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Review

Environmental, Social and Economic Sustainability Indicators Applied to Food Services: A Systematic Review

Dayanne da Costa Maynard [1,*], Mayara Daré Vidigal [1], Priscila Farage [2], Renata Puppin Zandonadi [3], Eduardo Yoshio Nakano [4] and Raquel Braz Assunção Botelho [3,*]

1 Post-Graduation in Human Nutrition, University of Brasília, Brasília 70910-900, Brazil; mayara.dv3@gmail.com
2 Faculty of Nutrition from Federal University of Goias, Goiânia 74690-900, Brazil; priscilafarage@ufg.br
3 Department of Nutrition from the University of Brasília, Brasília 70910-900, Brazil; rezandonadi@gmail.com
4 Department of Statistics from the University of Brasilia, Brasilia, DF 70910-900, Brazil; eynakano@gmail.com
* Correspondence: day_nut@yahoo.com.br (D.d.C.M.); raquelbabotelho@gmail.com (R.B.A.B.)

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Abstract: Sustainability is the integration of actions focused on three pillars: environmental, social, and economical. Implementing sustainable development ranges from the pursuit of quality of life, and from environmental balance to break with the current pattern of development. Therefore, the objective of this work was to understand and analyze the sustainability indicators implemented in the production of meals in food services. The authors developed specific search strategies for Scopus, Web of Science, Pubmed, Lilacs, Google Scholar, and ProQuest Dissertations & Theses Global to perform the systematic review. The authors evaluated the methodological quality of the included studies using the Meta-analysis Statistical Assessment and Review Instrument (MASTARI). A total of 31 cross-sectional studies were analyzed. Twenty four (77.41%) of the studies had activities that covered the three indicators (environmental, social, and economic); 22.59% (n = 7) used two indicators in which 12.90% (n = 4) presented environmental and economic indicators and 9.67% (n = 3) with environmental and social indicators. This research indicates that the studies in food services are seeking to insert indicators that cover the three pillars of sustainable meal production. It is worth mentioning that in the literature, many works encompasses the importance of sustainability, but few explore which indicators are most applied or detail their implementation in food services. More studies are needed to estimate better the indicators being applied in food services.

Keywords: sustainability; green restaurant; social; environmental; economic

1. Introduction

Modern societal changes in the way of life, from the inclusion of women in the labor market, the difficulty of displacing workers, to long working hours, and the lack of time to prepare meals, have contributed to the increasing number of meals out of the home [1–3]. This demand increases the number of food services emerging in the market, contributing to the economic sector, increasing job opportunities, and generating income [3,4].

Food services are an organized service, intended for the preparation and provision of meals, paying attention to the quality of the production. Services should meet the needs of customers in nutritional, hygienic-sanitary, social, and also cultural aspects, covering commercial restaurants, coffee shops, fast-food, catering, canteens, among others [5,6].

Meal production has two components: food production and provision of the service [7]. During all stages of meal production, ranging from field production, transportation, receiving, storage, production, and distribution of the meal, some actions cause environmental and economic impacts [3,8].

In the 21st century, there is still incomprehension and misinformation about the environment and the seriousness of the environmental problems faced. Economic growth favors the unsustainable use of non-renewable resources and therefore acting to increase biodiversity, to reduce the carbon dioxide concentration in the atmosphere, and the acidification of the oceans is necessary. Even though economic growth has improved the living conditions of billions of people, globalization is causing severe environmental crises, leading increasingly to the exhaustion of nature and its natural resources [9,10].

Therefore, the lack of sustainable procedures in food services can have a substantial environmental impact with regards to the generation of waste, the inadequacy of the disposal of products and packaging, the use of chemicals, and the use of large amounts of water in various stages of the meal production process. Globally, the possible scarcity of natural resources has aroused the interest and awareness of professionals involved in many sustainable meal production procedures [11].

According to Sachs [12], sustainability is the integration of actions focused on three pillars: environmental, social, and economical. Implementing sustainable development ranges from the pursuit of quality of life to environmental balance to break the current pattern of development [1,13].

Concerning food waste, the social aspect is expressed by partnerships with food banks and national policies to monitor food losses, in addition to redistributing the surplus, with ethical and food security concerns. Social activities can generate community growth, involvement in social projects, and commitment to personal management. Regarding the environmental aspect, it is necessary to implement clean technologies, comply with current legislation, use of environmentally friendly products, and perform composting or anaerobic digestion. In the economic aspect, it is necessary to implement "resource efficiency"—managing losses and surpluses to maximize economic efficiency, in addition to focusing on the market to obtain results and maintain business strategies [14–16].

It is estimated that 20 to 30 L of water is used to prepare a meal in commercial restaurants and that these are responsible for around 69% of all the garbage discarded [4]. Thus, the lack of sustainable procedures in food services can have an important environmental impact, considering the generation of waste, the inadequacy of product and packaging disposal, the use of chemicals, and the large amounts of water in different stages of the meal production process [9].

It is essential to analyze and identify the stages of the meal production process that generate environmental impacts for future decision making and the implementation of methods for its control and reduction [17]. It is also important to establish actions aimed at the conscious use of energy and water, as well as the training and monitoring of those involved in the process, to make environmental policy a reality and to guarantee the hygienic-sanitary quality of the meals [5]. In this sense, this study looks to investigate what are the sustainability practices adopted by food services. The work is justified by the need to understand the aspects and impacts of the environmental dimension resulting from the activities of this important segment of the economy, investigating the application of the three pillars of sustainability: environmental, social, and economical in food services. It is worth mentioning that in the literature, many studies encompass the importance of sustainability, but few explore which indicators are most applied or detail their implementation in food services. Thus, the objective of this work was to understand and analyze the sustainability indicators implemented in the production of meals in food services.

2. Materials and Methods

The high impact of the use of natural resources, as well as the high production of solid waste caused by the production of meals, justify the importance and the need to evaluate the sustainability indicators that are being adopted in food services. Increasingly, nutritionists involved in this sector are looking for more sustainable alternatives to implement in food services as these actions will subsidize a healthier and more sustainable diet [18].

This systematic review was prepared according to the items of the report for systematic reviews and meta-analyses (PRISMA) and the Checklist [19]. No protocol registration in PROSPERO was required because the platform is not intended for reviews that have food or food services as their main research subject.

2.1. Inclusion and Exclusion Criteria

The inclusion criteria were studies that evaluated sustainability indicators in environmental, social, and/or economic aspects and that were implemented in food services, without language or time constraints. Case studies, experimental studies, and a quali-quantitative sample study were included. The exclusion criteria applied were: (1) comments, letters, conference, review, abstracts, papers, and books; (2) studies that only analyzed the importance or feasibility of implementing indicators but they did not implement them; (3) studies that were not performed in food services; (4) studies that focused on consumers, not in the food production (Table S1—Supplementary materials).

2.2. Information Source

Detailed individual search strategies were developed for each database: Scopus, Web of Science, Pubmed, Lilacs. We performed a partial search of the gray literature in Google Scholar and dissertations and theses in ProQuest Global. The last search in all databases was performed on February 19, 2019. The reference lists of the selected articles were examined as relevant studies could have been missed during the data search.

