

Eco Friendly Solutions to the Food Waste Disposal in China

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Abstract

In order to enhance university students' resource-saving awareness and to alleviate the serious food waste in universities, the present research conducted the large-scale questionnaire survey among students and special interviews among administrative staff in 6 universities in Songjiang, Shanghai. The result showed that there was about 5062.5 kilograms food wastes produced everyday in Songjiang University town, which is much higher than students had once realized (15.03% average food waste rate) and also beyond the disposal ability of the canteens because of their single and simple method. Based on these findings and problems, the research referred to the Ecological Footprint Method put forward by Peking University, and designed an environmental protection model called EMPRC (education, meal structure, planned sales, recycling and composting). It can mobilize all parties to reduce food waste, which, thus, can better the disposal management, discipline students' wasting behaviors and improve students' food-saving and sustainable awareness.

Keywords

Food waste disposal; Songjiang university town; Eco friendly; Waste management.

1. Introduction

Recent years have witnessed growing concern about the large quantity of food waste, which has an adverse effect on the environment worldwide and plagues urban development (Badu & Kumar, 2017). The investigators have noted that current estimations of food loss and waste generation range between 194–389 kg per person per year at the global scale (Sara Corrado et al., 2018). As pointed out by An Ying (2016), as one of the main components of urban garbage, waste from canteens and restaurants is growing rapidly with the statistics showing that it accounts for 37% to 62% of the urban domestic garbage in China. The amount produced in major cities in China is not less than 60 million tons per year, with 5 million tons added in a year (Wang Xingmin, Zheng Xuxi & Lv Jing, 2007). The food waste disposal, however, is disorderly and arbitrary, which has become the main pollution source of garbage collection, transportation and landfill (Wang Xingmin et al., 2007). To our best knowledge, little attention has been directed towards the approach, so there is a lack of research on the methods of disposing food waste, especially in Songjiang University town, where it remains unclear how the college canteens can deal with the food waste and unknown where the improvement is going.

Further studies are needed to deal with the issue in Songjiang University town. The objective of the research is to investigate the current situation of food waste and evaluate some available and practical solutions to disposing food waste in Songjiang University town through literature research, questionnaire investigation and exclusive interviews which all paved the way for the final purpose. To determine the degree of the food waste and to evaluate available solutions to

disposing food waste, our study try to find the most frequent ways to eat and dispose of leftovers and examine students' environmental awareness by cross-analysis. In our study, we present interviews conducted among logistics teacher and canteen waiters of the universities, as well as some feasible models.

2. Literature Review

This section reviews the current estimation of food waste at the global scale and some possible solutions to disposing food waste in an eco-friendly way. The existing literature deals with the viable methods taken by foreign countries which may reduce or dispose the food waste without high energy pollutants and consumption to some extent. These studies, however, do not concern the specific approaches to food waste disposal that are suitable in canteens in China, taking Songjiang University Town as an example. Nearly two decades ago, Journal of the American Dietetic Association documented American foodservice operators are using composting to make use of the wasted food. In Japan, Takanashi, Futoshi (2000) introduced the "Food Waste Reduction and Recycling Promotion Law" submitted by the government and Analyzed the effect of the law. According to Getlinger, Laughlin, Bell, Akre, Arjmandi (1996), scheduling recess before lunch break reduces food waste.

One stream of research on food management behaviors centers on a specific educational intervention, directed at increasing consumers' perceived skills related to food preparation planning behaviors reduces domestic food waste (Simona, Romani et al, 2018). Huang and Lu (2016) proposed to use eco-labels to indicate the emissions of campus users' dietary footprints to reduce food waste and unnecessary food needs. Xiao et al. (2018) suggest using internet technology as a unique and effective way, such as an integrated Recyclable wastes recycling (RWR) framework using a Public-Private-Partnership (PPP) investment model and combining the RWR system with municipal solid waste (MSW) collection system. Ma et al. (2017) compare two holistic approaches for co-digestion of activated sludge and food waste and find a higher total economic revenue generated approach. There is an agreement that practical solutions to the food waste disposal must be developed. Different from each other, one study attempts to deal with food waste at source, and other two researches solve food waste through internet technology and ecological approaches.

