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SISA MAKANAN DI SEKOLAH ASRAMA: TINJAUAN LITERATUR SISTEMATIS

FOOD WASTE IN BOARDING SCHOOLS: A SYSTEMATIC LITERATUR REVIEW

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ABSTRAK

Enam studi dari Afrika Selatan, Indonesia, Tiongkok, dan Taiwan mendokumentasikan pemborosan makanan di sekolah berasrama dan lingkungan pendidikan yang sebanding. Di sebuah sekolah berasrama Islam, satu studi mengukur tingkat pemborosan rata-rata sebesar 4,36% (SD 8,41%), sementara studi lain dalam lingkungan yang serupa menemukan bahwa masalah suhu makanan secara signifikan meningkatkan pemborosan (p = 0,023). Di ruang makan universitas, pemborosan piring berkisar antara 16,9% hingga 26,7% dan mencapai 555 g per siswa per hari. Di sekolah dasar/menengah, 130 g terbuang per makan (21% dari makanan yang disajikan), dan di sekolah menengah swasta, tingkat pemborosan berkisar antara 14,71% hingga 25,25%. Barang yang sering dibuang termasuk sayuran, makanan penutup, makanan pokok, lauk pauk, dan nasi/mi. Praktik kelembagaan seperti sistem pemesanan, desain menu, dan logistik layanan, bersama dengan faktor perilaku seperti kebiasaan dan kesadaran diet, mendasari pemborosan yang diamati. Analisis ekonomi menunjukkan bahwa pengurangan limbah sebesar 10% dapat menghasilkan penghematan tahunan sebesar $80.000 atau mengimbangi biaya yang diperkirakan mencapai 0,31 miliar Yuan Tiongkok. Sebuah studi mengkuantifikasi kerugian lingkungan sebesar 15.560 ton limbah, 554 km² lahan, dan 23,12 juta m³ air. Rekomendasi berfokus pada strategi pendidikan dan administratif, perbaikan manajemen operasional, dan peningkatan sistem umpan balik, meskipun tidak ada studi yang menguji intervensi ini dalam kondisi terkendali.
Kata kunci : Sisa makanan, sekolah asrama, tinjauan literatur

ABSTRACT

Six studies from South Africa, Indonesia, China, and Taiwan documented food waste in boarding schools and comparable educational settings. In an Islamic boarding school, one study measured a mean waste rate of 4.36% (SD 8.41%), while another in a similar setting found that food temperature issues significantly increased waste (p = 0.023). In university dining halls, plate waste ranged from 16.9% to 26.7%, reaching 555 g per student per day. In primary/middle schools, 130 g were wasted per meal (21% of food served), and in private high schools, waste rates ranged from 14.71% to 25.25%. Frequently discarded items included vegetables, desserts, staple foods, side dishes, and rice/noodles. Institutional practices, such as booking systems, menu design, and service logistics, along with behavioural factors, such as dietary habits and awareness, underlie the observed waste. Economic analyses indicate that a 10% reduction in waste could yield annual savings of $80,000 or offset costs estimated at 0.31 billion yuan. One study quantified environmental losses at 15,560 tonnes of waste, 554 km² of land, and 23.12 million m³ of water. Recommendations focus on educational and administrative strategies, improved operational management, and enhanced feedback systems, although none of the studies have tested these interventions under controlled conditions.

Keywords : *Food waste, boarding school, literature review*

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INTRODUCTION

Providing nutritious, balanced meals in the dormitory environment is crucial for supporting student growth and learning abilities. Adequate energy and nutrition can support optimal student growth and development[1]. However, food waste and food loss in dormitory food management is a real problem. Various studies have shown high levels of food waste in boarding and full-day schools. For example, Velawati et al. (2021) conducted research in a girls' Islamic boarding school and reported that the average leftover rice (staple) reached 17.78%, vegetable side dishes 14.31%, and vegetables 9.27%[2]. Another study in a full-day elementary school showed an average uneaten portion of food of approximately 18–21%[3]. The portion of food wasted in university canteens and restaurants ranges from tens of grams per portion to tens of percent of the food served, depending on the serving method, portion policies, and consumer behaviour[4]. These conditions indicate that almost one-fifth of the food provided is not consumed.

