JST: Engineering and Technology for Sustainable Development
Volume 35, Issue 3, July 2025, 061-069

Food Waste in School Lunches in Hanoi Urban, a Weighing-Based Empirical Study

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Abstract

Food loss and waste (FLW) is a pressing issue in many countries. In developed countries, school FLW has received much attention, because it is directly linked to children's nutrition. But in low-and middle-income countries, FLW has not been considered as a priority yet. In Vietnam, there are no statistics on the issue. In the paper, we present an empirical study which investigates and measures FLW from school meals in urban Hanoi. Loss and waste are understood as portions of distributed food, discarded or unconsumed during school lunches. Surveys have been conducted at 8 school kitchens over a total period of 8 weeks. At each kitchen, the team recorded and measured parameters of food distributions and FLW at different stages. Participants to the study are children at primary and secondary schools, randomly selected by classes from grades 1 to 9. In terms of findings, the FLW quantity is estimated at 118 grams of food per individual at lunch on average, equivalent to 29% of the total cooked and served food-equivalence (excluding added water and/or species). Vegetables had the highest wastage rate, while that of meat was the lowest. We also found that FLW rate is sensitive to whether children are in primary or secondary school, to age, and to the menu's composition. By developing a protocol of FLW collect and analysis in Hanoi, adapted for Vietnam food, we produced for the first time in Vietnam a dataset and values, which are the basis for policy recommendations.

Keywords: Food loss and waste, school catering, sustainable food system, Hanoi.

1. Introduction

Food Loss and Waste (FLW) is a pressing global issue with significant environmental, economic, and social consequences. According to the Food and Agriculture Organization, about one-third of all food globally produced is lost or wasted per year. The United Nations Environment Programme (UNEP) estimates that the global food waste is about 1.025 million tons in 2022, which returns to 132 kg of waste per capita per year [1]. Such volume is equivalent to the loss of one billion meals per day.

According to UNEP, facts about food waste are regrettable, given that more than 800 million in the world are still being affected by hunger [2]. FLW generates critical impacts on the use of resources and the environment in particular. To put it differently, it represents an inefficient use of scarce natural resources (e.g. land, water…) and a considerable share in humanity's carbon footprint. Food production accounts for 1/3 of anthropogenic Greenhouse Gas (GHG) [3]. Since one third of food production is lost or wasted along the food chain, FLW might account for about 10% of human GHG emission. In addition, growing global population and diminishing per capita resources exacerbate food shortages and malnutrition, making food waste an increasingly urgent preoccupation in many countries. Vietnam's economy is much dependent on food and agriculture activities. With a Gross Domestic Product (GDP) share for agriculture at 12% and its 20 million farmers which represent more than 20% of the population, Vietnam is still an agricultural country.

Paradoxically, statistics on Vietnam's FLW are mostly unknown. The only source of FLW data comes from FAO. But for emerging countries in general, and for Vietnam in particular, FAO data are not empirical. They are fruits of extrapolation from some referential values, collected in the past. Most of the values in Vietnam are outdated today. In 2018, a company - the CEL Consulting Group - claims to be a pioneer in

ISSN 2734-9381
https://doi.org/10.51316/jst.183.etsd.2025.35.3.8
Received: Sep 23, 2024; revised: Oct 16, 2024;
accepted: Nov 13, 2024

deploying FLW measurement on three main food categories in Vietnam: fruits and vegetables, meat, and seafood [4]. Their findings show that FLW ratio is the highest for fruits and vegetables (32%), followed by meat (14%) and seafoods (12%). By implementing a value-chain approach, the CEL-consulting group also discovers that 25% of food is lost as soon as after the harvest. However, CEL's methodology was not revealed, that doesn't allow us to understand how the measurement was effected. Nevertheless, reducing FLW is one objective of the Vietnam National Action Plan on Food Systems Transformation in Vietnam towards Transparency, Responsibility, and Sustainability by 2030 [5].

Along with other objectives like developing organic farming, reducing children wasting and stunting, increasing smallholder income, a better management of FLW is highly expected. The lack of empirical data is challenging policy implementation. By the way, the National Climate Change Strategy, as outlined in Decision No. 896/QĐ-TTg, emphasizes Vietnam's commitment to achieving Net-zero emissions by 2050. This strategy underlines the importance of comprehensive efforts across various sectors, including energy, agriculture, forestry, land use, waste, and industrial processes, to reduce GHG emissions [6]. Reducing food waste will not only minimize environmental impacts of waste disposal, but will also directly contribute to the reduction of Vietnam's GHG emissions, thereby supporting the overarching aim of Net-zero emission by 2050.

