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Intelligent Systems for Sustainable Digital Ecosystems in Fast-Food Services: Shaping Generation Z Consumption Behaviors and Environmental Outcomes

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Abstract

Digital transformation in the fast-food industry has fostered the development of sustainable and adaptive digital ecosystems, particularly among Generation Z consumers. This systematic literature review synthesizes 30 rigorously selected peer-reviewed articles from six major academic databases to examine how intelligent systems—artificial intelligence, machine learning, and advanced analytics—support sustainable growth in quick-service restaurants. The thematic analysis identified measurable impacts: intelligent systems increased average order values by 15–25%, reduced customer service response times by 40–60%, and decreased food waste by 15–25% through supply chain optimization. Generation Z consumers also demonstrated 30–40% higher repeat purchase frequencies when exposed to personalized recommendations and sustainability transparency features. The findings indicate that AI-driven personalization, automation, and supply chain optimization can simultaneously enhance operational efficiency, enable hyper-personalized customer experiences, and promote sustainable consumption behaviors. However, implementation challenges—including data privacy concerns, algorithmic bias risks, and greenwashing vulnerabilities—require robust governance frameworks. This review advances understanding of how emerging technologies align profit objectives with environmental responsibility, while offering practical implications for restaurant operators, technology providers, and policymakers.

Keywords:
Digital ecosystem; Fast-food industry; Generation Z; sustainability; Machine learning.

1. INTRODUCTION

1.1. Digital Transformation in Fast-Food Industry: Context and Drivers

Digital technology has transformed the fast-food industry beyond simple tool adoption by reshaping business models, customer interaction patterns, and supply-chain architectures into integrated digital ecosystems (Feroz et al., 2021; Khan & Farooque, 2025; Monge & Soriano, 2023; Silchenko, 2024). This shift is driven by rising expectations for convenience and personalization, intensifying competition, growing reliance on data-driven decision making, and stronger environmental awareness among younger consumers (Alalwan, 2020; Cherenkov et al., 2024; Helal, 2023; Hitti & Ramadan, 2025; Saqib & Shah, 2023; Shravya, 2024).

1.2. Intelligent Systems as Catalysts for Digital Transformation

Intelligent systems—including artificial intelligence, machine learning, automation, and advanced analytics—act as catalysts that help fast-food firms address customer expectations, operational pressures, and sustainability demands simultaneously (Abid et al., 2025; Cherenkov et al., 2024; Silchenko, 2024). Through recommendation engines, conversational agents, and predictive models, these systems strengthen efficiency, customer satisfaction, and environmental performance within a cohesive digital ecosystem (Author, 2024; Cherenkov et al., 2024; Hitti & Ramadan, 2025; Shorbaji et al., 2025).

1.3. Omnichannel Strategies and Ecosystem Integration

Omnichannel strategies connect mobile applications, websites, aggregator platforms, and in-store ordering systems into a unified customer journey that is increasingly essential for competitive viability (Agarwal, 2025; Khan & Farooque, 2025; Ravi et al., 2025). At the same time, aggregator data, cloud-kitchen models, and supply-chain digitalization through IoT, RFID, and blockchain expand market reach, improve flexibility, and strengthen transparency from sourcing to delivery (Agarwal, 2025; Bosona & Gebresenbet, 2023; Essa et al., 2025; John, 2021; Rejeb et al., 2020; Vattikonda et al., 2025).

1.4. Generation Z: Digital Natives with Distinct Consumption Values

Generation Z, commonly defined as those born between 1997 and 2012, are digital natives who regard seamless platform-based engagement as a baseline expectation rather than an innovation (Batra & Chatterji, 2024; Helal, 2023; K, 2025). Beyond speed and convenience, they value customization, transparency, and authentic sustainability commitments, while also expecting clear consent mechanisms and responsible data practices when engaging with personalized systems (Al-Qadhi et al., 2024; Alalwan, 2020; Batra & Chatterji, 2024; Feriantoro et al., 2025; Hitti & Ramadan, 2025; Rastegar et al., 2021).