Food waste in boarding schools is a multidimensional problem that impacts food safety, the institution's economics, and the environment (greenhouse gas emissions and water/energy use associated with food production). Several studies have shown that student housing areas (dormitories) and campus catering facilities are significant contributors to total institutional waste, with food waste accounting for a substantial portion of the total residual waste[5]. This high food waste phenomenon is generally associated with menus or portion sizes that do not suit student preferences, as well as other operational factors in catering. This suggests that food waste reflects inefficiency in dormitory dining operations. As Velawati et al. (2021) found, student satisfaction with food taste and service is closely correlated with the amount of food waste generated. Unpopular menu items and inappropriate portion sizes tend to result in greater food waste[2].

A study of the health and nutrition aspects of research by Ilmi et al. (2022) states that the impact of high levels of food waste over a long period of time can trigger malnutrition due to deficits in important macro and micronutrients, such as protein, iron, and vitamins[6]. This condition can directly impact growth, learning concentration, endurance, and academic achievement. The types of food that are most often thrown away tend to be foods that easily wilt/are soupy (vegetables in soup, unpeeled fruit), side dishes that are less popular, and foods served in excessive portions or that do not suit students' cultural preferences/tastes. Furthermore, appearance (presentation) and temperature/timeliness of serving influence the level of waste. Side dishes, such as vegetables and fruits, often appear as components with high levels of waste[7].

From an economic perspective, food waste causes significant loss. The economic value and resources (water, land, and labour) lost due to food waste reflect significant waste in institutional food service delivery. Food waste and loss have become global issues that require serious attention. The United Nations (2021) reported that in 2019, approximately 931 million tons of food (equivalent to 17% of all available food) was wasted annually. Indonesia is estimated to contribute approximately 13 million tons of food waste annually, making it the country with the second-highest amount of food waste in the world, after Saudi Arabia[8]. The amount of food waste in Indonesia during the 2000–

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2019 period reached 23–24 million tons/year or 115–184 kg/capita/year. This figure reflects the high inefficiency of the national food system, with estimated economic losses of IDR 213–551 trillion, equivalent to 4–5% of Indonesia's Gross Domestic Product (GDP)[9].

Economic and environmental implications: Food waste in boarding schools causes two major losses: direct economic losses for the institution (including the cost of wasted raw materials and waste management costs) and environmental costs related to greenhouse gas emissions, land use, and water invested in producing food that is ultimately wasted. Policy analysis shows that reducing food waste in school environments can reduce emissions and operational costs, while increasing food use efficiency[10]. From a social perspective, this amount can be estimated to feed 61–125 million people, or 29–47% of Indonesia's population[11]. This indicates that food waste not only reduces the effectiveness of food service delivery but also places a significant economic burden at both the macro and micro levels.

Given this background and these issues, a study of food waste in dormitories is urgently needed. This study provides a comprehensive overview of the scale and characteristics of food waste in boarding schools. Through a systematic review, this study will identify the magnitude of food waste, patterns of the most frequently wasted food types, and factors influencing it, including institutional, operational, logistical, and student consumption behaviour. This study also assesses the economic and environmental implications of food waste and food loss, thus providing a more comprehensive analysis. The research results are expected to not only add to academic conclusions that produce evidence-based recommendations for improving food management in dormitories but also have the potential to provide practical benefits in supporting nutritional adequacy in dormitories, increasing the efficiency of food management, and contributing to efforts to reduce food waste at the national and global levels.

METHOD

Paper search

The primary search will be conducted using Elicit.com, a research assistant tool that uses language models to help researchers find relevant papers. Using the research question “Food waste in boarding schools”, we searched across over 126 million academic papers from the Semantic Scholar corpus. We retrieved 50 papers that were most relevant to the query. Using your research question “Food waste in boarding schools”, we searched across over 126 million academic papers from the Semantic Scholar corpus. We retrieved the 50 papers most relevant to the query.