2.3. Search Strategy

We selected the appropriate combinations of truncation and keywords and adapted for searching each database (Table S2—Supplementary materials). We used Rayyan software (Qatar Computing Research Institute-QCRI) to assist in selecting and deleting duplicate articles, and we managed all references using the Mendeley desktop software.

2.4. Studies Selection

Study selection was performed in two phases. In phase 1, two reviewers (DCM, MDV) independently reviewed the titles and abstracts of all identified references in the databases. We discarded all articles that did not meet the eligibility criteria. In phase 2, the same reviewers (DCM, MDV) applied the eligibility criteria to the full texts of the selected articles. In cases of disagreement, in both phases, the subject was discussed until a consensus was reached between the two reviewers. In situations where there was no consensus, a third reviewer (PGF) made the final decision. The final selection was always based on the full text. RBAB and RPZ examiners critically evaluated the reference list of the selected studies. Data were extracted by two reviewers (DCM, MDV). Additional studies were added by the third examiner (PGF) and the specialist (RPZ).

2.5. Data Collection Process

The following characteristics were collected from the selected studies: authors and year of publication, country of research, the objective of the study, indicator(s) evaluated, methods, and main results. Calibration exercises were performed before starting the review to ensure consistency between reviewers. Reviewers solved disagreements by discussion, and the third author (PGF) dismissed disagreements when unsolved. These data were synthesized by three reviewers (DCM, MDV, PGF) using a standardized table containing the following information: reference; parents; goal; type of study; sample; assessed indicator (environmental, social, economic); activity performed; result referring to the implemented indicator.

Quality criteria were synthesized using the meta-analysis and statistical review Assessment Instrument (MASTARI) and Joanna Briggs Institute protocol [20] to assess the risk of bias in the articles.

The bias risk assessment instrument included seven questions listed below (1. Were the indicators analyzed characterized?; 2. Has the indicator been implemented in food services?; 3. Did the evaluated indicator present a positive implementation response?; 4. Was the study design appropriate?; 5. Was the statistical analysis adequate to the objective of the study?; 6. Did the results answer the main question?; 7. In the case of food services, was the sample of establishments selected for analysis of the indicators representative and randomly determined?). After analysis, the risk of bias was categorized (Table S3—Supplementary materials) as "High" when the study reached up to 49% "yes" score; "Moderate" when the study reached 50–69% "yes" score; "Low" when the study reached more than 70% yes.

To facilitate the display of the leading sustainable activities mentioned by the studies, we used the Wordcloud®tool [21] to highlight the activities most mentioned by the studies (general sustainable activities, social, environmental, and economic).

3. Results and Discussion

A total of 2259 articles were initially found in the four electronic databases. After duplicate removal, the titles and abstracts of 1809 articles were selected and read. After reading the abstracts, 166 relevant studies were selected for full-text reading. Two studies' records were selected from the reference list of full papers and two suggested by the expert. Reviewers excluded 135 articles after complete reading (Table S1—Supplementary materials). By the end, 31 studies met the inclusion criteria and were considered for this systematic review. Figure 1 shows the process flowchart of identification, screening, and inclusion of the studies. A total of 135 studies were excluded as 21 of them were not original studies; 95 of them mentioned the importance of using sustainable indicators but did not implement them; seven studies were not performed on food services; 12 of them focused the study on the consumer and not on food production (Figure 1).

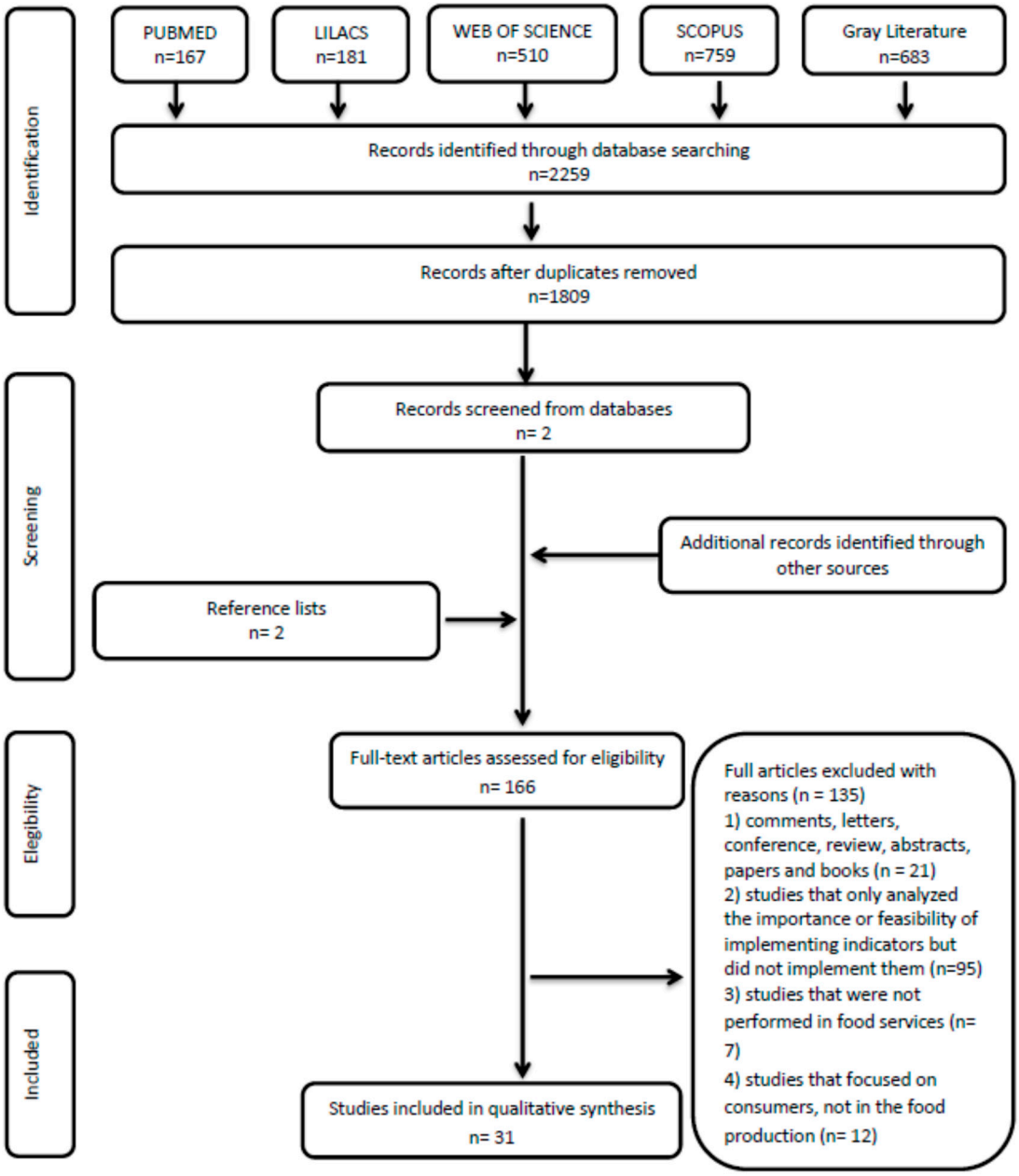

Figure 1. Flowchart of search and selection criteria. Adapted from PRISMA.

