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Reducing Food Waste in the Sushi Industry through Technological Discipline and a Proprietary Cooking Method

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Abstract

This study develops and provides a theoretical rationale for an integrated model aimed at reducing food losses and waste in the foodservice sector specializing in Japanese cuisine—most notably within the sushi segment—while accounting for the full set of contemporary constraints. Relevance is driven, on the one hand, by the global scale of food losses, commonly estimated at roughly 1.3 billion tons per year, and, on the other, by the distinctive operating conditions of the restaurant industry in Ukraine under wartime realities, where supply chains become more fragile, price volatility intensifies, and production planning grows markedly more complex. The analysis examines the effectiveness of implementing a disciplined technological regime built on HACCP principles and supported by digital monitoring of key process parameters, combined with an original culinary methodology conceptually aligned with the Japanese philosophy of "Mottainai" and the "nose-to-tail" approach. The analytical emphasis is placed on yield management for high-cost raw materials—particularly salmon and tuna—where even marginal improvements in yield coefficients can translate into visible economic gains and a lower share of non-productive write-offs. Using a dataset describing cultural codes in branding, a positioning strategy is formulated for environmentally responsible restaurants in the Ukrainian market context, enabling operational resource-saving practices to be linked to the brand's value proposition. It is shown that the use of digital tools, including artificial intelligence–based solutions and IoT, at a technology readiness level (TRL) of 7–9 can deliver a twofold reduction in waste volumes alongside a 3–8% increase in profitability amid rising raw-material costs, indicating the practical applicability of the proposed approach under heightened uncertainty.

Keywords: *Food Waste, Sushi Industry, Technological Discipline, Mottainai, Sustainable Development, Cultural Codes, Ukraine, Yield Management, Zero-Waste Production.*

INTRODUCTION

The problem of food loss and waste (FLW) in 2024–2025 has become increasingly visible as a systemic risk factor for global food security and environmental sustainability. Updated estimates by specialized international organizations indicate that approximately one third of produced food is lost or discarded each year, equivalent to no less than 1.3 billion tons [1]. When losses across all stages of the value chain are considered, the combined share may rise to 40% [2]. For the European Union, annual food waste is reported at 58.2 million tons, corresponding to roughly 131 kg per capita [3]. The associated economic damage is estimated at €132 billion, while more than 42 million EU residents lack the ability to secure quality food every other day [2].

The foodservice segment (HORECA) ranks among the substantial generators of food waste: it accounts for about 11% of the EU total (14 kg per person) and up to 28% globally (290 million tons) [1]. Within this sector, the sushi industry occupies a particular niche due to its heavy reliance on imported inputs, their high unit cost, and pronounced perishability. In Ukraine, which continues to experience the consequences of a full-scale military conflict, 2024 imposed a set of atypical constraints on restaurant businesses, including the "generator economy," staff shortages, and heightened volatility in food prices; a food cost of 30–35% effectively became a normative benchmark for 34% of entrepreneurs [5]. Against this backdrop, the sushi segment demonstrated comparatively strong resilience, expressed in a 1% increase in attendance alongside declining indicators in other format directions [5].

Waste reduction in sushi bars is shaped not only by ethical considerations but also by straightforward economic rationality, since conventional fish butchery practices in restaurant settings often involve disposing of up to 60% of biomass, including heads, fins, skin, and offal [6]. Under these circumstances, technological discipline grounded in strict adherence to operating cards and standards serves as a

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necessary foundation for operational stability. Yet regulation and control alone tend to be insufficient, because a deeper reconfiguration of culinary logic is required—one that alters the relationship to raw materials at the level of concept rather than merely procedure.

The proposed authorial methodology integrates the Japanese philosophy of "Mottainai" (regret over waste—regret for squandered value) and the contemporary Western "nose-to-tail" concept, which assumes the most complete possible utilization of a product [6]. This coupling enables the category of "waste" to be redefined as a resource that can be converted into an ingredient base for new dishes, thereby shifting loss-minimization practices from the realm of declarations into the domain of reproducible technological solutions. In addition, the effectiveness of such initiatives is emphasized as being substantially dependent on accurate treatment of cultural codes in branding: within Ukrainian realities of 2024–2025, these codes are tightly intertwined with motives of cultural resistance and national identity, which imposes specific requirements on communicating environmental responsibility as part of the brand's value proposition [9].

