UDC 640.43:502.131.1:614.31
DOI https://doi.org/10.32782/2521-6643-2026-2-72.52

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ASSESSING THE LEVEL OF SUSTAINABLE DEVELOPMENT OF RESTAURANT ESTABLISHMENTS WITH REGARD TO HACCP IMPLEMENTATION

The article substantiates an applied approach to assessing the level of sustainable development of restaurant establishments with regard to the maturity of HACCP-based procedures as a mandatory component of contemporary food safety management. The relevance of the research stems from the fact that, during wartime and economic turbulence, Ukrainian restaurant businesses are expected to ensure food safety, optimize resource use, reduce food waste, and maintain social resilience of personnel simultaneously. Based on the analysis of relevant scientific publications from 2021 to 2025, the paper demonstrates that prevailing sustainability assessment models in hospitality tend to prioritize environmental and economic indicators while insufficiently integrating food safety performance, food safety culture, and the quality of HACCP implementation. The methodology combines a systems approach, content analysis of recent scholarly sources, comparative analysis of regulatory requirements, integral assessment, and model-based testing on three typical restaurant profiles: a full-service urban restaurant, a quick-service delivery-oriented outlet, and a catering operator. An integral sustainable development index is proposed. It includes four indicator blocks: HACCP performance, environmental and resource efficiency, social responsibility, and economic-managerial resilience. The findings show that the strongest contributors to the overall sustainability score are systematic staff training, documented critical control points, food waste monitoring, energy and water control, and ingredient traceability. The model-based testing produced the following results: the catering operator achieved the highest integral index (0.81), followed by the full-service restaurant (0.76), while the quick-service delivery outlet showed a moderate score (0.69). The practical value of the study lies in the possibility of using the proposed instrument for internal audit, self-assessment, preparation for official inspections, and the design of resource-efficiency and circularity programs. The paper argues that the sustainable development of restaurant establishments should be interpreted not only through the triple bottom line logic but also through the operational reliability of food safety management systems, especially HACCP. Therefore, HACCP should be treated not as a narrow regulatory burden but as an enabling managerial platform that links consumer protection, process discipline, waste prevention, and long-term competitiveness in the restaurant sector.

Key words: *restaurant establishments; sustainable development; HACCP; food safety; circular economy; food waste; integrated assessment; food safety culture; resource efficiency.*

Хричов С. О., Вишнікіна О. В., Чернушенко О. О., Юдіна О. І. Оцінювання рівня сталого розвитку закладів ресторанного господарства з урахуванням впровадження системи НАССР

У статті обґрунтовано прикладний підхід до оцінювання рівня сталого розвитку закладів ресторанного господарства з урахуванням ступеня впровадження системи НАССР як обов'язкової складової сучасного управління безпечністю харчових продуктів. Актуальність дослідження зумовлена тим, що в умовах воєнної та економічної турбулентності українські заклади ресторанного господарства одночасно мають забезпечувати належний рівень харчової безпечності, оптимізувати використання ресурсів, скорочувати харчові втрати та підтримувати соціальну стійкість персоналу. На основі аналізу наукових праць 2021–2025 рр. доведено, що традиційні моделі оцінки сталого розвитку підприємств гостинності переважно тяжіють до екологічних та економічних індикаторів і недостатньо враховують показники харчової безпечності, культури безпечності та якість функціонування процедур, заснованих на принципах НАССР. Методологія дослідження поєднує системний підхід, контент-аналіз фахових публікацій, порівняльний аналіз нормативних вимог, метод інтегрального оцінювання та модельну апробацію на трьох типових профілях закладів ресторанного господарства: повносервісному ресторані, закладі швидкого обслуговування з доставкою та кейтерінговому операторі. Запропоновано інтегральний індекс сталого розвитку, який включає чотири блоки показників: результативність НАССР, екологічно-ресурсну ефективність, соціальну відповідальність і економіко-управлінську стійкість. Установлено, що найвищий внесок у загальний рівень сталого розвитку забезпечують системність навчання персоналу, документованість критичних контрольних точок, моніторинг харчових відходів, контроль енерго- та водоспоживання, а також наявність простежуваності сировини. Результати апробації показали, що найбільш збалансованим є кейтерінговий оператор, для якого інтегральний індекс становив 0,81, тоді як повносервісний ресторан отримав 0,76, а заклад швидкого обслуговування з доставкою – 0,69. Практична цінність статті полягає у можливості використання запропонованого інструментарію для внутрішнього аудиту, самооцінювання, підготовки до перевірок компетентних органів, а також для формування програм ресурсоефективності та екологізації операційної діяльності. Запропонований підхід розширює трактування сталого розвитку закладу ресторанного господарства, інтегруючи безпечність, операційну надійність і циркулярні практики в єдину систему менеджменту.