3.1. Studies Characteristics

The selected studies were conducted in the following countries: United States (n = 10), Netherlands (n = 2), Finland (n = 2), Australia (n = 2), Spain (n = 2), England (n = 2), Brazil (n = 2), Italy (n = 2), Thailand (n = 1), Japan (n = 1), Germany (n = 1), Sweden (n = 1), Canada (n = 1), United Kingdom (n = 1), China (n = 1), India (n = 1), Switzerland (n = 1). The date range for the included studies was between 2009 and 2018 (Table 1).

Table 1. Main descriptive characteristics and results from the included studies.

Reference, Year, and Country	Objectives	Foodservice Sample (FS) and Sustainability Indicators (SI) Evaluated	Performed Activities	Results
Cavagnaro and Gehrels (2009) [22] Netherlands	To analyze a hotel restaurant after a process change focusing sustainability	FS: Hotel restaurant (n = 1) SI: Environmental; Economic; and Social	Reduced portion of meat; introduction of organic products; menu with a list of ingredients; introduction of more vegetables; use of seasonal products; organic cotton table linen; selective collect; motivating employees to understand sustainability	No specific efforts were made during the move to reduce energy use and waste. However, the menu prices have not been increased due to the use of organic and fair-trade ingredients.
Babich and Smith (2010) [23] USA	Examine the distance traveled by food to reach the university, determine the amount of waste produced by the students, and to analyze a pre-composting system applied to the existing vermicomposting process	FS: University restaurants (n = 3) SI: Environmental; and social	Purchase of local products or up to 250 miles away; changed tray to a plate to reduce waste; used vermicomposting	As a result, 15.72% of the products purchased are sustainable; there was a reduction in waste after changing the tray for a plate and a reduction in the use of water to clean the trays. Concerning vermicomposting, it was beneficial to have a material that serves as organic fertilizer, however in quantity supplied to the restaurant, it became expensive.
Elbaum (2010) [24] USA	Present a university restaurant that modified its physical structure to be sustainable	FS: University restaurant (n = 1) SI: Environmental; Economic; and Social	Construction of a new restaurant that is energy and water efficient, equitable to staff, produces almost no waste; uses local and organic food; uses materials responsibly; increases the relationship between students and faculty; performs community work	The restaurant helped the university to increase its commitment to sustainability. With additional storage space, you can buy more local food. The integrated waste management program significantly reduced waste from the Faculty's landfill, and the building's design and systems conserve water and energy. Most importantly, the building is educating future world leaders about sustainable living.
Baldwin, Wilberforce e Kapur (2011) [25] USA	Develop a sustainability standard and certification program for restaurants	FS: Restaurants (n = 6) SI: Environmental; and Economic	Reduction of food waste; smaller portions; ordering best practices; buy organic food; reduced meat purchases; energy conservation; reduction of greenhouse gases	The results indicated that food purchases from a restaurant or foodservice are the biggest source of environmental impact, followed by the use of energy and disposable plastic products, although to a lesser extent.
Dauner et al. (2011) [26] USA	Assess how hospitals have changed their food system through more nutritious and sustainable foods	FS: Hospital-foodservice (n = 1) SI: Environmental; Economic; and Social	Healthier and more sustainable alternatives in food offerings; elimination of most trans fats and monosodium glutamate (MSG); elimination of bottled water and fryer (not serving fried food); purchase of locally produced organically and sustainably; purchase with several consumers; composting; ecological packaging	The incorporation of more nutritious and sustainable foods in a hospital is a dynamic process that should capitalize on institutional strengths and minimize barriers; this hospital was supported by resources offered by local producers and sustainability companies.
Tikkanen (2012) [27] Finland	Describe the process of developing two organic and local foods to be served for breakfast at a small independent coffee shop in Finland	FS: Cafeteria (n = 1) SI: Environmental; and Social	Breakfasts with organic and local foods were developed as a process and sold for eight months at the café	Coffee improved its sales and profits; the service concept has been moved in a more sustainable direction. The implications for the location are that sales by local and organic food producers have increased and jobs have improved.
Ip-Soo-Ching e Veerapa (2013) [28] Thailand	Analyze the contribution of family gardens to environmental sustainability	FS: Hotel restaurant (n = 1) SI: Environmental; and Social	Composting; organic garden; wastewater recycling; carbon footprint reduction; explanation to visitors about organic farming; raising pigs to provide fertilizer for the soil.	There is an organic garden that serves most of the herbal and vegetable needs of Soneva Resort restaurants in Thailand. The gardens produced a variety of fruits and vegetables and had a wastewater recycling system. This system can serve as an example for other entrepreneurs regarding the benefit of permaculture.
Higgins-Desbiolles, Moskwa e Gifford (2014) [29] Australia	Analyze the case of Stuart Gifford as a 'sustainability educator' who teaches sustainability through his sustainable coffee called Sarah's Sister's Sustainable Café	FS: Cafeteria (n = 1) SI: Environmental; Economic; and Social	Eco-market promotion; reuse of space for building a place that has good ventilation; energy-efficient lighting; water the plants using recycled water; recycled furniture; 50% reduction in energy use; vegetarian menu; use of local products; cultural coexistence	The study illustrates the potential of restaurants to practice cultural pedagogies and how they can be defenders of holistic sustainability. It also offers a greater understanding of the complexities of sustainability and the role of leisure, hospitality, tourism companies, and restaurants, in promoting the sustainable practice.