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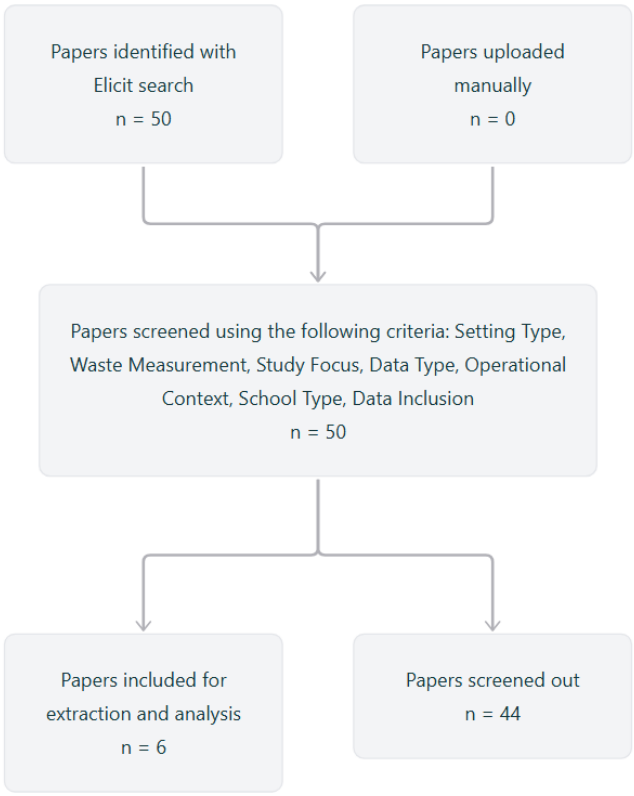

Figure 1. Flowchart of the study selection procedure

Screening

We screened sources that met the following criteria:

- **Setting Type** : Was the study conducted in a boarding school or residential educational institution with dining facilities
- **Waste Measurement** : Does the study include direct measurement or quantification of food waste?
- **Study Focus** : Is food waste (rather than other types of waste) the primary focus of the study?
- **Data Type** : Does the study include empirical data (rather than only theoretical models)?
- **Operational Context** : Does the study examine food service operations and/or student dining behaviours ?
- **School Type** : Does the study include boarding students (not exclusively day students)?
- **Data Inclusion** : Does the study include actual waste measurement data (not just procurement, financial, or composting data alone)?

We considered all screening questions together and made a holistic judgement about whether to screen each paper.

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Data extraction

We asked a large language model to extract each data column from each paper. We provided the model with the extraction instructions shown below for each column.

Study Design:
Identify and record the specific study design used:

- Cross-sectional
- Observational
- Mixed methods
- Case study

This information is primarily located in the Methods section. If the design is not explicitly stated, it is inferred from the study's methodology description. If multiple design elements are present, list all the relevant types.
If the design is unclear, note "Design not clearly specified" and provide a brief explanation of the study approach.

Setting and Context:
Extract detailed information about the study's location and institutional context:

- Type of institution (boarding school, university dining hall, etc.)
- Geographic location (country, region)
- Specific characteristics of the institution (e.g., gender composition, type of school)

Look for this information in the introduction, methods, or participant description sections. Be as specific as possible. If multiple settings are involved, list all of them.
If setting details are incomplete, note any partial information available and mark areas of missing data.

Sample Characteristics:
Record the following participant details:

- Total number of participants
- Gender breakdown
- Age range (if provided)
- Any specific demographic characteristics relevant to food waste

Prioritize finding this information in the methods section, participant description, or demographics subsection.
If exact numbers are not provided, use ranges or approximate values. If participant details are incomplete, clearly note which specific information is missing.
Ensure to distinguish between total participants and those actually analyzed in the food waste assessment.

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Food Waste Measurement:
Capture the specific methods used to measure food waste:

- Measurement technique (e.g., direct weighing, visual assessment)
- Specific tools used (e.g., Visual Comstock form)
- Duration of measurement period
- Units of measurement (grams per student, total weight, percentage)

Locate this information primarily in the methods section. If multiple measurement techniques were used, list all of them.
If measurement details are incomplete or unclear, note the specific gaps in the methodology.
Quantify the food waste measurement results if available, including any calculated waste rates or total waste volumes.

Primary Findings on Food Waste:
Extract the key quantitative and qualitative findings related to food waste:

- Total food waste generated
- Per capita food waste
- Factors influencing food waste
- Any economic or environmental implications

Prioritize information from the results and discussion sections. Include specific numerical data where available. If findings are complex or multifaceted, summarize the most significant points. Ensure to capture both the magnitude of food waste and any contextual explanations provided by the researchers.If findings are inconclusive or limited, clearly note the researchers' caveats or limitations.