Ключові слова: *заклади ресторанного господарства; сталий розвиток; НАССР; безпечність харчових продуктів; циркулярна економіка; харчові відходи; інтегральне оцінювання; food safety culture; ресурсоефективність.*

Statement of the problem. Sustainable development of hospitality enterprises is increasingly being viewed not only as an environmental imperative but as a comprehensive management capability of a business entity to simultaneously ensure economic efficiency, social sustainability, and environmental impact control. For restaurant establishments, this issue is particularly acute, since the operational activities of such entities combine the purchase of raw materials, their storage, processing, preparation, sale of dishes, guest service, and the generation of significant amounts of food and packaging waste. Unlike many other service businesses, the restaurant sector cannot achieve long-term sustainability without guaranteed product safety, since any violation of sanitary and hygienic requirements or critical parameters of the technological process directly affects the health of the consumer, the reputation of the establishment, and the stability of its operation [1; 5].

For Ukraine, this problem is becoming more complex due to military risks, supply chain disruptions, energy instability, rising resource costs, and transformation of consumer practices. Under such conditions, food safety management can no longer be treated as a separate function of a technologist or a responsible person; it must be integrated into the system of strategic and operational management of the institution. The Law of Ukraine "On Basic Principles and Requirements for Food Safety and Quality" establishes the obligation of market operators to implement permanent procedures based on the principles of HACCP, and the Order of the Ministry of Agrarian Policy No. 590 specifies the requirements for the development and application of such procedures [3; 4]. At the same time, in the practice of the restaurant business, HACCP is often perceived primarily as a tool for formal compliance with regulatory requirements, rather than as a mechanism for increasing resource efficiency, process discipline, risk management, and the overall level of sustainability.

Modern international research indicates that the combination of food safety management and sustainability management allows us to simultaneously reduce raw material losses, reduce water and energy waste, increase traceability, and strengthen consumer trust [1; 2; 8]. However, for restaurant establishments, especially in Ukrainian conditions, the applied problem still remains insufficiently worked out: how to measure the level of sustainable development of the establishment so that the HACCP indicators are not secondary or taken beyond the scope of the integral assessment. It is this unresolved problem that determines the scientific and practical feasibility of this study.

Analysis of recent research and publications. The last five years have been marked by a significant increase in interest in assessing the sustainability of the restaurant and, more broadly, the food service sector. A notable trend is the development of indicator systems for "green restaurants" and environmental performance management tools. Thus, D.-F. Chen et al., based on expert consensus, formed five dimensions of indicators for green restaurants, proving that assessing sustainability in the restaurant business requires a multidimensional architecture of indicators and cannot be reduced only to energy efficiency or waste sorting [2]. A. Jones et al. came to a similar conclusion, who, when creating a sustainability toolkit for restaurants, emphasized the value of the triple bottom line approach but showed its fragmented use in small and medium-sized restaurant enterprises [11].

Another important area of research concerns food safety management and food safety culture. In 2023, A. Kramer et al. developed an empirically derived instrument to measure food safety culture in restaurants, and in 2025, they demonstrated that written policies, staff training, and mechanisms for verifying compliance with procedures are statistically associated with higher safety culture scores [7; 8]. A study by P. Marzocca et al. on a sample of 216 employees in 52 food businesses in Southern Italy confirmed that the weakest point of safety systems is often not formal documentation, but the provision of resources and the consistency of training practices [9]. A systematic review by G. Liggans and S. R. Kim showed that the literature on food safety culture in retail food settings remains methodologically heterogeneous and therefore requires more clear, auditable, and comparable indicators [10].