Table 1. *Cont.*

Reference, Year, and Country	Objectives	Foodservice Sample (FS) and Sustainability Indicators (SI) Evaluated	Performed Activities	Results
Moskwa, Higgins-Desbiolles e Gifford (2014) [30] Australia	Explore how an entrepreneurial restaurant uses its coffee to engage customers and the community in sustainable development, food, hospitality and tourism, helping to transform our food culture and even life	FS: Restaurant (n = 1) SI: Environmental; Economic; and Social	50% reduction in energy use; maintenance of original furniture; serves local products (food and drinks); non-smoking policy; use of sunlight (energy-efficient lighting); use recycled water to keep garden plants; 50% reduction in landfills; separation of garbage collection; offers vegetarian food; events together society; sells magazines that talk about sustainability critically	The site achieves "accessible sustainability". It uses of "life cycle sustainability"—furniture used for more than 50 years, uses local products (reducing transport distances), and aims to reduce landfill and waste generated by 50%. All coffee waste is recycled, and food scraps are removed and collected daily for composting.
Perramon et al. (2014) [31] Spain	Examine the motivations for adopting green practices in Spanish restaurants and the impact on company's performance	FS: Restaurants (n = 374) SI: Environmental; and Economic	Water conservation; energy conservation; recycling of waste products; ecological food	Be proactive about environmental issues can provide restaurants with many benefits that improve the competitiveness of companies and performance. Restaurants must move on to more green practices related to its products, such as creating a sustainable menu.
Demicco et al. (2014) [32] USA	Describe the eco-restaurant as a new strategy to establish sustainability	FS: Restaurants (n = 4; all of the same owner) SI: Environmental; Economic; and Social	Hydroponics; organic products; recycling; renewable energy (wind and solar); process of biodiesel through the delivery of used oil; composting; donation of food to charity; wine hybridization; iPad menu to reduce paper	The new eco-restaurant concept facilitates the recycling of waste, oil, and paper and uses fewer resources and energy.
Ranke et al. (2014) [33] USA	Assess the use of tools and the 20% reduction in meat purchases	FS: Hospital restaurant (n = 6) SI: Environmental; Economic; and Social	Shopping tracking; recipe development—strategies to reduce meat purchases such as reducing meat portion sizes and increasing vegetarian options and replacing meat with cheaper cuts; Tracking to measure greenhouse gas emissions	The strategies adopted were increasing consumption options, changing meat-based meals for vegetarians, using meat as a condiment, switching to a more local source, reduced beef and pork and increased poultry. Educational materials were received and used by two hospitals. The greenhouse gas emission tracking tool was received and used once a year, a hospital, and the meat purchase tracking tool was neither received nor used by any hospital.
Iaquinto (2014) [34] Japan	Evaluate sustainability practices in informal restaurants in Japan	FS: Restaurants (n = 29) SI: Environmental; and Economic	Recycling through selective collection; longer lasting lamps; thermostat adjustment at night; purchase from local suppliers; use of paper straw; menus printed on recycled paper; double discharge for water-saving; cloth tablecloths; composting	46% of respondents say that they implement sustainability practices in their establishments. However, 74% stated that "they are always looking for ways to reflect on their impact on the environment". All restaurants separate garbage for recycling. This study showed that there was some movement to implement sustainable practices, although these initiatives were generally few, small and basic. Independent restaurant managers in Japan also face significant financial barriers, limiting the number of alternatives they can consider.
Haddock-Millar, Sanyal and Muller-Camen (2015) [35] Germany, England and Sweden	Explore how 3 restaurants in a multinational company are employing sustainable behaviors and engaging employees in sustainability	FS: Restaurants (n =3; all of the same food chain) SI: Environmental; Economic; and Social	Train Human Resources to change behavior and to adopt sustainable commitments; waste separation; oil recycling for biodiesel; work with the local community; energy measurement; CO_2 compensation scheme; recognition of the importance of employee involvement in environmental management	The results indicated that some practices, such as garbage patrol and cardboard recycling, are part of everyday practice. Environmental training can be planned and designed to develop such behavioral skills. However, to achieve proactive environmental management, the focus must be on behaviors that support environmental involvement, such as Employee involvement is critical to the organization's success.
Cook (2015) [36] USA	Assess the sustainable practices implemented in the food services of hospitals in Texas	FS: Restaurants (n = 62) SI: Environmental; and Social	Recycling of used oil, paper, aluminum, plastic, and cardboard; food composting; use of organic products; use of energy or water-saving equipment	The most common sustainable practices are the recycling of cooking oil and fat, and recycling of paper. Less common practices are composting food scraps and using organic dairy products.

Table 1. *Cont.*

Reference, Year, and Country	Objectives	Foodservice Sample (FS) and Sustainability Indicators (SI) Evaluated	Performed Activities	Results
Derriks and Hoetjes (2015) [9] Netherlands	Identify possibilities for changes in restaurant practices, that can lead to interventions that foster the development of sustainable destinations	FS: Restaurants (n = 4) SI: Environmental; and Economic	Restricting the flow of taps; urinal with water control; replacement of incandescent lamps with CFL or LED lamps; bathroom lighting sensor; A system that monitors and controls temperatures efficiently with HVAC; recycled paper; composting; reusable menus; composition of the menu of 80% vegetables and 20% meat or fish	The observed practices were compared with ideal sustainability practices to result in recommendations for the advancement of sustainability in the city.
Vivaldini and Pires (2016) [37] Brazil	Describe and discuss the implementation of sustainable actions in a closed-loop fast food supply chain using a service provider (PSL) through the practical case of using biodiesel	FS: Fast-food restaurant (n = 1) SI: Environmental	Transforming used frying oil into biodiesel to supply the company's trucks involved in supply chain logistics; recycling	The project ensures the correct reuse of this by-product within McDonald's supply chain, significantly reducing any risks. These actions, how the reuse of by-products is related to the path to sustainable projects. It is worth mentioning the fact that the project under study promotes the recycling of undesirable material (generally considered an environmental problem) and returns within the supply chain itself.
Derqui, Fayos and Fernandez (2016) [38] Spain	Identify causes and possible ways to minimize food waste in Spanish food services	FS: Restaurants (n = 14) SI: Environmental; and Economic	Purchasing planning software; purchasing local products; smart menu (use leftovers from a day in new dishes); using frozen portions; purchasing products by a single employee; FEFO system; training and awarding employees about waste; use transparent garbage bags in places; offering children's menus; reducing the number of buffet preparations; guiding customers to plate sizes; bagging for animals ("doggy bag")	Most companies tend to minimize food waste according to economic criteria, without considering social, ethical, or environmental factors. Consequently, only "visible" food waste that has an economic impact on results is minimized. However, the visibility of real waste is generally low.
De Chabert-Rios and Deale (2016) [39] USA	Understand the reasons why some restaurant owners are entering the agricultural business and the benefits and challenges encountered by restaurant owners who operate farms	FS: Luxurious restaurant (n = 3) SI: Environmental	Use of products from local farms	All sites considered that its ability to offer fresh and tasty products to its customers was very important and reinforced by having its products grown and produced on its farms.
Dragon (2016) [40] USA	Describe the perceptions of waiters and restaurant managers about local foods concerning customer orders, personal values, local food barriers, source of ingredients, and training	FS: Restaurant (n = 8) SI: Environmental; and Economic	Use of local ingredients in the menu; support the local economy; reduce the environmental impact; tasting of test dishes	The most frequently mentioned motivators for serving local food on the menu include supporting the local economy (83%) and reducing the environmental impact (59%). The biggest barrier to the supply of local food was the inconsistent supply of local food, reported by 100% of the chefs and 65% of the wait staff.
Vial (2016) [41] England	Present the experience of a sustainable restaurant	FS: Restaurant (n = 1) SI: Environmental; Economic; and Social	Vegetarian menu; cultural center that teaches a cooking class; buying local products; recycling; using biodegradable packaging; vegan laboratory	Spontaneous sustainable entrepreneurship, as exemplified in the restaurant, showed that the entrepreneurship that happens to fit sustainability definitions and criteria provides different food for sustainable entrepreneurship—entrepreneurship who first sees an opportunity and then builds a business model aimed at sustainability.

