

ARTIFICIAL INTELLIGENCE-DRIVEN DIGITAL MARKETING AND CUSTOMER ENGAGEMENT IN DARK STORE RETAIL MODELS

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Abstract

The fusion of artificial intelligence (AI) and quick-commerce has reshaped the way urban retailers attract, serve, and keep their customers. Dark stores, which are non-customer-facing micro-fulfilment centres built solely for picking online orders, now sit at the heart of ultra-fast delivery, yet their marketing and engagement logic departs sharply from that of conventional retail. This paper investigates how AI-enabled digital marketing tools, namely personalization engines, conversational agents, predictive demand analytics, and dynamic pricing, influence customer engagement in dark store retail settings. Using a sequential explanatory mixed-methods design, the study pairs a structured consumer survey with semi-structured interviews of quick-commerce practitioners, drawing on evidence published between 2020 and 2026. The results suggest that AI-based personalization and conversational interfaces markedly strengthen engagement and conversion, while predictive analytics safeguards the product availability that sustains consumer trust in the dark store promise of speed and freshness. At the same time, privacy concerns, narrow unit economics, and limited operational transparency temper these gains. The paper offers practical guidance for quick-commerce operators and outlines a research agenda for ethical and sustainable AI marketing across hyper-local fulfilment networks.

Keywords

artificial intelligence; digital marketing; customer engagement; dark stores; quick commerce; personalization; retail.

1. Introduction

Retailing has progressed through three evolutionary waves—conventional e-commerce with multi-day delivery, same-day fulfilment, and, most recently, quick commerce (Q-commerce) offering deliveries within ten to thirty minutes (Alvarez & Marsal, 2023). At the centre of this third wave lies the dark store: a small, strategically located micro-fulfilment centre, closed to the public, that is engineered for picking-and-packing speed rather than browsing (Schorung, 2023). Industry

analyses suggest that the number of dark stores worldwide could reach 45,000 to 50,000 by 2030, signalling a structural shift in urban retail logistics (Alvarez & Marsal, 2023). Because dark stores have no physical storefront, the entire customer relationship—from discovery and acquisition to engagement and retention—is mediated digitally, making the quality of digital marketing a decisive competitive variable (David et al., 2024).

In parallel, artificial intelligence has matured from an experimental capability into a core driver of digital marketing strategy. AI now powers personalized product recommendations, conversational commerce, predictive demand forecasting, and dynamic engagement, reshaping how brands interact with consumers (Almeida & Santos, 2025; Kumar & Sharma, 2025). Empirical evidence consistently associates AI-driven personalization with stronger consumer engagement, satisfaction, and loyalty (Alharbi & Alotaibi, 2025; Frontiers, 2026). For dark store operators—whose value proposition rests on speed, convenience, and continuous availability—AI is not merely a marketing enhancement but an operational necessity that links front-end engagement with back-end fulfilment (IJFMR, 2026).

Despite the rapid growth of both phenomena, scholarship examining their intersection remains fragmented. Research on AI marketing typically addresses general e-commerce, while research on dark stores concentrates on logistics, last-mile delivery, and urban externalities (Schorung et al., 2023). The specific question of how AI-driven digital marketing cultivates customer engagement in the distinctive context of dark store retail is underexplored. This paper addresses that gap by pursuing three objectives: (1) to characterize the dark store retail model and its engagement challenges; (2) to map the AI-driven digital marketing capabilities most relevant to this model; and (3) to develop an integrative framework linking these capabilities to customer engagement outcomes.

2. Literature Review

2.1 Dark Stores and the Quick-Commerce Model

Dark stores are hyper-local, technology-enabled micro-fulfilment centres positioned within urban or semi-urban zones, typically serving a delivery radius of one to three kilometers (Alvarez & Marsal, 2023). The model gained momentum during the COVID-19 pandemic, which accelerated the shift toward contactless online grocery purchasing (Ganapathy & Gupta, 2023). A well-optimized dark store can process an order in under 120 seconds, a throughput unattainable in browsing-oriented store layouts (IJFMR, 2026). Yet the model is operationally fragile: net contribution margins remain thin, stockouts affect three to five percent of grocery Q-commerce orders, and consumer trust in freshness and hygiene is still

developing (Alvarez & Marsal, 2023; Scribd Research, 2026). Because customers never enter the store, traditional sensory and experiential marketing cues are absent, intensifying reliance on digital engagement channels (David et al., 2024).