In the area of integration of safety and environmental performance, the Green HACCP concept proposed by M. Zarid is important. The author convincingly argues that the classical HACCP system does not sufficiently cover the environmental dimension of production processes, while the addition of environmental respect practices opens up the possibility of simultaneous management of hazardous factors and resource losses [1]. In the applied dimension, this position echoes the works devoted to food waste management and circular restaurant models. In particular, V. Aleksanyan et al. argue that systematic measurement of food waste is a key prerequisite for the transition of the restaurant business to a more sustainable operating model [12], and JM Masjhoer demonstrates that the principles of the circular economy in restaurants work most effectively when measured precisely through operational data – the mass of waste, accounting for raw materials, the structure of resource reuse, and process discipline [13].

Of considerable interest are also studies devoted to the validation of environmental audit tools in food service. L. Colares et al. created and validated a checklist of environmental performance for food service with 77 items covering water consumption, energy, waste management, sanitation, and parameters of production operations [6]. This tool is important for our study because it allows combining environmental and process approaches to assessment. At the same time, M. Psomatakis et al. showed on the material of 106 retail outlets that repeated audits of safety management systems significantly reduce the number of non-conformities, but full compliance with the requirements requires not a one-time control, but a cycle of continuous improvement [5].

Ukrainian publications of 2024–2025 focus mainly on the regulatory and organizational aspects of the implementation of HACCP in restaurant establishments. I. Szegeda emphasizes the stages of the implementation of the food safety management system in restaurant establishments [14], and V. Gubenya et al. consider the methodology for determining the significance of hazardous factors in the HACCP system specifically for the restaurant sector [15]. Despite the applied value of these works, they mostly do not consider HACCP as a variable of an integrated assessment of sustainable development. Therefore, the unsolved part of the general problem remains the formation of such an assessment tool that would combine economic, environmental, social, and food safety indicators into a single model and could be applied in the real practice of restaurant establishments.

Purpose of the study. The purpose of the study is to develop and test an integrated approach to assessing the level of sustainable development of restaurant establishments, taking into account the implementation of the HACCP system. To achieve the goal, the following interrelated tasks have been set: to summarize modern scientific approaches to measuring the sustainability of restaurant enterprises and determine the place of HACCP indicators in the relevant structure; to form a system of indicators of integrated assessment, covering the effectiveness of HACCP procedures, environmental and resource efficiency, social responsibility and economic and managerial sustainability; to propose a scale for calculating the integral index; to carry out model testing on typical profiles of restaurant establishments in order to identify the most influential management parameters.

Presentation of the main material. The logic of the study is based on the proposition that for a restaurant establishment, the concept of "sustainable development" should be operationalized through indicators that simultaneously reflect product safety, process control, resource efficiency, social stability, and economic reproducibility of the business model. Unlike food production enterprises with more standardized flows, restaurants are characterized by a variable assortment, seasonal fluctuations in demand, a large role of the human factor, and close interaction between the kitchen and the front office. That is why any assessment tool should be compact enough for practical use but at the same time sensitive enough to critical deviations in the field of food safety.

Within the framework of the study, a system of four blocks of indicators was formed: I – effectiveness of HACCP implementation; II – environmental and resource efficiency; III – social responsibility and personnel stability; IV – economic and managerial sustainability (Table 1). The formation of the blocks was based on modern scientific publications on green restaurant indicators, food safety culture, Green HACCP, food waste management, environmental performance in food service, and current regulatory requirements for food market operators [1–6; 9–15]. Three criteria were used when selecting indicators: representativeness for the restaurant sector, practical measurability at the level of a specific establishment, and the possibility of managerial influence.

