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## Food Loss and Waste in Food and Nutrition Units: A management tool proposal

### *Perda e desperdício de alimentos em Unidades de Alimentação e Nutrição: proposta de ferramenta para gestão*

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**ABSTRACT:** Studies related to Food Loss and Waste (FLW) in gastronomic enterprises are important and necessary to analyze the environmental, social and economic performance of this sector. In this sense, a market niche has emerged: Food and Nutrition Units (FNUs), which offer more sustainable services. However, there are no regulations or even specific management tools that allow measuring sustainability of an FNU in FLW control. From the Life Cycle Impact Assessment (LCIA) perspective, this paper presents a proposal for a tool to manage and compare the performance of commercial Food and Nutrition Units regarding Food Loss and Waste control throughout the production process. LCIA is a qualitative stage of the Life Cycle Assessment (LCA) that allows evaluating the potential environmental impact of an activity, process, product or service. Based on factors identified in the literature that are related to FLW, a survey was conducted with 14 *ad hoc* consultants holding degrees in Nutrition, specialized knowledge on the topic addressed and/or practical experience in FNUs. The participants were asked to rate the factors on a scale from 1 to 10 according to their detection and resolution ease and to their severity. As a result, a spreadsheet was generated with 64 factors to be monitored in FNUs and which provides numerical results that vary according to the enterprises' efficiency in FLW control. It is a versatile instrument that allows adaptations according to the type of food service offered and which can render the comparison between different FNUs and their processes less subjective.

*Keywords:* food services; gastronomy; sustainability; life cycle; food waste.

**RESUMO:** Estudos relacionados à perda e ao desperdício de alimentos (PDA) em empreendimentos gastronômicos são importantes e necessários para analisar o desempenho ambiental, social e econômico desse setor. Neste sentido, um nicho de mercado tem despontado: o de Unidades de Alimentação e Nutrição (UANs) que oferecem

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serviços mais sustentáveis. No entanto, não existem normativas ou mesmo ferramentas de gestão específicas que permitam mensurar o quão sustentável é uma UAN no controle de PDA. Partindo da perspectiva de avaliação do impacto de ciclo de vida (AICV), este trabalho apresenta uma proposta de ferramenta de gestão e de comparação do desempenho de Unidades de Alimentação e Nutrição comerciais quanto ao controle de perda e desperdício de alimentos ao longo do processo produtivo. A AICV é uma etapa qualitativa da avaliação de ciclo de vida (ACV), a qual permite avaliar os impactos ambientais potenciais de uma atividade, processo, produto ou serviço. Com base em fatores identificados na literatura que possuem relação com PDA, foi realizada uma pesquisa com 14 consultores *ad hoc* com formação em Nutrição, com conhecimento especializado no tema tratado e/ou vivência prática em UANs. Numa escala de 1 a 10, os participantes foram solicitados a realizar a ponderação dos fatores quanto a sua facilidade de detecção e solução e sua gravidade. Como resultado, foi gerada uma planilha com 64 fatores a serem monitorados em UANs que fornece resultados numéricos que variam conforme a eficiência dos empreendimentos no controle da PDA. Trata-se de um instrumento versátil que permite adaptações de acordo com o tipo de serviço de alimentação oferecido, e que pode tornar menos subjetiva a comparação entre diferentes UANs e seus processos.

*Palavras-chave:* serviços de alimentação; gastronomia; sustentabilidade; ciclo de vida; desperdício de alimentos.

## 1. Introduction

Food Loss and Waste (FLW) represents an old problem that has been seriously discussed since the mid-early 2010s. It takes place globally and throughout a complex chain, which starts in the fields, that is, food production, and ends at the consumption points. The FLW standards would vary across regions and would be mainly related to the socioeconomic development levels. The problem would also be evidenced as cultural and technological (FAO, 2011, 2013; Gunders, 2012; IMECHE, 2013; Osborn, 2016).

The term Food Loss (FL) would be related to unintentional food reduction, resulting from inefficiencies in the production and supply chain. The term Food Waste (FW) refers to permissive and/or voluntary disposal, generally associated with the end of the chain, as a result of the behavior of retail and consumer practices (Belik, 2018a; Melo, 2018; Souza *et al.*, 2021). As there is no consensus regarding the terminologies used, the Food Loss + Waste Protocol (WRI, 2017) suggests adopting the

more comprehensive term, that is, Food Loss and Waste (Food Wastage).

Several negative FLW factors can be listed, such as the following: greenhouse gas emissions; final solid waste disposal in landfills; water and energy waste, which are resources used for growing and processing food; unnecessary application of agrochemicals and fertilizers to produce food that is not even consumed; soil degradation; deforestation; use of large land tracts for growing food and raising animals for meat and milk; soil and water body pollution; and biodiversity loss (Gunders, 2012; FAO, 2013, 2015; IMECHE, 2013; Williams *et al.*, 2015; Thyberg & Tonjes, 2016; Moulton *et al.*, 2018; Sun *et al.*, 2018; Djekica *et al.*, 2019).

For being food consumption and distribution units, commercial Food and Nutrition Units (FNU) are subjected to FLW and require specific technological solutions that contribute to minimizing the negative environmental impacts. Recently, a market niche has also emerged, namely commercial FNU that claim to be more sustainable. However, there are no formal regulations in Brazil that indicate

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whether they are sustainable in fact. According to Strasburg & Jahno (2017), some consulting companies offer sustainability stamps but do not include Food Loss and Waste.

Implementing a Life Cycle Assessment (LCA) approach in the planning and execution of services provided by FNUs can assist in solving this gap. This is a technique that aims at assessing the potential environmental impacts of an activity, process, product or service throughout its life cycle. The detail level of an LCA can vary significantly; it is very useful for promoting improvements in products/processes and also assists in comparing them. Therefore, it is a tool for decision-making aiming at the lowest possible negative environmental impact (McDougall *et al.*, 2004; Willers *et al.*, 2013; Reichert & Mendes, 2014; Muralikrishna & Manickam, 2017). In Brazil, the tool structure is standardized by NBR ISO 14040: 2009 (ABNT, 2009a) and NBR ISO 14044: 2009 (ABNT, 2009b), and is divided into different phases, one of which is the Life Cycle Impact Assessment (LCIA).

In view of this, the objective of this paper is to present a tool that allows comparing the performance of different commercial Food and Nutrition Units in terms of Food Loss and Waste from the perspective of the Life Cycle Impact Assessment.