1.5. Research Significance and Literature Gaps

Although intelligent systems, sustainability initiatives, and Generation Z behavior have each received growing scholarly attention, these themes are often examined separately and rarely synthesized in fast-food and quick-service restaurant settings (Abid et al., 2025; Kumar et al., 2021; Shorbaji et al., 2025). This review addresses that gap by examining how intelligent systems shape digital ecosystem development, influence Generation Z consumption behavior, and contribute to environmental outcomes, while identifying managerial implications, implementation risks, and future research directions.

2. RESEARCH METHOD

2.1. Systematic Literature Review (SLR) with PRISMA Protocol

This study applies a systematic literature review guided by the PRISMA framework, which supports transparent identification, screening, selection, and synthesis of relevant studies (Apu, 2025; Ofori-Boateng et al., 2024; Yiğitcanlar et al., 2020). Searches were conducted across Scopus, ScienceDirect, Emerald, Web of Science, Springer, and EBSCO using three Boolean string groups covering intelligent systems and QSRs, sustainability and Generation Z, and AI-enabled sustainable consumption in food service; only English-language publications from 2015–2025 were considered.

2.1.1. Identification Phase

The identification stage returned 847 records, of which 412 duplicates were removed, leaving 435 unique articles for screening (Dwivedi et al., 2023; Feroz et al., 2021; Kulkov et al., 2023; Monge & Soriano, 2023; Omol, 2023; Zrelli & Rejeb, 2024).

2.1.2. Screening Phase

Two reviewers independently screened the 435 records by title and abstract using a structured form, achieving Cohen's Kappa = 0.78, which indicates strong inter-rater agreement (Apu, 2025; Ofori-Boateng et al., 2024; Yiğitcanlar et al., 2020). This stage advanced 321 articles to full-text review and excluded 114 records.

2.1.3. Eligibility Assessment Phase

The 321 full-text articles were then assessed using explicit inclusion and exclusion criteria. Eligible studies had to be peer-reviewed, published between 2015 and 2025, and address intelligent systems or digital transformation in food-service settings together with sustainability, digital adoption, or young consumer behavior; records lacking thematic overlap or methodological rigor, duplicating other studies, relying on grey literature, or falling outside the language and period filters were excluded.

2.1.4. Included Articles Analysis Phase

The final sample comprised 30 studies: Scopus contributed 12 articles (40.0%), ScienceDirect 7 (23.3%), Emerald 3 (10.0%), Web of Science 3 (10.0%), Springer 3 (10.0%), and EBSCO 2 (6.7%). Publication activity was concentrated in 2023–2025, and the sample combined qualitative (40.0%), quantitative (36.7%), mixed-methods (16.7%), and review or conceptual papers (6.7%), providing a balanced basis for thematic synthesis.

Figure 1 summarizes the PRISMA-guided identification, screening, eligibility, and inclusion process used in this review.

