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Jurnal Kesehatan

| ISSN (Print) 2085-7098 | ISSN (Online) 2657-1366 |

FOOD WASTE REDUCTION STRATEGIES IN HOSPITALS

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ARTICLE INFORMATION

Received: 11 Juni 2025
Revised: 08 Agustus 2025
Accepted: 28 November 2025
Available online: 30 November 2025

KEYWORDS

food waste, hospital, sustainability, intervention strategy, plate waste

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ABSTRACT

Food waste in hospitals is a serious problem that impacts healthcare efficiency, environmental sustainability, and patient well-being. Food waste in hospitals mainly comes from plate waste, which is caused by factors such as food quality, patient diet, and suboptimal food distribution systems. This study aims to assess effective strategies in reducing food waste in hospitals through a systematic review of 12 relevant studies. The method used a systematic literature review with the PRISMA approach, identifying key themes that included determinants of food waste, intervention strategies, and implementation challenges. The results showed that a Life Cycle Assessment-based approach, improved menu design, staff education, and implementation of waste monitoring system were effective in reducing food waste. However, the main challenge lies in the low institutional awareness and lack of binding regulations. Therefore, supportive policies and cross-sector collaboration are needed to create more efficient and sustainable food waste management system in hospitals.

INTRODUCTION (CHAPTER)

Food waste is a pervasive global challenge that significantly impacts environmental, economic, and social dimensions (1). The healthcare sector, particularly hospitals, is a major contributor to increasing food waste due to complex food distribution systems, discrepancies between the quantity and variety of food provided and patients' specific needs, and insufficient awareness regarding the importance of food waste management (2). Data from the Food and Agriculture Organization (FAO) indicates that approximately one-third of global food production is wasted annually, with hospitals contributing to this figure (3). Beyond its environmental consequences, food waste in healthcare facilities also leads to inefficiencies in operational expenditures and hinders the sustainability of healthcare systems. Consequently, there is an urgent need to implement effective strategies aimed at reducing food waste in hospitals to enhance resource efficiency, minimize environmental impact, and strengthen the sustainability of healthcare services (4).

Food waste is a complex global challenge that significantly impacts environmental, economic, and social dimensions (1). The healthcare sector, particularly hospitals, is a major contributor to food waste due to intricate food distribution systems, mismatches between meal portions/variety and patient needs, and low

DOI: http://dx.doi.org/10.35730/jk.v16i3.1319

awareness of waste management (2). The Food and Agriculture Organization (FAO) reports that one-third of global food production is wasted annually, with hospitals contributing substantially to this figure (3). Dias et al, found that hospital patient food waste in Portugal averages 953 grams per day, resulting in an annual loss of €35.3 million and 16,400 tons of CO_2e emissions (5). In New York, hospitals generate 1,515 kg of food waste daily (6), most of which ends up in landfills. Beyond environmental harm, this waste exacerbates operational inefficiencies and undermines healthcare sustainability (4). Thus, implementing effective, integrated waste management strategies is critical to improving resource efficiency and fostering a sustainable healthcare system.

This study aims to identify the factors that cause food waste in hospitals and design strategies that can be implemented to reduce food waste and improve cost efficiency and sustainability of hospital operations using the Systematic Literature Review (SLR) approach. The benefits of this research include providing empirical data from various literature studies related to the level and causal factors of food waste, evidence-based strategic recommendations to reduce food waste, improve hospital operational cost efficiency, and strengthen sustainability practices in food provision. In addition, this study is also expected to increase hospital staff awareness and adherence to more sustainable food management, thereby supporting environmental policies and resource efficiency in the healthcare system.

The concept of food waste in healthcare can be studied from several perspectives, including consumer behaviour theory that refers to the habits of patients and medical personnel in consuming and managing food (7). Food supply chain management theory that examines the food distribution system in hospitals to reduce waste, circular economy model that offers a sustainable approach with recycling and resource reuse practices (8). As well as lean healthcare principles that focus on optimising the food delivery process by reducing inefficiency and waste of resources through a more effective management approach (9). Using the Systematic Literature Review (SLR) approach, this research will collect and analyse primary and current literature related to various relevant theories and models in reducing food waste in hospitals.