## **2. Food Loss and Waste**

From a food perspective, several phenomena took place from 1930 onwards. Farmers in industrialized countries faced difficulties placing the food they produced in the market due to surpluses, and economists suggested reducing agricultural production. During the same period, certain scientific understanding of human biology pertaining to the

malnutrition phenomenon emerged, as well as a process of raising awareness towards the malnutrition and hunger issues in developing countries. This contradiction was questioned by Australian former Prime Minister Stanley Bruce before the League of Nations, leading to the creation of a commission to study the relationships between agriculture, nutrition, health and the economy, but the Second World War brought the commission's work to a premature end. However, such reflection continued during the war period and, with its end in 1945, American President Roosevelt called a United Nations meeting to deal with agriculture and food (Chonchol, 2008).

In 2011, publication of the report “Global Food Losses and Food Waste – Extent, Causes and Prevention” by the FAO (2011) indicated that the food problem continued to plague the world, which required rethinking the loss and waste issues. The report emphasized that research studies conducted by the Swedish Institute for Food and Biotechnology (SIK) revealed that approximately one-third of the global annual food production was lost or wasted. Other studies had been published before release of this report, but in isolation (Belik, 2018b).

The FLW minimization targets emerged more clearly in the Declaration of Sustainable Development Goals for 2030, agreed upon by 150 leaders at the United Nations General Assembly in 2015. According to Belik (2018b), this may have been influenced by greater understanding about the topic as a result of several research studies. The same author highlights that Brazil was successful in implementing policies to combat hunger until then, although it only began to address the FLW issue with more vigor after 2015 when the 5th National Conference on Food and Nutritional Security was held in Brasilia. Subsequently, according to Henz and Porpino

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(2017), “[...] Brazil seems to have woken up to the Food Loss and Waste (FLW) problem”.

According to major programs, such as the United Nations Environment Programme (UNEP), we are experiencing a serious “Food Waste epidemic”. This serves as a reminder that, in addition to all the environmental concerns associated with FLW, in 2019, that is to say during the COVID-19 pre-pandemic, almost 700 million people were already experiencing malnutrition conditions (PNUMA, 2021). Furthermore, considering FLW at the end of the chain, it is estimated that, in 2019, 61% of these situations took place in households, 26% in food services and 13% in retail (PNUMA, 2021).

In economic terms, FLW represents an annual value of US\$ 1 trillion worldwide, with the largest amount in industrialized countries (US\$ 680 billion) (Melo, 2018). In relation to FLW-related carbon emissions, the main responsible countries/continents are Europe, the United States and industrialized Asia; in turn, as it has a slightly greater contribution than the world average, Latin America does not stand out in this ranking (FAO, 2013). The social cost of the carbon emitted worldwide as a result of FLW is approximately US\$ 411 billion per year, which includes both damage and defense expenses associated with climate change (Scialabba, 2019).

Coudard *et al.* (2021) analyzed the water and energy losses associated with FLW that might be mitigated (Avoidable Food Waste) and identified significant amounts of wasted water resources, comparable to the combined annual consumption of Mexico and Vietnam, as well as of energy resources, equivalent to the combined consumption of

Germany and France, two of the largest economies in the planet. Therefore, it is incomprehensible that food that is completely fit for consumption reaches the end of the chain and is simply not used.

Despite FLW severity, the debate on the topic is still disproportionate across different nations with scarcely robust data (Filimonau & Ermolaev, 2021; Munir, 2022). The areas with the greatest data coverage include Europe, North America, Australia and New Zealand. In addition to the geographical limitations, the diverse information available from the retail and food service sectors, in which commercial FNUs fall, is much scarcer than that from households (PNUMA, 2021).

Due to the severe situation concerning FLW, the topic is represented by Target 12.3 from the Sustainable Development Goals (SDGs), which stipulates reducing by half global food waste per capita in retail and consumers by 2030, as well as reducing food loss throughout production and supply chains (Souza *et al.*, 2021). This is also one of the pillars of the Community of Latin American and Caribbean States (Comunidad de Estados Latino-Americanos e Caribenhos, CELAC) 2025 Action Plan for food security, nutrition and hunger eradication (CELAC, 2016), which reinforces the importance of discussing the subject matter and proposing public policies to combat FLW.

### **3. Methodology**

The starting point was bibliographical survey carried out by Zaro *et al.* (2020) in different media<sup>1</sup>, where 65 factors were identified that may adversely

<sup>1</sup> Standards and legislation, scientific articles, reports, abstracts, course conclusion papers, dissertations, theses in printed or digital media (CAPES Thesis Bank, Event annals, *Google*, *Google Scholar* and databases such as *Science Direct*, *Scopus* and *SciELO*).

affect the incidence of Food Loss and Waste in Food and Nutrition Units. These factors were organized and categorized in a spreadsheet created in Excel, namely: customer profile; food supply acquisition, receipt and storage; space, planning and procedures for meal preparation; food distribution in the FNU cafeteria; devices; collaborators; manuals; FNU policy; and solid waste and/or leftover management. Next to each of them, two blank columns were included, one for assigning values referring to Detection and solution ease (D) and the other to severity (S). These values were checked by *ad hoc* consultants with training in Nutrition. They were invited after a consultation carried out in the Thesis Bank of the Coordination for the Improvement of Higher Education Personnel (Coordenação de

Aperfeiçoamento de Pessoal de Nível Superior, CAPES), in the Lattes Curriculum, in journals, in event annals and in publications that made it possible to recognize the participants' proximity to the FLW and FNU topic.

A total of 106 individuals were directly contacted through email or WhatsApp messages, in addition to 10 coordinators of undergraduate and/or graduate courses in Nutrition from different Brazilian universities. The participating consultants received a Free and Informed Consent Form (FICF) and diverse information on how to fill out the spreadsheet. The guidelines for determining the indices referring to the D and S values were adapted by the authors based on Andrade & Turrioni (2000) and are presented in Tables 1 and 2.

TABLE 1 – Guidelines for determining the indices referring to detection and resolution ease of the factors related to Food Loss and Waste generation in FNUs.

INDEX	DETECTION AND RESOLUTION EASE
1-2	The factor is easy to detect, and the solution can be fast.
3-4	The factor is easy or moderate to detect, and the solution can be effectively implemented in the medium- or long-term.
5-6	The factor is moderate or difficult to detect, and the solution can be fast.
7-8	The factor is moderate or difficult to detect, and the solution can be effectively implemented in the medium- or long-term.
9-10	The factor is very difficult or impossible to detect, and the solution may be unfeasible.

