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SUSTAINABLE TRANSFORMATION OF CULTURAL AND GASTRONOMIC TOURISM THROUGH AHP ANALYSIS OF FOOD WASTE

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Abstract

The problem of food waste in tourism represents a significant challenge for achieving the principles of sustainable development, particularly in the segments of cultural and gastronomic tourism. The aim of this paper is to identify and rank key factors contributing to the sustainable transformation of the tourism offer in Serbia. The application of the Analytic Hierarchy Process (AHP) method enables the quantification and determination of the relative importance of factors influencing food waste reduction, including technological innovations, management of food preparation processes, employee education, and efficient use of resources. The main contribution lies in integrating a theoretical model with contemporary approaches to resource management in tourism and hospitality. The results highlight the importance of analytical methods in decision-making, enhancing the sustainability of tourist destinations, and strengthening competitiveness. Furthermore, the findings provide practical guidance for tourism managers and planners to optimize resources and reduce operational losses.

Key Words: *Sustainable transformation, cultural tourism, gastronomic tourism, food waste, AHP method, Serbia.*

JEL classification: *Z32, Q01, C44*

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Introduction

The sustainability of tourist destinations has become a key development issue, driven by the growing interest in authentic and environmentally friendly experiences. In this context, food waste reduction emerges as an imperative that integrates ecological principles and social responsibility through the rational use of raw materials. Proper valorization of Serbia's gastronomic resources contributes to the development of sustainable products, but requires the systemic integration of technological solutions and the optimization of operational processes. Such development implies the application of innovations and practices necessary for enhancing the tourist experience and preserving the local community. Accordingly, the primary objective of this paper is to, by applying the Analytic Hierarchy Process (AHP) method, identify and rank the key determinants of the sustainable transformation of the tourism offer in Serbia, with a focus on technological and managerial solutions for food waste reduction.

Theoretical framework of sustainable development and transformation of cultural and gastronomic tourism

Tourism sustainability analysis requires transforming traditional models toward circular resource management. Contemporary sustainable tourism balances economic, environmental, and socio-cultural impacts (UNWTO, 2005; Todorov, 2025a, p. 111; Todorov, 2025b, p. 478), necessitating an offer redesign (Hall, 2019) through innovative technologies and managerial models (Sigala, 2020). This approach meets demands for circular economy principles (Gössling et al., 2021) and efficient resource use (GSTC, 2023). While cultural tourism preserves local identity (Richards, 2018, pp. 12-14), gastronomic tourism focuses on process optimization and local food promotion (Ellis et al., 2018, pp. 254-255). Mitigating food waste in hospitality requires a transition to circular models and short supply chains (Sims, 2009; Filimonau & De Coteau, 2019, pp. 234-235). Strategic sustainability integration (Font & McCabe, 2017, p. 873) and stakeholder collaboration (Bramwell & Lane, 2011, pp. 412-414) ensure destination competitiveness (Buckley, 2012, pp. 529-531). Thus, the gastronomic offer becomes the primary testing ground for waste reduction strategies and the core of sustainably transformed tourism.

Multidimensional analysis and strategic framework for food waste management in tourism

Effective management of food flows requires deconstructing the problem through waste determinants, assessing consequences, and implementing integrated technological innovations. Food waste encompasses edible products discarded during the supply chain, emphasizing retail and final consumption stages (Garcia-Garcia et al., 2017, pp. 2122-2123; Vardopoulos et al., 2025). In scientific literature, it is classified as avoidable, unavoidable, and potentially avoidable (Garcia-Garcia et al., 2017; Cecchi & Cavinato, 2019). In tourism, waste results from operational inefficiency and consumer behavior (Filimonau & De Coteau, 2019, pp. 234-235), particularly in all-inclusive and buffet services where aesthetic requirements and excessive portions lead to significant untouched food (Papargyropoulou et al., 2019; Çetin & Süren, 2024, pp. 677-680). Its multidimensional impact involves energy, labor, and financial losses (Gustavsson et al., 2011; Koester, 2014), while generating 8-10% of global greenhouse gas emissions (IPCC, 2019). The social and ethical dimension is highlighted by the coexistence of massive losses and global supply insecurity (FAO, 2019). Effective mitigation requires a holistic approach combining technology, operational management, and behavioral changes (Filimonau & De Coteau, 2019). Advanced kitchen systems (Rational, 2026), circular economy solutions for waste digestion, and digital transformation through IoT, AI, and behavioral nudges form the framework for sustainable resource management.

Research Methodology: Application of the Analytic Hierarchy Process (AHP) Method

Combining a literature review with the Analytic Hierarchy Process (AHP), this research ranks factors influencing food waste reduction in Serbian tourism. The problem is deconstructed into hierarchical levels, with the second level consisting of four criteria: Technological Innovations, Process Management, Human Resource Education, and Resource Efficiency. This method provides an adequate framework for evaluating the gastronomic offer, following the successful application of AHP in previous sustainable tourism research (Todorov et al., 2023, pp. 180-181; Todorov, 2025c, p. 282). The third level includes alternatives inspired by trade fair solutions: smart kitchen appliances, organic waste treatment systems, digital inventory tools, and behavioral guest engagement strategies. Pairwise comparison matrices using the Saaty scale (1-9) were analyzed in Microsoft

Excel, with a consistency ratio check ($CR \leq 0.10$) identifying the most promising measures for resource optimization.

Determinants of sustainable transformation and food waste management in tourism

Identification of the key factors of sustainable transformation relies on the synergy of technological progress and operational optimization. Technological innovations, the practical application of which is visible through solutions from international trade fairs (Figure 1), represent the most significant determinant. Smart devices, such as Rational systems, drastically reduce overproduction and waste caused by human error through precise thermal processing control (Rational, 2026).

