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Environmental performance assessment instrument for food service: development and validation

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Abstract

The production of meals in Food Service (FS) corresponds to a series of steps that require the use of resources such as food, water, and energy and generate solid waste, requiring the adoption of strategies to minimize damage to the environment and protect workers´ health. This research aimed to develop and validate an environmental performance assessment instrument for FS. A descriptive, cross-sectional study was carried out from August 2022 to August 2023 in four stages: 1) Development of an environmental performance assessment instrument in FS; 2) validation of the instrument's content by a panel of experts; 3) Analysis of the reliability of the validated instrument, using the Pearson correlation test and 4) Assessment of internal consistency through the application of the instrument in twelve FS and the evaluation of the correlation of the checklist items using the *Cronbach's Alpha index*. The instrument developed comprised 77 items addressing aspects of environmental performance and environmental conditions in meal production. Eight experts participated in the content validation in two rounds of evaluation to obtain consensus, calculated by the content validity index (CVI). The items of the validated instrument presented a Pearson coefficient equal to 1 (r = 1) and Cronbach's alpha equal to 0.9391, providing maximum reliability and high consistency. It is concluded that the checklist developed presented content validity, reliability, and internal consistency, proving to be an important instrument to assist nutritionists and food service managers in establishing goals for the production of healthy and sustainable meals.

Keywords: Environmental performance; Assessment instrument; Validation; Food service; Meal production.

Highlights

- Validated environmental performance assessment instrument for food service
- The checklist showed reliability and internal consistency
- Instrument innovation in the assessment of environmental performance in food service

1 Introduction

The intensive exploitation of natural resources, the use of fossil fuels, and the use of intensive agriculture, among other factors, have been causing drastic pressures on the environment, resulting in extreme weather events, loss of biodiversity, and air, soil, and water pollution (Intergovernmental Panel on Climate Change, 2019). Considering that environmental impact refers to any change in the environment caused by the performance of a beneficial or harmful activity, local or global, in recent decades, there has been increasing concern by companies with environmental and social issues, in addition to economic ones, aiming to remain competitive in the market (Abreu et al., 2004).

Regarding eating behavior, the growth of eating out is a notable characteristic not only in developed countries but also in developing countries. Meal production in the food service (FS) sector in Brazil has gained importance over time, since, according to the family budget survey (Brasil, 2019), a large percentage of this budget is made on food outside the home (32.8%), pointing to the importance of this sector. The process includes a series of steps from the food selection and packaging and other materials, pre-preparation, preparation to meal distribution. All steps require the use of resources such as food, water, and energy and generate high amounts of solid waste, therefore requiring the adoption of administrative and technical strategies that help prevent impact on the environment and protect workers' health (Rohrich & Cunha, 2004; Abreu et al., 2004; Colares et al., 2019). The Food Service is responsible for around 26% of the total food waste, corresponding to 244 million tonnes in the European Union (EU). Data from 2012, indicates that in the EU, 11 million tons of food was wasted in Food Service Business, corresponding to 12% of total food waste, with economic costs (20 billion euros) and environmental consequences (use of resources and emission of greenhouse gases) (Forbes et al., 2021).

According to Pospischek et al. (2014), the food service sector still lacks effective environmental management. Research shows that the issue of sustainability in meal production is still far from what is desired, but there is already recognition of its importance and an effort to comply with sustainability guidelines in the food service sector (Rocha & Viegas, 2023; Carino et al., 2020; Nóbrega et al., 2019; Spinelli et al., 2020; Rodrigues et al., 2020; Harris et al., 2012; Santos et al., 2019; Pinto et al., 2018; Maynard et al., 2020a).

Besides the use of resources for the meal production process and the final product reaching consumers, the environmental impact is still present, due to the generation of leftovers, the need to dispose of post-consumer food and packaging waste, and the use of chemical products to sanitize utensils and physical structures. Colares et al. (2018) developed a checklist of good environmental practices for food services to assist environmental management during meal production. Actions related to good environmental practices in food services include encouraging the purchase of food from local and seasonal producers, preferably from family farming, the rational use of water and energy, the reduction of food waste, and the adequate disposal of waste solids with a focus on sending recycling and waste to environmentally appropriate locations. However, from the application of this instrument in several food services, it was verified the absence of an evaluation of activities based on environmental performance indicators that can help in establishing goals to be achieved in the short, medium, and long terms throughout the life cycle of the meals produced.

One of the most used conceptual references on environmental performance assessment (EPA) is the International Organization for Standardization (ISO) standard 14031 which emphasizes the need to select Environmental Performance Indicators and presents two categories of indicators: environmental condition indicator (ECI) and environmental performance indicator (EPI), divided into a management performance indicator (MPI) and an operational performance indicator (OPI) (International Organization for Standardization, 2021). According to Zobel et al. (2002) for environmental performance assessment, the process must be characterized by rigor and transparency, by generating logical, consistent, structured, detailed, and easy-to-understand data, the information must be traceable, favoring its reproducibility.