SOURCE: adapted by the authors from Andrade & Turrioni (2000).

TABLE 2 – Guidelines for determining the indices referring to severity of the factors related to the Food Loss and Waste generation in FNUs.

INDEX	SEVERITY
1-2	The factor exerts a very low influence on FLW generation.
3-4	The factor exerts a low influence on FLW generation, but may be representative in the long-term.
5-6	The factor exerts a moderate influence on FLW generation and may be representative in the medium- or long-term.
7-8	The factor exerts a high influence on FLW generation and may be representative in the short- or medium-term.
9-10	The factor exerts a very high influence on FLW generation and may be representative immediately or in the short-term.

SOURCE: adapted by the authors from Andrade & Turrioni (2000).

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The sampling type adopted for the consultants was non-probabilistic. It is acceptable when the size of a sample is difficult to obtain. Among the different formats of this sampling type, there is judgmental (or intentional) sampling. Thus, the researcher makes judgments about the members of a population that can present accurate information. In this case, specialized professionals can be chosen, such as the *ad hoc* consultants included in this research. In certain instances, non-probability methods may even be preferable and lead to satisfactory results (Oliveira, 2001). This sampling type is useful because it allows data collection to be ceased when the diverse information provided by the participants points to a repetition of ideas/subject matters and new information is no longer added.

The final index values for D and S were obtained by calculating the central tendency of the answers (values assigned based on the detection, resolution and severity indices). Among the best-known tendency measures are arithmetic mean (Me) and median (Md). Each of them has advantages and disadvantages, depending on the data and desired purposes. When the data are symmetrical, they tend to point to the same value (Feijoo, 2010; ENAP, 2015). The data median set is the value that divides the data into two equal halves and has the advantage of being less affected by extreme observations (outliers). It is usually the preferred measure when distribution is not symmetric (Montgomery & Runger, 2012). Given the above, and as a compromise, it was decided to adopt the median in this study. For the purpose of comparing and interpreting the results, the arithmetic mean is also presented in the Results section, together with the standard deviations (SDs). The guidelines presented

to the *ad hoc* consultants represent approximates on a scale from 1 to 10.

It was agreed that the factors that presented medians relating to D greater than or equal to 9 (a very difficult or impossible aspect to detect and a possibly unfeasible solution) would be disregarded from the final spreadsheet. The same was done when the medians for S were less than or equal to 2 (very low influence on Food Loss and Waste generation). Subsequently, the remaining factors were reorganized in an Excel spreadsheet, including the medians for D and S and an additional column for their occurrence (O). In the event of a situation that leads to possible FLW generation, a value of 1 was assigned. In opposition, when there is no occurrence, a value of zero was assigned. The D, S and O values for each line, referring to each factor, were multiplied and added up, allowing the General Index (GI) to be obtained. The sum of the values from all lines leads to the total General Index (GI<sub>t</sub>) value. According to the proposal herein presented, the lower this value, the better the performance of an FNU in combating FLW. The factors that are not applicable (n/a) to a specific Food and Nutrition Unit can be deleted from the spreadsheet.

#### **4. Results**

A total of 14 *ad hoc* consultants with training in Nutrition took part in the research, including nine PhDs, two MScs and three specialists.

In relation to the general Detection and resolution ease (D), that is to say, considering the 65 factors, it is found that 89.2% (f=58) of the median values are less than or equal to 4, indicating that the factors are of easy or moderate detection and capable of being solved. In addition, only five fac-

tors had medians equal to 5. Such being the case, no factor would need to be suppressed according to the criteria provided for in the methodology.

According to the *ad hoc* consultants, the median values for severity (S) varied between 1 and 10, with 73.8% (f=48) of all 65 factors considered referring to values greater than or equal to 7, representing high or very high severity. Therefore, it can be inferred that, for the most part, the factors selected are considered relevant when it comes to severity. Only the factor related to the information on physical activities, in the section referring to the customer profile, presented a median value that lies within the cutoff line foreseen in the methodology, that is, equal to or less than 2, and which represents very low severity.

Subsequently, to ease interpretation of the results, the factors are analyzed in categories – Tables 3 to 11. Table 3 shows frequencies, mean values, medians and standard deviations in relation to the indices assigned by the *ad hoc* consultants for the eight factors that relate FLW with the customer

profile in terms of Detection and resolution ease (D) and Severity (S).

In relation to Detection and solution ease, no factor had a median value greater than 5, meaning that in no case is detection very difficult or impossible and the solution unfeasible. However, the median values were higher in this group, indicating more difficult and time-consuming detection and resolution, respectively. An evident proof of this is that, when the eight factors referring to this subgroup are disregarded, 96.5% (f=55) of the median values are equal to or less than 4, evidencing their impact on the general results (89.2%). Among the eight subgroup factors, standard deviation values varying between 2.1 and 3.1 are also found. However, considering the remaining 57 factors, classified in other subgroups, 77.2% (f=44) of the values obtained for the standard deviation are equal to or lower than the smallest standard deviation obtained in the customer profile subgroup (2.1). These observations evidence high dissonance between the values presented by the *ad hoc* consultants for each of the factors referring to this subgroup. In

TABLE 3 – Frequencies, mean values, medians and standard deviations referring to the indices assigned by the *ad hoc* consultants for the factors that relate FLW with the customer profile in terms of detection and resolution ease and severity.

Customer Profile		Detection and Resolution (D)				Severity (S)			
Factors		<i>f</i>	<i>M<sub>e</sub></i>	<i>M<sub>d</sub></i>	<i>SD</i>	<i>f</i>	<i>M<sub>e</sub></i>	<i>M<sub>d</sub></i>	<i>SD</i>
1	No gender data	14	2.6	2	2.1	14	3.6	3.5	2.1
2	No data on eating habits, preferences and intolerances	14	4.8	5	2.4	14	6.5	7	2.9
3	No age group data	14	3.2	2	2.5	14	4	3.5	2.1
4	No physical activity data	14	5.1	5	3.1	14	2.7	2	2
5	No schooling data	14	4.6	4.5	2.8	14	4.2	4.5	1.8
6	No socioeconomic level data	14	4.9	5	2.8	14	5.3	5	2.1
7	No religion data	14	4.9	5	3.1	14	3.6	3	2.4
8	No customer origin data	14	4.1	3.5	2.6	14	4.1	3.5	2.4

SOURCE: prepared by the authors (2022).