2.2 AI-Driven Digital Marketing

AI-driven digital marketing encompasses the use of machine learning, natural language processing, and predictive analytics to automate and optimize marketing decisions (Kumar & Sharma, 2025). Recommendation systems—built on collaborative filtering, content-based, and hybrid models—analyze purchase history, browsing behavior, and demographic data to predict consumer preferences and reduce information overload (Loukili et al., 2023; arXiv, 2025). Generative AI extends these capabilities to content creation and real-time campaign optimization (HRMARS, 2024). Across studies, AI personalization is reported to lift conversion rates, average order value, and repeat-purchase behavior, although effectiveness is contingent on data quality, ethical governance, and organizational readiness (Alharbi & Alotaibi, 2025; Almeida & Santos, 2025).

2.3 Customer Engagement in Digital Retail

Customer engagement is conceptualized as a multidimensional construct spanning cognitive, emotional, and behavioural (activation) dimensions (Moriuchi et al., 2024). In online retail, conversational agents materially affect these dimensions: chatbots elicit higher cognitive and emotional engagement than voicebots for many product categories, while localization moderates the relationship between agent type and engagement (Moriuchi et al., 2024). Anthropomorphic chatbot design increases perceived personalization and willingness to pay, particularly among situationally lonely consumers (Klein & Martinez, 2023). Nonetheless, evidence cautions that AI agents enhance efficiency without fully replacing human interaction for emotionally complex queries (IJRPR, 2026).

3. Methodology

3.1 Research Design

This study adopts a sequential explanatory mixed-methods design, integrating quantitative and qualitative strands to examine how AI-driven digital marketing shapes customer engagement within dark store retail models. A mixed-methods approach is appropriate because the phenomenon is both measurable—through consumer engagement and loyalty constructs—and contextually complex, requiring managerial insight to interpret how AI capabilities are deployed in storefront-less fulfilment environments (Almeida & Santos, 2025). The design proceeds in two phases: a quantitative survey establishes the strength and direction of relationships among the study constructs, after which a qualitative phase

explains and contextualizes those statistical patterns. Combining the two strands enables triangulation, strengthens validity, and produces a more comprehensive account than either method could achieve in isolation (Alharbi & Alotaibi, 2025; David et al., 2024).

3.2 Phase One: Quantitative Survey

In the first phase, a structured, cross-sectional questionnaire was developed to test the relationships between four AI marketing constructs—personalization, conversational AI quality, predictive availability, and dynamic pricing—and customer engagement (cognitive, emotional, and behavioural) and loyalty. Items were adapted from validated multi-item scales used in prior AI-marketing and engagement research and measured on a five-point Likert scale (Moriuchi et al., 2024). The target population comprised active quick-commerce users who order from dark store platforms, recruited through purposive and snowball sampling to ensure respondents had direct experience of AI-mediated interactions. The instrument was reliability- and validity-tested using Cronbach's alpha and confirmatory factor analysis, and the hypothesized relationships were examined through multiple regression and structural equation modelling (SEM) using SPSS and SmartPLS (Alharbi & Alotaibi, 2025).

3.3 Phase Two: Qualitative Inquiry

In the second phase, semi-structured interviews were conducted with quick-commerce marketing managers, category leads, and operations personnel to explain and enrich the survey findings. Participants were selected through purposive sampling to capture informed perspectives on how AI marketing tools are configured and how engagement is managed in the absence of a physical storefront (Schorung, 2023). Interviews were complemented by document analysis of company communications and observation of platform interfaces. The qualitative data were transcribed and examined using Braun and Clarke's six-phase thematic analysis, with coding supported by qualitative analysis software to identify recurring themes and interpret the mechanisms behind the quantitative results (David et al., 2024).