RESULTS

Table 1. Characteristics of Included Studies

Study	Study setting	Sample size	Geographic location	Study design	Full text retrieved
[12]	University dining halls (7 residences, Stellenbosch University)	6 food service managers, 63 catering personnel, 517 students	Stellenbosch, Western Cape, South Africa	Cross-sectional	Yes
[13]	University dining halls (Rhodes University)	We didn't find mention of sample size	Grahamstown, South Africa	Observational	No
[14]	Islamic boarding school (junior high, HM Lirboyo)	11 female students	Kediri Regency, Indonesia	Cross-sectional, Observational	Yes
[15]	Islamic boarding	54 students (25	Samarinda, East	Cross-sectional, Observational	Yes

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	school (junior high, Istiqomah Samarinda)	male, 29 female	Kalimantan, Indonesia		
[16]	Primary and middle schools (6 schools, public/private)	998 students (923 effective responses)	Beijing, China	Mixed methods, Case Study	Yes
[17]	Private high schools (X Girls, Y Senior High)	3200 students	Taipei City, Taiwan	Mixed methods, case study	Yes

Table 1 presents studies on food waste in educational institutions conducted across a range of settings and geographic locations, providing a broad perspective on the issue. Two studies were conducted in university dining halls, two in Islamic boarding schools, one in a primary/middle school, and one in a private high school, reflecting differences in institutional structures and student populations. Geographically, the research spanned multiple regions, with two studies each from South Africa and Indonesia and one study each from China and Taiwan, suggesting that food waste in school-based settings is a global concern rather than a localised issue. Methodologically, there was considerable diversity, with three studies adopting a cross-sectional approach, three relying on observational designs, two employing mixed methods, and two using case-study approaches. In some instances, studies combined more than one design to strengthen their results. Regarding participants, five studies explicitly reported their sample sizes, while one study did not provide such information, indicating gaps in reporting standards. Taken together, these findings demonstrate the heterogeneity of research on food waste in educational contexts, both in terms of setting and methodology, while also highlighting the need for greater consistency in study design and reporting to facilitate cross-study comparisons in the future.

Table 2. Food Waste Patterns and Quantities

Study	Institution type	Waste per student	Type of food waste	Measurement method
[12]	University dining hall	16.9% plate waste; 26.7% total food waste	Vegetables (32%), dessert (59%)	Direct weighing (SECA scale), 3 days
[13]	University dining hall	555g/student/day; 450 tonnes/year	We didn't find mention of type of food wasted in the abstract	We didn't find mention of measurement method in the abstract

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14	Islamic boarding school (junior high)	4.36% (mean, standard deviation 8.41%)	We didn't find mention of type of food wasted	Visual Comstock form, 3 days
15	Islamic boarding school (junior high)	We didn't find mention of waste per student	We didn't find mention of type of food wasted	We didn't find mention of measurement method
16	Primary/middle school	130g/cap/meal (21% of food served)	Staple foods (43%), vegetables (42%)	Physical weighing, visual observation, 1 day
17	High school (private)	X Girls: 25.25% (7605kg); Y Senior: 14.71% (4496kg)	Side dishes (30.49%), rice/noodles (27.91%)	Direct weighing (electronic scale), 35 days

Table 2 shows that across the six reviewed studies on food waste in institutional dining settings, a diverse range of contexts and findings were identified. The institutions included two university dining halls, two Islamic junior high boarding schools, one primary/middle school, and one private high school, reflecting variations in age groups and food-service systems. Quantitative data on waste were reported in five studies, with four presenting waste as a percentage of food served, ranging from as low as 4.36% to as high as 26.7%. Two studies reported waste in absolute terms, at 130 g per student per meal and 555 g per student per day, while one large-scale study highlighted the magnitude of the issue by reporting 450 tons of waste generated annually. Regarding the types of food most frequently discarded, three studies provided detailed information, with vegetables consistently identified as the most wasted items in two studies. Other commonly wasted foods included desserts, staple foods, side dishes, and rice/noodles, although these were less consistently reported. In terms of methodology, three studies employed direct weighing of plate waste, one utilised visual estimation with the Comstock form, one combined weighing with visual observation, and two did not clearly specify their measurement approach. Collectively, these findings highlight the scale and complexity of food waste across different educational institutions, underscoring the importance of standardised measurement methods for generating comparable and actionable evidence.