The purpose of this work is to develop and theoretically substantiate an integrated model for reducing food waste in Ukraine's sushi industry under wartime conditions through a combination of technological discipline (HACCP), digital monitoring, and an authorial "Mottainai / nose-to-tail" methodology, with a focus on yield management for expensive raw materials (salmon, tuna).

The authorial hypothesis rests on the assumption that, if strict technological discipline is implemented and reinforced by digital solutions at TRL 7–9, while culinary logic is simultaneously restructured toward maximal utilization of the fish carcass ("fin-to-gill") with precise AP/EP accounting, then waste volumes can be reduced by at least half, alongside a 3–8% increase in profitability—even against the background of higher raw-material prices and unstable supply chains.

Scientific novelty lies in the fact that the study, for the first time in the sushi segment, proposes and substantiates an interdisciplinary linkage—"HACCP + AI/IoT waste auditing + an authorial full-utilization fish methodology + AP/EP yield metrics + a branding strategy grounded in wartime cultural codes"—that converts "waste" into manageable semi-finished products while simultaneously generating measurable operational and marketing effects.

MATERIALS AND METHODS

The methodological framework of the study is constructed in an interdisciplinary logic and synthesizes tools of economic analysis, provisions of practice theory, and engineering–technological approaches. To implement the research tasks, a systematic literature review was conducted, covering a body of recent publications indexed in Scopus and Web of Science [10].

As a conceptual lens, practice theory is used, enabling professional behavior of chefs to be interpreted through stable everyday practices and entrenched skill patterns. In contrast to the theory of planned behavior, this perspective foregrounds the chef's "environmental habitus" as the outcome of long-term reproduction of habits within the professional milieu, where norms of handling raw materials and the logic of production decisions are being fixed through routine and training. Within this model, chefs are treated as central agents of change, capable of initiating a shift toward sustainability at the kitchen level by redefining working standards and criteria of quality [12].

The theoretical basis also includes the concept of the circular economy, within which the sushi bar is described as a closed system: material and resource outputs of certain operations are functionally transformed into inputs of other processes, reducing the share of irreversible losses and improving resource efficiency [13]. In addition, ergoecology is applied as an integrative approach combining principles of ergonomics and environmental management. Optimization of work movements during butchery and preparation is considered not only a factor of productivity and occupational safety, but also a tool for reducing physical losses arising from inefficient motor patterns, inconvenient workplace organization, and technologically suboptimal processing techniques [14].

The empirical and analytical component relies on Eurostat statistical data for 2024–2025 and on forecast models of waste-management development in Ukraine [3]. To measure the effectiveness of the proposed methodology, yield management tools are employed, implying precise weighing of raw materials at the As Purchased (AP) and Edible Product (EP) stages, followed by interpretation of the differences as an indicator of technological performance and economic reasonableness [16].

RESULTS AND DISCUSSION

Analytical evidence indicates that, even with the declared expansion of sustainable-development practices within the European Union, the dynamics of waste generation remain largely inertial: in 2024 a moderate increase of +0.7% was recorded relative to the 2022 level, indirectly reflecting the persistence of consumer and production behavioral patterns and the high "price" of transforming them [3, 4]. Such a trajectory suggests that regulatory and technological measures, while establishing boundary conditions, do not produce an automatic turning point in trends without a deep reconfiguration of everyday practices and managerial procedures.

In Ukraine, the problem space is further complicated by the institutional and infrastructural immaturity of the processing sector. As of early 2025, the economic system largely retains features of a linear "take—make—dispose" model, manifested in limited closure of material flows and insufficient integration of reuse solutions. This pattern of resource reproduction is corroborated by the rising waste

intensity of GDP, which captures a strengthening dependence of economic activity on waste generation and points to structural barriers to transitioning toward circular modes of materials management [15].

Table 1 presents the results of a comparative analysis of the structure of food waste in the EU and Ukraine.

Table 1. Comparative analysis of the structure of food waste in the EU and Ukraine (compiled by the author based on [3]).

