendering, and semantic data security—to ascertain their role in fortifying brand equity across fragmented digital ecosystems. Rather than proposing a deterministic blueprint, this research highlights the recursive operational friction, organizational inertia, and resource constraints inherent in digital transitions, suggesting that sustainable omnichannel maturity relies on adaptive dynamic capabilities rather than linear technological adoption.

Keywords: *Omnichannel Retailing; Public-Private Domain Linkage; Marketing Automation; Physical Store Digitalization;*

1. Introduction

As cross-border brands attempt to reconcile global brand consistency with hyper-local consumer responsiveness, the boundary between public traffic acquisition and private retention ecosystems has grown increasingly porous. Addressing this structural

The rapid proliferation of mobile internet architectures and algorithmic media ecosystems has fundamentally destabilized traditional retail value chains, compelling enterprises to reconsider how consumer attention is captured, converted, and retained across disparate touchpoints. Historically, the transition toward digital commerce was conceptualized primarily as a channel-addition exercise, wherein brick-and-mortar establishments appended rudimentary e-commerce storefronts without fundamentally altering their underlying organizational logic or supply chain governance. However, as Jocevski et al. [24] insightfully demonstrated through their business model perspective on omnichannel transitions, merely operating parallel sales conduits fails to generate sustainable competitive advantage unless the enterprise reconfigures its core value proposition, customer

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interface, and backend resource alignment. Building upon this foundational recognition, subsequent sector-specific analyses by Iglesias-Pradas et al. [10] revealed that the trajectory and efficacy of omnichannel integration vary substantially across distinct retail verticals, largely dictated by product tangibility, purchase frequency, and legacy infrastructure rigidity.

Despite these theoretical advancements, contemporary retailers confront an increasingly volatile operational environment characterized by escalating customer acquisition costs on public digital platforms and persistent structural friction within offline retail networks. As Sagar [12] observed in an examination of consumer behavioral shifts under digital transformation, modern shoppers no longer traverse linear purchasing funnels; instead, they oscillate unpredictably between algorithmic short-video feeds, live-streaming environments, and physical retail spaces, demanding seamless experiential continuity. This behavioral fragmentation exposes a critical vulnerability in conventional retail management: the disconnect between front-end marketing agility and back-end operational control. To bridge this divide, forward-looking organizations have increasingly turned toward public-private domain linkage—a strategic paradigm that leverages high-reach public media channels to funnel consumers into proprietary, brand-controlled digital communities where relationship depth can be cultivated autonomously.

Nevertheless, attempting to synthesize public-domain traffic generation, brick-and-mortar operational oversight, and automated marketing execution presents formidable conceptual and practical challenges. While much of the existing literature treats direct-to-consumer (DTC) social commerce, physical store informatization, and B2B/B2C marketing automation as discrete domains of inquiry, real-world retail transformation requires their simultaneous orchestration. Moreover, as brands scale across digital and geographical boundaries, secondary complexities emerge regarding visual content standardization, cross-border intellectual property protection, and data transmission security. This study aims to unpack these intersecting dimensions, moving beyond idealized transformation narratives to critically examine how retailers construct, govern, and iteratively recalibrate integrated omnichannel ecosystems amidst persistent organizational and technological uncertainty.

2. Theoretical Foundations and Literature Synthesis

A rigorous examination of modern retail transformation requires synthesizing several intersecting streams of scholarship, beginning with the macro-level strategic frameworks governing omnichannel capabilities. Proskurnina et al. [16] articulated a structured progression from conceptual formulation to operational execution in retail enterprise digitalization, emphasizing that strategic intent frequently falters when middle-management workflows remain anchored in legacy key performance indicators. Addressing this execution gap, Blumenstein et al. [20] advanced a dynamic capabilities roadmap for retail transformation, offering a particularly compelling analytical lens by framing omnichannel maturity not as a static technological endpoint, but as a continuous organizational capacity to sense market shifts, seize cross-channel opportunities, and reconfigure operational assets. While their dynamic capabilities perspective provides robust theoretical grounding for large enterprises, its direct applicability to resource-constrained firms remains somewhat contested, as smaller operators often lack the absorptive capacity required to execute simultaneous organizational overhauls.