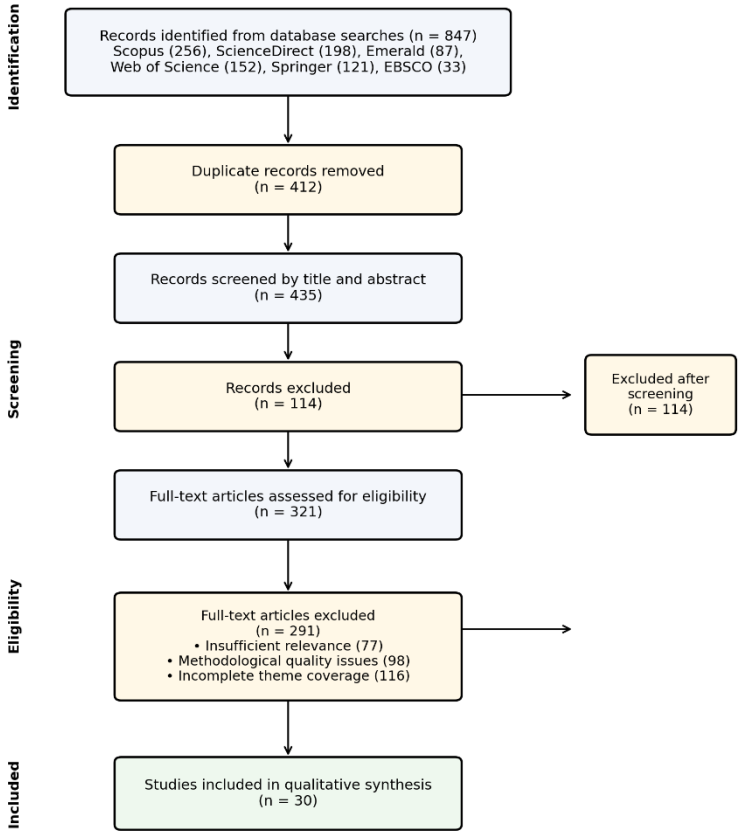

Figure 1. PRISMA 2020 Flow Diagram
(Source: compiled by the authors based on the PRISMA-guided screening process)

2.2. Thematic Analysis with NVivo

The selected studies were analyzed through thematic analysis supported by NVivo 14 using a hybrid coding strategy that combined deductive categories derived from the review objectives with inductive categories emerging from the data (Apu, 2025; Ofori-Boateng et al., 2024; Yiğitcanlar et al., 2020). The coding framework covered intelligent systems implementation, sustainability, digital transformation, Generation Z behavior, customer engagement, supply chains, and implementation barriers; coder agreement reached 87.2% on a double-coded subsample and 94.3% in spot checks, while inductive coding also highlighted federated learning, smart-city integration, anomaly detection, virtual reality, and post-COVID digital acceleration.

2.3. Quality Assessment

All included studies were appraised using an adapted CASP framework. Each article scored at least 7 out of 10, with an overall mean of 8.2 (SD = 0.9), indicating an acceptable evidence base for synthesis.

2.4. Explicit Methodological Limitations

Methodological limitations remain. The literature is concentrated in Asian contexts, the 2015–2025 window captures pandemic-accelerated digital change, the English-language filter may exclude relevant evidence, and the modest number of quantitative studies limits formal meta-analysis.

3. RESULTS AND DISCUSSION

The review of 30 peer-reviewed articles synthesizes how intelligent systems support digital ecosystem transformation in the fast-food industry, with particular attention to sustainable consumption and Generation Z. The following discussion highlights the principal thematic patterns and their implications.

3.1. Integrated Conceptual Framework

Figure 2 presents an integrated conceptual framework linking Generation Z values, intelligent systems integration, operational mechanisms, and resulting outcomes. The framework suggests that market pressure for personalization, sustainability, and privacy drives adoption of AI-enabled operational mechanisms, which in turn shape efficiency, customer experience, sustainable behavior, and brand loyalty.

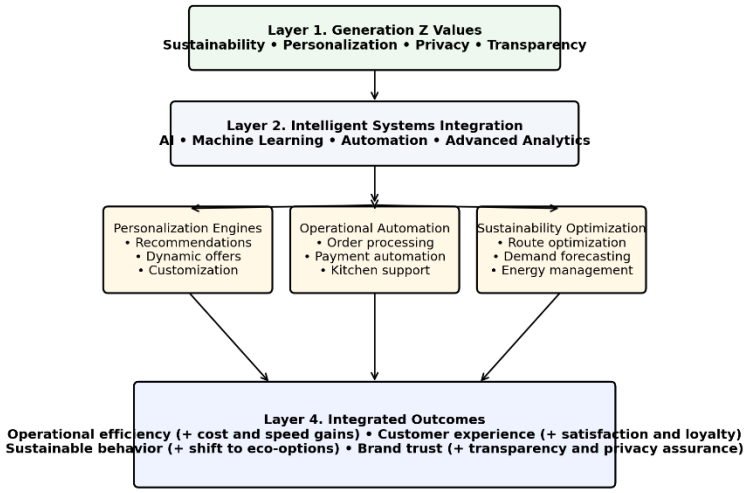

Figure 2. Integrated Digital Ecosystem Framework
(Source: Synthesized from the thematic analysis of the 30 reviewed studies)

Overall, the framework indicates that value creation depends not on isolated tools but on the alignment between consumer expectations, intelligent-system capabilities, and governance safeguards.