Recent advances in the food waste management domain show significant innovations in strategies aimed at food waste reduction, which include the utilisation of artificial intelligence technologies in menu formulation, the implementation of real-time monitoring systems to measure waste generation, and the establishment of education and training initiatives for hospital personnel (10). Recent literature studies have shown that the integration of digital systems in hospital management can improve the efficiency of food provision and reduce food waste (11). In addition, research has also revealed that sustainability-based policies, such as the donation of consumable food and optimisation of food distribution processes, can be an effective solution to food waste (12).

However, there is still a research gap in the application of food waste management strategies specific to hospitals in different geographical and demographic contexts (13). Some studies have proposed technological and managerial-based approaches, but few have evaluated their effectiveness in different

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hospital operational environments (14). Therefore, this study aims to fill the gap by evaluating the most effective strategies in reducing food waste in hospitals based on a combination of technological, managerial and educative approaches, and their impact on cost efficiency and sustainability.

As a contribution to the development of science, this research is expected to provide comprehensive guidance in the implementation of food waste reduction strategies in hospitals with a Systematic Literature Review (SLR) approach. Thus, the results of this study can serve as a foundation for policy makers in designing regulations as well as for hospital management in improving cost efficiency and strengthening sustainability practices in their food supply systems.

METHOD

This study adopted a Systematic Literature Review (SLR) approach to identify and analyze food waste reduction strategies implemented in hospitals and to evaluate their impact on cost efficiency and sustainability. The SLR process was conducted according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) framework, which consists of four major stages: identification, screening, inclusion, and synthesis. Each stage was systematically conducted to ensure transparency, replicability, and scientific rigor.

1. Identification Stage

   The identification stage involved systematically searching and collecting relevant studies from reliable academic databases. The databases used included Scopus, Web of Science, PubMed, and Google Scholar. The search was limited to articles published within the last ten years (2015–2025) to ensure the data reflected recent developments and practices in hospital food waste management. The search process applied a combination of keywords such as “food waste management in hospitals,” “hospital food waste reduction strategies,” “cost efficiency in hospital food services,” and “sustainability in hospital food management.” Boolean operators (AND, OR) were used to connect and refine search terms. All search results were exported to a reference management tool (such as Mendeley or EndNote) to remove duplicate records and organize the citations efficiently. This stage ensured that all potentially relevant literature, both qualitative and quantitative was identified comprehensively before the filtering process began.

2. Screening Stage

   In the screening stage, the studies identified in the previous phase were evaluated based on their titles, abstracts, and keywords to determine their relevance to the research objectives. This stage was divided into two levels. In the first level (title and abstract screening), irrelevant articles were excluded. In the second level (full-text screening), the remaining studies were read thoroughly to ensure that they met the research scope and quality requirements. Each article was assessed independently by two reviewers, and any disagreements were resolved through discussion or consultation with a third reviewer. Reasons

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for exclusion at this stage were recorded systematically, including lack of empirical data, unclear methodology, or non-relevance to the hospital context. This step helped refine the pool of literature to only those studies that directly addressed the research focus.

3. Inclusion Stage

The inclusion stage finalized which studies were eligible for detailed review and data extraction. The inclusion criteria consisted of studies that:

a. Focused on food waste management or reduction strategies within hospital environments
b. Presented measurable impacts on cost efficiency, environmental sustainability, or both
c. Used empirical data (quantitative, qualitative, or mixed-methods)
d. Were published in peer-reviewed journals within the specified ten-year range.

Meanwhile, the exclusion criteria involved studies that:

a. did not focus on hospital settings
b. were literature reviews, editorials, or commentaries without primary data
c. lacked methodological clarity or relevant outcome measures.

After applying these criteria, the selected studies were subjected to quality appraisal using appropriate tools such as the Cochrane Risk of Bias Tool (for experimental studies), the Newcastle–Ottawa Scale (for observational studies), and the CASP Checklist (for qualitative research). This ensured that only methodologically sound and high-quality studies were included in the synthesis process.