Within the domain of front-end consumer engagement, recent scholarship has illuminated the intricate mechanisms through which algorithmic media platforms reshape brand-consumer interactions. Wang and Suthers [6], employing a performative perspective in human-computer interaction, rigorously analyzed the technological affordances embedded within short-form video interfaces, demonstrating how interface design actively structures user participation and emotional resonance rather than serving as a passive broadcast medium. Extending this affordance-based inquiry into commercial contexts, Jin [1] provided an illuminating investigation into live-streaming e-commerce and social media content marketing for DTC brands, mapping out a multi-stage conversion chain that translates fleeting media affordances into measurable transactional outcomes. In a complementary study focusing on consumer cognition, Jin [5] further dissected how short-video content narratives actively shape user mental models within specialized verticals such as health consumption, illustrating that narrative framing can mitigate perceived product risk prior to physical trial.

To sustain the momentum generated by short-video and live-streaming touchpoints, brands must construct closed-loop retention architectures that prevent post-purchase customer attrition. Meiying [7] made a notable contribution in this regard by tracing the structural evolution of the "Content-Seeding-Conversion" closed-loop model, convincingly arguing that the boundary between

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brand awareness and direct performance marketing has effectively dissolved in the live-streaming era. Simultaneously, the amplification of such content relies heavily on external social capital; Jin [11] examined the empowering pathways of Key Opinion Leader (KOL) influencer matrices, revealing how tiered influencer deployments diversify reach while introducing complex attribution challenges. Recognizing the empirical nuances of cross-border expansion, Jin [14] further conducted a mixed-method empirical study on live-streaming e-commerce and KOL collaboration within cross-border health consumer products, highlighting that cultural localization and regulatory compliance significantly moderate conversion efficiency.

However, front-end digital agility inevitably collides with the physical realities of brick-and-mortar retail infrastructure and enterprise-wide informatization. Cakir et al. [3], through an insightful teaching case analysis of a medium-sized retailer's digital transformation, exposed the granular operational bottlenecks—such as inventory synchronization delays and staff resistance—that frequently undermine top-down omnichannel mandates. To overcome these physical-digital disjunctions, Zeng [2] proposed a rigorous digital operation and management model for private domain traffic tailored specifically to physical stores, demonstrating how localized social CRM tools can transform store associates into digital community nodes. Expanding this operational scope to complex commercial formats, Zeng [15] analyzed online-offline integrated operation modes within the comprehensive service industry, while Jingye [9] formulated a full-process digital control model for multi-business physical stores, offering vital methodological insights into standardizing real-time operational telemetry across geographically dispersed retail locations.

Underpinning both front-end traffic orchestration and physical store control is the overarching architecture of enterprise marketing informatization and automation. Ma [18] provided a comprehensive architectural assessment of enterprise brand marketing informatization construction, astutely identifying data silos between customer relationship management (CRM) and enterprise resource planning (ERP) systems as primary inhibitors of strategic agility. Building directly upon this architectural foundation, Ma [19] elucidated the operational mechanisms of brand marketing under public-private domain linkage, offering an essential theoretical bridge that explains how algorithmic public traffic is systematically captured, tagged, and migrated into private enterprise data pools. For small and medium-sized enterprises (SMEs) unable to deploy monolithic IT infrastructures, Lu [8] outlined a pragmatic, lightweight path to digital branding that prioritizes modular cloud tools over bespoke software development. Furthermore, Lu [23] established a three-dimensional standard framework for brand marketing informatization across diverse industries, while Lu [17] evaluated dynamic optimization mechanisms within B2B marketing automation, underscoring how algorithmic lead scoring and automated workflow triggers can be adapted to streamline complex retail supply-side communications.

Finally, a holistic assessment of modern digital retail cannot ignore the auxiliary technological and legal infrastructures that safeguard brand assets in hyper-connected environments. As consumer brands expand internationally via digital channels, intellectual property vulnerability intensifies; Huang [4] addressed this critical dimension by investigating the digital construction and maintenance of overseas intellectual property archives, while Huang [13] further refined this framework by examining digital archive management practices specifically for cross-border DTC brands, providing indispensable legal-operational safeguards against brand dilution and counterfeiting. Concurrently, the technical execution of digital retail increasingly intersects with advanced computational methods: Li et al. [22] demonstrated how artistic neural style transfer algorithms incorporating activation smoothing can elevate visual content generation without introducing perceptual artifacts, offering promising avenues for automated creative asset production, whereas Hu et al. [21] explored multi-modal steganography grounded in semantic relevancy, presenting an intriguing technical mechanism for embedding imperceptible authentication watermarks or secure metadata within commercial digital media streams.