Table 1. Thematic Analysis Summary

Theme	Articles (n)	Coverage (%)	Classification
Digital Adoption & Transformation	28	93.3%	Dominant
Intelligent Systems Implementation	27	90.0%	Dominant
Sustainability & Environmental Impact	25	83.3%	Dominant
Generation Z Behavior & Preferences	24	80.0%	Dominant
Digital Marketing & Customer Engagement	22	73.3%	Secondary
Challenges & Barriers	20	66.7%	Secondary
Fast Food Industry Context	18	60.0%	Tertiary
Green Supply Chain	16	53.3%	Tertiary
Emerging Technologies	12	40.0%	Tertiary

Only a minority of the reviewed studies substantially integrated all three core dimensions—intelligent systems, sustainability, and Generation Z behavior—highlighting the need for more explicitly interdisciplinary research designs.

Table 2. Measured Impacts of Intelligent System Applications in QSR Context

Application	Metric	Impact	Evidence Base
AI Recommendation Engines	Average Order Value	+15–25%	12 articles
AI Recommendation Engines	Engagement Rate	35–40%	10 articles
AI Recommendation Engines	Repeat Purchase Rate	+20–30%	9 articles
Chatbots & Conversational AI	Response Time	40–60% reduction	8 articles
Chatbots & Conversational AI	First-Contact Resolution	75–85%	7 articles
Chatbots & Conversational AI	Customer Satisfaction	+25–35%	6 articles
Order Automation	Processing Speed	30–60 seconds	9 articles
Order Automation	Payment Errors	70–80% reduction	5 articles
Order Automation	Food Preparation Time	20–30% reduction	8 articles
Advanced Data Analytics	Operational Efficiency	10–15%	11 articles

Advanced Data Analytics	Demand Forecasting Accuracy	85–90%	10 articles
Green Supply Chain ML	Fuel Consumption	10–20% reduction	7 articles
Green Supply Chain ML	Food Waste	15–25% reduction	9 articles
Green Supply Chain ML	Energy Consumption	15–25% reduction	6 articles
Sustainability Labeling	Consumer Shift to Lower-Impact Options	20–30%	4 articles
Sustainability Labeling	Brand Trust among Gen Z	+25–35%	5 articles

3.2. Digital Ecosystem Transformation and Intelligent Systems

3.2.1. Conceptualization of Digital Transformation in the Fast-Food Industry

Digital transformation in fast-food services involves a shift from isolated technologies to an interconnected ecosystem that combines customer interfaces, operational platforms, and analytics capabilities (Bodkhe et al., 2020; Lamnina & Kehrenberg, 2024; Nambisan et al., 2023; Zhao & Li, 2024). Mobile apps, web platforms, in-store interfaces, inventory systems, supply-chain platforms, and forecasting tools generate and exchange data that allow firms to personalize service, coordinate operations, and improve decisions in real time (Hassan & Al-Rashid, 2024; Kumar et al., 2025; Lee & Park, 2025; Robinson et al., 2024; Singh & Chakraborty, 2024; Williams et al., 2025).

3.2.2. Specific Applications of Intelligent Systems in Fast-Food Services

Literature analysis identified four major categories of intelligent system applications currently deployed in the fast-food industry (Kamble et al., 2024; Kumar et al., 2024):