Following the ISO standard 14031 in the process of evaluating environmental performance, based on indicators, it is necessary to study the product's life cycle, so that there is rigor in data collection enabling the generation of reports about environmental impacts resulting from performed initiatives (International Organization for Standardization, 2021). Product life cycle assessment (LCA) is a technique that aims to study environmental aspects and potential impacts throughout the life of a product, from the acquisition of raw materials, through production and use, to disposal of waste generated, considering the use of resources, human health and the ecological consequences of this process. LCA can help to identify opportunities to improve the environmental aspects of a product at various points in its production stages, in decision-making for strategic planning, in company marketing and mainly, in the selection of indicators relevant to environmental performance, including measurement techniques for these indicators (International Organization for Standardization, 2020).

In view of the above, it is urgent to adopt sustainable practices in the FS sector and the use of environmental performance indicators can constitute an important step towards improving the quality of service, and observing the life cycle of meal production (Nogueira et al., 2021; Ghisellini et al., 2023; Maynard et al., 2020b). This research aimed to develop and validate an environmental performance assessment instrument for Food Service.

2 Materials and methods

A descriptive study with a cross-sectional design was carried out from August 2022 to August 2023. The study consisted of 1) the development of an instrument for evaluating environmental performance in a Food Service; 2) validation of content (clarity of grammar, ease of understanding, and usefulness, using the Delphi technique), 3) Reliability analysis of the validated instrument and 4) Assessment of the internal consistency of the validated instrument, according to the COnsensus-based Standards for the selection of health Measurement INstruments (COSMIN) checklist (Mokkink et al., 2010), which aims to assess the methodological quality of studies that present measurement instruments, as shown in Figure 1.

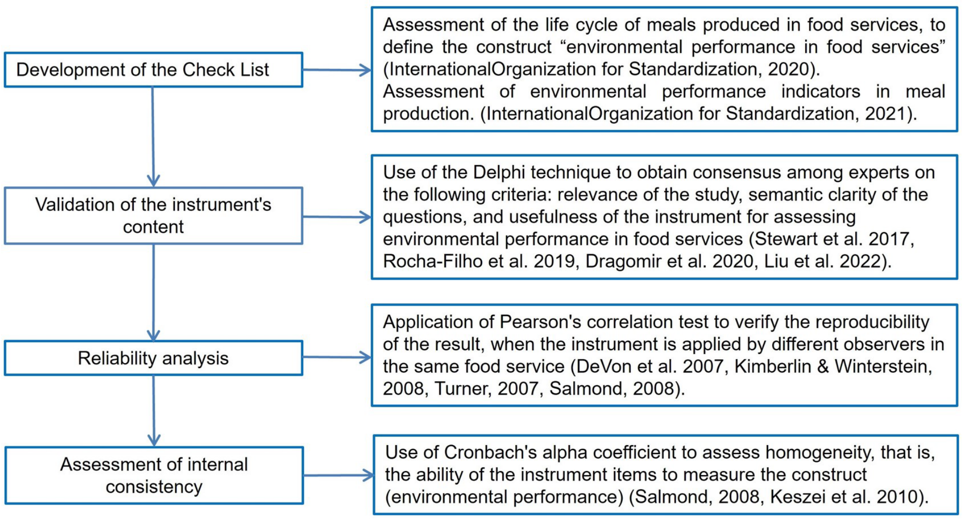

Figure 1. The methodological approach according to the Consensus-based Standards for the selection of health Measurement Instruments – COSMIN.

2.1 Development of the checklist to evaluate environmental performance

The checklist was developed taking into account the life cycle of meal production (inputs, transformation, and outputs), highlighting the following categories for the development of environmental performance indicators: Energy, water and gas consumption, waste management, and chemical product management throughout the meal production process, i.e., receiving and storing materials and food, pre-preparation of vegetables and meat products, preparation/cooking and distribution of meals, cleaning of utensils and physical area and final disposal of solid waste.

The environmental indicators were classified according to the categories proposed in ISO 14031 (International Organization for Standardization, 2021), into a) Management Performance Indicators (MPI), b) Operational Performance Indicators (EPI), and c) Environmental condition indicators (ECI). Management indicators provided information about the organization's capacity and efforts to manage issues that influence environmental performance. Operational indicators provided information about the environmental performance of the organization's operations, such as inputs (Materials, energy, services); processes (physical facilities and equipment and outputs (products, services, waste, and emissions), and environmental condition, provided information on environmental working conditions.