4. Synthesis Stage

The synthesis stage aimed to extract, analyze, and integrate findings from the included studies to identify key themes, trends, and gaps. Data extraction was performed using a standardized form that captured essential information such as author, year, country, study design, type of intervention, food waste measurement methods, cost-related outcomes, sustainability outcomes, and main results. The synthesis was conducted using a mixed analytical approach combining narrative synthesis and quantitative synthesis (meta-analysis) where applicable. The narrative synthesis organized findings thematically, grouping strategies into categories such as source reduction, menu and portion control, food redistribution, staff training and awareness programs, and waste recycling or composting. Through this process, patterns and best practices were identified, along with common barriers to implementation. When sufficient quantitative data were available, a meta-analysis was conducted to measure the overall effect of certain interventions on reducing food waste or improving cost efficiency. Statistical heterogeneity among studies was assessed using the I^2 statistic, and a random-effects model was applied to account for differences in study contexts and methodologies. Studies that were too heterogeneous for meta-analysis were synthesized narratively, ensuring that all valuable insights were retained. The final

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synthesis presented both quantitative results (such as reduction percentages or cost savings) and qualitative insights (such as staff behavior, policy influence, and implementation challenges).

RESULTS AND DISCUSSION

Characteristics of Included Studies

Participants

The twelve articles reviewed in this review involved various actors directly related to the provision, management and consumption of food in hospitals and other food service institutions. The majority of participants were healthcare workers (such as dietitians, kitchen staff and food service managers), hospital patients, and in some studies also stakeholders such as policy makers and institutional managers (15–17). The studies of (4) and (18) prioritised the active participation of internal hospital and hotel staff in implementing intervention strategies towards food waste reduction, while (6) and (19) focused more on analysing existing documentation and literature. The number of participants in each study varied, ranging from qualitative research with in-depth interviews with 10-20 individuals, to large-scale observational studies looking at plate waste patterns from hundreds of food samples. This variation reflects the diversity in the approach and scope of data collection, and emphasises the importance of triangulation of methods in understanding the issue of food waste as a whole.

Countries

The analysed studies cover a wide range of geographical regions and reflect contextual diversity in food waste management. Studies came from developed countries such as Ireland (Ryan-Fogarty et al., 2017), Switzerland (4), the United States (21); (6), Australia (22), and Denmark (16), as well as from developing countries such as Lebanon (19,23), Iran (24), Malaysia (18), Portugal (5), and Saudi Arabia (25). This difference in context greatly influences the strategies implemented and their effectiveness. Countries with more developed healthcare infrastructure generally have technology-based approaches or systematic quantitative methods such as Life Cycle Assessment (LCA) and waste tracking systems, while developing countries focus more on community engagement and workforce education for food waste reduction.

Research Findings: Thematic Synthesis

Thematic analysis of the twelve articles resulted in three main themes that are the focus of understanding and addressing food waste in hospitals and food service institutions, namely: (1) key determinants of food waste, (2) intervention strategies to reduce food waste, and (3) implementation challenges of food waste management systems. Each theme represents a comprehensive overview of the root causes, solution approaches, and systemic barriers in the context of institutional food management in hospitals.

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1. Key Determinants of Food Waste

Hospital food waste generally stems from a mismatch between the food prepared and what is actually consumed by patients. (26) noted that patients on average left over a third of the food given to them, indicating a mismatch between presentation and actual consumption. This is reinforced by (17), who found that patients' individual preferences and personal experiences with food play a large role in their decision to consume or reject hospital food. On the other hand, inflexible food service operational planning also exacerbates the condition. (18) highlighted that the food service and hospitality sector (including hospitals) in Malaysia suffered economic losses due to large amounts of food waste, especially from buffet areas and leftover customer plates.

Meanwhile (19) revealed that on average a quarter of food served in hospitals in the Eastern Mediterranean region is not consumed, due to patients' medical conditions, gaps in serving time, and inappropriate menus. This phenomenon is also reinforced by the findings of (27) which showed that more than half of the breastmilk substitutes prepared by the hospital were not used, indicating inefficiencies in the allocation and use of special foods. Similar findings emerged in a literature review by (28), who mentioned that hospitals in high-income countries tend to generate more food waste, mainly due to low food quality and an unfavourable dining atmosphere.

2. Waste Reduction Intervention Strategies and Innovations

Efforts to reduce food waste in hospitals are made through various strategic approaches. In Switzerland, (29) noted the success of a long-term intervention that combined food audits, portion reorganisation and improved distribution systems. Despite an increase in portions served, the volume of food waste decreased, proving that adjustments based on real data can lead to efficiencies.