Although there have been a range of resolutions to the reduction of food waste, the implementation of these methods are far from satisfaction. These approaches are in a high demand for technology and finance, which leaves difficulties for some small cities or towns to implement the solutions. Besides, considering that habits and emotions are important determinants of food waste behavior, it is also hard to evaluate the real psychology of people when producing food waste just through questionnaires and thus mobilize it to reduce food waste. Therefore, an efficient but practical approach to food waste disposal, especially for China, is still being improved and perfected. What's more, no attention has been given to the food waste disposal in the Songjiang University Town, where students there having meals at the canteens or food courts tend to produce a large amount of food waste. In response to this gap, the key research question addressed here is: investigate the current situation of food waste and evaluate the available solutions to disposing food waste of the major canteens and food courts in Songjiang University Town. In this respect, the present study has investigated whether there are any practical solutions to the food waste disposal in Shanghai University of International Business and Economy. To clarify the possibility of developing eco-friendly methods to deal with the issue, this research relies on questionnaires, literature research and in-depth interviews.

3. Methodology

This study aims to investigate the current situation of food waste and evaluate the available solutions to disposing food waste of the major canteens and food courts in Songjiang university town. Therefore, the study chooses the approaches of questionnaire investigation and exclusive interviews because of the university setting. Questionnaire investigation to students in Songjiang University Town and staff in surrounding canteens reflects the actual situation of food waste and the way food residues are dealt with. In addition, literature research about the advanced technology or management system of food waste disposal at home and abroad also contributes to our solutions. Finally, in-depth interview will be conducted with our school's logistics teachers and canteen waiters, which is also the most available and effective way to understand our school's disposal methods.

3.1. Questionnaires

The questionnaire which investigates the actual situation of food waste is aimed at students of Songjiang University Town whose average age is 19.66. The result showed students have realized they waste 15.03% of the food on average. Detailed description is showed in the Diagram 1.

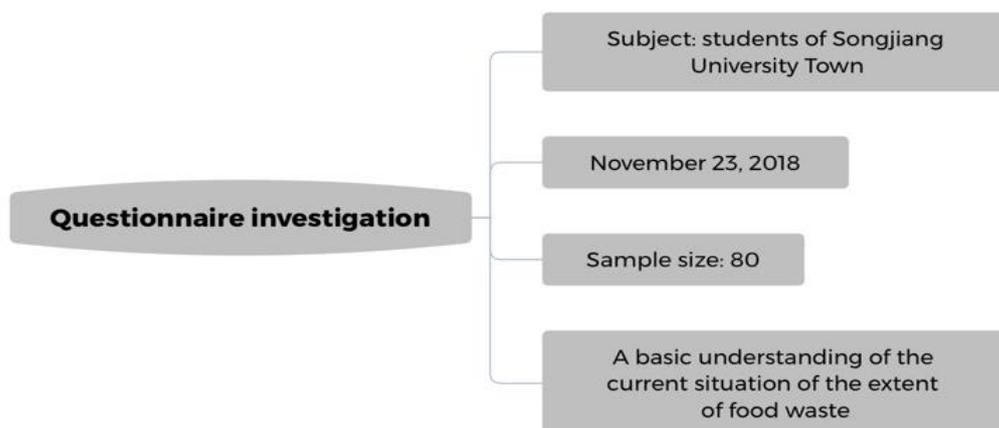


Diagram 1. Detailed description of questionnaire investigation

3.2. Exclusive Interviews

Exclusive interviews will be conducted with logistics teachers and canteen waiters of the universities shown in diagram 2 to know the current situation of food waste in Songjiang University. Through interviews, as much diversity as possible among the final destination of food residues can be sampled so that we could look for and give suggestion on the most environmentally friendly solution from these diverse sources.

The interviews were conducted among logistics teacher and canteen waiters of six universities. The samples of waste consisted of the canteens of Shanghai University of International Business and Economics (SUIBE), Donghua University (DHU), Shanghai University of Engineering Science (SUES), Shanghai International Studies University (SISU), East China University of Political Science and Law (ECUPL) and Shanghai Lixin University of Accounting and Finance (SLUAF).

In interviews, the logistics teachers and canteen waiters of the above universities were asked to answer the following questions:

- (1) Where will the wasted food finally go?
- (2) What is the amount of wasted food every day?

(3) Is there any method to reduce food waste in the canteen?