Once again, data will be the keystone of collective action. In recent years, there has been increasing public awareness of food waste at school catering all over the world. The school canteen plays a crucial role in students' food consumption outside their homes. As school-aged children undergo rapid growth and development, maintaining a nutritious and balanced diet is essential for their health, well-being, and long-term academic success. Recent research has highlighted food waste in school caterings through case studies in various countries, indicating that these places are significant areas where food waste often occurs [7].

The rate of food waste in school catering can vary significantly depending on the country and specific circumstances, with some studies indicating that this rate can reach up to 30-40% of the total amount of food prepared. For example, for early elementary students in the US, nearly 45.3% of foods and beverages were wasted in a full school week [8]. In the UK, FLW was the primary component of school waste, accounting for between 1/3 to 1/2 of the total distributed foods, depending on students' age-based groups [9]. More than 15% of school food in Italy will be finished as food waste [10]. The ratio of total school food waste (including kitchen waste) accounted for nearly 17% [11]. In low-and-middle-income countries (LMICs), FLW publications are much less present, probably because the topic has not been considered as a social priority yet. For example, the average quantity of food waste generated by school students in Beijing was 130 g/cap/meal, accounting for 21% of total food served, in which staple food and vegetables were the dominant proportions [10]. Another study in Malaysia shows that wastage rate is very low at about 6.4 g/ portion [12]. In general, there's a discrepancy in FLW study between LMICs and high-income countries. Scientific publications on the issue are dominated by authors from the USA, Canada, EU countries, Switzerland, etc, while there's almost no publication from LMIC.

Food waste in schools is influenced by various factors, including food quality, the organization of catering services, the dietary habits of students, and the food environment where schools are located. Volume of portions that does not match student's needs and preferences will lead to waste excess [13]. Poor quality meals or menu composition would make students unwilling to eat, while the way food is distributed and served at the catering room would increase the volume of food leftover [14]. Other psychological factors including children's limited awareness ofenvironmental and ethical implications, established dietary habits, and low autonomy in finishing meals can also be named as food waste's causes [9].

In Vietnam, the topic of food waste at school has not been studied. Although it is recognized as a concerning issue, there is up to present no effort to quantify the waste volume, nor to know about food waste's consequences. One of the consequences could be whether energy and nutrition provided to children through school catering are enough for their growth, given the presence of waste? The energy and nutrient content of a school meal is often calculated by software to match with children's legal needs required by texts of law. But it doesn't take into account the fact that children don't eat the calculated food quantity.

A method of food waste measurement at school catering merits then cognitive investment, since it will be the first step of a long process of awareness raising, that helps policymakers and concerned organizations to have right adjustments. In this study, we investigate food waste quantity and its patterns in school lunches in Hanoi, Vietnam. To our knowledge, this is the first study of its kind in Vietnam, which consists of providing a method and empirical data on the often-overlooked issue of food waste in the country's school catering system. In this study, loss and waste will be understood as portions of distributed food, discarded or unconsumed during school lunches. Then, the study assesses the extent of food waste in school meals and analyzes waste patterns by student, class, school level, menu, and cooking method. We first introduce the method of measurement in the next section.

Findings will be presented after, and a discussion and conclusion section will end the paper.

2. Methodology

2.1. Period and Zone of Study

The study, conducted from March 4th to April 26th 2024, involved eight schools in urban Hanoi. Four primary and four secondary schools have been targeted, covering all grades from 1 to 9. The selection of schools was based on discussions with school meal suppliers, in order to ensure representativeness in terms of social geography. Hence, the 8 schools were strategically chosen from various locations across Hanoi (Fig. 1), ranging from the center to suburban areas.

Each school was surveyed during lunchtime for one week. In each school, we targeted 3 classes, randomly selected from 1-5 for primary schools, and from 6-9 for secondary schools. In some schools, students have lunch in a collective catering room. It implies that waste from the studied classes is mixed together, instead of being registered class by class. It could be for example a 2nd class mixed with a 5th class in the same room, or a 7th with a 9th class.