Table 3. Contributing Factors

Study	Factor Category	Spesific Factors	Number of Studies Identifying	Impact Level
12	Institutional/Operational	Blooking	1	High

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		system, menu, serving style, meal plan (dessert, starch)		
13	Contextual/Operational	Distance to dining hall, gender composition, meal times/options	1	Moderate
14	Menu/Nutritional	Menu variation, student acceptance	1	Low (waste low, but all students undernourished)
15	Food Quality/Logistics	Food temperature (due to kitchen-dining distance)	1	Significant (p=0.023)
16	Institutional/Behavioral	Food supply pattern, canteen service, dietary habits, knowledge	1	High
17	Institutional/Behavioral	Meal quality, budget, tracking/feedback, eating behavior, awareness, lack of initiatives	1	High

Table 3 shows that the six reviewed studies revealed considerable variation in study settings, covering two university dining halls, two Islamic boarding schools at the junior high level, one primary/middle school, and one private high school. Geographically, the studies were conducted in South Africa (two studies), Indonesia (two studies), China (one study), and Taiwan (one study), underscoring that food waste in educational institutions is a global issue rather than a localised phenomenon. Methodologically, the designs were diverse, with three studies adopting a cross-sectional approach, three an observational approach, two a mixed methods approach, and two a case study approach, with some studies applying more than one design. Sample sizes were reported in five studies, while one did not provide this information, reflecting gaps in the reporting consistency.

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The findings on the magnitude of food waste varied considerably. Five studies presented quantitative data, with four reporting waste as a percentage of food served, ranging from 4.36% to 26.7%. Two studies reported absolute amounts, namely 130 g per student per meal and 555 g per student per day, while one large-scale study highlighted the severity of the problem by reporting 450 tons of waste generated annually. Information on the types of food wasted was provided in three studies, with vegetables consistently identified as the most wasted item in two studies. Other frequently discarded items included desserts, staple foods, side dishes, and rice/noodles, each reported in a single study. In terms of measurement methods, three studies used direct weighing, one employed visual estimation using the Comstock form, one combined both weighing and observation, and two did not clearly specify their methods.

Analysis of the contributing factors revealed a broad distribution across the institutional, operational, nutritional, logistical, and behavioural domains. Institutional factors were the most frequently identified, with three studies emphasising either operational or behavioural issues, while contextual/operational, menu/nutritional, and food quality/logistics factors were identified in one study each. Grouping by secondary categories, operational and behavioural factors appeared in two studies each, while nutritional and logistical factors appeared once. The reported level of impact varied: three studies reported a high impact, one reported a moderate impact, one reported a low impact, and one study reported statistically significant effects ($p = 0.023$). Recurring patterns included menu- or meal-related influences (three studies), service- or logistics-related issues (three studies), and behavioural or eating habits (three studies). Additional factors, such as contextual access, budgeting, tracking/feedback systems, and awareness, were also reported, albeit less consistently.

Regarding intervention strategies, none of the included studies implemented or empirically tested waste reduction programs under controlled conditions. Nonetheless, several authors have proposed potential strategies. Marais et al. (2017) emphasized education for catering staff and students, along with the establishment of representative forums[12]. Painter et al. (2016) discussed possible educational, technical, and administrative interventions and projected substantial cost savings from waste reduction[13]. Chu et al. (2023) proposed five management strategies for contracted catering companies, including monitoring systems and feedback mechanisms[17]. Taken together, these findings indicate that while the determinants of food waste in schools and boarding institutions are relatively well documented, there remains a critical evidence gap in terms of tested and validated interventions, leaving most recommendations as conceptual proposals rather than proven solutions.