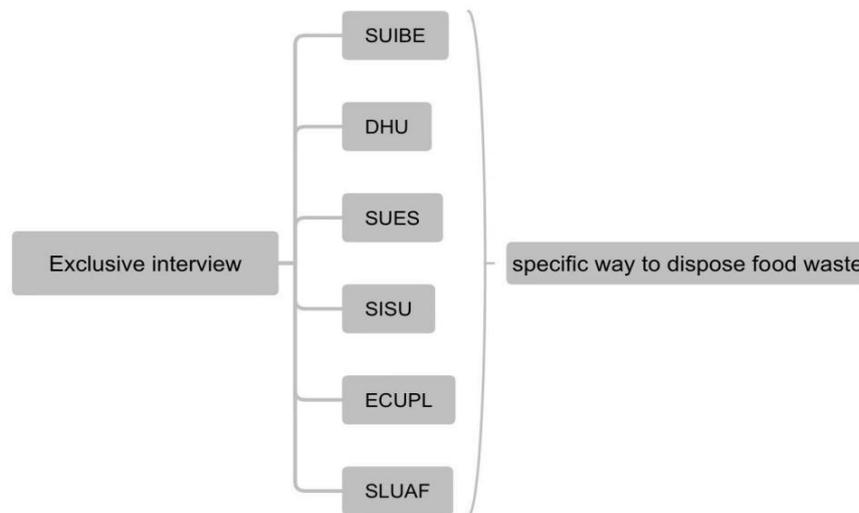


Diagram 2. Exclusive interview

Despite our diverse approaches, this study merely investigates the overall condition of food waste in the Songjiang University town and the available solutions to disposing it. There exist some limitations. First, the size of the dataset may not be large enough to draw a general conclusion. Second, the data we gained on the amount of food waste through special interviews may be rough but it is consistent with the data in literature.

4. Results

In this section, we report the results of the current situation of food waste in the Songjiang University town. The aim of this study was to learn about the degree of food waste and evaluate available solutions to disposing food waste in this certain area.

4.1. Subjective Evaluation Reflected by Students

The feedback of the questionnaire has been analyzed by SPSS17 and Microsoft Excel software. Attachment is the default report for the survey. This research aimed to Songjiang University town, so we regarded the questionnaires filled out by students in other universities as invalid. The questionnaire can be divided into two dimensions. The first dimension was the volume of food waste, while the second was about the individual environmental awareness.

In the default report given by the Wenjuanxing, it created sub-cubes based on the number of answer options for each question. The result shows a dataset that consists of the answers of one question, such as “How much food students feel they usually have left”, whose average answer was 15.03%.

Table.1 shows a cross-analysis of the most frequent ways to eat and dispose of leftovers. Dependent variable X was the most frequent way to eat, and independent variable Y was how to tackle the surplus. What’s more, 15% is a ratio considered as food waste rate. Canteen’s food waste rate should be $15\% \times 40/80 \times 67.5\% = 5.0625\%$. According to the consumption of one kilogram of food per person per day, there was estimated 5062.5 kilograms waste food in the canteen of Songjiang University City per day.

Table 1. Cross-analysis of the most frequent ways to eat and dispose of leftovers

X\Y	Throwing away	Packing out	It depends	Others	Subtotal
A. Canteen	27 (67.50%)	2 (5.00%)	10 (25.00%)	1 (2.50%)	40
B. Fast food	17 (60.71%)	0 (0.00%)	11 (39.29%)	0 (0.00%)	28
C. Takeaways/Snacks	6 (54.55%)	1 (9.09%)	4 (36.36%)	0 (0.00%)	11
D. Others	0 (0.00%)	0 (0.00%)	1 (100.0%)	0 (0.00%)	1

The result illustrates that singly 15.73% of the respondents held the view that food waste around them was fairly severe, and 69.66% felt that the amount of wasted food is normal, or even not serious (12.36%). Most students did not think that their food waste was exceedingly influential and had serious consequences.

Table 2. Cross-analysis of students' environmental awareness and the dispose of leftovers

X\Y	Throwing away	Packing out	It depends	Others	Subtotal
A. Great effect	23 (52.27%)	3 (6.82%)	17 (38.64%)	1 (2.27%)	44
B. A little effect	20 (68.97%)	0 (0.00%)	9 (31.03%)	0 (0.00%)	29
C. No effect	2 (100.00%)	0 (0.00%)	0 (0.00%)	0 (0.00%)	2
D. Unclear	5 (100.00%)	0 (0.00%)	0 (0.00%)	0 (0.00%)	5

Similarly, Table 2 shows the cross-analysis of students' environmental awareness, which was whether too much food waste will have an impact on the ecological environment and the disposal of leftovers. The answer to the seventh question depicts that rarely two respondents believed that food waste had no impact on the ecological environment. Though students indicated that they knew the impact of wasted food on the environment when filling out the questionnaire, cross-analysis found that more than half of the student still threw the surplus away. This demonstrates that students had so-called environmental awareness, but did not take applicable action.