In this situation, we denote class-mix for the observation. Measurements were taken in the kitchen where meals are prepared, then at classes during weekdays. The meals varied daily, with portion sizes tailored by the catering service to fit the legal nutritional requirements for students.

Food waste at the end of lunch service contains two parts: (a) the food not-served to students, which will be returned to the kitchen before being put into the collective recycle bin: we call it for Non Served Waste (NSW) (b) the food that has been served but not eaten by students, also called plate waste in the literature.

The latter will be collected separately in 4 recycle bins, respectively for vegetables, meats, rice, and other. This part is called for Served Waste (SW). These 4 recycle bins are put at the door of the selected classes under study. Before, a short video explaining how to separate food waste had been displayed to students, allowing them to make the separation by themselves.

Table 1. Font and paragraph format - an example of single-column format for a large table or figure

School code	Category	District	Number of students taking lunch at school	Period
A	Primary school	Hai Ba Trung	685	04/03-08/03
B	Primary school	Hoang Mai	620	11/03-15/03
C	Secondary school	Cau Giay	470	18/03-21/03
D	Primary school	Tay Ho	505	25/03-29/03
E	Secondary school	Long Bien	197	02/04-05/04
F	Primary school	Dong Da	562	08/04-12/04
H	Secondary school	Hoang Mai	408	15/04-18/04
G	Secondary school	Cau Giay	594	22/04-26/04

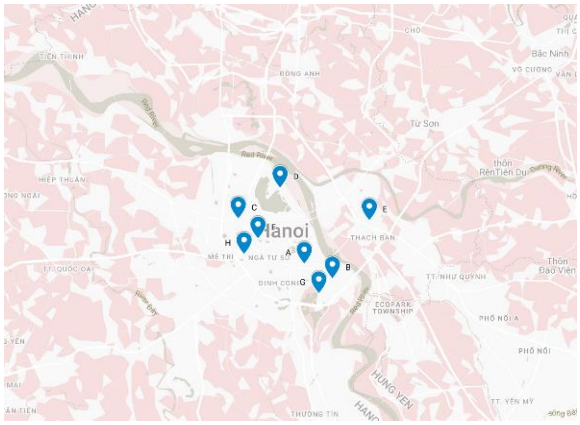

Fig 1. Location of schools under study

2.2. Data Collection Process

Data was systematically collected at 4 milestones every day: *T0, T1, T2, T3*. (See Fig. 2)

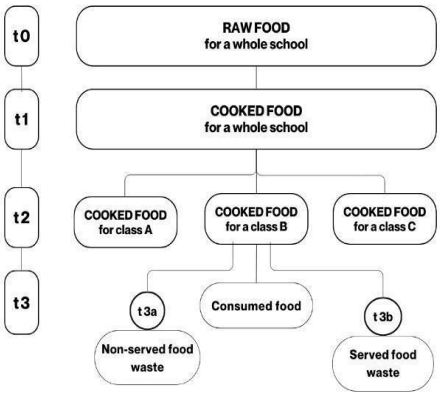

Fig 2. Diagram of key points of the measurement process

T0: is the milestone for raw food reception. Data on the quantity of raw food (i.e fresh and non-processed food) supplied to the kitchen is collected. The quantity value is directly taken from the delivery note that the chef of the kitchen received in the morning, which also serves as the basis of payment to their suppliers. After receiving raw food, kitchen's workers proceed to the cleaning, peeling and/or cutting of food. A certain quantity of inedible parts of food are removed. These values will next be deducted from the initial quantity, and *T0* data is then updated.

T1: is the moment when the food have been cooked at the kitchen in overall, ready to be allocated to classes. Measurement of the total weight of all cooked foods is collected at *T1* for some foods but not all. Very often, the only total weight of meat-based meals is known, but not that of vegetables, rice, or soup. However, *T1* values are registered for the purpose of control when needed.

T2: is the moment when the food has been allocated to each class proportionally to the number of effective children in the class. Measurement of the weight of ready-to-consumed meals is collected based on the real volume delivered to our 3 selected classes under study. These *T2* values are proportionally much lower than *T0* and *T1* values, because they are values at class level, compared to that of school level at *T0* and *T1*. *T2* values are registered before meals are served to class's students.