Table 4. Economic and Environmental Implications

Study	Economic Implication	Environmental Implications
[12]	Reducing waste could minimize unnecessary production/disposal	Reducing waste mitigates environmental impacts (not quantified)
[13]	$80,000 annual savings per 10% reduction	We didn't find mention of environmental implications in the abstract

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14	We didn't find mention of economic implications	We didn't find mention of environmental implications
15	We didn't find mention of economic implications	We didn't find mention of environmental implications
16	0.31 billion Chinese Yuan annual cost	15,560 tons/year; 554 km² land, 23.12 million m³ water lost
17	Budget constraints increase waste	Food waste contributes to environmental issues (not quantified)

Table 4 shows that the findings on the broader consequences of food waste highlighted both economic and environmental dimensions, though with varying levels of detail across the studies. Economic implications were addressed in four of the six studies included in this review. Two of these provided quantified estimates, demonstrating the potential for substantial cost savings or losses linked to wasted food, while the other two described qualitative impacts, such as inefficiencies in resource allocation and financial strain on institutional budgets. In contrast, two studies did not discuss economic aspects at all. Environmental implications were discussed less frequently, appearing in only three studies. One study offered quantified assessments of environmental impact, such as resource depletion and waste generation, while the other two provided qualitative descriptions of negative environmental effects, including strain on waste management systems and contributions to broader sustainability challenges. The remaining three studies did not address the environmental consequences. Taken together, these findings suggest that although food waste in educational institutions carries clear economic and environmental burdens, the explicit quantification of these impacts remains limited, indicating an important gap in the evidence base.

DISCUSSION

Food waste in educational institutions, including boarding schools, primary and secondary school lunch programs, and university dining halls, remains substantial and variable across contexts. Recent audits have reported per-student plate waste ranging from approximately 130 g per meal to several hundred grams per student per day, with institutional waste rates approaching 25% of the served food in some settings[18,19]. These magnitudes are consistent with national syntheses showing that schools and campuses are critical hotspots of avoidable food loss and waste owing to their scale, uniform service models, and centralised procurement systems [20,21]. Even modest reductions of 10% can translate into large absolute savings in food mass, cost, and resource use at the institutional level[22].

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The drivers of food waste in boarding and institutional settings are multidimensional, spanning the operational, sensory, and behavioural domains. Institutional and operational factors, such as menu design, portion control, serving logistics, and kitchen-to-dining distance, directly affect waste generation[19]. Meanwhile, sensory aspects such as food temperature, flavour, and presentation strongly influence acceptability[23]. Behavioural and sociocultural factors, including student preferences, time constraints, and lack of awareness, also play critical roles[24]. Studies have shown that fixed portion sizes or mandatory serving systems often encourage over-serving and plate waste, whereas limited mealtime duration discourages complete consumption[22,25]. Consequently, effective strategies must simultaneously address both supply (institutional services) and demand (student behaviour) components.

Beyond the immediate loss of edible food, institutional food waste has nutritional, economic, and environmental impacts. Frequent discarding of key staples and protein components may reduce students' energy and micronutrient intake, especially in boarding contexts where institutional meals are the primary food sources[19]. Several analyses indicate that waste reduction directly lowers procurement costs, yielding measurable financial savings for food service providers[20]. Environmentally, food waste contributes substantially to greenhouse gas emissions, resource depletion, and nutrient loss, representing an inefficient use of agricultural inputs[26]. Reducing food waste supports multiple Sustainable Development Goals (SDGs), including zero hunger (SDG 2), responsible consumption (SDG 12), and climate action (SDG 13).

Current evidence of interventions demonstrates a growing toolkit of effective measures. Recent systematic reviews and field studies have highlighted three main categories: (1) operational interventions, such as portion control, trayless dining, and demand forecasting; (2) behavioural strategies, such as taste testing, waste feedback, and nudging; and (3) institutional system redesign through student co-creation and meal reservation systems[23,25]. However, most interventions remain single-site or short-term, with limited replication across different cultural contexts[22,24]. Furthermore, combined approaches that integrate operational and behavioural changes appear to be more effective but require higher institutional commitment and monitoring capacities[18]. Advanced data-driven solutions, such as machine learning for demand prediction, offer promise for precision food preparation but require stronger evaluation evidence[22].

Several recommendations have emerged for practice and research. Practitioners should integrate operational redesign with behavioural engagement and regular waste auditing to identify priority items for intervention[19]. Aligning policies and contractual incentives can encourage caterers and institutions to minimise waste[20]. Researchers should expand multi-site controlled intervention trials to test combined strategies and quantify nutritional, economic, and environmental benefits[23,26]. Future studies should also address implementation fidelity and equity, ensuring that waste reduction does not compromise access to adequate nutrition for vulnerable students[24]. Collectively, these actions will advance evidence-based policies that improve nutrition, reduce costs, and strengthen sustainability in educational institutions.

