

AI, SUSTAINABILITY, AND ETHICS IN FUTURE RESTAURANTS: EVIDENCE FROM THE LATEST SCIENTIFIC RESEARCH (2023–2025)

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ABSTRACT

Recent scientific literature published between 2023 and 2025 demonstrates that the global restaurant sector is undergoing a significant transformation driven by the convergence of artificial intelligence (AI), sustainability-oriented operational strategies, and evolving ethical expectations regarding human-centred hospitality. While prior research has primarily focused on technological innovation to improve operational efficiency, emerging studies suggest that integrating predictive analytics, carbon footprint communication tools, and circular gastronomy practices is reshaping not only restaurant workflows but also customer perceptions, staff autonomy, and organisational transparency.

This study aims to synthesise recent peer-reviewed scientific findings on AI-supported decision-making systems, sustainability interventions such as carbon-labelled menus, and the ethical considerations associated with automation in restaurant environments. A structured literature review methodology was employed to analyse research indexed in Scopus and Web of Science databases between January 2023 and January 2025. The reviewed studies were categorised into thematic clusters, including AI-assisted forecasting systems, lifecycle-based ingredient sourcing, zero-waste kitchen workflows, and human–technology interaction in hospitality settings.

The findings indicate that AI-enabled predictive models significantly improve demand estimation and inventory accuracy in high-variability service environments, potentially reducing food waste by up to 20–30%. Sustainability-oriented practices—such as carbon-labelled menu design and regenerative sourcing strategies—were found to positively influence customer trust, perceived authenticity, and behavioural loyalty when transparently communicated by service staff. At the same time, automation technologies introduce ethical challenges related to workforce autonomy, professional identity in culinary practice, and the risk of algorithmic bias in labour allocation and customer profiling.

Particular attention is given to the role of applied R&D restaurant environments embedded within higher education institutions, which may function as experimental “living laboratories” for empirically testing AI-supported operational models and sustainability communication strategies in real-service conditions. In smaller urban ecosystems such as Kaunas, these environments provide opportunities to generate practice-based evidence relevant to both academic research and industry innovation.

The study concludes that future restaurant models must adopt human-centred implementation frameworks in which artificial intelligence functions as an augmentative decision-support system rather than a substitute for professional judgement. Integrating AI, sustainability metrics, and ethical governance within applied hospitality education may enable institutions such as St. Ignatius Loyola College to contribute locally grounded yet internationally relevant insights into the evolving socio-technical architecture of sustainable restaurant operations.

Keywords: *artificial intelligence; sustainable gastronomy; ethical hospitality; R&D restaurant; carbon labelling; circular economy; applied research.*

1. INTRODUCTION

The restaurant sector is increasingly positioned at the intersection of technological innovation, environmental governance, and evolving service paradigms, reflecting broader systemic transformations within contemporary hospitality ecosystems. Recent

scientific literature published between 2023 and 2025 demonstrates a rapid expansion of research examining artificial intelligence (AI)-enabled operational optimisation, sustainability-oriented decision-making frameworks, and customer behavioural responses to environmentally informed service design. Despite this growing body of work, existing studies tend to examine these domains—technological efficiency, environmental responsibility, and ethical service provision—in relative isolation, thereby limiting the development of an integrated theoretical understanding of how AI-driven systems interact with sustainability practices and human-centred hospitality principles in real-world restaurant environments.

Artificial intelligence has emerged as a dominant technological paradigm in hospitality management research, particularly in predictive analytics, automated inventory management, and labour allocation models. Empirical studies indicate that AI-assisted forecasting systems can significantly improve demand estimation accuracy and reduce food waste in high-variability service environments. However, the prevailing emphasis on operational efficiency has been critiqued for privileging techno-centric performance metrics at the expense of socio-organisational considerations, including workforce autonomy, professional identity, and the experiential dimensions of hospitality service delivery.

Concurrently, sustainability-oriented operational strategies—such as carbon-labelled menu systems, lifecycle-based sourcing models, and circular gastronomy practices—have gained prominence as measurable indicators of environmental responsibility in restaurant management. While these interventions are frequently associated with reductions in environmental impact and increased consumer trust, their implementation introduces new communicative and ethical challenges related to transparency, data reliability, and the potential instrumentalisation of sustainability as a reputational asset. As such, sustainability practices must be understood not solely as technical solutions but as socio-material signals embedded within complex service interactions.

The convergence of AI-driven optimisation and sustainability-oriented governance raises fundamental questions concerning the future architecture of hospitality systems. In particular, the increasing reliance on algorithm-supported decision-making processes may alter traditional forms of tacit knowledge, creative autonomy, and emotional labour that underpin culinary professionalism and guest engagement. This tension reflects a broader theoretical dilemma between automation-oriented efficiency models and the preservation of human dignity in service work, underscoring the need for a socio-technical framework that integrates technological augmentation with ethical governance mechanisms.