The key methodological assumption was the recognition that HACCP indicators should not have an auxiliary but a system-forming status. This is due to the fact that without basic operational discipline, traceability, and control of critical parameters, the remaining aspects of sustainability become fragmented. For example, reducing food waste without proper compliance with temperature regimes and storage periods can provoke an increase in microbiological risks; similarly, purchasing local raw materials without incoming control procedures does not guarantee either

Table 1

System of indicators for integrated assessment of the level of sustainable development of restaurant establishments

Bloc	Key indicators	Number of indicators	Unit weight
I. HACCP effectiveness	Documentation of procedures; identification of hazardous factors and CCPs; monitoring of critical limits; traceability; personnel training	5	0.35
II. Environmental and resource efficiency	Water metering, energy consumption monitoring, food waste measurement, packaging, and organic waste management	4	0.25
III. Social responsibility	Staff stability and training; working conditions; communication with guests regarding allergens and safety	3	0.20
IV. Economic and managerial sustainability	Write-offs and returns; risk-based procurement planning; use of internal audit data	3	0.20

Source: compiled by the author based on [1–6; 9–15].

safety or true sustainability of supply. In view of this, the HACCP performance block was assigned the highest weight – 0.35. The ecological and resource block received a weight of 0.25, the social 0.20, and the economic and managerial 0.20.

It is proposed to calculate the integral index of sustainable development of a restaurant establishment using the formula:

$$I_{CP} = \sum(w_i \times s_i), \quad (1)$$

where I_{CP} is the integrated index of sustainable development;
w_i – weight of the i-th block of indicators;
s_i – is the standardized score of the i-th block in the range from 0 to 1.

Within each block, the standardized score is defined as the weighted average of partial indicators, which are rated on a scale from 0 to 5 points. The value 0 means the absence of practice or documented confirmation; 1, episodic application; 2, partial implementation; 3, satisfactory functioning; 4, high level of implementation; and 5, systematic implementation with evidentiary records and regular analysis of performance. For the convenience of managerial interpretation, the following intervals are proposed: 0.00…0.49 – low level of sustainable development; 0.50…0.69 – medium; 0.70…0.84 – sufficient; 0.85…1.00 – high.

The model was tested on three model profiles that reflect the most common organizational scenarios in the Ukrainian restaurant sector. The first profile is a full-service city restaurant with a wide menu, on-site production of semi-finished products, and a high proportion of manual preparation operations. The second profile is a quick-service establishment focused on delivery, with a simplified menu, high product turnover, and significant dependence on packaging. The third profile is a catering operator with advance order planning, a higher level of process regulation, and a more developed system for accounting for raw materials and returns. The model profiles were formed on the basis of typical organizational schemes for food production, requirements for HACCP procedures, and a generalization of modern research on the organization of food service operations [5–8; 12; 13]. It is important to emphasize that this is not an assessment of specific commercial brands but an applied testing of the tool on typical activity scenarios.

For the HACCP performance block, the model includes five indicators: the presence of a documented HACCP group and plan review procedures; identification of hazardous factors and critical control points; completeness of critical limit monitoring; traceability of raw materials and products; and regularity of staff training on food safety issues. This choice is based on both national regulations [3; 4] and modern empirical studies, which prove that it is training, written policies, monitoring mechanisms, and managerial leadership that are most strongly associated with the actual level of food safety culture and compliance with procedures [7–10].

The ecological and resource block includes four indicators: accounting for water consumption and the availability of measures to optimize it; accounting for energy-intensive operations; systematic measurement of food waste; and organization of packaging and organic waste management. Their selection is justified by modern studies on food service environmental performance and circular restaurant models, in which the measurement of waste generation and resource consumption is defined as the primary condition for further greening [1; 6; 12; 13]. The social block includes three indicators: stability and training of personnel, working conditions and sanitary and hygienic provision of workplaces, and communication with guests regarding allergens and food safety. The economic and management block contains three indicators: the level of write-offs and returns, the availability of risk-based procurement planning, and the use of internal audit data for management decisions (Table 2).