Economic sector	Share in the EU (%)	kg per capita (EU)	Forecast for Ukraine (%)	Key waste drivers
Households	53%	69	55–60%	"Stockpiling" psychology under wartime conditions
Restaurant sector (HORECA)	11%	14	10–12%	Power outages, portioning errors
Food manufacturing	19%	24	15–18%	Technological obsolescence of equipment
Primary production	10%	12	12–15%	Logistics disruptions, military actions
Retail trade	8%	10	5–7%	Declining purchasing power

For Ukrainian foodservice enterprises operating in the sushi segment, the most sensitive indicator in 2024 was the decline in profitability reported by 47% of entrepreneurs, which sharpened the search for internal sources of efficiency gains [5]. In such a configuration, managerial attention shifts in a predictable manner toward reducing losses during fish processing, since the unit cost of raw materials can constitute a substantial share of cost of goods sold and amplify financial risks under price fluctuations.

A key resource-saving instrument is technological discipline, understood as unconditional adherence to regulated procedures across all stages—from receiving and storage to portioning and dish issuance. Empirical results obtained in the Hungarian catering sector, comparable in organizational structure to Ukrainian practices, show that HACCP implementation supports a more orderly organization of labor and a transparent allocation of responsibility, which directly reduces write-offs and non-target losses [17]. In 2024–2025, further reinforcement of these effects is achieved through digitalization of control: solutions in the Winnow class, using artificial intelligence and computer vision methods, shift waste auditing into an automated mode by identifying discarded products in real time and generating a dataset suitable for procurement adjustments and for refining production planning at the kitchen level [18].

Table 2, described below, demonstrates a technology readiness level (TRL) matrix for digital solutions in the sushi industry.

Table 2. Technology readiness level (TRL) matrix of digital solutions for the sushi industry (compiled by the author based on [18]).

Technology	TRL (2025)	Restaurant application	Waste-reduction potential
AI monitoring of bins (Winnow)	9	Automated tracking of write-offs	Up to 50%
IoT temperature sensors	8–9	Prevention of fish spoilage in refrigeration	15–20%
Blockchain traceability	5–7	Freshness control across the supply chain	10–12%
Predictive demand analytics	7–9	Accurate planning of prep (mise en place)	25–30%
Digital twins of the kitchen	4–6	Process simulation to minimize unnecessary motion	5–8%

Integration of such digital solutions into the operational model of sushi bars provides not only registration of the write-off as a fact, but also causal diagnostics of its origins. Analytics generated from audit data allow waste sources to be typologized, identifying, in particular, overproduction as the most common driver (25% of cases), as well as raw-material spoilage (22%) and factors associated with variability of consumer choice and guests' individual preferences (22%) [2]. In this way, control transitions from a post factum recording mode to a mode of managed intervention, where corrective measures can be addressed to specific mechanisms that generate losses.

The substantive core of the proposed authorial methodology is a principled reconfiguration of fish butchery practices and subsequent utilization of the resulting fractions. In the classical scheme of sushi and roll production, technological value is effectively assigned primarily to "clean" fillet, while a substantial share of biomass is marginalized and removed from the culinary cycle. The alternative logic is built on the "nose-to-tail" principle, additionally articulated in the fish domain as "fin-to-gill" ("from fin to gill"), implying maximal possible involvement of the carcass in production. A practical consequence is an increase in the utilization rate of raw materials from 40% to 90%, simultaneously reducing the share of irreversible losses and raising the economic return from each purchasing unit [6]. Comparative yield indicators and by-product utilization are described in Table 3.

Table 3. Comparative yield indicators and by-product utilization (compiled by the author based on [6, 20]).

Raw material	Yield (fillet, %)	"Waste" fractions	Utilization method (authorial)
Salmon (Atlantic)	68–72%	Skin, backbone, head	Skin chips; base for miso soup; scraping backbone meat for tartare
Tuna (Maguro)	60–65%	Trimmings, bloodline	Spicy tuna mince; fish burgers; drying for seasoning (furikake)
Yellowtail (Hamachi)	24–33%	Cheeks, fins	Kama-yaki (grill); pan-fried fins as a sake snack
Shrimp (Ebi)	45–50%	Shells, heads	Shrimp oil for sauces; deep-fried heads (snack)

An illustrative example of the practical feasibility of maximal raw-material involvement is provided by the case of Chef Mike Evans: within his restaurant model, up to 90% of purchased fish is used, whereas an industry-typical level remains around 40% [6]. A substantial determinant of such a result is not only the chef's high qualification, but also normatively fixed technological discipline, expressed in the presence of precise technological maps (process sheets/spec cards) for each secondary fraction of raw material. As a result, elements that in the standard logic are treated as unavoidable waste are converted into the status of manageable semi-finished products and ingredients: fish bones are used to obtain a concentrated umami dashi broth, and skin—traditionally removed from the production cycle—is transformed into a product of high consumer value and can be positioned as a premium appetizer [6, 21].