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other words, it seems to be no clarity or consensus in relation to the detection and resolution ease of the factors from this small subgroup among the subjects who participated in the research.

In relation to severity of the factors in this same subgroup, only one factor presented a median that represents a high influence on FLW generation; in this case, it does not have data on the customers' eating habits, preferences and intolerances. As observed for detection and resolution ease, the subgroup again proved to represent a large influence on the general results. If we disregard its 8 factors, the percentage of medians with severity values greater than or equal to 7 rises from 73.8% to 82.5% ( $f=47$ ). And from an opposite perspective, focusing only on the aforementioned subgroup (customer profile), only 12.5% of the median values ( $f=1$ ) would represent values equal to or above 7. Therefore, it is assumed that the customer data are not that important in relation to FLW control from the *ad hoc* consultants' point of view and considering severity. The standard deviation corresponding to the medians of the factors in the same subgroup varied between 1.8 and 2.9. Taking into account the remaining 57 factors classified in other subgroups, 42.1% ( $f=24$ ) of the values obtained for the standard deviation are equal to or lower than the smallest standard deviation obtained in the subgroup (1.8). To summarize, whether viewed from the detection and resolution ease or severity perspectives, the factors pertaining to the subgroup referring to the customer profile are controversial among the *ad hoc* consultants.

Table 4 presents the frequencies, mean values, medians and standard deviations of the indices assigned by the *ad hoc* consultants for the factors that relate FLW to supply acquisition, receipt and storage

in terms of detection and resolution (D) ease and severity (S). Among the 15 factors in the subgroup, 73.3% ( $f=11$ ) have medians for detection and resolution ease equal to or less than 2; in other words, the factors were considered easy to detect and have fast solutions. Only the factor that deals with the presence of humidity in storage areas for dry goods reached a value of 4, although still representing a factor that is easy or moderate to detect and capable of being solved. The standard deviations varied between 1.3 and 2.3, remembering that the lowest value was equal to 2.1 in the previous subgroup (customer profile).

In relation to severity, 93.3% ( $f=14$ ) of the subgroup factors presented median values greater than or equal to 7, that is, signaling a high or very high influence on Food Loss and Waste generation, according to the *ad hoc* consultants. The standard deviations referring to severity in the subgroup varied between 1.4 and 2.9, with the highest values observed for the factors related to checking the food amounts delivered by the suppliers and providing information to the suppliers about the FNU valuing FLW control. As for this last factor, despite the higher standard deviation value when compared to values of other factors, Dal'Magro (2019) supports its importance by reporting that the sustainable food system construction, with consumers aware of the difficulties related to food production and the value of food itself, requires efforts from all actors in the food chain. Therefore, Food and Nutrition Units and their suppliers should be aligned regarding FLW control, and this occurs through communication between the parties.

The frequencies, mean values, medians and standard deviations referring to the indices assigned by the *ad hoc* consultants for the 14 factors that

TABLE 4 – Frequencies, mean values, medians and standard deviations referring to the indices assigned by the *ad hoc* consultants for the factors that relate FLW with food supply acquisition, receipt and storage in terms of detection and resolution ease and severity.

Food supply acquisition, receipt and storage		Detection and Resolution (D)				Severity (S)			
		<i>f</i>	<i>M<sub>e</sub></i>	<i>M<sub>d</sub></i>	<i>SD</i>	<i>f</i>	<i>M<sub>e</sub></i>	<i>M<sub>d</sub></i>	<i>SD</i>
9	Does not purchase fresh, locally sourced food products	14	3.1	3	1.8	14	5.5	5	2.4
10	Does not prefer seasonal food products	14	2.6	2.5	1.9	14	6.6	7	2.4
11	Does not check expiration dates on food products delivered by suppliers	14	2.4	1.5	2.1	14	8.1	8	2.4
12	Does not check the food amounts delivered by suppliers	14	2.5	1.5	2.1	14	7	7.5	2.9
13	Does not check the quality specifications of food products delivered by suppliers	14	2.6	2	2.1	14	8.6	9.5	1.5
14	Does not check integrity of the food packaging received	14	2.5	2	2.1	14	8	8	2
15	Does not monitor the expiration dates of food products in stock	14	2.2	2	1.9	14	8.4	8.5	1.8
16	Does not monitor the food amounts in stock	14	2.4	2	1.8	14	8.6	9	1.4
17	Does not monitor the quality specifications of food products in stock	14	2.6	2	1.8	14	8.4	8.5	1.5
18	Does not inform suppliers that the FNU values FLW control	14	1.8	1	1.3	14	6.6	8	2.9
19	There is humidity in the storage areas for dry goods	14	4.3	4	1.9	14	7.9	8	1.8
20	Does not control temperature in storage areas	14	3.4	3	2.2	14	7.9	7.5	1.8
21	Does not have periodic cleaning procedures for storage areas	14	2.6	2	2.3	14	7.4	7.5	2
22	Does not carry out periodic pest control actions in the storage areas for perishable and non-perishable food products	14	2.7	2	2.1	14	8.1	8	1.9
23	Does not carry out FIFO (First In – First Out) stock movement	14	2.4	2	1.5	14	7.7	8	2.6

SOURCE: prepared by the authors (2022).

relate FLW with space, planning and procedures for preparing meals in terms of detection and resolution ease (D) and severity (S) are presented in Table 5. As for detection and resolution ease, only lighting control in the kitchen reached a median of 5. This value denotes that the factor is moderate or difficult to detect, but that its solution can be fast. In any

case, 78.6% ( $f=11$ ) of the factors had medians less than or equal to 3. The standard deviations varied between 1 and 2.4.

In the case of severity, the median of the factors maintained the upward trend observed in the preceding subgroup (food supply acquisition, receipt and storage), with 85.7% ( $f=12$ ) of the

TABLE 5 – Frequencies, mean values, medians and standard deviations referring to the indices assigned by the *ad hoc* consultants for the factors that relate FLW with space, planning and procedures for preparing meals in terms of detection and resolution ease and severity.