The classification of the environmental performance is based on the points achieved to the fulfilment of the checklist, according to the scoring ranges proposed in RDC 275 of 2002 (Agência Nacional de Vigilância Sanitária, 2002) into three groups: 1) satisfactory environmental performance (76% to 100% suitability); 2) average environmental performance (51% to 75% suitability) and 3) Need to establish environmental performance targets (0% to 50%). The score is obtained from Equation 1.

$$score = \sum \text{“yes” answers} * 100 / \text{“yes”and“no”answers} \quad (1)$$

2.2 Content validation

For content validation the Delphi technique was applied with a panel of experts, aiming to obtain consensus in a systematic and reliable manner (Bellucci Junior & Matsuda, 2012). The Delphi technique is based on the careful selection of panelists, the anonymity of responses, and an interactive process of controlled feedback and it has been used to validate the content of instruments in several areas of knowledge (Stewart et al., 2017; Rocha-Filho et al., 2019; Dragomir et al., 2021; Liu et al., 2022). It is characterized by identifying questions of high relevance to the study to be answered by experts. In this study, adjustments were necessary to improve the understanding of the content of the items (clarity) and the usefulness of the instrument for evaluating environmental performance in a Food Service.

Twelve professionals were selected and eight agreed to participate and remained as expert judges to evaluate the instrument, based on the following criteria: being a nutritionist or teacher in food and nutrition with experience of 3 or more years and/or having carried out a sustainability study in Food Service, including the process of evaluating meal production indicators. Professionals who had research projects and/or recent publications on the topic of sustainability in meal production were searched on the Lattes-CNPq Platform. Invitations to professionals who met the inclusion criteria were made individually, by personalized email.

The Checklist for Environmental Performance Assessment of Food and Nutrition Units (CLEEP-FS), a form containing instructions on how to carry out the assessment and the link to access a form prepared on Google Forms, so that the specialist could read and accept the Free and Informed Consent Form (FICF). The experts were instructed to evaluate the instrument only after reading and agreeing to the informed consent form. Dialogue between the participant and the main researcher was continuously open for any clarification or questioning at any stage of the research. Participants were informed they could request to withdraw from the research, without any consequences, at any time. During the consent process, the researcher made all necessary clarifications to the participants clearly and objectively. The main researcher downloaded the data from the Free and Informed Consent records to a local electronic device, deleting all records from any virtual platform, a shared environment, or “cloud”.

The validation of the instrument was carried out using resources from the virtual environment (e-mail), and expert judges were asked to evaluate the items based on the following requirements: grammatical adequacy (correct use of written language), clarity (ease of understanding/understanding of the item, division of topics, coherence, cohesion and form of presentation of the item) and adequacy to what is proposed to be evaluated (Pasquali, 2009). A 4-point Likert scale with the following gradient was used: (1) completely disagree, (2) disagree, (3) agree and (4) totally agree (Dalmoro & Vieira, 2013). The use of digital tools was necessary, since the selected professionals lived in several Brazilian states, impairing to deliver and collect the forms in person. The data collected remained the responsibility of the researcher, being stored appropriately, confidentially, and not shared under any circumstances. (Hasson et al., 2000).

Once data collection was completed, the main researcher downloaded the collected data to a local electronic device, erasing all records from any virtual platform, a shared environment, or "cloud". For the instrument items to be considered validated, a percentage of agreement between experts equal to or greater than 80% was used (Grant & Davis, 1997; Rubio et al., 2003), obtained from the sum of gradients 3 (agree) and 4 (totally agree) on the Likert scale. To obtain agreement, two rounds of evaluation were carried out, including experts' suggestions in each round.

The Content Validity Index (CVI) was calculated, which assesses experts' agreement regarding the representativeness of the measure in the content covered, based on the sum of the average points for each item (based on a gradient from 1 to 4) divided by the total number of experts (Bellucci Junior & Matsuda, 2012; Martins, 2006). CVI was calculated per item and attribute (clarity of grammar, ease of understanding, and usefulness). The score was calculated by summing the agreement of the items that received "3 and "4" as evaluation responses. The equation CVI = number of responses 3 and 4/Total number of responses was used (Alexandre & Coluci, 2011). The results of this analysis constituted the basis for modifying the instrument, as foreseen in the Delphi technique (Colares et al., 2018; Munaretto et al., 2013; Oliveira et al., 2014; Scarparo et al., 2012).

2.3 Reliability analysis of the validated instrument

Reliability refers to the ability to reproduce results by different observers and portrays the ability of the instrument to measure a certain attribute in a consistent and stable way, even with variations in time and space. The stability of an instrument can be measured based on inter-observer equivalence and internal consistency. (DeVon et al., 2007; Kimberlin & Winterstein, 2008; Turner et al., 2007; Salmond, 2008).

To analyze reliability, the instrument was applied by four different researchers to Technical Managers (RT) of three Food Services with the following characteristics: food services that produced 3,000 to 10,000 meals/day for the academic community of public universities of the State of Rio de Janeiro-Brazil. The choice of locations was due to the ease of movement of the researchers, who applied the same instrument in the three locations.