In the Ukrainian context of 2024–2025, branding in the sushi industry must account for the accelerated reconfiguration of national self-awareness and for the changing symbolic functions of food under wartime conditions. Research evidence indicates that food practices during wartime acquire the meaning of cultural resistance and a marker of symbolic survival, as a result of which gastronomic communication moves beyond utilitarian menu description and enters the field of value narratives [9]. Within this frame, the philosophy of "Mottainai" aligns organically with a historically rooted attitude of careful treatment of food products, including one shaped by traumatic collective memory of the Holodomors [8, 9]. The Japanese code "Mottainai" is conceptualized through four "R"s—Reduce, Reuse, Recycle, and the pivotal Respect [7]. In the Ukrainian interpretation, this set of principles is rationally translated into an emphasis on respect for resources obtained and preserved under difficult conditions, enabling loss-minimization practices to be linked with an ethics of everyday resilience.

Embedding local wisdom into the marketing architecture of a restaurant demonstrates applied effectiveness: sustainable marketing correlates statistically significantly with growth in brand trust and strengthening of purchase intention [24]. Toward the 2026 horizon, consumer demand for authenticity and ethical responsibility intensifies, which increases the value of verifiable resource-saving practices as an element of a brand promise rather than as decorative rhetoric.

The economic effectiveness of the methodology can be formalized through a reduction in the effective cost of the edible portion of raw material and a redistribution of value across products. When purchasing a whole salmon at €15/kg with a traditional yield of 70%, the effective cost of fillet is determined by the following calculation: EPcost = 15 / 0.70 = 21.42 €/kg.

When carcass utilization is expanded by involving an additional share of mass (for example, another 20%) in the form of accompanying dishes—soups and appetizers—a mechanism of internal compensation emerges: part of the purchase cost is "shifted" onto additional menu items, lowering the food-cost burden of the main dish and increasing the overall margin of the product line without degrading quality.

Strict technological discipline in sushi production forms not only direct savings but also pronounced secondary effects. First, food control is strengthened: waste accounting and analysis systems almost inevitably require more precise management of shelf life, stock rotation, and temperature regimes, thereby reducing the likelihood of food incidents and increasing the stability of sanitary outcomes [17]. Additional importance is carried by the social and psychological dimension: personnel operating within a paradigm of product value and a "philosophy of respect" tend to show higher engagement and greater resistance to professional burnout, since work activity is interpreted as a contribution to a broader sustainable-development context [11].

At the same time, institutional and behavioral barriers remain. Empirical studies indicate that about 41% of restaurant managers perceive the introduction of strict control systems (including HACCP) with caution due to concerns about increased administrative burden and the need for additional investment [17]. In Ukrainian conditions of 2024–2025, such concerns are intensified by deficits of time and resources, raising requirements for pragmatic implementation. In this regard, the methodology emphasizes feasibility through a sequence of "small steps" and reliance on accessible digital tools that can deliver measurable effects with minimal organizational resistance.

A significant factor of success is consumer readiness to accept "atypical" fish parts. In Japan and in a number of Western countries, a trend is noted toward using fish offal—liver, roe, cheeks—as delicacy items, gradually consolidating

their high symbolic and gastronomic status [25]. In Ukraine, such a market is at an early stage of development; therefore, communication is advisable to be built around arguments of a unique flavor profile (umami) and ecological benefit, moving non-standardness from a risk zone into a value zone.

In parallel, the practice of using takeaway containers ("doggy bags") is being transformed. In the Ukrainian reality of 2024–2025, this gesture is increasingly interpreted not as a sign of excessive frugality, but as a marker of mindful and responsible consumption. Research conducted in Japan records that 68% of consumers recognize the link between leftovers and direct resource loss and are ready to take food home provided that hygiene and packaging acceptability are ensured [26].