<b>Space, planning and procedures for meal preparation</b>		<b>Detection and Resolution (D)</b>				<b>Severity (S)</b>			
<b>Factors</b>		<i>f</i>	<i>M<sub>e</sub></i>	<i>M<sub>d</sub></i>	<i>SD</i>	<i>f</i>	<i>M<sub>e</sub></i>	<i>M<sub>d</sub></i>	<i>SD</i>
24	The number of customers is not estimated	14	2.8	2.5	1.9	14	9.3	10	1.2
25	Does not control ambient temperature in the kitchen	14	3.9	3	2	14	6.2	5.5	2.4
26	Does not control kitchen lighting	14	4	5	2.2	14	5.4	5	2.2
27	There is no nutritionist in charge	14	3	2.5	2.1	14	7.4	8	2.2
28	There is no per capita food standardization for preparations	14	3.6	4	2	14	8.4	8.5	1.7
29	There is no standardization of food correction factors	14	4.1	3.5	2.4	14	8.3	8.5	1.7
30	The menus are not in accordance with the region's climate	14	2.4	2	1.3	14	8.1	9	2.2
31	There is no customer satisfaction data on food appearance	14	2.6	3	1	14	7.6	8	1.8
32	There is no customer satisfaction data on food taste	14	2.6	3	1	14	7.5	8	1.7
33	There are no criteria for nutritional harmonization of food products	14	3.4	3	2.2	14	6.7	7.5	2.2
34	Does not make full use of the food	14	3.3	3	1.7	14	8.6	8.5	1.1
35	No hygiene requirements when preparing meals	14	2.8	3	1.3	14	8	8	2
36	Does not define and/or adapt the menu based on stock	14	2.9	2.5	1.8	14	8.9	9	1.1
37	No technical sheets/preparation recipes	14	3.2	3	1.2	14	8.1	9	1.9

SOURCE: prepared by the authors (2022).

median values above 7. The standard deviations varied between 1.1 and 2.4. It drew the attention that temperature and lighting controls in the kitchen were not considered as serious as the other factors in the subgroup, with median values of 5.5 and 5, respectively. These values represent factors that exert a moderate influence on Food Loss and Waste generation and that may only be representative in the medium- or long-term. Anyhow, in the case of lighting, item 4.1.8 from Resolution No. 216 dated

September 15th, 2004 (ANVISA, 2004), which provides for technical regulations on good practices for food services, reports that lighting in the preparation area should provide good viewing so as not to compromise the food hygiene and sensory characteristics.

Table 6 presents the frequencies, mean values, medians and standard deviations of the indices assigned by the *ad hoc* consultants for the 14 factors that relate FLW with food distribution in the

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cafeteria in terms of detection and resolution ease (D) and severity (S). In relation to detection and resolution ease, all factors (f=14) presented median values lower than 4, that is, a range in which detection is not difficult and the solution is possible, and may even be fast. The standard deviations varied between 1.3 and 2.7. The factor referring to the provision of means for customers to take their leftover meals home was the one that presented the highest standard deviation (2.7). The dissonance becomes evident when it is observed that 71.4% (f=10) of the subgroup factors presented standard deviations less than or equal to 2. These numbers denote possible absence of consensus among the *ad hoc* consultants in relation to detection and resolution ease of the factor that deals with offering customers the means to take their leftovers home. In this sense, the observation presented below, contributed by one of the consultants in the data collection instrument, reinforces the finding:

I had doubts about the question “Does not offer ways for customers to take leftovers home”, as it involves three issues: packaging, the leftovers themselves, given that there was already waste, in addition to the hygienic-sanitary issue (time x temperature), even if there was authorization for distribution of the leftovers.

When it comes to severity, 35.7% (f=5) of the factors had medians lower than 7, signaling little relevance regarding FLW, although still important and above the cutoff line defined in the method. Namely: temperature and lighting controls in the cafeteria; existence of data about customer satisfaction with the physical space; offering means for customers to take leftovers home; and, interestingly,

carrying out informative and/or awareness-raising practices aimed at customers. The other factors, that is, 64.3% (f=9), had medians greater than or equal to 7, showing high severity in terms of Food Loss and Waste generation. The variation in standard deviations (between 1.2 and 3.3) was higher than those observed in the previous subgroups. While 42.8% (f=6) of the standard deviations were less than or equal to 2, for comparison purposes, in subgroups 2 and 3 the percentages were 60% and 64.3%, respectively.

The frequencies, mean values, medians and standard deviations referring to the indices assigned by the *ad hoc* consultants for the factor that relates FLW with adequate functionality of devices in FNUs in terms of detection and resolution ease (D) and severity (S) are presented in Table 7. Relatively low median values for detection and resolution ease ( $\leq 5$ ) and high severity scores ( $\geq 7$ ) were observed, in accordance with the general trend identified across the 65 factors. When compared to values seen in other subgroups, the standard deviations did not stand out in any aspect. Item 4.1.16 from Resolution No. 216 (ANVISA, 2004) states that Food and Nutrition Units should carry out scheduled and periodic maintenance of devices and utensils, as well as calibrate instruments or measuring equipment, keeping records of when these operations are performed.

Table 8 presents the frequencies, mean values, medians and standard deviations referring to the indices assigned by the *ad hoc* consultants for the three factors that relate FLW with the employees in terms of detection and resolution ease (D) and severity (S). In relation to the results obtained, an observation about the factor that deals with con-

TABLE 6 – Frequencies, mean values, medians and standard deviations referring to the indices assigned by the *ad hoc* consultants for the factors that relate FLW with food distribution in the cafeteria in terms of detection and resolution ease and severity.