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CONCLUSION

This systematic literature review demonstrates that food waste in boarding schools and other educational institutions is a global issue, with considerable variation in magnitude ranging from 4.36% to 26.7% of food served, equivalent to approximately 130 grams per student per meal to 555 grams per student per day. Commonly discarded items include vegetables, staple foods, side dishes, and rice or noodles. The contributing factors include institutional (operational and behavioural), menu variation, service quality, food logistics, and students' dietary habits. The implications extend beyond nutrition to significant economic and environmental losses, with some studies estimating annual financial burdens of hundreds of millions of Chinese Yuan and the substantial depletion of natural resources. Although strategies such as nutrition education, improved operational management, and integrated feedback systems have been recommended, no study has empirically tested their effectiveness in boarding school contexts.

RECOMMENDATIONS

Efforts to reduce food waste in boarding schools should prioritise improved food service management, nutrition education for students and catering staff, and adopting integrated monitoring and feedback systems. Schools can implement practical measures, such as portion adjustment, menu diversification based on student preferences, and better logistics for food delivery and serving. From a research perspective, controlled intervention studies are needed to evaluate the effectiveness of food waste reduction strategies and provide comprehensive analyses of their economic and environmental implications. Such evidence is crucial for guiding school-level practices and informing policy development aimed at achieving more efficient, sustainable, and environmentally responsible food service systems.

REFERENCES

1. Soliman A, Alaaraj N, Hamed N, Alyafei F, Ahmed S, Shaat M, et al. Nutritional interventions during adolescence and their possible effects. Acta Biomed. 2022;93(1):1–14.
2. Velawati M, Kusuma HS, Fitriyanti AR, Hagnyonowati. Sisa Makanan Indikator Tingkat Kepuasan Pelayanan Makan di Pondok Pesantren Salafiyah Kauman Pemalang. Pros Semin Nas UNIMUS. 2021;4:1147–60.
3. Nabila HF, Ruhana A. Evaluasi Ketersediaan Energi dan Zat Gizi Makro, Tingkat Kepuasan, sertaSisa Makanan pada SD Khazanah Ilmu Sidoarjo. J Gizi dan Kesehat. 2025;17(2):159–69.
4. Li Y, Liang Y, Yu D, Xu L, Song Q. Reducing food waste behaviors from the viewpoint of university students through the E-TPB model. Circ Econ. 2025;4(3).
5. Rodríguez-Guerreiro MJ, Torrijos V, Soto M. A Review of Waste Management in Higher Education Institutions: The Road to Zero Waste and Sustainability. Environ - MDPI. 2024;11(12):1–24.
6. Ilmi N, Hardiansyah A, Lestari P. The Relationship Between Nutritional Knowledge and Food Quality with Food waste at the International Muhammadiyah Boarding School (IMBS) Miftakhul Ulum Pekajangan. J Nutr Culin. 2022;3(1):8–16.
7. Vidal-Mones B, Diaz-Ruiz R, M. Gil J. From evaluation to action: Testing