Table 1. *Cont.*

Reference, Year, and Country	Objectives	Foodservice Sample (FS) and Sustainability Indicators (SI) Evaluated	Performed Activities	Results
Mota et al. (2017) [42] Brazil	Develop an assessment tool for the collective food sector, concerning the production of sustainable meals and menus	FS: Restaurant (n = 1) SI: Environmental; Economic; and Social	Reduced dependence on imported food; solid waste audit; choice of equipment with better energy efficiency; adoption of measures to prevent different types of pollution; donation of fresh food leftovers to food banks or NGOs; performing preventive maintenance on equipment; products and raw materials purchased with a proven origin, not being produced by minors or slave labor; noise control; sufficient energy and water consumption; loss/leftovers control; renewable energy; minimizing the amount of waste disposed of with water; offering a variety of food choices, including the selection of regional preparations and the rescue of gastronomic heritage; windows that facilitate the entry of natural light; strategies for saving and reusing cooking water; employee appreciation; distribution of safe preparations using vegetable peels as ingredients; biodegradable cleaning products, such as detergent and washing powder	The proposed instrument proved to be feasible to evaluate the unit with regard mainly to the adequate planning of menus as a potential tool to guarantee sustainability in services that produce meals. The evaluated unit demonstrated the implementation of actions that seek to optimize the production of meals in a sustainable approach, but there is a need for improvement in terms of offering a balanced menu, adequate in calories and nutrients, and attractive to customers, as well as energy audit and solid waste.
Clark (2017) [43] Canada	Determine the actions that Victoria restaurants can take to build a sustainable food system, exploring relevant examples from other Canadian cities	FS: Restaurant (n = 32) SI: Environmental; and Social	Sustainable food; grown, processed and packaged in the city or neighboring agricultural areas	Many restaurants in Victoria share common goals with other actors in the local food system and have the potential to achieve positive results through collaboration. This exploration has resulted in several examples of successful partnerships between private sector restaurants, OSCs, and local government.
Laakso (2017) [44] Finland	Analyze the leftover lunch from canteens and how the restaurant in Finland has been using this leftover	FS: Canteens (n = 3) SI: Environmental; and Social	The leftover lunch at three schools are distributed to people with lower income (retired or unemployed)	Canteens are directing leftovers to other people, reducing waste and increasing consumption, as many people who consume "leftovers" report it is an opportunity to eat together.
Amato and Musella (2017) [45] Italy	Qualitatively and quantitatively assess food waste from restaurants in Naples and point out what alternatives the locals are doing to reduce leftovers	FS: Restaurant (n = 89) SI: Environmental; Economic; and Social	Precise supply of inputs; use of travel packaging; donation of food about to expire; donation of prepared and uneaten food; preparation of smaller portions of food; changing the menu	About 80% of the companies carry out some waste reduction activity. The most frequently carried out activities are donations to charitable organizations, accurate supply, and promoting the use of travel packaging. Lastly, there are activities to prepare smaller portions or changes to the menu.
Iraldo et al. (2017) [46] Italy	Investigate the relationship between pro-environmental strategies and competitiveness and how these strategies can be exploited to outperform competitors	FS: Restaurant (n = 317) SI: Environmental; Economic	Awareness campaign about bathing and reusing towels; purchase of organic, national foods; energy-saving; waste reduction; eco-label certification	Actions aimed to investigate green food products (for example, organic food) and awareness campaigns emerge as strong predictors of good commercial performance. Entrepreneurs and owners evaluate the implementation of internal sustainability monitoring systems as relevant support to increase their competitive performance.
Vu et al. (2017) [13] United Kingdom	Provide an understanding of business in the foodservice sector, through the development of a new questionnaire to measure sustainability	FS: Fast-food restaurant (n = 1) SI: Environmental; Economic; and Social	Encourage the conservation of natural resources; recycling; pollution control to ensure cleaner air and water; landfill waste; biodegradable packaging; selective collect; uses oil and transforms it into biodiesel; companies that supply raw materials with animal welfare; green building certification; career path; healthy menu	The finding shows that economic, environmental and social factors are applicable in measuring the corporate sustainability of foodservice operations. The most significant contribution of this research is that it provides a new study on sustainable business in the foodservice sector.

Table 1. *Cont.*

Reference, Year, and Country	Objectives	Foodservice Sample (FS) and Sustainability Indicators (SI) Evaluated	Performed Activities	Results
Wen et al. (2018) [47] China	Evaluate the implementation of a sensor-based network of IoT to improve restaurant food waste management (RFW) in the city of Suzhou, China	FS: Catering (n = 6265) SI: Environmental; and Economic	Waste reduction; waste collection and transportation; pollutant emissions generated in the disposal process are monitored in real-time	Positive results include better management of food waste generation; better law enforcement and a general reduction in illicit RFW activities and better optimization across the RFW value chain. Negative results include: radiofrequency of identification tags that need to be renewed frequently due to the frequent handling of dumps increased operating costs; the sensors had a degree of error, and there were disagreements between city government agencies on how to interpret system data, which has led to some inefficiencies in management.
Sakaguchi et al. (2018) [48] USA	Identify which factors influence the behaviors and attitudes among restaurant owners and incentive policies to reduce food waste	FS: Restaurants (n = 29) SI: Environmental; Economic; and Social	Questionnaire application and visit to verify the data collected on waste reduction strategies	65% of restaurants measure the amount of food waste and more than three-quarters of them (84%) use compost bins to dispose of harmful food waste. The most common method used to dispose of food waste (72%) was to give edible leftovers to restaurant staff. However, three-quarters of restaurants avoided donating food because they were afraid of legal responsibility. Finally, 14% of the surveyed restaurants dumped their food waste into landfill dumps.
Bharucha (2018) [49] India	Investigate how restaurants are dealing with food waste and recommend ways to manage the problem better	FS: Restaurants (n = 63) SI: Environmental; and Social	Correct waste disposal policy; distribute surplus food among employees; treatment of leftovers	43% of the surveyed restaurants refrigerate prepared food immediately, 18% of those stated that they have a complete disposal policy, and 30% reuse leftovers in some way. Most restaurants have a clear policy of distributing excess food among their employees and checking stock daily. More sophisticated restaurants are more sensitive to the importance of waste management.
Martins-rios et al. (2018) [50] Switzerland	Analyze foodservice projects to reduce food waste	FS: Restaurants (n = 110) SI: Environmental; and Economic	Offer smaller portions of food; better menu organization; allow the customer to pay a fee and return to the buffet as many times as necessary; take leftovers for pets; full use of food; composting; use of software that signals waste to partner companies (glass bottles, plastic cups, etc.); use of biodegradables; food donation (practice less explored by restaurants)	This article study managers with a set of tools (i.e., practices from various committed companies and the adoption of waste reduction initiatives) to provide a practical reflection on food waste issues.

The 31 studies were conducted in 17 different countries. The country that presented the highest number of studies was the United States of America (32.25%; n = 10). Studies in this country have discussed from food waste reduction strategy [25,48] to purchasing local products [23,39,40], energy and water efficiency [24,36], renewable energy use [32] to healthier food supply [26,33].