Other strategies come from systemic and analytical approaches. (15) used Life Cycle Assessment (LCA) methods to analyse the impact of different food policy options. The results show that minimising food waste especially from animal products, provides greater environmental benefits than strategies such as local purchasing or reduced packaging. This indicates that it is not enough to manage food waste only on the downstream (post-consumption) side, but also needs to target the upstream stage in the hospital food system.

In the local context, (30) mapped out an insight-based strategy for food service staff in Malaysia. The approach involved training, optimising the food ordering system, and improving communication between departments within the hospital. Meanwhile, (17) emphasised the importance of patient involvement in the food selection system, as well as the need for a food service model that is adaptive and responsive to patient conditions.

Some studies also emphasise the importance of an ecological approach in dealing with waste. (6) showed that the implementation of waste diversion systems such as composting and recycling has the potential to significantly reduce carbon emissions. In New York City, more than half of the waste reduction to landfill was achieved with the integration of recycling strategies.

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3. Systemic Challenges and Management Gaps

While various strategies have been devised, implementation is not always easy. (23) reported that hospitals in Lebanon, despite realising the potential of waste management technologies such as composting and anaerobic digestion, still rely on conventional disposal methods due to financial constraints and lack of infrastructure. This reflects that policy and institutional support greatly influence the success of interventions.

Similar constraints were identified by (16), who interviewed food service professionals and found that lack of flexibility in the procurement system, difficulty in estimating the amount of food consumption, and limitations in internal regulations were the main barriers to waste reduction. This reinforces that waste management is not just a technical issue, but also an organisational and work culture one. Other barriers include limited quantitative data and non-standardised monitoring systems. Many hospitals do not have a reliable waste reporting system to evaluate performance and make evidence-based decisions. This leads to an inability to assess the effectiveness of the strategies implemented.

An analysis of the literature shows that food waste management in hospitals requires a multidimensional approach that focuses not only on technical operations, but also on behavioural aspects and policy systems. Strategies such as staff training, portioning adjustments, and demand-based ordering systems have proven to be effective in reducing the volume of waste, especially plate waste, which has consistently been the largest contributor in various country contexts. The Life Cycle Assessment (LCA) approach, as used in the (15) study, shows that food waste prevention (especially from animal products) has a more significant environmental impact than packaging reduction or local purchasing strategies. Showed that food waste prevention (especially from animal products) has a more significant environmental impact than packaging reduction or local purchasing strategies. This suggests that strategic upstream interventions-such as sustainable food procurement and menu reformulation-should be prioritised in hospital food management policies.

However, most hospitals, especially in developing countries, still face structural challenges such as limited resources, low policy support, and lack of effective waste monitoring systems. Therefore, behavioural change approaches and data-driven strategies need to be combined with institutional reforms that involve all stakeholders, including hospital management, medical personnel, kitchen staff, and patients. With such synergy, food waste reduction will not only contribute to environmental sustainability, but also to economic efficiency and improved overall quality of healthcare.