T3: is the last moment of the survey. It correspond to the end of the lunch service. Measurement of food waste is done here, based on the weight of the recycle bin. As mentioned above, two kinds of waste are registered: (1) *T3a* value was the weight of cooked food distributed at *T2*, which was not served to students (also service leftover, or *NSW* in our study); and (2) *T3b* value was the weight of food waste left by students after lunch (also plate waste). *T3b* values were collected at 4 recycle bins put at the door of the class, respectively for meat (sometimes with fish), vegetables, rice, and other dishes. They are served wastes (*SW*) in our study.

2.3. Raw Volume to Cooked Volume Conversion

Vietnamese food is usually cooked as a mix of meat, vegetables, and other ingredients. We use a factor of conversion coefficients, to convert raw volume (and its related waste) into equivalences in cooked volume. Conversion factors are based on different cooking methods. The factors are published by Food Standards Australia [15]. Despite *T1* empirical values for meat, we do need conversion coefficient because all other meal volumes are not registered at this milestone.

The conversion is made as soon as raw food is processed to become meals, i.e at the *T1* milestone. In general, data conversion allows calculation of the quantity of meat equivalence and vegetables equivalences in each meal.

$$T1 = T0 \times conversion\ factor \quad (1)$$

More concretely

T1 meat equivalence = *T0* fresh meat put into the meal x conversion factor

T1 vegetable equivalence = *T0* fresh vegetable put into the meal x conversion factor.

When it comes to *T*2 milestones, we use student effective proportions to calculate meat and vegetables equivalences at classes. Concretely,

$$T2 = \frac{T1}{school\ effective} \times class\ effective \quad (2)$$

2.4. Data Processing

Waste measurement formula

A food waste ratio is understood as the percentage of waste quantity relative to the weight of served food. Our unit of measurement is class food waste, i.e quantity of waste at class level. Two waste ratios for *NSW* and *SW* (respectively at *T3a* and *T3b* milestones) are calculated for each class, and for each of the 3 categories: meat, vegetable and rice.

Waste ratio of *NSW* (or T3a ratio) is:

$$NSW = \%wastet3a = \frac{t3a}{t2} \times 100 \quad (3)$$

where:

T3a: the amount of non-served food waste (kg)

T2: the amount of cooked food distributed to each class (kg)

Waste ratio of *SW* (or *T3b* ratio) is:

$$SW = \%wastet3b = \frac{t3b}{t2} \times 100 \quad (4)$$

where:

T3b: the amount of waste collected at recycle bins (kg)

T2: the amount of cooked food distributed to each class (kg)

Individual waste volume can be calculated next, by dividing class waste quantity (in kg) to student number in the class. In percentage, waste ratio doesn't change whether it is a class or an individual value.

3. Results and Discussion

3.1. General Findings

After 8 weeks of implementation, data for 102 class observations in 8 schools have been collected, which involves 4,041 students from grades 1 through 9, of whom 1,949 are male and the remaining are 2,092 females. These include 4 primary schools (Code A, B, D, F) and 4 secondary schools (C, E, G, H) distributed in 6 districts in Hanoi. In general, although daily menus are usually varied, there have often been repetitive meals or replication of certain foods with the same cooking techniques from day to day. As mentioned before, food waste is categorized in 4 recycle bins: (1) staple foods (rice and noodles), (2) fresh and prepared vegetables, (3) animal origin products (chicken, pork, and beef), and (4) others (soup, oil, and unidentified foodstuff). Although the measurement of "other" type is not separately calculated, it is still contributing to total food waste. In some situations, the separation of food waste into 4 categories was impossible, because of students (children at early age), or due to meal texture. At this moment, these values are removed from our database. At the end, only 86 observations have been used to produce statistics.

3.2. NSW and SW Ratio for Categories of Foods

We found that meat *NSW* ratio (*T3a*) is close to null (1.3%). The result is because meat-based meals are almost always served. This principle of distribution was constantly observed in all 8 schools under study. Consequently, meat waste in school lunches is mainly caused by *SW* (*T3b*). The average value of meat *SW* ratio is 18.6%, which makes the total meat waste ratio (*SW* and *NSW*) 20%. In individual value, total meat waste is estimated at 16.2 grams per capita per lunch (See Fig. 3). For rice, the average value of rice *NSW* ratio is 11%. It's worth noting that the median value of rice waste is 0, which means that in more than half of the cases, rice is all distributed to students. For secondary schools, rice, and other meals are distributed by plate, giving no room for unserved rice. For primary schools, non-served rice is rather important. In final, rice *SW* ratio is 13% while the total rice waste is expected at 24% of all distributed rice. Individual value of rice waste is 54 grams per capita per lunch (See Fig. 4).