3.4 Hypotheses Development and Conceptual Framework

Drawing on the reviewed literature, the quantitative phase tests a set of directional hypotheses linking each AI marketing capability to customer engagement, and engagement, in turn, to retail outcomes. Personalization has repeatedly been associated with stronger consumer engagement and higher purchase intention (Alharbi & Alotaibi, 2025; Wang & Li, 2025), while conversational agents shape the cognitive and emotional facets of engagement in online retail (Moriuchi et al., 2024). Predictive analytics protects product

availability, which sustains the perceived usefulness that drives continued use (ASRC, 2025), and dynamic pricing, when personalized, reinforces perceived value and behavioural engagement (Kumar & Sharma, 2025). Accordingly, the following hypotheses are advanced:

H1. AI-driven personalization and recommendation positively influence customer engagement in dark store retail.

H2. Conversational AI quality (chatbots and voicebots) positively influences customer engagement in dark store retail.

H3. Predictive demand analytics, through improved product availability, positively influences customer engagement in dark store retail.

H4. AI-enabled dynamic pricing and real-time targeting positively influence customer engagement in dark store retail.

H5. Customer engagement positively influences retail outcomes (conversion, basket size, and customer loyalty).

The conceptual relationships among these constructs, together with the moderating contextual factors specific to the dark store model, are summarized in Figure 1.

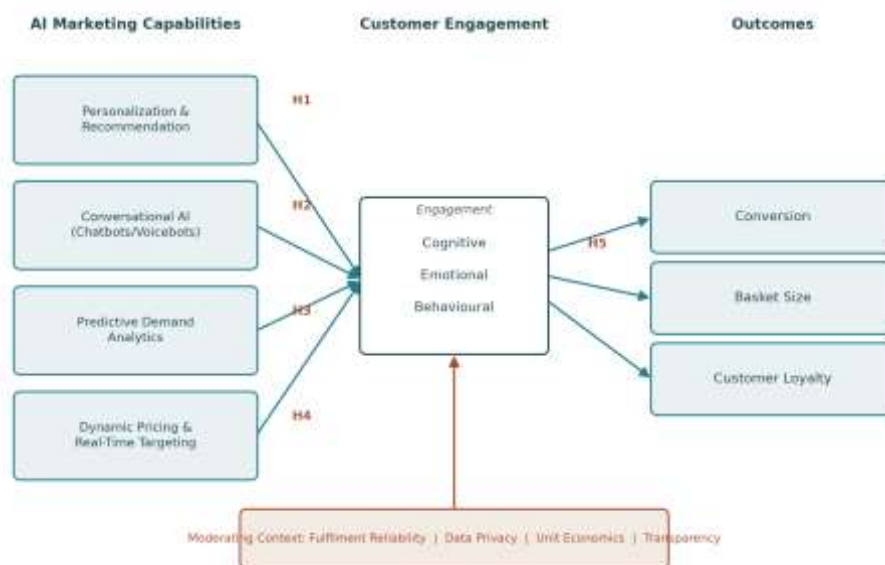


Figure 1. Conceptual framework linking AI marketing capabilities, customer engagement, and retail outcomes.

3.5 Data Integration, Validity, and Ethics

Consistent with the explanatory logic, the two datasets were integrated at the interpretation stage, where qualitative themes were used to explain, contextualize, and, where relevant, qualify the statistical relationships, with points of convergence and divergence reported openly. Trustworthiness was supported through methodological triangulation, member checking, and an audit trail, whereas

quantitative rigour rested on established reliability and validity tests. All procedures followed standard research ethics, including informed consent, voluntary participation, anonymity, and secure data handling, with close attention to the privacy sensitivities inherent in AI-driven marketing research (Alharbi & Alotaibi, 2025). The integrated evidence informs the discussion developed in Section 4.