Among the motifs that can explain the number of studies in the USA is the importance of the Green Restaurant Association (GRA), an American organization that works for 29 years focusing on environmental sustainability. It issues certificates and studies the best way to increase sustainability inside food services. The USA are considered one of the big responsible for the negative climatic changes, probably encouraging studies that plan strategies to reduce the environmental impacts and search for more sustainable alternatives for the food chain. In South America, Brazil presented only two (6.45%) studies included in this review, with activities such as the reuse of oil for biodiesel production, recycling [37], and donation of fresh food leftovers to food banks or NGOs [42].

Concerning Brazil, we have seen that few studies have verified the implementation of sustainability indicators in food services. Among the reasons, it may be the lack of a validated instrument to verify the specific sustainable management of food services, the high cost for implementing activities such as the purchase of organic food, the use of renewable energy, among others and, mainly, the lack of public policies aimed at the need to implement sustainability in food services, which leads to few locations in Brazil that have sustainable activities.

In North America, Canada presented only one study, with sustainability activities such as sustainably grown food or purchased from neighboring cities [43]. For European countries like Finland, the Netherlands, Spain, England, and Italy, they also had two studies each, involving activities such as waste reduction, environmental certification [46], preparation of smaller portions [45], reduction in the use of meat [22,41], employee training on sustainability [35,38], and composting [9]. Germany, Sweden, United Kingdom, and Switzerland had only one study each, with sustainability activities such as oil recycling [35], selective collection [13], use of biodegradable packaging [13], and full use of food [50].

We only had Australia with two studies involving sustainability activities such as reducing the use of meat [29] and reducing energy consumption [30]. Asian countries such as Thailand, Japan, China, and India had only one study each, with sustainability activities such as vegetable garden, carbon footprint reduction [28], and selective garbage collection [34].

The data found in Asian countries are worrying, especially in China, as it is a populous country (1.4 billion Chinese) with a large number of food services, which increased 52% between the years 2014 and 2016. Only one study showed the application of sustainability indicators. China is already considered one of the countries with a high rate of food waste and high production of plastic. Within China, for example, around 40 million tonnes of food waste were produced in 2014, representing 50% of all food waste that year [51]. It reinforces the lack of public policies and investments in the sector to reduce environmental impacts. In contrast, countries with smaller populations such as the Europeans Finland, Holland, Spain, England, among others, showed more studies with the application of sustainability indicators, showing greater concern with environmental impacts.

It is evident from the date of the articles that sustainability in foodservice is a new subject of investigation. Articles before 2009 showed sustainability but not related to foodservice. Sustainability in foodservice production is described as ecologically sustainable practices focused on reducing the environmental impact with the rational use of natural resources. It can be reached through reduction, of residues, an increase of recycling, a boost of agroecological food, waste reduction, companies certification, besides workers training for the use of more environmentally adequate technologies [25,52].

The use of sustainable practices in foodservice helps these services to be recognized and certified. Increasingly, dietitians working in this area are searching for more sustainable alternatives to put into practice in food services since these actions can be directed to a healthier and more sustainable diet.

To identify sustainability indicators in food services, 77.41% (n = 24) of the studies used interviews and 22.59% (n = 7) used questionnaires (Table 1). It is worth mentioning that most studies used

interviews as an evaluation method, which can be flawed concerning the best clarifications of the implemented actions. The analyzed studies had a cross-sectional quantitative design, case study or quali-quantitative sample study. Table 1 shows the study characteristics in chronological order.

3.2. Prevalence of Sustainability Indicators

A total of 31 studies were selected for the systematic review. Of the studies, 77.41% (n = 24) covered the three sustainability indicators (environmental, social, and economic); 22.59% (n = 7) used two indicators; 12.90% (n = 4) with environmental and economic indicators, and 9.67% (n = 3) with environmental and social indicators. The 31 selected studies included commercial restaurants (n = 19), cafeterias (n = 2), fast food (n = 2), hospital (n = 2), hotel restaurants (2), university restaurants (n = 2), canteens (n = 1), and catering (n = 1), showing the diversity of food services in the analyzed papers.

3.3. Main Types of Activities Performed in Food Services

The activities that were most performed among food services and that have a positive impact on sustainability were: purchase of local or seasonal products—51.61% (n = 16); selective collection or recycling of solid waste—51.61% (n = 16); energy reduction or purchase of equipment with better energy efficiency—38.70% (n = 12); purchase of organic or sustainably produced food—32.25% (n = 10); water reduction or conservation—29.03% (n = 9); composting—25.80% (n = 8). Figure 2 shows the main sustainable activities mentioned in the studies. The main sustainable activities were also evaluated in each sustainability indicators (environmental, social, and economic) (Figures S1, S2, and S3—Supplementary materials).

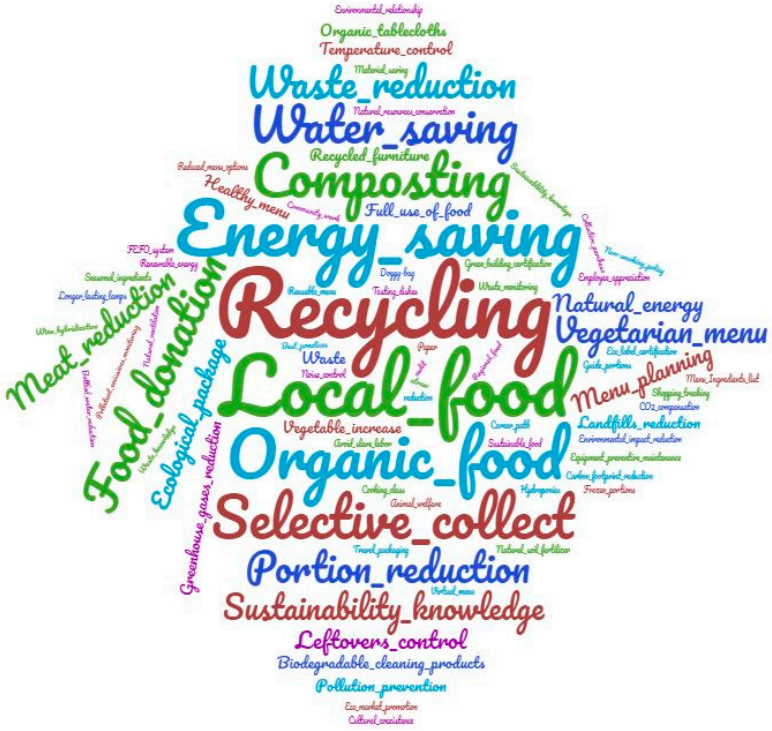

Figure 2. Word cloud of the main sustainable activities mentioned by the studies.

When we analyze the activities most implemented in food services (Figure 2), recycling (oil, paper, water, aluminum, etc.) is highlighted [9,13,28,29,31,32,35–37,41], purchase of local products [23,24,27, 29,30,38–42,46], reduction in energy consumption [9,25,29–31,36,42,46], composting [9,26,28,32,34,50], use of organic foods [22,24–26,32,36], and food donation [32,42,45,49,50].