Fig 3. Value of meat in % of served food

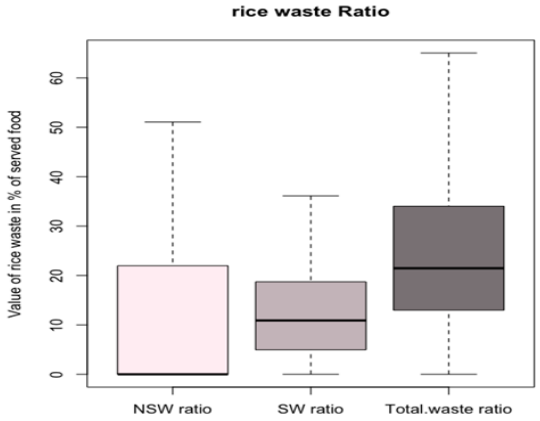

Fig 4. Value of rice waste in % of served food

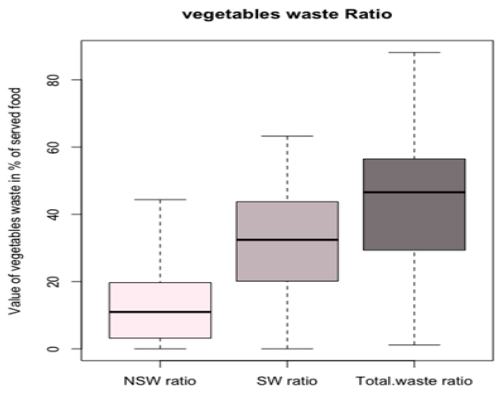

Fig. 5. Value of vegetable waste in % of served food

3.3. Assessment of Menu and Cooking Method's Impacts on Food Waste

The impact of the menu on FLW ratio merits a deeper insight. Some specific meals have been re-built according to the mode of cooking (fried or simmered), which allows us to compare food waste when these meals are served with situations when they are not served. The difference would be the menu or cooking method's impact. Two cooking methods will be particularly studied because of their frequency during our period of study. First, three vegetable dishes are found repetitively in daily menus. They are stir-fried cabbage and carrots, stir-fried chayote and carrots, and stir-fried sprouts and carrots. We call a menu with one of these 3 meals a veg menu, to be distinguished with a menu where they are not served. Second, fried or simmered meat is often served by school students. We call these menus with the presence of fried or simmered meat a meat menu, compared to menus where meat is cooked differently.

In terms of findings, we discover that both veg and meat menus have impacts on FLW, but their impacts are opposite. Students leave much more vegetable waste the day when the veg menu is served. Vegetable *SW* on the day of the veg menu is 40 grams per individual per lunch on average, compared to 25 grams per individual per lunch when the veg menu is not served. At present, one explanation would be students' general negative attitude towards mixed vegetables, with the presence of carrots. On the contrary, meat menus reduce FLW. The meat *SW* quantity in grams is much lower the day when meat menu are served compared to the day that it is not (7-8 grams vs. 24 grams, per individual per lunch)

Such findings are confirmed by kitchen workers, who know that simmered and fried meats are always appreciated by children, whereas the frequency of their cooking is limited by the kitchen because of adverse effects on health.

3.4. Assessment of Food Waste in Relation to Schools

According to data, primary school students (depicted by light grey columns in Fig. 6) tend to have a more important quantity of *NSW*, while secondary schools (dark grey columns) have more important *SW*. The main wasted food component for the latter is rice, standing at around 20 to 60 grams per student (See Fig. 6).

The fact that the average value of *SW* of secondary school students outweighs that of primary school students is stunning. In general, students in secondary school should require more food than primary school. But in reality, they leave more waste despite the fact that the same food quantity per individual is served to them, given the regulation from the Ministry of Education and Training of Vietnam. One probable reason is that secondary students might have access more easily to food out of school catering. They can get money from parents to buy the food they want at the grocery, or they can bring food with them to class. Thus, they are not really hungry at the moment of lunch service.