To compare the results, the Pearson correlation test was used, according to the intensity of the coefficient (r): weak correlation ($r \leq 0.3$), regular ($0.3 < r \leq 0.6$), strong ($0.6 < r \leq 0.9$), and maximum ($0.9 < r \leq 1.0$). The correlation coefficient enables to verify the existence of dependence/connection between the forms of completion (DeVellis, 2003).

2.4 Assessment of the internal consistency of the validated instrument

The internal consistency or homogeneity of an instrument aims to verify the extent to which all items can measure a construct, that is, all its subparts measure the same concept. To achieve this, the scale questions must correlate or be complementary (Salmond, 2008; Keszei et al., 2010). Cronbach's alpha is a method for evaluating internal consistency, being effective for long instruments comparing each question on a scale simultaneously with another, and measuring the average correlation between all items (Catallo & Sidani, 2013; Pryse et al., 2014).

To assess internal consistency, the instrument was applied by a trained researcher to managers/technical managers of 12 Food Service companies located in different segments of the sector. In the FS located in the city of Rio de Janeiro, the instrument was applied in person and the others, virtually. Cronbach's Alpha index was used through the comparison of the results obtained. This coefficient considers the correlation between the items of the scale and varies from zero to one, with values closest to an indication of greater internal consistency and it is used to verify whether the items on a scale measure the same theoretical construct or latent trait, therefore, considering the nature of the scale evaluated. For this study, Cronbach's alpha was calculated for each of the question blocks of the prepared instrument and Cronbach's alpha value between 0.5 and 0.7 was considered acceptable and ≥ 0.7, satisfactory (DeVellis, 2003).

All collected data were organized in an Excel® spreadsheet, Microsoft 365 version, and analyzed using STATA statistical software, version 15 (Stata Corp. 2017. Stata Statistical Software: Release 15. College Station, TX: Stata Corp LLC). The study was submitted to the Research Ethics Committee of the Clementino Fraga Filho University Hospital of UFRJ (CAAE: 37770713.0.0000.5257. Opinion No. 5,674,255, on 09/29/2022), and all participants signed the informed consent form (ICF). The confidentiality of participant identification and data confidentiality was guaranteed, following Resolution Nº. 466/12.

3 Results and discussion

3.1 Development of the instrument for evaluating environmental performance

In the initial stage, it was necessary to study and characterize meal production according to the segments and subsegments of food supply to communities: companies and institutions, event catering, commissaries, commercial restaurants, prison units, hospitals, general clinics, Long-Term Institutions for the Elderly (ILPI) and similar, Hotels, Schools, Street food services, Commercial restaurant, maritime hospitality, onshore, and offshore, among others, according to Resolution No. 600 of the Federal Council of Nutritionists (Conselho Federal de Nutricionistas, 2018). This step was necessary so that the CLEEP-FS developed could be widely used. A similar procedure was carried out by Colares and collaborators in the preparation of the Checklist of good environmental practices for food services (Colares et al., 2018).

From this study, environmental performance indicators were developed, based on the life cycle of the meal (input, transformation, and output) and the stages of the meal production process (Receiving, storage, pre-preparation, preparation, distribution, and hygiene of utensils, and physical area). According to the ISO 14040 Standard of the International Organization for Standardization (International Organization for Standardization, 2020), the assessment of the life cycle of a product can help in the development of environmental performance indicators, since the inputs, transformation, and outputs of a product are analyzed.

In this research, 88 indicators were created and, after careful analysis to choose indicators that could portray the environmental performance of Food Service, some were excluded and a category of general indicators was created, when these did not portray a specific stage of production of meals, but rather the food service. The final instrument includes 83 indicators distributed as follows: 49% IDO, 34% IDG, and 17% ICA (Colares et al., 2024). Based on the indicators developed, it was possible to develop the environmental performance assessment instrument for FS (CLEEP-FS).

The CLEEP-FS was developed containing three sessions, one of an informative nature, another of an evaluative nature and the last, of a classificatory nature: 1) Characterization of the FS, with information about the segment and subsegment of insertion of the FS in the job market, form of management, type and number of meals produced, type of service provided and meal distribution system, this topic being informative in nature and 2) 77 items addressing aspects of environmental performance and environmental conditions in meals' production, separated into general topics, and the other topics corresponding to the stages of meal production (receiving materials, dry and refrigerated storage, pre-preparation, preparation, distribution and hygiene), related to the indicators prepared: OPI (52%), MPI (35%) and ECI (13%), this session being of an evaluative nature, in accordance with ISO Standard Nº 14031 of the International Organization for Standardization (International Organization for Standardization, 2021). The last session presented the classification bands considering the environmental performance items presented by the FS.