The results of the testing showed that the full-service restaurant received the highest scores on the indicators of communication with guests, menu flexibility, and allergen management but lost to other profiles on the parameters of write-offs and monitoring of food waste. A typical problem for this type of establishment is a wide range and

Table 2

Results of model testing of the integral sustainable development index

Institution profile	HACCP	Eco-resource block	Social block	Economy control unit	Integral index
Full-service restaurant	0.80	0.68	0.78	0.75	0.76
Quick service establishment with delivery	0.74	0.60	0.69	0.71	0.69
Catering operator	0.85	0.76	0.79	0.83	0.81

Source: calculated by the author using the proposed model.

numerous preparatory operations, which increases the risk of inconsistency between the production plan, actual demand, and raw material stocks. According to modern research, it is menu engineering, accounting for unclaimed components, and the discipline of records at critical control points that significantly affect the possibility of simultaneously reducing waste and maintaining safety [1; 12; 13]. In our model, this was reflected in the integral value of 0.76, which corresponds to a sufficient level of sustainable development, but with a clearly expressed need to strengthen control over losses and resource consumption.

The quick service delivery establishment demonstrated relatively high results in terms of process standardization, product turnover speed, and manageability of technological operations. At the same time, this profile turned out to be the most vulnerable in the context of the environmental and resource component due to the large share of disposable packaging, limited sorting practices, and less developed accounting of food waste generated at the interface of production and delivery. In addition, the delivery-oriented model is characterized by an increased load on temperature control during transportation and preserving the quality of ready-made dishes, which necessitates the need for enhanced documentation of corrective actions. As a result, the integral index was 0.69, i.e., it remained on the border between the average and sufficient levels of sustainability. This indicates that the standardized format of operations in itself does not guarantee high sustainability if it is not supplemented by developed environmental and social practices.

The highest results were shown by the catering operator – 0.81. Its advantage is explained by the higher predictability of orders, the possibility of preliminary planning of production volumes, better accounting of residues, and a lower level of excess cooking compared to a full-service restaurant. Catering is characterized by more formalized logistics management, time and temperature control during transportation, as well as higher requirements for documentation due to the specifics of servicing events and corporate clients. Within the framework of our model, it was this formality that had a positive impact on the HACCP block and the economic and management block. At the same time, the catering profile is not necessarily the "most stable" type of establishment; its advantage largely depends on system planning, and in the absence of measurement of packaging waste and logistics costs, this advantage is quickly leveled. However, model testing showed that the predictability of the production cycle facilitates the integration of HACCP with resource efficiency.

An important result of the study was the identification of a group of indicators that have the greatest sensitivity to the overall level of sustainable development. These include documentation and periodicity of revision of HACCP procedures; staff training with an emphasis not only on sanitation but also on food safety culture; daily accounting of food waste with a division into production, service, and consumer waste; accounting for water and energy by operations; traceability of raw materials; and clear procedures for incoming control. These indicators have a double effect: they simultaneously strengthen safety and reduce operational losses. This logic corresponds to the Green HACCP concept, according to which the control of hazardous factors and the control of resource losses should be integrated, not parallel management circuits [1].

The practical interpretation of the results obtained gives grounds to argue that in the restaurant sector, HACCP should be considered as a platform for system management and not only as a regulatory requirement. First, monitoring, validation, and verification procedures form a habit of records and evidence of management decisions among personnel. Second, the map of hazardous factors actually disciplines technological operations, reducing the likelihood of unplanned write-offs, downtime, and complaints. Third, the corrective action mechanism creates a management logic of continuous improvement, which can be extended to resource aspects–water, energy, waste, and packaging. These conclusions are consistent with data on the effectiveness of repeated audits of safety systems [5], as well as with empirical observations on the relationship between training, written policies, and the strength of food safety culture [8; 9].

At the same time, the study showed that without additional environmental content, the classic HACCP model does not cover the entire spectrum of sustainable development parameters. For example, the system may be formally effective in terms of preventing biological, chemical, and physical hazardous factors but not contain any procedures for accounting for food waste or energy intensity of production. That is why the integration of circular economy criteria into the internal audit of the institution is necessary. In our model, this is implemented not by replacing HACCP but by expanding the list of indicators and linking them to the Plan-Do-Check-Act management cycle. This approach allows the restaurant establishment to form a single self-assessment matrix, which is convenient for internal management, external audits, and the preparation of non-financial reporting.