Recycling is one of the best alternatives to reduce environmental problems and to increase the useful life of landfills [9,42]. It is the process in which the materials that would be discarded, or even

those that have already been, are collected, separated, and processed to be used as a raw material in the manufacture of goods. Recycling benefits everyone involved in the production process, from suppliers, consumers, the environment and the government. It brings benefits to the environment, as it allows natural resources, water, energy, and raw materials to be saved, and to society, generating jobs and income with the sale of recyclables [9].

Among the activities that involve the environmental indicator (Figure S1—Supplementary materials), the selective collection is an alternative to reduce the excessive production of waste. It is carried out from the separation of recyclable materials from diverse sources that generate waste, and, after separation, they are sent to the recycling process. It is an advantageous process, as it is capable of generating work and income, reducing the use of raw materials, promoting environmental education, saving natural resources, and reducing waste disposal in landfills [13]. Therefore, selective collection has contributed a lot to sustainable practices in the population. Waste management has become a key priority referring to all related activities on how to avoid, reduce, or recycle waste throughout the production and consumption chain [50]. However, from the studies that mentioned the waste recycling (n = 10) [9,13,31,32,34–37,41,42], only 40% (n = 4) also mentioned the selective collect [13,34,35,42], and from studies that mentioned composting (n = 8) [9,23,26,28,32,34,36,50], only one mentioned the selective collect [34] as an sustainable activity. According to Demicco et al. [32], composting is a set of techniques applied to control the decomposition of organic materials to obtain a more stable material, rich in humus and minerals, which generates a production chain with sustainable characteristics. Composting is an important practice for disposing of waste, being an inexpensive solution, in addition to serving as fertilizer for crops. Despite the lack of highlighting to the selective collect in the studies that mention waste recycling, it is not possible to do that without waste management. Therefore, the selective collection is essential to achieve sustainable activities in food services [13,30,34,35,42].

Regarding the purchase of local products, the focus of these actions also involves working with local producers and distributors to increase the local supply chain, and it may occur through relationships between chefs/dietitians and farmers [39,43]. Local culinary/foods play a fundamental role in cultural identity [53]. In this sense, studies show that consumers are buying local food because they believe it tastes better than the non-local foods, it has better quality, and it helps the local economy, increasing the demand for local products in restaurants [27,30,40]. The local food is also associated with the food security of low-income people as it presents a multidimensional nature and includes food access, availability, food-use, and stability. In this sense, studies have been showing the achievement of food security by trying to stimulate the promotion of sustainable models of family-based production, bringing food production and consumption closer, and valuing the diversity of eating habits [54–56]. The modern industrial food supply system faces many significant environmental and social sustainability challenges. Local food systems, in which consumers prefer geographically closer food producers, is one of the ways to face these challenges. However, the costs associated with distributing food from many small-scale producers to consumers have been a primary barrier to long-term local food system success as well as the lack of supplier, the high price and the seasonality [57].

When analyzing the environmental indicator (Figure S1—Supplementary materials), the most studied activities were reduction of energy consumption [9,25,29–31,36,42,46], recycling [9,13,28,29,31, 32,35–37,41], organic food [22,24–26,32,36], and selective collection [13,22,34]. The purchase of organic food is an environmental indicator that stood out among the actions implemented in the analyzed studies. Organic products are estimated to generate around US$ 60 billion a year worldwide. The organic food market has been growing faster than the traditional market, attracted by the interest of supermarket chains, which seek to provide a differentiated and healthy product, having a major impact on sustainability [58].

The studies showed that concern with the sustainability in food services has the potential to attract consumers who are interested in ethical and environmental aspects and who can be directly involved in sustainable business management [46]. Besides, the adoption of sustainable strategies

can lead to cost savings, for example, energy/water savings, energy efficiency or waste reduction through techniques such as recycling or composting [24,29,36]. Regarding the economic indicator, the most studied activities (Figure S3) were local products [23,24,27,29,30,38–42,46], recycling (oil, paper, etc.) [9,13,28,29,31,32,35–37,41], portion reduction (meat or portion size) [9,22,25,29,30,41,42,45,50], and reduction in energy consumption [9,25,29–31,36,42,46]. Regarding the reduction of the meat portion, it is important to highlight that the animal agriculture sector takes for 18% of human-made greenhouse gas emissions, which is higher than the transport sector, being one of the primary contributing sources of greenhouse gases, and water and farmland consumption [22,25,33]. In a study carried out in Uganda which assessed women's dietary patterns and their relationship to sustainability by assessing the environmental and economic impact caused by food production found that high intake of meat, chicken, and soup was the dietary profile with greater impact. The consumption of legumes, roots, tubers, vegetables, and fresh fruits was considered the dietary pattern with the least environmental and economic impact [59]. It is important to highlight that multiple factors influence fruit and vegetable ingestion, including economic barriers, inadequate nutrition knowledge and awareness, food preferences and attitudes, and cultural factors. Mainly out of the home, it can be influenced by confidence in the hygiene of served raw products (salad), variety, attractiveness, sensory balance, and appearance [9,22,60]. In this sense, the offer of a healthier menu including more vegetables, as well as consumer information are important to improve sustainable attitudes [9,13,22,26].

Many studies have used energy reduction among the selected activities. It is important to make consumers aware of the good management of natural resources, including energy generation. To ensure future energy resources by saving, and not overloading these resources is a fundamental attitude to provide their durability in the future [29,30].

A study conducted by Strasburg and Jahno [52] in five university restaurants in Brazil evaluated the implementation of eco-efficiency, which promotes more efficient use of materials and energy, combining economy and environmental performance and therefore reducing the environmental impact. Products of animal origin cause greater environmental and financial impacts, therefore, it is important to implement eco-efficiency in food services for planning more sustainable menus.

Regarding sustainability, other activities that appeared in the studies and should be highlighted: friendly packaging or biodegradable products (e.g. straw)—16.12% (n = 5); reduction of food waste—16.12% (n = 5); smart orders—16.12% (n = 5); greenhouse gas reduction—12.90% (n = 4); use of sustainable tablecloths or products—12.90% (n = 4); use or production of biodiesel—12.90% (n = 4); paper reduction or use of recycled paper—9.67% (n = 3); sustainable construction or building material—9.67% (n = 3); community works or events—9.67% (n = 3).

Food waste has been highlighted by researchers, the media, politicians, and others, primarily because of its far-reaching effects on the environment and the economy [49]. Food waste is an issue that needs to be rethought as it results in food shortages around the world, as well as other negative implications due to excessive consumption of freshwater and fossil fuels and methane and CO_2 emissions from food decomposition, which contribute to global climate change [23,47]. Reducing food waste may be part of the solution to food security and environmental challenges, including the need to feed more people while making the food value chain more environmentally sustainable [38].

Derqui, Fayos, and Fernandez [38] highlighted inventory minimization, employee training, rapid food cooling to prevent microorganism growth, portion size adaptation to customer needs, attractive meal presentation, small use of portions, as well as customer awareness of food waste and "doggy bag" delivery among recommended initiatives to reduce food waste.