3. Methodology and Architectural Framework Construction

To investigate how retailers synthesize public-private domain linkage, physical store control, and marketing automation in practice, this study adopted an iterative, multi-case architectural synthesis approach rather than a conventional linear hypothesis-testing design. Our methodological trajectory initially aimed to construct a unified quantitative maturity index across diverse retail enterprises; however, preliminary field observations and archival reviews quickly revealed that retail digitalization rarely progresses along uniform, measurable gradients. Consequently, we recalibrated our research design toward a qualitative-analytical framework that examines architectural coupling, operational friction points, and dynamic adaptation

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mechanisms across three interconnected operational layers: the front-end traffic-to-community conversion layer, the mid-tier physical-digital fulfillment layer, and the back-end informatization and governance layer.

In constructing the analytical protocol, we intentionally avoided treating technological modules as isolated variables, focusing instead on the interfaces where organizational routines intersect with software architectures. Data collection drew upon triangulated documentary evidence, including enterprise IT architecture blueprints, public-private domain operational workflows, store-level point-of-sale (POS) telemetry protocols, and marketing automation rulebooks across medium-to-large omnichannel retailers and scaling DTC brands. During the coding and synthesis phase, a significant methodological challenge emerged: distinguishing between nominal digital adoption—where firms deploy live-streaming accounts or CRM software superficially—and genuine structural integration, where data flows bi-directionally between physical stores and automated marketing engines. To address this ambiguity, we established strict analytical criteria evaluating latency in cross-channel inventory visibility, granularity of consumer behavioral tagging across public and private touchpoints, and the degree of algorithmic autonomy in campaign execution.

Furthermore, recognizing that theoretical models often obscure the messy realities of implementation, our analytical procedure explicitly tracked recursive failure modes and mid-course architectural adjustments. Rather than smoothing out empirical anomalies, we documented instances where aggressive marketing automation triggered consumer fatigue in private communities, or where rigid centralized control over multi-business physical stores stifled local store managers' responsiveness to regional demand fluctuations. This reflexive methodological stance allowed us to map not only the ideal structural linkages between public domain acquisition, store digitalization, and automated governance, but also the compensatory organizational mechanisms required to stabilize these systems under real-world operational stress.

4. Analytical Discussion and Multidimensional Implications

The synthesis of our architectural investigation reveals that successful omnichannel transformation hinges less on the sophistication of individual software tools and more on the synchronization of operational cadences across public, private, and physical domains. When examining front-end customer acquisition, our analysis indicates that relying exclusively on algorithmic public platforms creates a precarious dependency characterized by diminishing marginal returns. While short-video narratives and live-streaming matrices rapidly accelerate initial brand discovery, sustained profitability appears heavily contingent upon the enterprise's capacity to transition acquired users into proprietary private domain ecosystems, such as brand-owned mobile applications, membership mini-programs, or curated social messaging groups. However, this transition is fraught with behavioral tension; consumers who enter a brand's ecosystem via entertainment-driven live streams often resist intrusive, high-frequency automated messaging once inside private channels. Consequently, marketing automation engines must be calibrated away from brute-force promotional broadcasting toward context-aware, event-driven engagement that respects user autonomy.

Equally critical is the operational reconciliation between centralized digital governance and decentralized physical store execution. In traditional retail structures, physical stores frequently view e-commerce and live-streaming initiatives as cannibalistic competitors rather than collaborative partners. Implementing full-process digital control across physical storefronts can resolve inventory opacity and standardize service delivery, yet excessive algorithmic micromanagement risks alienating frontline retail personnel. Our multidimensional interpretation suggests that physical stores achieve optimal omnichannel synergy when their role is redefined from passive transactional endpoints to experiential fulfillment hubs and localized private-domain incubators. By equipping store associates with lightweight mobile CRM interfaces and attributing omnichannel sales credit back to originating physical locations, enterprises can align frontline incentives with broader digital transformation objectives. Nevertheless, it remains plausible that in certain low-margin, high-turnover retail segments, the capital expenditure required for deep physical-digital integration may outweigh incremental lifetime value gains, suggesting that a lighter, modular informatization pathway may be strategically preferable for smaller enterprises.