In response to these limitations, recent scholarship has begun to conceptualise hospitality environments as dynamic socio-technical ecosystems in which technological infrastructures, sustainability metrics, and human-centred service practices co-evolve. Within this emerging framework, applied research and development (R&D) restaurant environments embedded in higher education institutions offer a distinctive methodological context for examining the empirical implications of AI adoption and sustainability communication under real-service conditions.

Institutionally supported R&D restaurants—such as those integrated into applied hospitality education at St. Ignatius Loyola College in Kaunas—may therefore function as experimental “living laboratories” that enable the systematic investigation of AI-assisted operational models, behavioural responses to sustainability interventions, and staff perceptions of automation in practice-based settings. By

bridging theoretical inquiry with operational experimentation, such environments yield locally grounded yet internationally relevant insights into the evolving socio-technical configuration of future restaurant systems.

Accordingly, this study aims to synthesise recent scientific findings on AI-supported decision-making, sustainability-oriented operational practices, and ethical governance in restaurant environments, and to examine their theoretical and applied implications in the context of R&D restaurant infrastructures.

2. MATERIALS AND METHODS

This study employed a structured scoping review methodology to systematically examine recent peer-reviewed scientific literature addressing the integration of artificial intelligence (AI), sustainability-oriented operational practices, and ethical governance in restaurant environments. The scoping review approach was selected due to the interdisciplinary nature of the research field and the relative conceptual fragmentation observed across technological, environmental, and socio-organisational dimensions of hospitality management research.

The review process followed established methodological principles for evidence synthesis in applied social sciences. Relevant academic publications were identified through comprehensive database searches conducted in Scopus, Web of Science Core Collection, and ScienceDirect. The search strategy combined controlled vocabulary terms and keyword-based queries related to artificial intelligence in restaurant management, including predictive analytics and automated inventory systems, sustainability interventions such as carbon labelling, lifecycle assessment and circular gastronomy, as well as ethical considerations associated with automation, including workforce autonomy, algorithmic transparency, and customer data governance.

The temporal scope of the analysis was restricted to studies published between January 2023 and January 2025 to ensure relevance to current technological capabilities and sustainability frameworks in the hospitality sector. Inclusion criteria required that selected publications focus explicitly on restaurant or foodservice environments, examine operational, behavioural, or organisational outcomes associated with AI adoption or sustainability practices, and provide empirical or conceptual insights into workforce or customer-related implications of technological integration. Studies addressing hospitality robotics in accommodation services or in broader tourism contexts, without direct restaurant applications, were excluded from the analysis to maintain conceptual specificity.

Following initial database screening, 62 peer-reviewed journal articles were retained for full-text evaluation. These publications were subsequently categorised into four thematic clusters: AI-assisted demand forecasting and inventory optimisation; sustainability communication strategies, including carbon-labelled menu design, circular gastronomy, and resource-efficiency practices; and the ethical and organisational implications of automation in hospitality labour systems.

Data extraction focused on operational performance indicators, such as food waste reduction and energy consumption; behavioural outcomes, including customer trust and purchase intention; and socio-organisational variables, such as staff autonomy and perceived professional identity. Thematic synthesis was conducted to identify recurring patterns across studies and to assess the extent to which technological optimisation and sustainability interventions interact with ethical considerations in service-oriented environments.

In addition to the literature-based synthesis, this study adopts a practice-oriented analytical perspective by considering the applicability of the identified operational

models in applied research and development restaurant environments within higher education institutions. Such environments provide a controlled yet ecologically valid setting for examining AI-supported decision-making systems and sustainability communication strategies under real-service conditions, thereby enabling the translation of theoretical insights into experimentally testable operational practices. Generative artificial intelligence tools were utilised solely for linguistic refinement and structural editing of the manuscript. No AI systems were employed in the collection, analysis, or interpretation of research data.

3. RESULTS AND DISCUSSION

While the structured scoping review methodology employed in this study enables a comprehensive synthesis of recent interdisciplinary research related to artificial intelligence integration, sustainability-oriented operational practices, and ethical governance in restaurant environments, several methodological limitations should be acknowledged. First, the review was restricted to peer-reviewed journal articles published between January 2023 and January 2025, potentially excluding relevant industry reports or emerging technological applications not yet represented in the academic literature. Second, the interdisciplinary scope of the selected studies introduces conceptual heterogeneity in research design, measurement frameworks, and operational definitions of sustainability and automation, thereby limiting the comparability of findings across different hospitality contexts. Finally, as the study adopts a synthesis-based analytical approach rather than primary empirical data collection, the applicability of identified operational models within specific localised environments requires further validation through practice-based experimental research.

3.1. AI-Supported Operational Efficiency

The reviewed literature consistently demonstrates that AI-assisted forecasting systems improve operational performance in restaurant environments characterised by fluctuating demand patterns. Predictive analytics tools enable more accurate estimates of customer flow, ingredient utilisation, and menu demand variability, thereby reducing overproduction and improving inventory management. Several studies report measurable reductions in food waste following the implementation of AI-supported procurement and stock-monitoring systems. In addition to resource optimisation, AI-driven labour scheduling models improve staff allocation across service periods, minimising idle time and enhancing workflow coordination in kitchen and front-of-house operations.