Three possible answers were allowed: a) yes, when the FS carried out and recorded the activity that could enable the construction of environmental performance indicators for monitoring at different times; b) no, when the FS did not carry out and record the activity that could enable the construction of environmental performance indicators for monitoring at different times and c) does not apply, when the FS did not provide for the activity according to the segment and subsegment, informed in the FS characterization.

The issue of sustainability in meal production has been widely addressed in recent years, as it is well recognized that in the food service sector, there is a need for high consumption of food, water, and energy and generation of solid waste, contributing to negative impacts on the environment. (Zotesso et al., 2016; França et al., 2019; Pereira et al., 2022; Silva et al., 2022; Pivetta et al., 2023).

Many authors, when addressing the issue of sustainability in meal production, point to food waste as a generator of solid organic waste (Araújo & Carvalho, 2015; Birisci & McGarvey, 2018; Pereira et al., 2022; Deus & Krivan, 2023). Pivetta et al. (2023), when evaluating sustainability practices in twelve food services located in the northwest region of São Paulo (Brazil), found that the most common activity was the selective collection of solid waste, carried out by 75% of the food services. In addition, non-food and food waste were sent for recycling and composting, respectively.

França et al. (2019) studied the practice and perception of sustainability in seven food services inserted in clubs in the city of São Paulo (Brazil) and found that, although managers had a good perception of sustainability in meal production, this did not result in good practice in favor of reducing environmental impacts during meal production.

To support good sustainable practices in food services, several instruments are proposed (Magrini & Basso, 2016; Colares et al., 2018; Spinelli et al., 2020; Martinelli et al., 2020). Magrini & Basso (2016) developed a checklist of good sustainable practices and applied it to seven hospital food services, addressing issues related to the use of water and energy, generation of solid waste, and disposal of oil during meal production. Colares et al. (2018) present a checklist of good environmental practices in which food services can be evaluated, consisting of three blocks: Solid waste, water consumption, energy consumption, and supporting documentation regarding the good environmental practices implementation in establishments. The Good Sustainable Practices Checklist proposed by Martinelli et al. (2020) presents 50 criteria, related to equipment and facilities and management measures and stages of the meal production process, to assist establishments in planning actions for continuous improvement.

Although the proposed instruments address important issues related to sustainable practices to be carried out in the production of meals, the checklist proposed in this research presents as a differential the possibility of establishing environmental performance goals in the short, medium, and long term, based on the election and monitoring of operational performance indicators, managerial performance, and environmental conditions appropriate to the service provided.

3.2 Validation of the instrument's content

The Delphi Technique has been widely used in the validation of instruments, techniques, and professional skills, mainly in the nursing area (Alexandre & Coluci, 2011; Boulkedid et al., 2011; Santos et al., 2020; Zarili et al., 2021), but, despite the various checklists developed to assess good environmental practices and sustainability in the production of meals, only the one proposed by Colares et al. (2018) presents the phases used to validate its content. At this stage, the Delphi technique was used to form a panel of experts to obtain consensus among the professionals involved to validate the instrument. The Delphi method is a widely used strategy for validating instruments, to determine evidence of validity and reliability of questionnaires, tests, scales, and intervention proposals (Yoshinaga et al., 2018; Stewart et al., 2017; Dragomir et al., 2021).

Some limitations have been reported in the Delphi technique use such as the involvement of expert judges in the entire process, as there may be a need for several rounds of evaluation of the instrument until consensus is reached (Boulkedid et al., 2011). Zarili et al. (2021) reported a response rate in the first round of evaluation of a questionnaire to assess primary health care in Brazil of 73.6% and a reduction in the number of expert judges who carried out the second round of evaluation, despite having improved the response rate of this group to 92.8%. In the present research, twelve experts were selected, but only eight remained until the end of the evaluation. This limitation may be due to the need to establish deadlines for the evaluations to be returned, analyzed, and returned to the experts for a new evaluation.

In the present research two rounds were carried out to obtain consensus among experts regarding the questions presented in the CLEEP-FS, the panel of experts for the first round of evaluation was composed of 8 professionals who agreed to participate in the validation stage, with the following characteristics: 100% with training in nutrition, 87% with a doctorate in the area of food and nutrition, 75% with more than 9 years of professional experience and 87% with publications or participation in research projects on sustainability.

After the first round, there was a Content Validity Index (CVI) equal to 91.6%, considering the topics that reached consensus among experts. The sum of the answers "agrees" and "completely agree" for the item's clarity, grammar and adequacy were above 80%, however, 7 questions achieved consensus below 80% and were submitted to a new round evaluation.

Of the seven questions reviewed, five referred to grammatical form, 2 to adequacy, and one to clarity. Of these items, 43% were related to operations in the receiving area. The other items were associated with topics relating to pre-preparation and the hygiene area, both of which were related to worker health. Thus, five questions were reformulated, one remained, and one was deleted. In addition, 2 general topics related to environmental conditions and worker health were reformulated, based on observations made by the evaluating judges.