4. Findings and Discussion

The integrated quantitative and qualitative findings are organized around the study's core constructs and read against prior evidence. The quantitative strand points to the relative weight of each AI marketing capability in shaping engagement and loyalty, while the qualitative strand clarifies the mechanisms and contextual conditions behind these effects in the dark store setting. The discussion that follows is structured around the five hypotheses and the conceptual framework set out in Figure 1, with the consolidated interpretation presented in Section 4.6.

4.1 Personalization as the Engagement Engine

The synthesis indicates that AI-driven personalization is the principal mechanism through which dark store operators generate engagement. Because the dark store interface is entirely app-based, recommendation systems function as the digital equivalent of an in-store layout, guiding discovery and basket construction (arXiv, 2025). Advanced models—ranging from random-forest recommenders to graph-attention networks—can predict individual preferences with high accuracy, enabling tailored offers that raise conversion and order value (Hossain et al., 2024; Wang & Li, 2025). Critically, AI cross-selling is also an operational lever: by optimizing basket size, it helps offset the thin delivery margins that constrain Q-commerce profitability (IJFMR, 2026). The evidence supports the proposition that personalization simultaneously advances marketing and unit-economics objectives in the dark store model.

4.2 Conversational AI and Relational Engagement

Conversational AI extends engagement from transactional to relational. In the absence of human store staff, chatbots and voice assistants become the primary interactive touchpoint, handling discovery, order tracking, and post-purchase support (Klein & Martinez, 2023). Studies report that well-designed conversational agents lift online conversion and strengthen cognitive and emotional engagement, especially when anthropomorphic and localized to linguistic and cultural context (Moriuchi et al., 2024). However, consumer surveys reveal persistent dissatisfaction with generic, low-capability bots, underscoring that engagement gains depend on conversational quality rather than mere deployment (IJRPR, 2026). For dark store

operators, this implies that investment in context-aware conversational systems – not basic scripted bots – is necessary to convert speed into loyalty.

4.3 Predictive Analytics, Availability, and Trust

A distinctive finding is that, in dark store retail, marketing engagement is inseparable from fulfilment reliability. Predictive demand forecasting—using neural networks and AI-enhanced analytics—improves inventory placement and reduces stockouts, directly protecting the speed-and-freshness promise on which engagement depends (Zhou & Chen, 2021; ASRC, 2025). Where AI accurately anticipates hyper-local demand, customers experience consistent availability, reinforcing the perceived usefulness that drives continued adoption under the Technology Acceptance Model (IJFMR, 2026). Conversely, a failed promise—an out-of-stock item or delayed delivery—erodes trust more sharply than in traditional retail, because speed is the core value proposition. Thus AI predictive analytics operates as both a supply-chain tool and an engagement safeguard.

4.4 Loyalty, Sustainability, and Ethical Constraints

Beyond acquisition, AI contributes to retention. Studies link AI capabilities to enhanced e-customer loyalty by enabling proactive service recovery, personalized rewards, and behavioural prediction of churn (Frontiers, 2026). Yet several constraints moderate these benefits. Data-privacy and transparency emerge as the most influential factors shaping consumer trust in AI personalization, requiring secure and transparent data practices (Alharbi & Alotaibi, 2025). Additionally, the environmental externalities and limited operational transparency of dark stores—noise, traffic, and consumer uncertainty about hygiene—can offset digital engagement gains if left unaddressed (Schorung et al., 2023; Scribd Research, 2026). Sustainable, ethically governed AI marketing therefore represents both a risk-mitigation and a differentiation opportunity for operators.