Figure 1: *Trade fair presentation of food preparation in smart devices*



Source: *Author's own archive*

Such solutions contribute to process standardization and better yield control in professional kitchens (Filimonau & De Coteau, 2019, p. 235; Vardopoulos et al., 2025). Process optimization also encompasses final waste management systems, such as Eco Flow devices, which enable the

conversion of organic waste into recyclable raw materials at the point of origin (Cecchi & Cavinato, 2019). The integration of these technologies supports circular economy principles, ensuring the long-term competitiveness of destinations (Buckley, 2012, pp. 529-531; Sigala, 2020). Finally, sustainable transformation requires continuous employee education and behavioral strategies, such as subtle nudges and portion adjustments, which motivate guests toward responsible consumption (Papargyropoulou et al., 2019; Wang et al., 2021). Only through the synergy of technological solutions from trade fair exhibitions, precise process management, and educated staff can a model for resource preservation in cultural and gastronomic tourism be created (Font & McCabe, 2017; Todorov & Simonović, 2026, p. 713).

Research results and discussion

The constructed AHP model is hierarchically structured into three levels to identify priorities for food waste reduction. The second level consists of the following criteria: Technological Innovations (K_1), Process Management (K_2), Employee Education (K_3), and Resource Efficiency (K_4), while the third level encompasses the alternatives: Smart Kitchen Systems (A_1), Waste Treatment Systems (A_2), Behavioral Strategies (A_3), and Digital Monitoring (A_4). Evaluation was conducted using the Saaty scale (Table 1).

Table 1: *The Saaty scale*

Intensity	1	3	5	7	9	2, 4, 6, 8
Significance	Equal	Moderate	Strong	Very strong	Extreme	Intermediate values

Source: Saaty, 1980.

By forming the pairwise comparison matrix (Table 2), it was determined that technological innovations (51.8%) represent the dominant influencing factor in waste reduction.

Table 2: *Pairwise comparison matrix and criteria weights*

Criteria	K_1	K_2	K_3	K_4	Weight (w)
K_1 Technological innovations	1	2	5	6	0.518
K_2 Process management	0.5	1	3	4	0.282
K_3 Employee education	0.2	0.333	1	2	0.124
K_4 Resource efficiency	0.167	0.25	0.5	1	0.076

Source: Author's research

Consistency check of the criteria matrix: $\lambda_{\max} = 4.116$; $CI = 0.038$; $CR = 0.042$ ($RI = 0.90$). The statistical consistency check confirms that the value $CR = 0.042$, is significantly below the 0.10, threshold, thereby validating the expert assessments. Based on the obtained weights, it is evident that technological innovations (51.8%) represent the dominant influencing factor.

$$CI = \frac{\lambda_{\max} - n}{n - 1}$$

$$CR = \frac{CI}{RI}$$

$$RI = 0.90 \text{ (Saaty, 1980)}$$

If it is $CR < 0.10$, the matrix is consistent.

By comparing the alternatives to the criteria (Table 3), the final ranking of strategies was identified. The results indicate that Smart Kitchen Systems (A_1) offer the highest degree of efficiency (0.355), primarily due to the direct optimization of preparation at the source.

Table 3: *New local priorities and final ranking of alternatives*

Alternative	K ₁	K ₂	K ₃	K ₄	Total weight	Rank
A ₁ Smart Kitchen Systems	0.450	0.250	0.200	0.350	0.355	1
A ₂ Waste Treatment Systems	0.200	0.350	0.400	0.250	0.271	2
A ₃ Behavioral strategies	0.250	0.200	0.250	0.200	0.232	3
A ₄ Digital inventory monitoring	0.100	0.200	0.150	0.200	0.142	4

Source: *Author's research*

The synthesis of the AHP analysis results indicates that Smart Kitchen Systems (A_1) represent the most promising factor for sustainable transformation, justified by their direct impact on preparation optimization and the drastic reduction of waste at the source. Waste Treatment Systems (A_2) rank second, confirming the importance of circular economy principles in tourism, while Behavioral Strategies (A_3) and Digital Monitoring (A_4) are recognized as key tools for shifting consumer awareness and precise managerial inventory planning. The

primacy of technical factors over behavioral measures suggests that the most significant progress in food waste reduction in Serbia is achieved through process automation, which minimizes the negative impact of the human factor and optimizes resource consumption. These findings serve as clear argumentation for managers that investments in modern equipment are not merely a cost, but a strategic step toward strengthening the economic efficiency and ecological competitiveness of a destination. Although the research is limited by the subjectivity of expert assessments within the AHP method and the focus on specific trade fair innovations, it establishes a firm foundation for future longitudinal studies on the effects of implementing these systems within cultural routes. Future scientific contributions should aim to integrate a broader spectrum of psychological determinants and socio-economic factors. In this way, a comprehensive model of sustainable resource management would be formed, successfully balancing technological progress with the necessary shift in awareness among all stakeholders in the tourism value chain.

Conclusion

The research has confirmed that the sustainable transformation of gastronomic tourism in Serbia primarily depends on the synergy between advanced technologies and analytical management models. Through the application of the AHP method, it was identified that technological innovations, primarily smart kitchen systems and waste treatment solutions, represent the key factor in eliminating operational inefficiency. The automation of food preparation processes has proven to be the most effective path toward minimizing losses, thereby directly strengthening the economic and ecological competitiveness of the destination. By linking theoretical postulates with innovations presented at trade fairs, this paper provides managers with a concrete roadmap for strategic investments. Although the transition toward the zero waste concept requires the redefinition of traditional routines, this direction is essential for the long-term vitality of the tourism offering. The integration of modern technologies and authentic cultural heritage forms the foundation upon which Serbia should build its profile as a responsible and sustainable tourist destination.

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