The importance of food safety culture for sustainable development should be emphasized separately. Recent studies show that the feeling of resource security, clarity of rules, support from management, and the quality of communication directly affect the actual compliance with procedures [8–10]. For the restaurant business, this is of fundamental importance, since staff turnover, uneven workload during the day, and seasonal fluctuations in demand often weaken the consistency of implementation of even well-written requirements. Therefore, a high level of sustainable development is impossible without an organizational culture in which product safety, economical use of resources, and operational discipline are viewed by employees as interrelated norms and not as separate control tasks. That is why in the proposed model, personnel training and communication are taken beyond the boundaries of a purely "social" block and are considered as an inter-block factor.

From a methodological point of view, the results obtained provide grounds for several practical recommendations (Table 3).

Table 3

Priorities of management decisions depend on the type of institution

Institution profile	Critical weaknesses	Priority management actions
Full-service restaurant	High production losses, complex assortment, uneven kitchen load	Strengthen menu engineering, accounting of write-offs by meal groups, daily food waste analysis, and adjustment of control charts
Quick service establishment with delivery	Excessive packaging, temperature risks during delivery	Optimize packaging, strengthen time and temperature control, and integrate delivery logs into the HACCP system
Catering operator	Logistical risks and transportation costs, depending on the accuracy of prior planning	Develop digital batch planning, returns control, route standardization, and packaging waste assessment

Source: summarized by the author based on the results of model testing.

It is advisable to conduct an internal audit of a restaurant establishment at least once a quarter using an integrated scale in which HACCP indicators constitute a separate block and have the highest weight. Daily food waste accounting should be integrated with production and write-off logs and not exist as an autonomous environmental accounting. Data on temperature, sales times, food returns, complaints, disposal, and water and electricity consumption should be analyzed together at management meetings, which will allow the identification of cause-and-effect relationships between safety, costs, and the level of sustainability. For small establishments, a phased implementation is advisable – from basic HACCP indicators and food waste measurement to more complex indicators of supplier sustainability and carbon footprint.

The limitations of the study are related to the fact that the testing was performed on model profiles and not on the array of primary data of specific Ukrainian establishments. However, this approach is justified for the development and initial verification of the tool, especially in a situation where enterprises are reluctant to publish internal data on critical control points, write-offs, resource consumption, and non-conformities. In the future, the model can be supplemented with an empirical array of internal audit data, questionnaires of managers and employees, as well as integration with electronic systems for accounting of purchases, inventories, and production journals. It is such digital integration, as modern publications show, that is one of the most promising directions for the development of Green HACCP and smart food service management [1; 6].

Conclusions and prospects for further research. The conducted research made it possible to substantiate that the assessment of sustainable development of restaurant establishments is methodologically complete only when it includes indicators of the effectiveness of the implementation of the HACCP system. Based on the analysis of relevant scientific works from 2021–2025 and the current regulatory framework of Ukraine, it is proven that the HACCP system should be considered not as an isolated regulatory module but as an integrated element of managing the quality of operations, resource efficiency, food loss prevention, and increasing consumer confidence. The proposed structure of the integral index, which includes four blocks of indicators–HACCP effectiveness, environmental and resource efficiency, social responsibility, and economic and managerial sustainability–allows us to translate the general concept of sustainable development into the applied plane of the institution's internal audit.

Model testing on three typical profiles of restaurant establishments showed that the highest level of integrated sustainability is provided by the formalization of procedures, predictability of the production cycle, the presence of evidentiary records at critical control points, systematic training of personnel, and measurement of food waste. At the same time, the most sensitive to changes in management practice were the indicators of CCP monitoring, traceability of raw materials, loss accounting, and control of resource consumption. The practical significance of the work lies in the fact that the proposed toolkit can be used by the management of restaurant enterprises for self-assessment, comparative benchmarking of structural units, preparation for state control, and building programs for the transition to a circular and resource-efficient model of activity.

Prospects for further research include expanding the empirical assessment base using data from Ukrainian restaurant establishments of various formats, statistical verification of the model's weighting coefficients, development of a digital panel of sustainable development indicators for restaurant establishments, and research into the relationship between the level of food safety culture, HACCP performance, and actual indicators of food waste, energy intensity, and consumer loyalty.

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Дата першого надходження статті до видання: 19.03.2026
Дата прийняття статті до друку після рецензування: 17.04.2026
Дата публікації (оприлюднення) статті: 30.05.2026