Activities that were barely reported in the studies, but were also related to sustainability, are ingredients list menu or ingredient list control software—6.45% (n = 2); healthy menu—6.45% (n = 2); full utilization of food—6.45% (n = 2); employee career path—6.45% (n = 2); renewable energy use—6.45% (n = 2); place of cultural coexistence—6.45% (n = 2); doggy bags or permission to carry pet scraps—6.45% (n = 2); pollution prevention—6.45% (n = 2); thermostat adjustment at night—6.45% (n = 2); environmental certification—6.45% (n = 2); reuse of leftovers in new revenues—3.22% (n = 1);

use of frozen portions—3.22% (n = 1); vegetable garden—3.22% (n = 1); smoking policy—3.22% (n = 1); landfill reduction—3.22% (n = 1); sell sustainability magazine—3.22% (n = 1); hydroponics—3.22% (n = 1); preventive maintenance of equipment—3.22% (n = 1); products purchased from places without slave labor—3.22% (n = 1); noise control—3.22% (n = 1); use of biodegradable cleaning products—3.22% (n = 1) and raising pigs to provide soil fertilizer—3.22% (n = 1) (Figure 2).

Although less mentioned as an indicator implemented in the food services, studies report the importance of having a sustainable menu, ranging from environmental as well as social indicators, given the high impact on the consumers health especially by foods that cooperate to promote human health and prevent the onset of chronic diseases and sustainable thinking by ensuring that future generations have their health and quality of life [6,26,41,42].

Likewise, to minimize the generation of organic residues within the food services, it is necessary to make full use of the food, which consists of the total use of the input and all its parts, whether these are of vegetable or even animal origin [61]. The greatest difficulty in using this activity in sustainability is the lack of knowledge about food and its characteristics, as well as in the application of techniques so that the input can be fully utilized also in households.

Similarly, although only two studies reported environmental certification, it is clear that incorporating green management into food services is a growing phenomenon, fueled by the perception that green credentials increase opportunities for competitive advantage [31] and increases the company's visibility [35]. According to Iaquinto [34], restaurants that employ green practices should see significant improvements in costs and management, being a company with market differentiation, and improving the environment.

Other sustainable indicators that are less mentioned but of great importance are the use of renewable energy and the cultivation of vegetable gardens. According to Demicco et al. [32], renewable energy is an essential factor for any sustainable restaurant, which must implement different sources of energy. Regarding vegetable gardens, the study by Ip-Soo-Ching and Veerapa [28] reported that they demonstrate the environmental sustainability values in foodservice activities, besides bringing with it an increase in the use of renewable energy sources, biodiversity, and recycling programs.

3.4. Risk of Bias

The studies were heterogeneous; 30 had a low risk of bias, and one had a moderate risk of bias. All studies characterized the indicator to be evaluated in food services. All studies also answered the main question.

One of the questions was whether the indicator was implemented in food services, and, for this reason, only the studies carried out by Ranke et al. [33], Iaquinto [34], Haddock-Millar, Sanyal, and Muller-Camen [35], Cook [36], Dragon [40], Mota et al. [42], Amato and Musella [45], Wen et al. [47], Sakaguchi et al. [48], and Bharucha [49] had the answer "no." Studies that did not perform statistical analysis because they only present the location and the indicators implemented had the answer "does not apply," and the percentages were calculated as if the table had six questions (Table 2).

Table 2. Summarized risk of bias assessment.

Author, Year	Risk of Bias	Risk Percentage
Cavagnaro and Gehrels, 2009 [22]	Low	85.71%
Babich and Smith, 2010 [23]	Low	85.71%
Elbaum, 2010 [24]	Low	85.71%
Baldwin, Wilberforce, and Kapur, 2011 [25]	Low	100%
Dauner et al., 2011 [26]	Low	100%
Tikkanen, 2012 [27]	Low	85.71%
Ip-Soo-Ching and Veerapa, 2013 [28]	Low	85.71%
Higgins-Desbiolles, Moskwa, and Gifford, 2014 [29]	Low	85.71%
Perramon et al., 2014 [31]	Low	100%
DeMicco et al., 2014 [32]	Low	85.71%
Ranke et al., 2014 [33]	Low	71.42%
Iaquinto, 2014 [34]	Low	85.71%
Moskwa, Higgins-Desbiolles, and Gifford, 2015 [30]	Low	85.71%
Haddock-Millar, Sanyal, and Muller-Camen, 2015 [35]	Moderate	57.14%
Cook, 2015 [36]	Low	85.71%
Derriks and Hoetjes, 2015 [9]	Low	100%
Vivaldini and Pires, 2016 [37]	Low	85.71%
Derqui, Fayos, and Fernandez, 2016 [38]	Low	71.42%
De Chabert-Rios and Deale, 2016 [39]	Low	100%
Dragon, 2016 [40]	Low	85.71%
Vial, 2016 [41]	Low	85.71%
Mota et al., 2017 [42]	Low	71.42%
Clark, 2017 [43]	Low	100%
Laakso, 2017 [44]	Low	100%
Amato and Musella, 2017 [45]	Low	85.71%
Iraldo et al., 2017 [46]	Low	100%
Vu et al., 2017 [13]	Low	85.71%
Wen et al., 2018 [47]	Low	71.42%
Sakaguchi et al., 2018 [48]	Low	85.71%
Bharucha, 2018 [49]	Low	85.71%
Martins-Rios et al., 2018 [50]	Low	100%

3.5. Limitations

This study presents some limitations. Some studies analyzing more than one foodservice did not make it clear whether the applied indicator had a positive response for all locations. As there is no single measure to whether the applied indicator had a positive impact on sustainability, we used as a parameter what was mentioned in each study. Some sustainable aspects, like selective collect, was implicit in some studies, and it was not mentioned in Table 1. Therefore, it can represent an underestimate data. Finally, some studies have reported a lack of similar work to compare results and the inability to track whether the indicator had a positive impact on sustainability.

4. Conclusions

This study aimed to evaluate the sustainability indicators implemented in the production of meals in food services. The results presented in the articles indicated that food services are increasingly concerned with sustainability, and they have been implementing indicators that cover the three pillars: environmental, economic, and social. We can highlight activities such as recycling (waste, water, oil, paper, aluminum), energy saving, using local and organic products, performing selective collect, saving energy, planning, or modifying the menu, among others, which were found in the analyzed studies.

It is worth mentioning that a large number of studies did not show the application of sustainability indicators in food services but instead discussed the importance of applying sustainability, or even about the problem that involves food waste.

The implementation of sustainable practices has been identified as a promising strategy for better use of natural resources in food services. Further studies are needed to estimate and better apply the

sustainability indicators used in food services since such actions will serve as a subsidy for a healthier and more sustainable diet.

Supplementary Materials: The supplementary materials are available online at http://www.mdpi.com/2071-1050/12/5/1804/s1, Table S1: full-text articles excluded, with reasons; Table S2: database and terms used to search references on sustainability indicators applied in food services; Table S3: quality criteria of the studies selected for the systematic review of sustainability indicators applied in food services; Figure S1: word cloud of the main sustainable environmental activities mentioned by the studies; Figure S2: word cloud of the main sustainable social activities mentioned by the studies; Figure S3: word cloud of the main sustainable economic activities mentioned by the studies.

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