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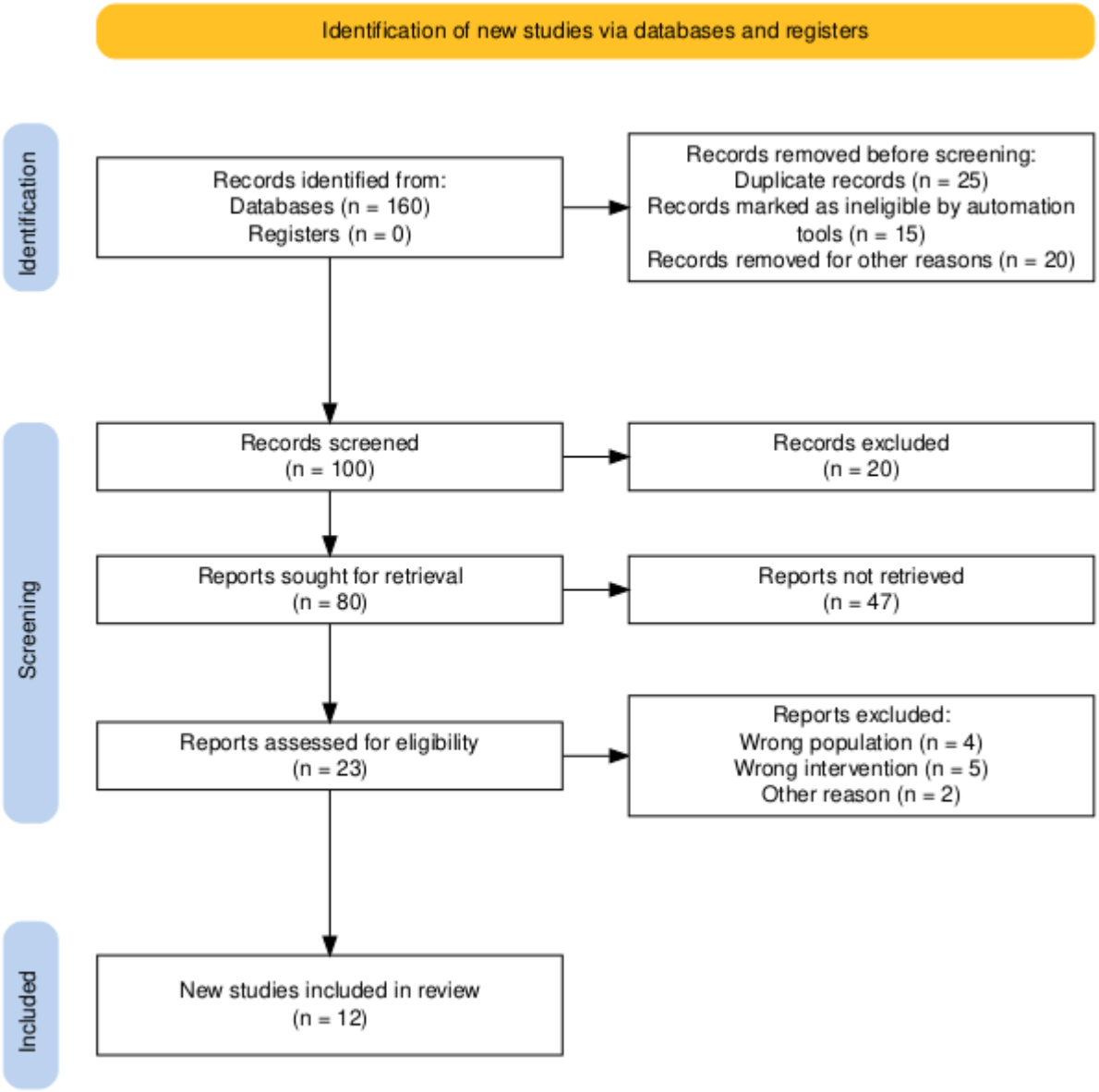

Gambar 1. PRISMA Flow Chart

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DOI: http://dx.doi.org/10.35730/jk.v16i3.1319

CONCLUSION

Table 1: Summary of Characteristics of 12 Included Studies (SLR)

No	Country	Setting	Methodology	Intervention	Outcome
1	Portugal	Acute Care Hospital (Inpatients)	Waste Audit (Plate Waste Weighing) and LCA Analysis.	Characterization of plate waste volume, cost, and environmental impact.	Average waste was 953 g/patient/day (35% of food served). Substantial national economic loss and CO_2e emissions estimated.
2	Australia	Hospital Wards (Oncology, Maternity, General Medicine)	Qualitative Study (Semi-structured Interviews) with patients.	Exploring patient perspectives on the causes of plate waste.	Main causes: Poor food quality/taste, excessive quantity/portions, and meal timing issues. Suggested modification of the foodservice system.
3	United States (US)	Multiple Hospital Networks	Comparative Observational Study (Staff Surveys)	Implementation of Room Service Model vs. traditional meal delivery systems.	*Room Service Model* consistently reduced plate waste, improved patient satisfaction, and showed potential for long-term cost reduction.
4	Australia	Hospital Foodservice	Behavioral Analysis Study (TDF & COM-B Framework).	Identifying behavioral drivers and barriers for staff performing Food Waste Audits (Waste Monitoring Systems).	Barriers: Time constraints and lack of knowledge. Interventions should focus on staff education/training, resource provision, and managerial support.