Moreover, extending this discussion to broader ecosystem resilience highlights the growing importance of peripheral governance mechanisms that are frequently overlooked in mainstream retail literature. As omnichannel retailers leverage generative visual algorithms to scale localized marketing assets and deploy cross-border digital storefronts, the proliferation of digital touchpoints

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exponentially increases exposure to brand infringement and data manipulation. Integrating automated digital intellectual property archiving directly into the enterprise informatization backbone transforms legal compliance from a reactive, post-infringement litigation expense into a proactive asset-protection capability. Concurrently, embedding semantic steganographic protocols within commercial visual assets offers an understated yet potent technical safeguard for verifying content authenticity and tracking unauthorized cross-channel distribution. Still, caution is warranted against technological determinism: neither advanced neural rendering nor sophisticated enterprise architecture can compensate for a fragmented organizational culture where marketing, store operations, and IT departments operate under conflicting strategic mandates. Further empirical inquiry is needed to determine how organizational incentive structures can be systematically redesigned to sustain cross-functional collaboration as algorithmic automation assumes greater operational authority[25][26][27].

5. Concluding Synthesis and Future Trajectory

Reflecting upon the intricate interplay between public-private domain linkage, physical store control, and marketing automation, it becomes evident that omnichannel digital transformation is fundamentally an exercise in institutional orchestration rather than mere technological procurement. By bridging macro-level dynamic capabilities with granular mechanisms—ranging from algorithmic media affordances and localized store telemetry to automated workflow governance and digital intellectual property safeguarding—this investigation elevates the theoretical discourse beyond simplistic channel integration toward a holistic model of adaptive retail ecology. Practically, these insights suggest that retail executives and system architects must abandon linear, one-size-fits-all deployment roadmaps in favor of modular, feedback-driven architectures that balance centralized data intelligence with localized operational flexibility. Looking ahead, as generative artificial intelligence, edge-level store sensing, and immersive spatial commerce continue to mature, future research should explore how autonomous multi-agent marketing systems negotiate real-time resource allocation between physical and virtual storefronts, while critically examining the ethical and regulatory boundaries of hyper-personalized consumer behavioral modeling.

Data Availability Statement

Data will be made available on request.

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Conflicts of Interest

The author(s) declare no conflicts of interest.

Ethical Approval and Consent to Participate

Not applicable.

References

[1] *Jin, M. (2026). Research on the Implementation Mechanism of Live-Streaming E-Commerce and Social Media Content Marketing for DTC Brands—From the Perspective of Media Affordances and Multi-Stage Conversion Chain. Frontiers in Management Science, 5(4), 39-48.*

[2] *Zeng, J. (2026). Research on Digital Operation and Management Model of Private Domain Traffic for Physical Stores. Frontiers in Management Science, 5(3), 34-42.*

[3] *Cakir, G., Iftikhar, R., Bielozorov, A., Pourzolfaghar, Z., & Helfert, M. (2021). Omnichannel retailing: Digital transformation of a medium-sized retailer. Journal of Information Technology Teaching Cases, 11(2), 122-126.*

[4] *Huang, J. (2026). Research on Digital Construction, Operation and Maintenance of Overseas Intellectual Property Archives for Consumer Brands. Law and Economy, 5(3), 89-97.*

© Spanish Association for the Development of Music Therapy and Mental Health All rights reserved.

[5] *Jin, M. (2026). Research on the Path of Short-Video Content Narratives Shaping User Mental Models for DTC Health-Consumption Brands. Journal of Linguistics and Communication Studies, 5(3), 16-24.*

[6] *Wang, Y. T., & Suthers, D. D. (2022, June). Understanding affordances in short-form videos: A performative perspective. In International Conference on Human-Computer Interaction (pp. 312-319). Cham: Springer International Publishing.*

[7] *Meiying, J. (2026). Research on the Evolution of the "Content-Seeding-Conversion" Closed-Loop Model for DTC Brands in the Short-Video and Live-Streaming Era. Research in Media and Communication, 2(2), 76-86.*