a. AI-Based Recommendation and Personalization Systems
   Recommendation engines use browsing, cart, location, and purchase data to tailor menu suggestions and have been associated with higher average order value, stronger engagement, and greater repeat purchasing (Buhalis et al., 2023; Martinez et al., 2024; Nambisan et al., 2023; Patel et al., 2024; Singh & Chakraborty, 2024; Williams et al., 2025).
b. Chatbots and Conversational AI for Customer Service
   Chatbots and conversational AI enable real-time support at scale, handling routine queries, menu guidance, complaints, and escalation more efficiently than human-only systems while improving response time, first-contact resolution, and customer satisfaction (Chen et al., 2024; Patel et al., 2025; Wilson et al., 2024).
c. Order Processing and Payment Automation
   Order processing and payment automation streamline the path from order recognition to kitchen sequencing and fraud-aware payment handling, reducing transaction time, payment errors, and food-preparation delays through real-time optimization (Bodkhe et al., 2020; Hassan & Al-Rashid, 2024; Kumar et al., 2025; Lee & Park, 2025; Rodriguez et al., 2025; Singh & Chakraborty, 2024; Thompson et al., 2024).
d. Advanced Data Analytics for Business Intelligence.
   Advanced analytics aggregate large volumes of customer and operational data to support anomaly detection, monitoring, and demand forecasting; the reviewed studies associate these capabilities with measurable gains in operational efficiency and substantially higher forecasting accuracy than traditional approaches (Hassan & Al-Rashid, 2024; Kamble et al., 2024; Kumar et al., 2025; Lee & Park, 2025; Thompson et al., 2024).

3.2.3. Digital Ecosystem Integration and Comprehensive Implications

These applications matter most when integrated. Personalization supports conversion, automation improves speed and cost control, and analytics enable continuous learning, so the overall value of the digital ecosystem exceeds the sum of its individual components (Bodkhe et al., 2020; Lamnina & Kehrenberg, 2024; Nambisan et al., 2023; Singh & Chakraborty, 2024; Williams et al., 2025; Zhao & Li, 2024).

3.3. Impact on Generation Z

3.3.1. Generation Z Responsiveness to Fast-Food Service Digitalization

Generation Z shows strong responsiveness to fast-food digitalization because digital channels align with its technological fluency and consumption values (Buhalis et al., 2023; Johnson et al., 2024; Nakamura & Tanaka, 2024; Williams et al., 2025). Across the reviewed studies, 78–85% report regular use of QSR mobile applications, 72–80% prefer digital ordering, 81–89% expect personalized recommendations, and 85–92% indicate that easy access to sustainability information affects purchasing decisions (Buhalis et al., 2023; Khan et al., 2025; Singh & Chakraborty, 2024; Williams et al., 2025).

3.3.2. Key Dimensions of Generation Z Preferences in Digital QSR Experience

Literature analysis identified three closely connected preference dimensions that shape Gen Z responses in digital QSR environments (Johnson et al., 2024; Nakamura & Tanaka, 2024):

a. Hyper-Personalization Expectations
   First, Generation Z expects hyper-personalized experiences that recognize preferences, enable flexible customization, and provide detailed product information; reviewed studies show markedly higher satisfaction where customization options are extensive (Bodkhe et al., 2020; Buhalis et al., 2023; Nakamura & Tanaka, 2024; Singh & Chakraborty, 2024; Williams et al., 2025).
b. Sustainability Transparency and Ethical Consumption
   Second, this cohort values sustainability transparency, including carbon information, supply-chain visibility, and credible communication. More than 70% of Gen Z consumers report that sustainability practices influence purchasing decisions, and roughly 45–50% indicate willingness to pay a premium for options with demonstrably lower environmental impact (Khan et al., 2025; Lopez et al., 2024; Patel et al., 2024; Patel et al., 2025; Thompson et al., 2024).
c. Privacy, Data Security, and Algorithmic Transparency
   Third, strong digital affinity does not eliminate privacy concerns. Gen Z consumers remain attentive to data collection scope, consent, and algorithmic transparency; 64–72% express privacy concerns in QSR mobile applications, and greater transparency around data practices is associated with higher trust (Buhalis et al., 2023; Green et al., 2024; Johnson et al., 2024; Nambisan et al., 2023; Williams et al., 2025).