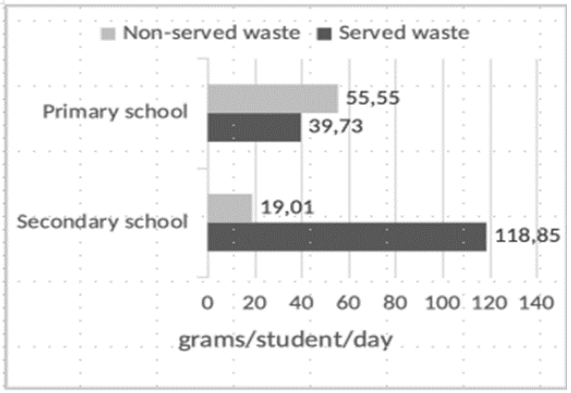

Fig. 6. Waste quantity according to school levels

Concerning the high *NSW* quantity at primary school, we discover that the reason is because primary school teachers manage portion sizes strategically, to minimize the served food waste. Younger students might have lower consumption demands, and teachers don't want them to throw away a large quantity of uneaten food. Unfortunately, non served food also finishes by being put in a recycle bin as served food, without any difference.

3.5. Overall Impact Through Linear Regression

In order to assess overall factors that impact FLW, we carry out a linear regression where the independent variable is the FLW volume (by adding *NSW* with *SW*). Explanatory variables are class level (from 1 to 9), school level (primary or secondary), menu meat, menu veg, and male ratio. The latter is obtained by dividing the number of male students to

class' effective number. The implicit hypothesis is that a more important of male presence in class would impact FLW, because male and female children don't eat the same quantity of food.

Two models have been run. The first model uses FLW volume as the sum of total waste of 3 categories: meat, vegetable and rice. The second model uses FLW volume as the total waste of all categories included, i.e 3 categories as in the 1st model, plus the category other waste. The latter is a mixed of water and all wastes that cannot be physically separated (i.e spagetti sauce mixing tomato with meat).

The Fig. 7 and Fig. 8 present the findings of these two models.

	term	*estimate*	*std.error*	*F statistic*		*p.value*
1	(Intercept)	152.62	18.70	8.16	***	0.000
2	class.vnclass.3	-32.24	21.00	-1.54		0.129
3	class.vnclass.4	-84.83	27.79	-3.05	**	0.003
4	class.vnclass.5	-46.40	21.07	-2.20	*	0.031
5	class.vnclass.6	-91.65	36.48	-2.51	*	0.014
6	class.vnclass.7	-85.29	37.12	-2.30	*	0.025
7	class.vnclass.8	-121.76	41.17	-2.96	**	0.004
8	class.vnclass.9	-80.15	41.20	-1.95	.	0.056
9	class.vnclass.mix	-101.97	24.33	-4.19	***	0.000
10	school.levelsecondary	78.35	30.32	2.58	*	0.012
11	male.ratio	-20.93	23.71	-0.88		0.381
12	menu.meat1	-38.24	11.58	-3.30	**	0.002
13	menu.veg1	32.64	11.44	2.85	**	0.006
	Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1					
	Residual standard error: 46.89 on 69 degrees of freedom					
	(4 observations deleted due to missingness)					
	Multiple R-squared: 0.4349, Adjusted R-squared: 0.3366					
	F-statistic: 4.425 on 12 and 69 DF, p-value: 3.261e-0					

Fig. 7. Model 1 findings

Model 1 (Fig. 7) shows that except for male ratio, all other variables, including class level, school level, menu veg, and menu meat, have significant impact on the quantity of FLW. Class level impact shows that students from higher class have clearly less FLW than those in the 1st class (6 year old children), which is logical. The difference between FLW quantities from different classes is however less evident, because of the relatively similar value of their estimators. Strangely, students at secondary school let more FLW than those in primary school. In primary schools, except for the 1st class, FLW quantity of students from 2nd to 5th class is rather low for both *NSW* and *SW* compared to students from secondary schools. Consequently, primary schools as a bloc have less FLW than secondary ones. This finding is rather counterintuitive, but it is confirmed by statistics and by direct observation. Our explanation is that secondary students have access to other sources of food (taken from home or bought from grocery), making them less independent to catering food. We also look at the variance inflation factors (VIF) to check if there is a problem of multi-correlation between two variables: class and school level. The VIF of variable class is 1.2 while the VIF of variable school level is 2.9, which confirms that such findings were not biased by an eventual multi-correlation. Concerning the 2 variables menu meat and menu veg, the regression confirms their impacts already mentioned above. Menu meat reduces the FLW, while menu veg increases FLW.