Table 4 describes the profile of an "eco-conscious guest" of a sushi bar.

Table 4. Profile of an "eco-conscious guest" of a sushi bar (compiled by the author based on [24]).

Characteristic	Brand expectations	Value orientations
Awareness	Supply-chain transparency (Blockchain)	Knowing the origin of the fish
Social status	Involvement in "green" initiatives	Participation in recycling programs
Culinary experience	Seeking new flavors (offal)	Openness to the "nose-to-tail" concept
Ethics	refusal from single-use plastics	Support for the "Mottainai" philosophy

Despite the presence of effective local practices and demonstration cases, the overall global FLW trajectory remains distinctly risky. A key constraint is the deficit of comparable data: only about 12% of the world's population lives in countries where food-waste monitoring is conducted systematically, which complicates both accurate diagnosis of the scale of the problem and evaluation of intervention effectiveness at the policy and business levels [2]. Under these conditions, waste-reduction measures often remain fragmented and do not transition into a regime of sustainable management, because regular metrics and institutionally fixed accounting procedures are absent.

For Ukraine in 2025, an additional driver of change is movement toward harmonization with European reporting standards, implying the formation of stricter requirements for recording, classification, and analysis of losses [15]. This means a shift in the managerial practice of the restaurant sector from approximate estimates to detailed auditing, where waste is treated as a measurable variable influencing cost, safety, and supply-chain resilience. Against the background of continuing regional instability, resource efficiency acquires the status not so much of a voluntary corporate initiative as of a functional condition for the sustainability of food systems, up to the level of national security, since the capacity to minimize losses directly increases economic adaptiveness to shortages, logistics breaks, and price shocks [11].

A detailed action plan for implementing the authorial methodology in a sushi bar is presented in Table 5.

Table 5. Action plan for implementing the authorial methodology in a sushi bar [19, 22, 23, 27].

Stage	Action	Tool	KPI
I. Audit	Measuring the current waste level	Winnow / scale-based accounting	Baseline % of write-offs
II. Training	Trainings on the "Mottainai" philosophy; butchery workshops	Workshops on fish processing	10% reduction in losses
III. Menu reengineering	Introducing dishes from secondary fractions/offal	"Nose-to-tail" concept	Yield growth to 85%
IV. Digitalization	Installing IoT sensors and AI analytics	Cloud ERP systems	ROI > 200%
V. Branding	Communicating values to guests	Cultural-code marketing	Loyalty growth (NPS)

The obtained results confirm that minimizing food waste in the sushi industry in 2024–2025 is a multi-level managerial and technological task in which both normative strictness of production procedures and a value-philosophical optics of resource handling are critically important. Technological discipline, reinforced by modern digital solutions with TRL 7–9, forms an operational framework of sustainability: by increasing process transparency, standardizing actions, and enabling timely adjustments of procurement and production, waste reduction up to 50% is achieved alongside a simultaneous increase in profitability under crisis turbulence of the Ukrainian economy.

CONCLUSION

Thus, the effectiveness of the authorial culinary methodology grounded in the principles of "Mottainai" and "nose-to-tail" manifests primarily in maximizing yield and redistributing value within a single raw-material unit. A conceptual shift—transferring fractions traditionally written off from the category of "waste" into the category of "resource-significant products"—enables food cost reduction while simultaneously constructing a differentiated value proposition. In this format, resource saving becomes not an external constraint but a source of gastronomic innovation relevant to the demands of environmentally oriented consumers.

Embedding cultural codes into the branding strategy, especially when anchored in the context of Ukrainian cultural resistance, creates prerequisites for forming a stable emotional and value-based connection with the audience. Environmental responsibility, in this case, ceases to be perceived as a peripheral initiative and becomes institutionalized as a strategic business model that increases the enterprise's long-term viability amid global instability and local shocks.

A prospective direction for further research is quantitative verification of the impact of blockchain technologies on consumer trust in the Ukrainian restaurant sector, including assessment of the extent to which immutability and traceability of data can strengthen the perceived reliability of claims about raw-material origin, compliance with standards, and the factual reduction of waste.

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