Food distribution in the FNU cafeteria		Detection and Resolution (D)				Severity (S)			
Factors		<i>f</i>	<i>M<sub>e</sub></i>	<i>M<sub>d</sub></i>	<i>SD</i>	<i>f</i>	<i>M<sub>e</sub></i>	<i>M<sub>d</sub></i>	<i>SD</i>
38	Does not control ambient temperature in the cafeteria	14	3.1	3	2.2	14	5.2	5.5	2.4
39	Does not control ambient lighting in the cafeteria	14	3.3	3	1.6	14	4.8	5.5	2.8
40	There is no criteria for the size of the dishes offered	14	3.1	3	1.4	14	7.9	8	1.8
41	The serving sizes are not flexible	14	2.7	2.5	1.7	14	8.4	8	1.2
42	There is no control over the temperatures of hot and cold preparations served	14	2.9	3	1.8	14	7.8	7.5	2.1
43	There is no control over the exposure time of the preparations served	14	2.8	3	1.8	14	8.1	8.5	1.8
44	Performs automatic food offers	14	2.9	3	1.3	14	8	8	1.9
45	Does not present information about the food products offered (e.g., ingredients)	14	4	3.5	2.2	14	7.1	7.5	2.1
46	Does not use buckets with varying depths on the buffet in order to meet variations in demand	14	3.4	3	2.4	14	7.8	8	1.8
47	There are no hygiene requirements in the cafeteria during meals	14	2.6	2	1.9	14	7.2	7	2.4
48	No data about customer satisfaction with meals	14	2.6	2	1.9	14	7.1	8	2.4
49	No data about customer satisfaction with the physical space	14	3.4	3	2.2	14	5.1	4.5	2.2
50	Does not offer ways for customers to take leftovers home	14	3.8	3.5	2.7	14	5.5	5	3.3
51	Does not carry out informative/awareness-raising practices aimed at customers	14	2.5	2.5	1.7	14	6.7	6.5	1.8

SOURCE: prepared by the authors (2022).

TABLE 7 – Frequencies, mean values, medians and standard deviations referring to the indices assigned by the *ad hoc* consultants for the factor that relates FLW to the devices in terms of detection and resolution ease and severity.

Devices		Detection and Resolution (D)				Severity (S)			
Factors		<i>f</i>	<i>M<sub>e</sub></i>	<i>M<sub>d</sub></i>	<i>SD</i>	<i>f</i>	<i>M<sub>e</sub></i>	<i>M<sub>d</sub></i>	<i>SD</i>
52	Does not have a preventive plan for checking and maintaining devices	14	4.4	4.5	2.1	14	7.1	7	2.2

SOURCE: prepared by the authors (2022).

trolling the employees' working hours is pertinent. This is because, contrary to the trend observed across the 65 factors from all subgroups, the median

value for severity was below 7. Although a higher median value was expected, it still represents considerable severity, varying between moderate and

high. According to NBR ISO 22000 (ABNT, 2019), which deals with “Food security management systems – Requirements for any organization in the food production chain”, an organization should determine, provide and maintain the resources necessary for establishing, managing and maintaining the work environment. A suitable environment can be a combination of social, psychological and physical factors. In the case of the psychological factor, attention should be paid to controlling stress and preventing exhaustion.

The frequencies, mean values, medians and standard deviations of the indices assigned by the *ad hoc* consultants for the factors that relate FLW to absence of manuals in relation to detection and resolution ease (D) and severity (S) are shown in Table 9. Among the results obtained, the median value referring to the severity of not having a Good

Practices Manual (GPM) stood out, which was below 7, representing a moderate to high influence on Food Loss and Waste generation. According to Resolution No. 216 (ANVISA, 2004), FNUOs should have a Good Practices and Standardized Operating Procedures Manual, which must be accessible to the employees and available to the health authority. According to the publication prepared by ANVISA (2020, p. 40) and entitled “Booklet on Good Practices for Food Services”, the Good Practices Manual is:

[...] a document that describes the work performed in the facilities and the correct way to do it. In it, general information can be found about how cleaning is carried out, pest control, water use, employee hygiene and health control procedures, employee training, what to do with waste, and how to ensure safe and healthy food production.

TABLE 8 – Frequencies, mean values, medians and standard deviations referring to the indices assigned by the *ad hoc* consultants for the factors that relate FLW with the employees in terms of detection and resolution ease and severity.

<b>Employees</b>		<b>Detection and Resolution (D)</b>				<b>Severity (S)</b>			
<b>Factors</b>		<i>f</i>	<i>M<sub>e</sub></i>	<i>M<sub>d</sub></i>	<i>SD</i>	<i>f</i>	<i>M<sub>e</sub></i>	<i>M<sub>d</sub></i>	<i>SD</i>
53	No control over maximum working hours	14	3.1	3	2.2	14	6.6	6.5	2.1
54	Does not provide periodic training for employees on FLW	14	2.8	3	1.8	14	8.4	8.5	1.8
55	Does not promote motivational actions for employees in the workplace	14	2.7	2	1.5	14	6.9	7	2

SOURCE: prepared by the authors (2022).

TABLE 9 – Frequencies, mean values, medians and standard deviations referring to the indices assigned by the *ad hoc* consultants for the factors that relate FLW with manuals in terms of detection and resolution ease and severity.

<b>Manuals</b>		<b>Detection and Resolution (D)</b>				<b>Severity (S)</b>			
<b>Factors</b>		<i>f</i>	<i>M<sub>e</sub></i>	<i>M<sub>d</sub></i>	<i>SD</i>	<i>f</i>	<i>M<sub>e</sub></i>	<i>M<sub>d</sub></i>	<i>SD</i>
56	Does not have a Good Practices Manual (GPM)	14	3.5	3	2	14	7	6.5	2.2
57	Does not have a Standard Operating Procedures (SOP) manual	14	3.4	3	2	14	7	7	2.2

SOURCE: prepared by the authors (2022).

Nevertheless, the fact that the *ad hoc* consultants did not consider the absence of a GPM as severe can be attributed to the simple formality assumption that the document sometimes seems to assume, as evidenced by the information contributed by one of the consultants in the data collection instrument: In the FNU area, we know that there's a huge gap between having the manual and having the manual implemented, actually being put into practice in the FNU.

Table 10 presents the frequencies, mean values, medians and standard deviations referring to the indices assigned by the *ad hoc* consultants for the factor that relates FLW and the FNU policy regarding detection and solution ease (D) and severity (S). It was observed that the median values and standard deviations followed the general trend identified across the 65 factors in all subgroups. However, the median for severity presented a remarkable value of 9, which signals that the consultants understand that existence of an institutionalized policy covering the fight against Food Loss and Waste as very important, as its absence would be considered serious. However, results of a research study carried out by Vizzoto *et al.* (2020) with hotel, restaurant and cafeteria managers in Italy show that the FLW topic does not always receive due attention. For example, the researchers found that one out of five managers views it as irrelevant.

