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Understanding Food Waste Generation Patterns in Swedish Schools Through Long-term Monitoring Using Smart Bin

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Abstract

Food waste in school meal systems represents a significant loss of food, public resources, and nutritional value, yet most existing studies rely on short-term audits and aggregated measurements that do not capture behavioural and temporal waste-generation patterns. This study was conducted on food waste generation in two municipal schools in Borås, Sweden using a smart bin-based monitoring system over long-term continuous operation period. Two smart bins were installed in each school dining hall and kitchen. The quantification of waste events was determined by the net weight, categorized based on the captured images from smart bin, normalized by portions served, and analysed through the meal service dynamics, Pareto analysis, temporal trend analysis, and comprehensive statistical analysis. Data analysis was conducted for 20 weeks of data having approximately 15,000 data point for each dining smart bin and 1000 data points for each kitchen bin. To enable comparison of food waste across schools and over time, waste quantities were normalized to the number of portions served. The primary unit used in this study was grams of waste per portion served (g/portion). The findings revealed that in School A and B, average plate waste per portion was 15 g/portion and 21 g/portion, respectively and serving waste per portion was 4 g/portion and 12 g/portion, respectively.

Meal service dynamics were examined to know the percentage of students who generate food waste during lunch service. To approximate the number of students generating waste, waste events occurring within a 2-second interval were aggregated and considered as a single disposal event. The results show that, on average, 42% of students generated plate waste, while the remaining 58% did not produce any measurable waste in both schools. To further narrow down, Pareto analysis was conducted to examine the distribution of plate waste events and to identify whether a small fraction of events contributes large amount of plate waste. The analysis showed that approximately 36% of waste events accounted for nearly 70% of total plate waste in school A, while about 40% of events contributed around 75% of total waste in school B. From analysis of meal service dynamics and pareto distribution of recorded events, it is found that 15 – 17% of students are responsible for 70 – 75% of plate waste. Temporal analysis showed that plate waste generation is increasing over the lunch time in School B. The study highlights the value of long-term, event-level smart bin monitoring for identifying food waste patterns and supporting the design of targeted, context-specific intervention strategies in school meal settings.

Keywords: Food waste quantification, Commercial kitchens, Food waste classification, Hots-pot identification