After the modifications suggested by the experts, the instrument was again forwarded to the judges to carry out the second round of evaluation and there was obtained 100% agreement between the experts, without any additional comments about the instrument. The final list had 76 items, 43% of which were general and 57% related to the meal production stages: 17% for receiving dry and refrigerated/frozen storage; 16% for the pre-preparation stage of vegetables and meat products; 7% for the preparation/cooking stage; 8% for the meal distribution stage and 9% for cleaning and disposal of solid waste. Regarding environmental performance and environmental condition indicators, the final CLEEP-FS presented 53% of items related to OPI, 34% related to MPI, and 13% to ECI (Table 1).

The classification of FS in relation to compliance with the items contained in the CLEEP-FS was also evaluated and reached a consensus among the expert judges in the first round of evaluation.

Table 1. Composition of checklist for environmental performance assessment of food and nutrition units after content validation by expert judges.

ENVIRONMENTAL PERFORMANCE CHECKLIST IN FOOD AND NUTRITION UNITS
Food Service (FS) characterization
Type of FS: companies and institutions, event catering, commissary, commercial restaurant, prison unit, hospital/clinic, long-term care institutions for the elderly (LTCF), hotel, school, mobile food service. commercial restaurant, maritime hotel, other
Management method: own service; outsourced service/branch of activity of the company in which the FS is inserted.
Type and number of meals produced: breakfast; collation; lunch; snack; To have lunch; supper.
Type of service provided: local production and distribution; transported meal; both.
Distribution Systems: fixed cafeteria; self-service; mixed; à la carte; other.
Environmental Performance Aspects in meal production
A. General aspects
A1. Operations-related topics
A.1.1 Is there a record of energy consumption (kW) per month?
A.1.2 Is there a record of gas consumption per month?

Table 1. Continued…

ENVIRONMENTAL PERFORMANCE CHECKLIST IN FOOD AND NUTRITION UNITS
A.1.3 Is there a record of the volume of water (m^3) used per month?
A.1.4 Does the unit have a water meter for each production area?
A.1.5 Is there a daily record of the amount of food (kg) wasted considering all production areas?
A.1.6 Is there a daily record of the amount of total waste generated?
A.1.7 Is there a daily record of the amount of organic/food waste generated?
A.1.8 Are menus prepared considering the water footprint of the food?
A.1.9 Are menus prepared considering the carbon footprint of the food?
A1.10. Is there a record of the quantity (kg) of waste sent to landfill?
A1.11. Is there a record of the total quantity (kg) of waste that can be recycled?
A1.12. Is there a record of the quantity (kg) of waste destined for recycling?
A1.13. Is there a record of the quantity (kg) of waste treated by composting?
A1.14. Does the unit use biodegradable cleaning materials?
A2. Management Related Topics
A2.1. Is there a record of training activities carried out per year regarding the rational use of energy for employees?
A2.2. Is there a record of awareness activities scheduled per year regarding the rational use of water for diners?
A2.3. Is there a record of training activities scheduled per year regarding the rational use of energy for employees?
A2.4. Is there a record of awareness activities scheduled per year regarding the rational use of energy for diners?
A2.5. Is there a record of training activities carried out per year regarding the rational use of water for employees?
A2.6 Is there a record of awareness activities carried out per year regarding the rational use of water for diners?
A2.1. Is there a record of training activities scheduled per year on the rational use of water for employees?
A2.8. Is there a record of awareness activities carried out per year regarding the rational use of energy for diners?
A2.9. Is there a record of training activities scheduled per year regarding solid waste management for employees?
A2.10. Is there a record of training activities carried out regarding solid waste management for employees?
A2. 11. Is there solid waste separation at the FS?
A2.12. Is there a record of the frequency of preventive maintenance of equipment scheduled per year?
A2.13. Is there a record of the frequency of preventive maintenance of equipment carried out per year?
A2.14. Is there a record of the frequency of corrective maintenance of equipment carried out per year?
A2.15. Are there goals for implementing sustainable actions per year?
A2.16. Is there a record of the number of sustainable actions implemented during the year?
A2.17. Is there control of the number of employees trained in the rational use of water, energy, and waste management?
A3. Topics related to FS environmental conditions and worker health
A3.1 Do all employees have access to the necessary protective individual equipment (PIE)?
A3.2. Is there a record of the number of employees who do not use PIE?
B. Receiving of food and materials
B1. Topics related to operations
B1.1. Is there a record of materials that can be recycled in the receiving area?
B1.2. Is there a record of the amount of waste generated in the reception area?
B1.3. Is there a record of the quantity (kg) of non-food waste generated in the reception area?
B1.4 Is there a record of how many scheduled purchase orders are delivered on time?
B1.5 Is there a record of the quantity of non-conforming food delivered?
B2. Topics related to management.
B2.1. Do the contracted suppliers have sustainable initiatives?
B2.2. Are visits made to suppliers?
B2.3. Is there a record of the number of trained employees in the receiving area?
C. Dry and refrigerated/frozen storage stage
C1. Topics related to operations.