Table 11 presents the frequencies, mean values, medians and standard deviations referring to the indices assigned by the *ad hoc* consultants for the seven factors that relate FLW with solid waste and/or leftover management in terms of detection and resolution ease (D) and severity (S). In 100% of the cases ( $f=7$ ), the medians of the factors for detection and resolution ease were less than or equal to 4, that is, pointing to easy or moderate detection and a possible solution in the short- or medium-term. The standard deviations varied between 1.7 and 2.7, with the highest value attributed to the factor related to food waste treatment. Despite the higher standard deviation value, which may indicate absence of consensus among the consultants, Zago & Barros (2019) indicate that recognizing organic waste as a resource can benefit not only Brazilian municipalities but also companies and agriculture, which can boost job generation and contribute to cost reductions related to urban solid waste disposal in landfills. However, this is not always the case, as evidenced, for example, by the research study carried out by Aamir *et al.* (2018) where, out of 58 restaurants in Pakistan, only six recycled food waste.

In relation to severity, it was verified that all values were above 8, that is, signaling a high or very high influence on FLW generation with impacts that can be representative even in the short-term. The highest standard deviation among the subgroup factors in relation to severity was observed for the

TABLE 10 – Frequencies, mean values, medians and standard deviations referring to the indices assigned by the *ad hoc* consultants for the factor that relates FLW with the FNU policy regarding detection and resolution (D) and severity (S).

FNU Policy		Detection and Resolution (D)				Severity (S)			
		<i>f</i>	<i>M<sub>e</sub></i>	<i>M<sub>d</sub></i>	<i>SD</i>	<i>f</i>	<i>M<sub>e</sub></i>	<i>M<sub>d</sub></i>	<i>SD</i>
58	It does not have an institutional policy covering the fight against FLW	14	4.5	4	1.7	14	8.7	9	1.7

SOURCE: prepared by the authors (2022).

factor related to food donation (3.5). In the research, diverse evidence of doubts and disagreements among the Nutrition professionals consulted were observed about food donation from commercial FNUs, mainly due to sanitary concerns. For example, one of the *ad hoc* consultants expressed himself informally when handing over the data collection instrument, indicating his insecurity about food donation.

In order to explain the results obtained for the “food donation” factor, in addition to the possible distrust among Nutrition professionals in donating food, it must be considered that the practice is still new in Brazil, at least formally, as well as the recent enactment of Federal Law No. 14,016 dated June 23rd, 2020 (Brasil, 2020), which encourages donations. In addition, it is possible to infer that this distrust and/or discomfort is related to the factor referring to offering means for customers to take leftovers home.

In relation to the general values obtained for means and medians, regardless of the factor or in-

dex treated (detection and resolution and severity), it was verified that the differences did not present values that represented asymmetry relevant to the study.

As a final result of the research carried out with the *ad hoc* consultants, Table 12 presents the spreadsheet prepared in Excel, where D represents detection and resolution ease, S severity and O the occurrence of a given situation. The abbreviation GI represents the General Index, the result of multiplying the D, S and O values in each line, whereas GI<sub>t</sub> refers to the total General Index, the result of adding up the GI values. The spreadsheet (Table 12) allows evaluating and comparing the performance of different FNUs in terms of FLW control.

The spreadsheet presented in Table 12 represents an innovation in pointing out factors to be observed by the FNUs with a view to adequate FLW management, in addition to allowing different food services to be compared and properly qualified in terms of their performance towards the customers.

TABLE 11 – Frequencies, mean values, medians and standard deviations referring to the indices assigned by the *ad hoc* consultants for the factors that relate FLW to the solid waste and/or leftover management in terms of detection and resolution ease and severity.

Solid waste and/or leftover management		Detection and Resolution (D)				Severity (S)			
Factors		<i>f</i>	<i>M<sub>e</sub></i>	<i>M<sub>d</sub></i>	<i>SD</i>	<i>f</i>	<i>M<sub>e</sub></i>	<i>M<sub>d</sub></i>	<i>SD</i>
59	Does not quantify or record food waste	14	4	3	2.5	14	8.7	9	1.4
60	Does not have a Solid Waste Management Plan (SWMP)	1	4.6	4	1.7	14	8.1	8	1.7
61	Does not segregate solid waste	14	4	4	2	14	7.9	8	1.7
62	Does not provide adequate cooking oil disposal for treatment with a view to reusing it for another purpose	14	2.9	2.5	1.7	14	7.9	8.5	2.4
63	Does not treat the solid food waste generated	14	4.4	4	2.7	14	7.7	8	2.6
64	Does not carry out periodic training of employees for solid waste management	14	3.2	3	2	14	8.2	9	1.6
65	Does not donate food	14	3.4	3	2.1	14	6.6	8	3.5

SOURCE: prepared by the authors (2022).

TABLE 12 – Spreadsheet proposal to evaluate and compare performance of the FNU in FLW control terms.

<b>FACTORS</b>		<b>INDICES</b>			
<b>Customer profile</b>		<b>D</b>	<b>S</b>	<b>O</b>	<b>GI</b>
1	No gender data	2	3.5		
2	No data on eating habits, preferences and intolerances	5	7		
3	No age group data	2	3.5		
4	No schooling data	4.5	4.5		
5	No socioeconomic level data	5	5		
6	No religion data	5	3		
7	No customer origin data	3.5	3.5		
<b>Food supply acquisition, receipt and storage</b>		<b>D</b>	<b>S</b>	<b>O</b>	<b>GI</b>
8	Does not purchase fresh, locally sourced food products	3	5		
9	Does not prefer seasonal food products	2.5	7		
10	Does not check expiration dates on food products delivered by suppliers	1.5	8		
11	Does not check the food amounts delivered by suppliers	1.5	7.5		
12	Does not check the quality specifications of food products delivered by suppliers	2	9.5		
13	Does not check integrity of the food packaging received	2	8		
14	Does not monitor the expiration dates of food products in stock	2	8.5		
15	Does not monitor the food amounts in stock	2	9		
16	Does not monitor the quality specifications of food products in stock	2	8.5		
17	Does not inform suppliers that the FNU values FLW control	1	8		
18	There is humidity in the storage areas for dry goods	4	8		
19	Does not control temperature in storage areas	3	7.5		
20	Does not have periodic cleaning procedures for storage areas	2	7.5		
21	Does not carry out periodic pest control actions in the storage areas for perishable and non-perishable food products	2	8		
22	Does not carry out FIFO (First In – First Out) stock movement	2	8		
<b>Space, planning and procedures for meal preparation</b>		<b>D</b>	<b>S</b>	<b>O</b>	<b>GI</b>
23	The number of customers is not estimated	2.5	10		
24	Does not control ambient temperature in the kitchen	3	5.5		
25	Does not control kitchen lighting	5	5		
26	There is no nutritionist in charge	2.5	8		
27	There is no per capita food standardization for preparations	4	8.5		
28	There is no standardization of food correction factors	3.5	8.5		
29	The menus are not in accordance with the region's climate	2	9		
30	There is no customer satisfaction data on food appearance	3	8		