	term	*estimate*	*std.error*	*statistic*		*p.value*
1	(Intercept)	163.66	17.62	9.29	***	0.000
2	class.vnclass.3	-32.01	20.01	-1.60		0.114
3	class.vnclass.4	-98.56	24.68	-3.99	***	0.000
4	class.vnclass.5	-61.74	20.09	-3.07	**	0.003
5	class.vnclass.6	-143.22	34.58	-4.14	***	0.000
6	class.vnclass.7	-91.08	34.92	-2.61	*	0.011
7	class.vnclass.8	-159.87	39.24	-4.07	***	0.000
8	class.vnclass.9	-101.68	39.28	-2.59	*	0.012
9	class.vnclass.mix	-119.27	22.23	-5.37	***	0.000
10	school.levelsecondary	157.66	28.72	5.49	***	0.000
11	male.ratio	-3.50	23.05	-0.15		0.880
12	menu.meat2	-14.69	11.25	-1.31		0.196
13	menu.veg1	23.47	10.95	2.14	*	0.035
	Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1					
	Residual standard error: 45.7 on 73 degrees of freedom					
	Multiple R-squared: 0.6616, Adjusted R-squared: 0.606					
	F-statistic: 11.89 on 12 and 73 DF, p-value: 7.233e-13					

Fig. 8. Model 2 findings

Model 2 (Fig. 8) provides similar findings than model 1, except that the estimator's values change. The main reason is because the independent variable of the model is the total FLW including the category other waste. The latter has not been discussed along the paper because it contains different items that the research team was not able to control along the process, such as eggs, some inedible part of food, and especially water (from soup). Once this part is re-integrated to FLW values, the model 2 shows that the latter is still conditioned by two key variables: class and school level.

The trend of impact remains the same as in the model 1: FLW of all classes is higher than that of 1st class, and secondary students have more FLW than primary students. The two models are then consistent in terms of findings. The variable male ratio's impact stays insignificant while that of the menu veg significantly positive. The only change between two models is that the impact of menu meat is significant in model 1, but insignificant in model 2. This is due to the fact that the quantity of meat in the menu is rather small, which was not enough to have influences on FLW quantity used in model 2 which contains a big part of water.

4. Discussion and Conclusion

Our study on FLW was conducted at 8 Hanoi schools during 8 weeks, 1 per week. It established for the 1st time in Vietnam a method of food waste measurement at school catering and provided empirical data. With 86 observations, we covered

4,041 studentsin 6 districts in Ha Noi, ranging from 1st to 9th classes. We distinguished two types of food waste: the non served waste and the served waste for the classes under study, and for each of three main categories of food: meat, rice and vegetables.

A breakdown of waste values indicates that students discard an average of 48 grams of vegetables (46% waste rate), and 54 grams of rice (21% waste rate), 16 grams of meat (18% waste rate), so a total of 118 grams per individual per lunch. Among the three, vegetables displayed the highest waste rate, followed by rice and meat.While meat, rice, and vegetables account for the majority of served food waste, non-served waste consists primarily of vegetables, rice and soup. Our study revealed that the average daily food waste per student is 118 grams, representing a 30 % of total waste rate. This result is somehow consistent with statistics from other countries.

Furthermore, student preferences are leaning towards simmered meat and fried food, while stir-fried vegetable mixes are their least favored meals. Waste patterns differed upon school level, and also upon class level. Primary school students tended to waste more non-served food compared to secondary school students. On the contrary, secondary school students exhibited a higher waste rate for served food items. Potential explanations for this trend may include varying consumption demands between age groups, disparities in food awareness, and differences in the kitchen service model between primary and secondary schools. In perspective, these findings would enable different types of intervention. For example, it helps predicting waste causes, such as portion sizes, serving methods; evaluating the effectiveness of future initiatives through measurement methods and fostering continuous improvement; facilitating deeper research into student behaviors, the role of education, and environmental impacts, which uses this data as a reference point.

Acknowledgments

We express our gratitude toward the Deans of primary and secondary schools of Hanoi for accepting our research team operating necessary measurements at classes, in contact with students. We also want to warmly thank Huong Viet Sinh company for the many help on access to raw data and food processing in kitchens.

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