Table 1. Continued…

ENVIRONMENTAL PERFORMANCE CHECKLIST IN FOOD AND NUTRITION UNITS
C1.1. Is there a record of the frequency of preventive maintenance of equipment in the storage area?
C1.2 Is there a record of the frequency of corrective maintenance of equipment in the storage area?
C1.3. Is there a record of the amount of scheduled maintenance in the storage area?
C2. Management Related Topics
C2.1. Is there a record of the number of trained employees in the storage area?
C3. Topics related to FS environmental conditions and worker health
C3.1. Is there a record of the number of employees exposed to low storage temperatures?
D. Pre-preparation stage of vegetables and meat products
D1. Operations-related topics
D1.1. Is there a record of the amount of water (L) used to clean vegetables?
D1.2. Is the water used to clean vegetables reused?
D.1.3. Is the water used to clean vegetables reused in its entirety?
D.1.4. Does the unit have its own food correction factor table?
D1.5. Is there a record of the quantity (kg) of trimmings generated in the pre-preparation of meat?
D1.6. Is the generated shavings used?
D1.7. Is there a record of the quantity (kg) of waste generated in the pre-preparation of meat?
D1.8 Does the unit present its own table of losses in the pre-preparation of meat?
D2. Topics related to management.
D2.1. Is there training in relation to food handling in the pre-preparation stage?
D2.2. Is there a record of the number of employees trained in the pre-preparation area?
D3. Topics related to FS environmental conditions and worker health
D3.1. Is there temperature control in the meat pre-preparation area?
D3.2. Do employees exposed to low temperatures in the meat product pre-preparation area have access to PIE?
E. Preparation/cooking stage
E1. Topics related to operations
E1.1. Is the volume of oil waste generated quantified?
E1.2. Is the oil waste destined for recycling?
E2. Topics related to management.
E2.1. Are the preparation technical sheets updated when there is a change in the preparations?
E3. Topics related to FS environmental conditions and worker health
E3.1. Is the temperature measured in the meal preparation area periodically?
E3.2. Is noise measured in the meal preparation area periodically?
F. Meal distribution stage
F1. Topics related to operations
F1.1. Is there a record of the amount of food leftovers?
F1.2. Is the acceptance of meals by diners assessed?
F1.3 Is there a record of the frequency of preventive maintenance of equipment (passthrough and thermal counter) during the year?
F 1.4 Is there a record of fuel consumption used to transport meals?
F2. Topics related to management.
F2.1. Is there a training activity carried out for the portioning of preparations during meal distribution?
F3. Topics related to FS environmental conditions and worker health
F3.1. Is the temperature of the distribution area periodically measured?
G. Sanitation stage and solid waste disposal
G1. Topics related to operations
G1.1. Is there a record of the amount of food waste daily?
G1.2. Is food waste sent for treatment?

Table 1. Continued…

ENVIRONMENTAL PERFORMANCE CHECKLIST IN FOOD AND NUTRITION UNITS
G1.3 Is there a record of the amount of food waste sent for treatment?
G1.4 Is there a record of the frequency of preventive maintenance of equipment during the year?
G2. Topics related to management.
G2.1 Are there training activities for workers on the correct management of solid waste?
G3. Topics related to FS environmental conditions and worker health
G3.1. Is noise in the cleaning area periodically measured?
G3.2. Is the humidity of the hygiene area periodically measured?

3.3 Reliability analysis of the validated instrument

The objective of this stage was to verify whether, when applying the validated instrument in the same location by different evaluators, they would obtain the same result, guaranteeing the reliability of the validated instrument in its content. Some authors emphasize the importance of analyzing the reliability of an instrument, since, regardless of the evaluator, the instrument must measure what it really intends to. (Catallo & Sidani, 2013; Pryse et al., 2014).

The reliability of an instrument refers to its ability to reproduce a result consistently over time and space, that is, the ability to measure what the instrument actually intends to (Keszei et al., 2010; Souza et al., 2017). However, reliability estimates can be affected by the assessment environment, which includes the evaluators, the sample characteristics, the type of instrument, and the application method (Keszei et al., 2010).

There are different indices to measure the reliability of an instrument and not all of them apply to a given scale. It is not necessary, for example, to show inter-rater reliability if a test is self-administered. It is also important to emphasize that reliability is not a fixed property of a scale, as it depends on the instrument, the group with which it is being used, and the circumstances in which the instrument is applied. According to Keszei et al. (2010), inter-rater reliability can be measured using Pearson's coefficient, with a result between 0 and 1, with a result equal to 1 representing the maximum reliability of the instrument.