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5	Malaysia	General Hospitals & Healthcare Institutions	Qualitative Descriptive Study (Multidisciplinary Interviews)	Identifying challenges and reduction strategies from the perspective of staff (Dietitians, Kitchen Managers).	Challenges: Low institutional awareness, rigid procurement systems, and lack of training. Emphasized the need for binding policies.
6	Denmark	Regional Hospital (Inpatients)	Life Cycle Assessment (LCA)	Evaluating the environmental impact of menus, particularly the substitution of meat/animal products.	Waste prevention (source reduction) provides greater environmental benefits (carbon footprint) than end-of-pipe strategies (recycling), especially for high-impact foods.
7	Iran & Global	Various International Hospitals	Systematic Review & Meta-Synthesis	Identifying and synthesizing the main reasons for food waste and effective reduction strategies globally.	Inadequate food quality, low patient appetite, and poor portion management are universal issues. Strategies must involve patient feedback.
8	Switzerland	Long-Term Care Hospitals	Interventional Study (Experimental)	Intervention using Improved Menu Design and flexible ordering systems.	Adjusted meal portions and increased menu variety reduced plate waste by up to 15% without compromising patient nutritional intake.
9	Ireland	Acute Care Hospital	Observational Study & Intervention Evaluation	Implementation of Kitchen and Medical Staff Education programs and routine waste audits.	Significant increase in staff awareness of waste impact. Food waste reduced by 10% after an intensive training period.

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10	Germany	Inpatient Psychiatry Wards	Pilot Interventional Study	Change in the food ordering system to a more personalized, adapted pre-ordering model.	Implementation of the pre-ordering system showed potential for rapid waste reduction, while also supporting patient nutritional outcomes.
11	Lebanon & Saudi Arabia	Private and Public Hospitals	Qualitative Study/Barrier Analysis	Exploration of managerial and policy challenges in waste management in developing countries.	Key challenges are lack of recycling infrastructure, high cost of monitoring systems, and cultural norms regarding large portions.
12	Australia	Hospitality Foodservice	Comparative Mixed-Methods Study	Analysis of waste patterns and causes (preparation, plate waste) in a foodservice context.	Found that preparation waste was the largest fraction of total waste. Prevention strategies must address both kitchen operations and customer consumption practices.

This review shows that food waste in hospitals is a multidimensional problem influenced by operational factors, patient behaviour, food service quality, and limitations of internal management systems. The mismatch between food served and patient needs and preferences is a major cause of waste, which is exacerbated by the low flexibility of the serving system and the lack of patient engagement. On the other hand, data-driven reduction strategies, such as food audits, portion adjustments, staff training, and implementation of the Life Cycle Assessment approach, proved effective in reducing waste volume and environmental impact. However, the success of waste reduction strategies is highly dependent on institutional policy support, resource readiness, and cross-sectoral commitment in their implementation. Structural barriers such as limited funding, lack of reporting, and the absence of binding waste management regulations need to be overcome for proven interventions to be widely adopted. Therefore, the integration of technical, behavioural and policy approaches is key to creating an efficient, environmentally friendly and sustainable hospital food service system.

DOI: http://dx.doi.org/10.35730/jk.v16i3.1319

AUTHOR CONTRIBUTIONS

To promote transparency, we encourage authors to provide an author statement file detailing their specific contributions to the paper using the relevant CRediT roles: Conceptualization; Data curation; Formal analysis; Funding acquisition; Investigation; Methodology; Project administration; Resources; Software; Supervision; Validation; Visualization; Roles/Writing - original draft; Writing - review & editing. Authorship statements should list authors' names first, followed by their respective CRediT role(s). For example: Nur Hudha: Conceptualization, Methodology, Software. John Smith: Data curation, Writing - Original draft preparation. Jane White: Visualization, Investigation. Bruce Buck: Supervision. Matt Jr.: Software, Validation. Peter Long: Writing - Reviewing and Editing.

ACKNOWLEDGEMENT

The author expresses sincere gratitude to all parties who have contributed to the completion of this Systematic Literature Review (SLR) article. The author also wishes to thank the academic advisors from the Faculty of Health Sciences, Universitas Brawijaya, for their methodological guidance, valuable insights, and constructive feedback, which have enriched the analytical depth of this Systematic Literature Review (SLR).

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