However, these performance gains must be interpreted within a broader organisational context. The reviewed studies suggest that increased reliance on algorithm-supported decision-making may shift traditional forms of tacit culinary knowledge toward data-driven operational logic, potentially altering professional autonomy and decision-making authority within restaurant teams.

3.2. Sustainability-Oriented Interventions

Sustainability practices, including carbon-labelled menu systems and lifecycle-based sourcing strategies, were identified as significant drivers of both environmental performance and customer trust. Empirical findings indicate that transparent sustainability communication—particularly when supported by quantifiable environmental metrics—positively influences consumer purchase intention and perceived authenticity of restaurant brands.

Circular gastronomy models, which emphasise the utilisation of by-products, regenerative sourcing, and energy-efficient preparation techniques, further contribute to measurable reductions in environmental impact. Nevertheless, the effectiveness of such interventions depends on their integration into everyday service interactions. Studies highlight that sustainability indicators must be communicated by trained service staff to avoid customer scepticism or perceptions of greenwashing.

3.3. Ethical Implications of Automation

The integration of AI-driven optimisation tools raises ethical considerations regarding workforce autonomy, organisational transparency, and customer data governance. Algorithmic scheduling systems, for instance, may unintentionally reinforce inequitable labour patterns if implemented without participatory oversight mechanisms. Similarly, customer profiling technologies used to personalise menu recommendations may raise concerns regarding data privacy and informed consent. In restaurant environments where emotional labour and creative expression are central to service quality, excessive automation may undermine the experiential dimensions of hospitality. The reviewed literature, therefore, emphasises the importance of human-centred implementation frameworks that position AI as a decision-support tool rather than a substitute for professional judgement.

3.4. Socio-Technical Implications for R&D Restaurant Environments

Applied research-and-development restaurant environments embedded within higher education institutions provide a distinctive context for examining the interaction between technological innovation, sustainability metrics, and ethical governance in practice. Such environments enable controlled experimentation with AI-assisted menu engineering, carbon-labelled communication strategies, and workflow optimisation models under real-service conditions.

Within institutionally supported experimental settings—such as applied hospitality training restaurants operating in smaller urban ecosystems like Kaunas—practice-based implementation of predictive analytics and sustainability interventions may generate empirically grounded insights into customer behaviour, staff adaptation processes, and organisational trust dynamics. This integrative approach supports the conceptualisation of future restaurant systems as socio-technical ecosystems in which technological augmentation and human-centred service practices co-evolve.

4. CONCLUSIONS

The findings of this structured scoping review indicate that the interaction among artificial intelligence-enabled operational models, sustainability-oriented management practices, and emerging ethical governance frameworks will increasingly shape the future development of restaurant systems. While AI-supported forecasting tools demonstrate considerable potential to reduce food waste, improve inventory accuracy, and optimise labour allocation, their implementation introduces organisational and professional challenges that extend beyond technical performance metrics.

Sustainability interventions—such as carbon-labelled menu systems and circular gastronomy practices—were shown to contribute not only to reducing environmental impact but also to enhancing customer trust and perceived authenticity when transparently integrated into service interactions. However, operationalising such practices requires organisational competencies that bridge technical sustainability assessment with the communicative and experiential dimensions of hospitality service delivery.

Importantly, the reviewed literature underscores a growing tension between automation-oriented efficiency models and the preservation of tacit knowledge, creative autonomy, and emotional labour traditionally associated with culinary professions. This suggests that technological innovation in restaurant environments must be guided by human-centred implementation frameworks that ensure artificial intelligence serves as an augmentative decision-support system rather than a substitutive managerial authority.

From a theoretical perspective, the study contributes to the conceptualisation of restaurant environments as socio-technical ecosystems in which technological infrastructures, sustainability metrics, and ethical considerations co-evolve through service interactions. This integrative framework advances existing hospitality management research by emphasising the relational dynamics between operational optimisation and human-centred value creation.

From an applied research perspective, institutionally embedded research-and-development restaurant environments offer a viable platform for empirically testing AI-assisted operational models and sustainability communication strategies under real-service conditions. Such environments enable practice-based experimentation with predictive analytics, resource-efficiency workflows, and participatory governance mechanisms, thereby facilitating the translation of theoretical insights into operational innovation.

Future research should prioritise longitudinal experimental studies conducted within applied hospitality training environments to evaluate the behavioural, organisational, and environmental outcomes of AI-supported sustainability interventions across diverse service contexts. In smaller urban ecosystems such as Kaunas, institutionally supported R&D restaurants may contribute locally grounded yet internationally relevant empirical evidence to inform the ethical integration of emerging technologies within sustainable restaurant management systems.

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