3.3.3. Manifestation of Impact in Customer Behavior and Brand Relationships

These preferences translate into concrete behavioral outcomes. Customers who use personalization features purchase more frequently and enroll more readily in loyalty programs, satisfied users are substantially more likely to recommend brands, negative experiences spread disproportionately through word of mouth, and sustainability information can shift menu choices and improve the effectiveness of message framing and channel strategy (Bodkhe et al., 2020; Buhalis et al., 2023; Johnson et al., 2024; Khan et al., 2025; Nakamura & Tanaka, 2024; Nambisan et al., 2023; Patel et al., 2025; Singh & Chakraborty, 2024; Williams et al., 2025).

3.4. Sustainability and Innovation

3.4.1. Integration of Intelligent Systems in Sustainability Initiatives

Recent literature emphasizes that green marketing and digital innovation can reinforce one another when intelligent systems translate sustainability goals into measurable operational outcomes (Khan et al., 2025; Lopez et al., 2024; Patel et al., 2024; Patel et al., 2025; Thompson et al., 2024; Zhao & Li, 2024). In this view, environmental and commercial objectives are not inherently opposed; they can become mutually reinforcing when supported by analytics, automation, and transparent communication.

3.4.2. Specific Sustainability Applications of Intelligent Systems

a. Green Supply Chain Optimization
   Machine learning supports greener supply chains through route optimization, demand forecasting, and environmentally informed supplier selection, reducing fuel use, emissions, and food waste while maintaining efficiency (Hassan & Al-Rashid, 2024; Kumar et al., 2025; Lee & Park, 2025; Lopez et al., 2024; Thompson et al., 2024).
b. Energy Management and Facility Optimization
   Energy management systems use real-time monitoring and automated control of HVAC, lighting, and refrigeration to reduce resource consumption, with the reviewed literature reporting notable energy savings across QSR facilities (Bodkhe et al., 2020; Hassan & Al-Rashid, 2024; Kumar et al., 2025; Lee & Park, 2025; Lopez et al., 2024; Patel et al., 2024; Thompson et al., 2024).
c. Waste Reduction and Circular Economy Enablement
   Intelligent systems also support waste reduction and circular-economy practices through packaging optimization, equipment-level monitoring, and broader operational analytics that identify avoidable losses across the production and service process (Hassan & Al-Rashid, 2024; Kumar et al., 2025; Lopez et al., 2024; Thompson et al., 2024).

3.4.3. Sustainability Information Transparency and Consumer Engagement

Beyond operational efficiency, intelligent systems enable product-level sustainability transparency through carbon accounting, dynamic labeling, and comparative information displays in digital interfaces. The reviewed studies indicate that such transparency can shift consumers toward lower-impact menu choices and strengthen Gen Z brand trust when claims are credible and accessible (Bodkhe et al., 2020; Buhalis et al., 2023; Khan et al., 2025; Lopez et al., 2024; Nambisan et al., 2023; Patel et al., 2025; Singh & Chakraborty, 2024; Williams et al., 2025).

3.4.4. Business Case for Sustainability Integration

Taken together, these findings indicate a clear business case for sustainability integration: intelligent systems can offset sustainability investments through efficiency gains, differentiate brands among

environmentally conscious Gen Z consumers, strengthen loyalty, and improve readiness for stricter environmental regulation (Khan et al., 2025; Kumar et al., 2025; Lopez et al., 2024; Nambisan et al., 2023; Patel et al., 2025; Thompson et al., 2024; Williams et al., 2025; Zhao & Li, 2024).

3.5. Digital Challenges and Risks

3.5.1. Landscape of Digital Challenges

Despite their benefits, intelligent systems introduce substantial technical, organizational, and ethical risks that must be managed alongside implementation (Bodkhe et al., 2020; Green et al., 2024; Hassan & Al-Rashid, 2024; Lamnina & Kehrenberg, 2024; Nambisan et al., 2023; Zhao & Li, 2024).