ISSN 2829-2057
E-ISSN 2829-2014

nudging strategies to prevent food waste in school canteens. Waste Manag. 2022;140(December 2021):90–9.
8. United Nations Environment Programme. UN: 17% of all food available at consumer levels is wasted [Internet]. 2021. Available from: https://www.unep.org/resources/report/unep-food-waste-index-report-2021
9. BAPPENAS. Food Loss and Waste di Indonesia: Dalam Rangka Mendukung Ekonomi Sirkular dan Pembangunan Rendah Karbon [Internet]. Badan Perencanaan Pembangunan Nasional. 2021. Available from: http://greengrowth.bappenas.go.id/pengelolaan-limbah-makanan-yang-berkelanjutan-berkontribusi-pada-pembangunan-rendah-karbon-di-indonesia/
10. Love DC, Conrad Z, Altema-Johnson D, Ramsing R, Bassarab K, Thorne-Lyman AL, et al. Food Substitution and Waste Reduction Can Reduce the Environmental Impacts and Food Costs of School Meal Programs in the United States: An 2011-2018 NHANES Analysis. J Acad Nutr Diet [Internet]. 2025; Available from: https://doi.org/10.1016/j.jand.2025.04.006
11. Suryana EA, Effendi MW, Luna P. TANTANGAN DAN STRATEGI KEBIJAKAN PENGURANGAN LIMBAH PANGAN DI INDONESIA Challenges and Strategies for Food Waste Reduction Policy in Indonesia. Forum Penelit Agro Ekon. 2023;41(1):1–12.
12. Marais ML, Smit Y, Koen N, Lötze E. Are the attitudes and practices of foodservice managers, catering personnel and students contributing to excessive food wastage at Stellenbosch University? South African J Clin Nutr [Internet]. 2017;30(3):60–7. Available from: http://dx.doi.org/10.1080/16070658.2017.1267348
13. Painter K, Thondhlana G, Kua HW. Food waste generation and potential interventions at Rhodes University, South Africa. Waste Manag [Internet]. 2016;56:491–7. Available from: http://dx.doi.org/10.1016/j.wasman.2016.07.013
14. Cerdasari C, Prameswari NY. Menu Variation, Food Waste, and Nutrient Sufficiency Level of Female Student at Islamic Boarding School. Nutr J [Internet]. 2022;1(3):43. Available from: http://dx.doi.org/10.31290/nj.v1i3.3750
15. Faisal M, Wiryanto, Utami RP. Factors that Influence Food Waste at the Istiqomah Samarinda Islamic Boarding School. Formosa J Appl Sci [Internet]. 2023;2(10):2339–52. Available from: http://dx.doi.org/10.55927/fjas.v2i10.6336
16. Liu Y, Cheng S, Liu X, Cao X, Xue L, Liu G. Plate Waste in School Lunch Programs in Beijing, China. Sustainability [Internet]. 2016;8(12):1288. Available from: http://dx.doi.org/10.3390/SU8121288
17. Chu CM, Chih C, Teng CC. Food Waste Management: A Case of Taiwanese High School Food Catering Service. Sustainability [Internet]. 2023;15(7):5947. Available from: http://dx.doi.org/10.3390/su15075947
18. Cisse RS, Aguilar FS, Ezenagu SB, Cisse MS, Niang A. Characterization of food waste in Grizzly Dining Hall at Georgia Gwinnett College: A critical step toward sustainable food waste management. Heliyon [Internet]. 2025;11(2):e41750. Available from: https://doi.org/10.1016/j.heliyon.2025.e41750
19. Leal Filho W, Ribeiro PCC, Setti AFF, Azam FMS, Abubakar IR, Castillo-Apraiz J, et al. Toward food waste reduction at universities. Environ Dev Sustain. 2023 May 6;26(7):16585–606.
20. ReFED. Insights from ReFED's Food Loss and Waste Estimates 2023 [Internet]. New York; 2023. Available from: https://refed.org/articles/slow-progress-big-opportunities-in-food-waste-reduction-insights-from-refed-s-food-loss-and-waste-estimates-for-2022/

ISSN 2829-2057
E-ISSN 2829-2014

21. EPA. From Farm to Kitchen: The Environmental Impacts of U.S. Food Waste. New York; 2023.
22. Turker GF. Reducing Food Waste in Campus Dining: A Data-Driven Approach to Demand Prediction and Sustainability. Sustain. 2025;17(2).
23. Radhakrishnan G, Manivannan SK, Karmegam D. Interventions for reducing food waste and behavioural change among students in higher education institutions – A systematic review. Clean Waste Syst [Internet]. 2024;9(November):100180. Available from: https://doi.org/10.1016/j.clwas.2024.100180
24. Gardner G, Burton W, Sinclair M, Bryant M. Interventions to Strengthen Environmental Sustainability of School Food Systems: Narrative Scoping Review. Int J Environ Res Public Health. 2023;20(11).
25. Sundin N, Malefors C, Strotmann C, Orth D, Kaltenbrunner K, Obersteiner G, et al. Sustainability assessment of educational approaches as food waste prevention measures in school catering. J Clean Prod. 2024;481(November).
26. UNEP. Food loss and waste as a contributor to greenhouse gas emissions: Policy brief. Geneva; 2024.