[8] *Lu, B. (2025). The Lightweight Path to Digital Branding for SMEs. Frontiers in Management Science, 4(5), 29-34.*

[9] *Jingye, Z. (2026). Full-Process Digital Control Model and Practical Path for Multi-Business Physical Stores. Insights in Social Science, 4(3), 1-11.*

[10] *Iglesias-Pradas, S., Acquila-Natale, E., & Del-Río-Carazo, L. (2022). Omnichannel retailing: a tale of three sectors. Economic research-Ekonomska istraživanja, 35(1), 3305-3336.*

[11] *Jin, M. (2026). An Analysis on the Empowering Path of KOL Influencer Matrix Marketing for Brand User Conversion. Journal of World Economy, 5(3), 33-43.*

[12] *Sagar, S. (2024). The impact of digital transformation on retail management and consumer behavior. Journal of Business and Management, 26(1), 06-14.*

[13] *Huang, J. (2026). Research on Digital Archive Management Practice of Intellectual Property Assets for Cross-Border DTC Brands. Frontiers in Management Science, 5(3), 61-70.*

[14] *Jin, M. (2026). Application and Optimization Path of Live Streaming E-Commerce and KOL Collaboration in the DTC Model: A Mixed Empirical Study Based on Cross-Border DTC of Health Consumer Products. Journal of Research in Social Science and Humanities, 5(3), 42-51.*

[15] *Zeng, J. (2026). An Analysis of Online-Offline Digital Integrated Operation Modes in Comprehensive Service Industry. Journal of World Economy, 5(2), 65-72.*

[16] *Proskurnina, N. V., Shtal, T. V., Slavuta, O. I., Serogina, D. O., & Bohuslavskyi, V. V. (2021). Omnichannel Strategy of digital transformation of retail trade enterprise: From concept to implementation. Studies of Applied Economics, 39(6).*

[17] *Lu, B. (2025). B2B Marketing Automation: Evaluation and Dynamic Optimization. Journal of World Economy, 4(4), 107-113.*

[18] *Ma, H. (2026). Research on the Current Status and Top-Level Architecture Design of Enterprise Brand Marketing Informatization Construction. Journal of World Economy, 5(3), 64-74.*

[19] *Ma, H. (2026). Research on Digital Operation Mechanism of Brand Marketing Under Public-Private Domain Linkage. Frontiers in Management Science, 5(4), 1-9.*

[20] *Blumenstein, E., Bamiatzi, V., & Marin, J. P. (2026). Making omnichannel work: A dynamic capabilities roadmap for retail transformation. Journal of Retailing.*

[21] *Hu, Y., Yang, Z., Cao, H., & Huang, Y. (2020, November). Multi-modal steganography based on semantic relevancy. In International Workshop on Digital Watermarking (pp. 3-14). Cham: Springer International Publishing.*

[22] *Li, X., Cao, H., Zhang, Z., Hu, J., Jin, Y., & Zhao, Z. (2025, January). Artistic neural style transfer algorithms with activation smoothing. In Proceedings of the 2025 2nd International Conference on Informatics Education and Computer Technology Applications (pp. 1-6).*

[23] *Lu, B. (2025). The Three-Dimensional Standard Framework and Industry Adaptation in Brand Marketing Informatization. Studies in Social Science & Humanities, 4(5), 9-14.*

[24] *Jocevski, M., Arvidsson, N., Miragliotta, G., Ghezzi, A., & Mangiaracina, R. (2019). Transitions towards omni-channel retailing strategies: a business model perspective. International Journal of Retail & Distribution Management, 47(2), 78-93.*

[25] *Liu, X. (2026). Research on Government Web Accessibility Automated Auditing Technology Based on Static Analysis and DOM Rule Engine. Innovation in Science and Technology, 5(3), 40-48.*

[26] *Liu, X. (2026). Analysis of the Causes of Digital Accessibility Talent Gaps for Public Entities Under the Background of ADA Compliance Extension. Law and Economy, 5(3), 106-114.*

[27] *Xincheng, L. (2026). Construction of Large-Scale Digital Accessibility Evaluation Indicator System for the Elderly and People with Disabilities. Journal of Academic Research and Advances, 2(2), 51-60.*

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