31	There is no customer satisfaction data on food taste	3	8		
32	There are no criteria for nutritional harmonization of food products	3	7.5		
33	Does not make full use of the food	3	8.5		
34	No hygiene requirements when preparing meals	3	8		
35	Does not define and/or adapt the menu based on stock	2.5	9		
36	No technical sheets/preparation recipes	3	9		
<b>Food distribution in the FNU cafeteria</b>		<b>D</b>	<b>S</b>	<b>O</b>	<b>GI</b>
37	Does not control ambient temperature in the cafeteria	3	5.5		
38	Does not control ambient lighting in the cafeteria	3	5.5		
39	There is no criteria for the size of the dishes offered	3	8		
40	The serving sizes are not flexible	2.5	8		
41	There is no control over the temperatures of hot and cold preparations served	3	7.5		
42	There is no control over the exposure time of the preparations served	3	8.5		
43	Performs automatic food offers	3	8		
44	Does not present information about the food products offered (e.g., ingredients)	3.5	7.5		
45	Does not use buckets with varying depths on the buffet in order to meet variations in demand	3	8		
46	There are no hygiene requirements in the cafeteria during meals	2	7		
47	No data about customer satisfaction with meals	2	8		
48	No data about customer satisfaction with the physical space	3	4.5		
49	Does not offer ways for customers to take leftovers home	3.5	5		
50	Does not carry out informative/awareness-raising practices aimed at customers	2.5	6.5		
<b>Devices</b>		<b>D</b>	<b>S</b>	<b>O</b>	<b>GI</b>
51	Does not have a preventive plan for checking and maintaining devices	4.5	7		
<b>Employees</b>		<b>D</b>	<b>S</b>	<b>O</b>	<b>GI</b>
52	No control over maximum working hours	3	6.5		
53	Does not provide periodic training for employees on FLW	3	8.5		
54	Does not promote motivational actions for employees in the workplace	2	7		
<b>Manuals</b>		<b>D</b>	<b>S</b>	<b>O</b>	<b>GI</b>
55	Does not have a Good Practices Manual (GPM)	3	6.5		
56	Does not have a Standard Operating Procedures (SOP) manual	3	7		
<b>FNU Policy</b>		<b>D</b>	<b>S</b>	<b>O</b>	<b>GI</b>
57	It does not have an institutional policy covering the fight against FLW	4	9		
<b>Solid waste and/or leftover management</b>		<b>D</b>	<b>S</b>	<b>O</b>	<b>GI</b>
58	Does not quantify or record food waste	3	9		

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59	Does not have a Solid Waste Management Plan (SWMP)	4	8
60	Does not segregate solid waste	4	8
61	Does not provide adequate cooking oil disposal for treatment with a view to reusing it for another purpose	2.5	8.5
62	Does not treat the solid food waste generated	4	8
63	Does not carry out periodic training of employees for solid waste management	3	9
64	Does not donate food	3	8

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**GI**

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According to diverse information on the Michelin Guide website, it has valued sustainability practices in restaurants (commercial FNU) since 2020, which includes those that avoid FLW, using the shamrock symbol to identify restaurants considered sustainable. The preference for organic and local suppliers and full food use are examples of criteria taken into account when considering FLW. The interest in conferring new value to FLW in restaurants from an end-of-chain perspective is also a Michelin Guide objective, with a focus on composting and biofertilizer production (Michelin Guide, 2019, 2020). However, this guide does not present the complete list of criteria used to determine the sustainability level of a restaurant. In this sense, critics questioned the absence of auditing and proof of more sustainable practices in restaurants recognized as sustainable (Pershan, 2020; Puglisi, 2020). In any case, the initiative indicates a growing concern about sustainability in FNUs.

In addition to the Michelin Guide, to the present day, no widely publicized sustainability stamps and/or standards (whether national or international) have been identified that directly address FLW in FNUs. There are already standards aimed at lodging facilities, such as NBR ISO 21401:2020, which deals with tourism and related services and

establishes the requirements for a sustainability management system for lodging facilities (ABNT, 2020), although without mentioning FLW in a direct way. The same occurs with NBR 15401:2014, which provides for the requirements for a sustainability management system (ABNT, 2014). Both standards are limited to encouraging local food and beverage supply that respects seasonality of the ingredients, adopting good food safety practices and giving preference to fresh food use.

Guides and standards are tools that can assist public policies in combating FLW. In this sense, Decree No. 58,862 dated July 19th, 2019, of the municipality of São Paulo, which established a municipal program to combat food waste and loss, draws our attention (São Paulo, 2019). The classification matrix proposed, which represents a management tool, can collaborate with initiatives such as the one presented by the municipality of São Paulo, allowing the performance of FNUs to be measured and compared in a more equal way in the fight against FLW. The use of management tools is still little explored in commercial FNUs, as shown by Santiago (2015). In a research study conducted at 12 restaurants from Rio de Janeiro between January and March 2015, it was possible to verify that the use of management tools is reduced.

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According to the author, it is believed that absence of these tools is related to the informality associated with the opening of businesses by entrepreneurs in the gastronomy area. In the final considerations of her paper, the researcher highlights the neglect in evaluating waste in the processes, whether as raw materials or in production and distribution of the dishes. Santiago (2015) also highlights: “Controlling waste in management processes provides necessary data, with real-time information, for immediate decision-making, from planning to financial control, becoming the fundamental gain point for the company”.

## 5. Conclusion

The study presented a proposal to fill a gap in the literature that refers to tools for evaluating and comparing services provided by FNUs regarding FLW. It is expected that the spreadsheet presented will contribute to better FNU management, which will help reduce Food Loss and Waste. It is a versatile instrument that allows adaptations depending on the type of service offered.

Among the research strengths, the initiative of comparing literature data with the perspective of *ad hoc* Nutrition consultants with specialized knowledge in FLW and/or practical experience in Food and Nutrition Units stands out.

Finally, it is suggested that more research be carried out to offer solutions for managing Food Loss and Waste in FNUs, including obtaining diverse information from managers and other employees of these units, as this problem requires a collective and interdisciplinary effort.

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