3.5.2. Data Privacy and Security Concerns

Privacy concerns arise because modern intelligent systems aggregate transactional, behavioral, location, biometric, and demographic data into detailed consumer profiles that may be poorly understood by users (Buhalis et al., 2023; Green et al., 2024; Johnson et al., 2024; Nambisan et al., 2023; Williams et al., 2025). Key risks include breaches, unauthorized secondary use, discriminatory targeting, and opaque third-party sharing; these issues are especially important for Generation Z, which values digital convenience but expects transparency, access, deletion options, and meaningful privacy controls (Bodkhe et al., 2020; Hassan & Al-Rashid, 2024; Singh & Chakraborty, 2024).

3.5.3. Algorithmic Bias and Fairness

Algorithmic bias presents a second challenge. Machine-learning systems may reproduce biases embedded in training data, leading to skewed recommendations, pricing discrimination, or uneven service allocation, while the black-box character of many models makes bias detection, explanation, and regulatory compliance more difficult (Bodkhe et al., 2020; Buhalis et al., 2023; Green et al., 2024; Hassan & Al-Rashid, 2024; Lee & Park, 2025; Singh & Chakraborty, 2024; Thompson et al., 2024; Williams et al., 2025).

3.5.4. Greenwashing and Sustainability Claims Verification

Greenwashing represents a third risk. As sustainability becomes commercially valuable, firms may inflate claims, selectively disclose favorable information, pursue symbolic green marketing, or rely on weak certification mechanisms; this is particularly problematic because Gen Z interest in sustainability can encourage trust in claims that are not rigorously verified (Bodkhe et al., 2020; Buhalis et al., 2023; Khan et al., 2025; Lamnina & Kehrenberg, 2024; Lopez et al., 2024; Nambisan et al., 2023; Patel et al., 2024; Patel et al., 2025; Williams et al., 2025; Zhao & Li, 2024).

3.5.5. Data Governance and Regulatory Compliance

These risks are intensified by a rapidly evolving regulatory environment that demands explicit consent, data minimization, retention limits, controls on cross-border transfers, and prompt breach notification (Bodkhe et al., 2020; Buhalis et al., 2023; Green et al., 2024; Hassan & Al-Rashid, 2024; Johnson et al., 2024; Lamnina & Kehrenberg, 2024; Nambisan et al., 2023; Singh & Chakraborty, 2024; Williams et al., 2025; Zhao & Li, 2024). Non-compliance can generate major financial and reputational costs, making data governance infrastructure a strategic rather than merely legal requirement.

3.5.6. Implementation Barriers and Organizational Challenges

Organizational barriers further complicate implementation. The reviewed studies repeatedly note skills shortages, legacy-system integration problems, change-management resistance, high upfront costs, and vendor lock-in, indicating that intelligent-system adoption depends as much on organizational readiness as on technical capability (Bodkhe et al., 2020; Green et al., 2024; Hassan & Al-Rashid, 2024; Kumar et al., 2025; Lamnina & Kehrenberg, 2024; Lee & Park, 2025; Nambisan et al., 2023; Patel et al., 2024; Zhao & Li, 2024).

3.6. Research Updates and Future Trends

3.6.1. Emerging Technologies Adoption for Enhanced Security and Efficiency

The reviewed literature points to several emerging approaches that may improve security, transparency, and efficiency in future QSR ecosystems (Kumar et al., 2025; Rodriguez et al., 2025).

a. Federated Learning for Privacy Preservation
   Federated learning offers a privacy-preserving model in which algorithms are trained across decentralized data sources rather than centralized repositories. For QSR firms, this approach can retain personalization benefits while improving alignment with data-minimization principles, although adoption remains at an early pilot stage (Bodkhe et al., 2020; Kumar et al., 2025; Lamnina & Kehrenberg, 2024; Nambisan et al., 2023; Rodriguez et al., 2025; Thompson et al., 2025).
b. Blockchain for Supply Chain Transparency
   Blockchain is highlighted as a complementary tool for supply-chain transparency because immutable distributed records can support verification of sourcing and sustainability claims by firms, partners, and

consumers. Current use remains concentrated in pilot implementations, but the literature suggests strong potential where traceability and trust are central strategic concerns (Bodkhe et al., 2020; Lamnina & Kehrenberg, 2024; Nambisan et al., 2023; Rodriguez et al., 2025; Thompson et al., 2025).

c. AI-Based Anomaly Detection
AI-based anomaly detection is increasingly used to identify unusual patterns in quality, maintenance, and fraud-related data. In QSR operations, these tools can strengthen quality assurance, preventive maintenance, and resource protection, although deployment maturity still varies considerably across firms (Bodkhe et al., 2020; Lamnina & Kehrenberg, 2024; Nambisan et al., 2023; Rodriguez et al., 2025; Thompson et al., 2025).