4.5 Dynamic Pricing and Real-Time Engagement

A further capability shaping engagement is AI-enabled dynamic pricing and real-time promotional targeting. Because dark store demand is highly time-sensitive and hyper-local, machine-learning models can adjust promotions, delivery-fee waivers, and bundle offers in response to live demand signals, weather, and individual basket composition (Kumar & Sharma, 2025). Such micro-targeted incentives nudge consumers toward larger or more frequent orders during low-traffic windows, smoothing fulfilment load while sustaining behavioural engagement. Evidence from broader digital-marketing contexts shows that strategic pricing combined with personalization meaningfully strengthens consumer engagement and perceived value (Alharbi & Alotaibi, 2025; Almeida & Santos, 2025). For dark store operators, the analytical challenge is to balance short-term

conversion incentives against margin erosion, since aggressive discounting can deepen the unit-economics pressures already characteristic of quick commerce (Andreas, 2024). When calibrated well, however, real-time engagement transforms pricing from a blunt acquisition tool into a continuous relationship mechanism that rewards loyalty and rebalances operational demand.

4.6 An Integrative Framework

Integrating these findings, the study proposes a framework in which four AI marketing capabilities—personalization, conversational AI, predictive analytics, and dynamic engagement—drive three engagement dimensions (cognitive, emotional, behavioural), which in turn influence conversion, basket size, and loyalty. This pathway is moderated by contextual factors specific to the dark store model: fulfilment reliability, data-privacy governance, unit economics, and operational transparency (David et al., 2024; IJFMR, 2026). The framework positions AI not as an isolated marketing function but as the connective tissue binding customer-facing engagement to the speed-dependent fulfilment engine that defines quick commerce.

The framework also clarifies why generic e-commerce marketing prescriptions transfer imperfectly to dark store retail. In conventional online retail, a marketing failure typically reduces conversion; in the dark store model, the same digital touchpoint must simultaneously create demand and signal a credible promise of near-instant, reliable delivery. Engagement is therefore conditional: a compelling personalized recommendation generates little durable value if the predicted item is unavailable or the delivery window slips (Scribd Research, 2026). This interdependence elevates the importance of closed-loop AI systems in which engagement data continuously informs demand forecasting, and forecasting accuracy in turn protects the engagement experience. Operators that treat marketing AI and fulfilment AI as a single integrated capability are thus better positioned to convert the speed advantage of dark stores into sustained customer relationships (David et al., 2024; ASRC, 2025).

5. Conclusion and Implications

This paper has examined how AI-driven digital marketing shapes customer engagement within dark store retail models. The synthesis demonstrates that AI personalization and conversational agents are the primary engines of engagement and conversion, while predictive analytics secures the availability and reliability on which the entire dark store value proposition rests. Crucially, in this storefront-less context, marketing engagement and operational fulfilment are deeply interdependent, and AI is the mechanism that integrates them (David et al., 2024; IJFMR, 2026).

For managers, three implications follow. First, operators should invest in high-quality, context-aware conversational and recommendation systems rather than basic automation, as engagement gains scale with capability (Moriuchi et al., 2024). Second, AI cross-selling should be deployed deliberately to expand basket size and counter thin margins (IJFMR, 2026). Third, transparent data governance and sustainability practices are prerequisites for converting short-term engagement into durable trust and loyalty (Alharbi & Alotaibi, 2025). The study is limited by its conceptual design and the nascency of dark store scholarship; future research should empirically test the proposed framework across markets, examine the ethical boundaries of AI personalization, and assess the long-term sustainability of AI-intensive quick-commerce operations.

REFERENCES:

- Alharbi, S., & Alotaibi, M. (2025). Exploring the impact of AI-driven personalization on consumer engagement in digital marketing. *Argumenta Oeconomica / Management*. <https://www.management-poland.com/Exploring-the-Impact-of-AI-Driven-Personalization-on-Consumer-Engagement-in-Digital,200968,0,2.html>
- Almeida, R., & Santos, P. (2025). AI-powered personalization in marketing: Balancing engagement and privacy. *Journal of Productivity*. <https://journal.ppipbr.com/index.php/productivity/article/view/650>
- Alvarez & Marsal. (2023). *In-city warehousing: The emerging backbone for quick commerce*. https://www.alvarezandmarsal.com/sites/default/files/2023-04/In-City%20Warehousing%20-%20Urban%20Logistics%20Report_2.pdf
- Andreas, M. (2024). A systematic review on dark stores in quick commerce. *Delhi Business Review*, 26(2). https://www.delhibusinessreview.org/V26n2/dbr_v26n2g.pdf
- ASRC. (2025). Artificial intelligence-enhanced predictive analytics for demand forecasting in retail supply chains. *ASRC Procedia: Global Perspectives in Science and Scholarship*. <https://global.asrcconference.com/index.php/asrc/article/view/43>
- David, R., Gund, P., & Daniel, A. (2024). Dark stores as enablers of last-mile logistics in quick commerce. *Delhi Business Review*, 26(2). https://www.delhibusinessreview.org/V26n2/dbr_v26n2g.pdf
- Frontiers. (2026). Assessing artificial intelligence's impact on e-customer loyalty. *Frontiers in Artificial Intelligence*. <https://pmc.ncbi.nlm.nih.gov/articles/PMC12075180/>

Ganapathy, S., & Gupta, R. (2023). The growth of e-grocery and quick-commerce platforms during the pandemic. *Delhi Business Review*, 26(2). https://www.delhibusinessreview.org/V26n2/dbr_v26n2g.pdf

Hossain, M., et al. (2024). E-commerce product recommendation system based on machine learning. *arXiv*. <https://arxiv.org/abs/2407.21026>

HRMARS. (2024). A review on generative AI in digital marketing: Transforming customer engagement and firm performance. *Human Resource Management Academic Research Society*. https://hrmars.com/papers_submitted/28297/

IJFMR. (2026). Adoption of quick commerce in the food sector. *International Journal for Multidisciplinary Research*. <https://www.ijfmr.com/papers/2026/1/67942.pdf>

IJRPR. (2026). Impact of AI-based chatbots on customer satisfaction in retail. *International Journal of Research Publication and Reviews*. <https://ijrpr.com/uploads/V7ISSUE2/IJRPR59740.pdf>

Klein, K., & Martinez, L. (2023). AI-based chatbots in conversational commerce and their effects on product personalization. *Electronic Markets*. <https://pmc.ncbi.nlm.nih.gov/articles/PMC10206356/>

Kumar, A., & Sharma, V. (2025). AI in digital marketing: Enhancing customer engagement and brand performance. *International Journal of Advanced Production Technology*. <https://ijapt.org/index.php/journal/article/view/473>

Loukili, M., et al. (2023). Recommendation systems in e-commerce platforms using association rule mining. *International Journal of Creative Research Thoughts*. <https://www.ijcrt.org/papers/IJCRT26A4186.pdf>

Moriuchi, E., et al. (2024). Consumer engagement in chatbots and voicebots: A multiple-experiment approach in online retailing. *Journal of Retailing and Consumer Services*. <https://www.sciencedirect.com/science/article/abs/pii/S0969698924000249>

Schorung, M. (2023). Quick commerce: Will the disruption of the food retail industry happen? Investigating the quick commerce supply chain and the impacts of dark stores. *Logistics City Chair, University Gustave Eiffel*. <https://shs.hal.science/halshs-04098596>

Schorung, M., et al. (2023). Dark stores in the City of Light: Geographical and transportation impacts of quick commerce in Paris. *Journal of Transport Geography*. <https://www.sciencedirect.com/science/article/abs/pii/S0739885923000732>

Scribd Research. (2026). *Dark stores: Impact on urban shopping behavior*. <https://www.scribd.com/document/837197661/Brmmr-Final>

Wang, Y., & Li, J. (2025). Personalized recommendation system of e-commerce using graph attention networks. *Applied Artificial Intelligence*. <https://www.tandfonline.com/doi/full/10.1080/08839514.2025.2487417>

Zhou, H., & Chen, X. (2021). Neural networks in predicting consumer behavior and market trends. *American Journal of Artificial Intelligence and Neural Networks*. <https://australiansciencejournals.com/ajainn/article/view/345>