In the present study, after applying the instrument by four different researchers to the Technical Managers of three FS, 100% agreement was obtained for the classification of the FS in relation to the fulfillment of the items that are part of the CLEEP-FS, achieving a Pearson coefficient equal to 1 in the analysis, therefore obtaining maximum reliability.

3.4 Assessment of the internal consistency of the validated instrument

The twelve food services where the validated instrument was applied produced and served an average of 2023 meals per day (from 200 to 5200 meals/day) located in industries (16.7%), Universities (33.3%), companies (16.7%), hospitals (16.7%), social restaurants (8.3%) and commercial restaurants (8.3%) from cities in the following Brazilian states: Acre, Alagoas, Bahia, Brasília, Minas Gerais, Rio de Janeiro, Paraná and Santa Catarina.

The result of applying the instrument in food services is shown in Table 2. The assessment of Environmental performance during the life cycle of the meals produced showed that the FS obtained an average of 35% adequacy, classified in Group 3 (0 to 50% adequacy). When evaluating the stages of the life cycle, better adaptation is observed during the process. This result is in line with some research on sustainability in the meal production sector, in which FS has better control of the pre-preparation and cooking stages, perhaps due to the implication of these stages in the cost of the meal. (Quested et al., 2013; Birisci & McGarvey, 2018; Choi et al., 2019; Carletto et al., 2023). However, Costa et al. (2023) point out the importance of environmental impact assessment based on the analysis of inputs, since this phase is the one that most impacts the environment.

At the end of the production cycle, the lowest percentages of adequacy were observed, mainly regarding solid waste management. Several studies have highlighted the need for adequate management of solid waste in the FS sector, especially organic solid waste, as its generation is closely related to food waste and contributes to increased production costs, in addition to negatively impacting the environment. (Severo et al., 2018; Conrad et al., 2018; Ernstoff et al., 2019; Turchetto et al., 2021).

Table 2. Assessment of the environmental performance of twelve food services in several Brazilian cities according to the life cycle of the meals produced.

Aspects of Environmental Performance	Percentage of adequacy in the twelve services											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Raw material input												
A. General aspects	12.1	16	0	27.3	9.1	40	21.2	33.3	27.3	30.3	57.6	12.1
B. Receiving of food and materials	62.5	37.5	28.5	50	12.5	33.3	50	0	50	12.5	62.5	25
Processing												
C. Dry and refrigerated/frozen storage stage	40	40	60	20	20	80	25	40	0	40	100	20
D. Pre-preparation stage of vegetables and meat products	40	25	36.4	83.3	33.3	66.7	22.2	66.7	40	40	172.7	50
E. Preparation/cooking stage	60	20	50	60	20	60	80	66.3	80	60	80	80
Usage/end of life												
F. Meal distribution stage	37.5	40	60	80	16.7	80	50	66.7	66.7	66.7	83.3	50
G. Sanitation stage and solid waste disposal	0	0	14.3	16.7	16.7	42.9	0	14.3	0	14.3	71.4	0

When evaluating the internal consistency, it was observed that 86% of the topics presented a Cronbach's alpha coefficient equal to or greater than 0.7, showing that the items are highly correlated with each other and presented a satisfactory internal consistency. Only the block related to hygiene and disposal of solid waste presented Cronbach's alpha equal to 0.6, presenting acceptable internal consistency, as shown in Table 3.

Table 3. Cronbach's Alpha index values for the analysis blocks of the validated Environmental Performance Assessment Checklist for Food Service.

Evaluated items	Alpha de Cronbach
A – General items	0.8049
B – Receiving of food and materials	0.7675
C – Dry and refrigerated/frozen storage stage	0.8148
D – Pre-preparation stage of vegetables and meat products	0.9088
E – Preparation/cooking stage	0.7397
F – Meal distribution stage	0.7308
G – Sanitation stage and solid waste disposal	0.6372

It is worth mentioning that the objective of this stage was to evaluate the internal consistency of the instrument, to observe whether it would apply to different FS, and not to generalize the results, however, the FS evaluated needs to invest more in evaluating Environmental performance based on use of indicators throughout the meal production life cycle and the instrument presented can contribute to establishing goals to be achieved in the short, medium and long term.

4 Conclusion

The production and large-scale distribution of meals undeniably has environmental impacts because, observing its life cycle, resources are used, and waste is generated at all stages and the implementation of strategies that can minimize these impacts is urgent.

The checklist for environmental impact assessment in Food Service presented content validity, reliability, and internal consistency, proving to be an important instrument to assist nutritionists and food service managers in establishing goals to be achieved towards the production of healthy and sustainable meals.

Due to the scarcity of instrument validation studies on the subject, there is a need for a more in-depth discussion on environmental performance in the food service sector and this research can serve as a first step in that direction.

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