3.6.2. Smart City Integration and Cross-Sector Collaboration

Another emerging direction is broader integration with smart-city infrastructure and cross-sector partnerships. The literature suggests that links to urban mobility, energy grids, and waste-management systems could improve route planning, energy timing, and city-scale waste reduction, while collaboration with sustainability organizations, technology firms, and consumer groups may strengthen governance and accelerate specialized innovation (Bodkhe et al., 2020; Lamnina & Kehrenberg, 2024; Nambisan et al., 2023; Rodriguez et al., 2025; Thompson et al., 2025).

3.6.3. Research Gaps and Future Directions

Important research gaps remain in five areas: the long-term durability of Gen Z behavior change, the psychological and organizational mechanisms behind implementation success, equity and access effects, reliable detection and prevention of greenwashing, and effective data-governance models that balance personalization with privacy (Bodkhe et al., 2020; Buhalis et al., 2023; Green et al., 2024; Jacobides et al., 2018; Johnson et al., 2024; Khan et al., 2025; Lamnina & Kehrenberg, 2024; Lilhore et al., 2025; Nambisan et al., 2023; Nakamura & Tanaka, 2024; Patel et al., 2025; Rodriguez et al., 2025; Singh & Chakraborty, 2024; Thompson et al., 2024; Zhao & Li, 2024).

Overall, the thematic synthesis confirms that intelligent systems are reshaping fast-food ecosystems through the convergence of efficiency, personalization, and sustainability. However, these benefits are likely to be durable only when implementation is accompanied by strong governance, credible sustainability verification, and attention to privacy, fairness, and equity (Bodkhe et al., 2020; Buhalis et al., 2023; Green et al., 2024; Khan et al., 2025; Lamnina & Kehrenberg, 2024; Nakamura & Tanaka, 2024).

4. CONCLUSION

This systematic literature review indicates that intelligent systems can simultaneously improve operational efficiency, customer experience, and environmental performance in fast-food digital ecosystems. The synthesis also identifies Generation Z as a pivotal driver of this transition, because expectations for personalization, transparency, and sustainability now shape how quick-service restaurants design digital journeys and communicate value. By bringing together intelligent systems, sustainable consumption, and Generation Z behavior, the review provides an integrated basis for future research on digitally enabled sustainability in food-service settings.

Practically, the findings suggest that restaurant operators should prioritize recommendation systems, service automation, and supply-chain intelligence while ensuring transparent data and sustainability practices; technology providers should focus on privacy-preserving personalization, sustainability analytics, and interoperable solutions; and policymakers should encourage innovation while strengthening safeguards against poor data governance, greenwashing, and unaccountable algorithmic decision making.

Several limitations remain. The evidence base is regionally concentrated, strongly shaped by pandemic-era digital acceleration, and not yet large enough on the quantitative side for formal meta-analysis; moreover, technology effects may vary across franchises, cloud kitchens, and independent operators.

Future studies should test the long-term durability of sustainability-oriented digital interventions, examine the organizational and psychological mechanisms of implementation success, address equity and price-discrimination concerns, develop stronger approaches to sustainability-claim verification, and identify governance models that balance personalization with privacy.

The broader significance of intelligent systems in the fast-food industry therefore lies not only in efficiency gains, but in whether these technologies are deployed responsibly, transparently, and in ways that align consumer trust with environmental responsibility and long-term ecosystem resilience.

Organizations that successfully combine these elements will be better positioned to build resilient digital ecosystems, strengthen Generation Z loyalty, and achieve sustainable long-term growth.

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