4.2. Waste Situation Collected in College Canteens

The interviews were conducted among logistics teacher and canteen waiters of the universities shown in diagram 2. The samples of waste consisted of the canteens of six universities in Songjiang University town. The interviews were carried out in the first canteen of SUIBE, the second canteen of DHU, the largest canteen of SUES, the C1 canteen of SISU, the first canteen of ECUPL and the canteen of SLUAF. The results of the interviews are shown in the table 3.

These results reveal that all the canteens we visited deal with the wasted food by outsourcing it to sanitation companies. We also discover that the amount of the food wasted per day on average in ECUPL is much higher than our expectations. Different from other canteens, the second canteen of DHU and the C1 canteen of SISU collect and classify food waste by an electrical conveyor belt, which makes the process more efficient and economical. Additionally, it should be highlighted that the sales volume of food is planned according to the previous records before selling. And the rest wasted food will be consumed by the canteen staff or poured into a special barrel for leftovers which would be used to feed the livestock eventually. Due to this strategy of food sales, the canteen of SUIBE reduces the amount of wasted food. Nevertheless, food waste is still beyond the handling capacity of the canteens because of their single and simple method.

Table 3. The results of the interviews

University	Place	Interviewee	Information & Result
SUIBE	1st canteen	staff	Recycled by sanitation company; planned sales of food; manual operating
DHU	2nd canteen	staff	Recycled by sanitation company; collected in some special rubbish bins; collected by an electrical conveyer belt
SUES	the largest canteen	staff	Recycled by sanitation company; manual operating
SISU	C1 canteen	staff & logistics teacher	Recycled by sanitation company; collected by an electrical conveyer belt
ECUPL	1st canteen	staff	Recycled by sanitation company; manual operating; about 15 to 20 bins of wasted food per day on average
SLUAF	the canteen	staff	Recycled by sanitation company; manual operating

4.3. Possible Solutions Found in Literature

Through literature research, we have learned and summarized some feasible models which contribute to food waste disposal. They are expected to be concluded in the proposal and be taken by the logistics department of SUIBE.

Firstly, the Ecological Footprint Method put forward by Peking University is an effective way taken by the canteen of reducing food waste from the fountainhead, and thus cutting carbon emissions. In this method, the amount of each food ingredient purchased can be estimated by the average consumption of food per person per meal, purchasing cycle and the number of consumers per day. The formula for estimation is listed as follows:

The average consumption of food per person per meal = the amount of each ingredient purchased / (purchasing cycle * the number of consumers per day)

By estimating the number of consumers and the average food consumption according to the canteen supervisor, the amount of each kind of food purchased will be generally known. The purchase quantity is close to the actual consumption per day, so it will leave a minimal amount of food waste, and subsequently set aside spending for the canteen to dispose food waste.

There is one more point that the dietary structure can be improved. Some food ingredients have lower ecological footprint such as coarse cereal and agricultural products. In that way, a new menu can be formulated this contains ingredients with one high and one low footprint so that the meal footprint can reach a balanced complementarity, leaving as little impact as possible on the environment. What's more, increasing dietary diversity is also one of the effective ways to reduce food waste among students proven by Donghua University's relatively minor amount.

The last but not the least, composting is also an alternative. According to the Municipal Solid Waste (MSW) Collection System, composting is a process in which organic waste is collected and stored under certain conditions. These organic materials are regarded as wasted product and are helped to break down naturally. Thereafter, the compost left can be used to produce soil conditioner or natural fertilizer. By composting, the expenses of canteens to outsource their disposal of food waste can be saved to some extent.

5. Discussion

The present study has investigated the current situation of food waste and evaluated available solutions to disposing food waste in Songjiang University town. The findings in the questionnaire revealed that there were estimated 5062.5 kilograms waste food in the canteen

of Songjiang University City per day, but personal food waste was subjectively underestimated. What's more, although students had so-called environmental awareness, they did not take applicable action to improve this situation. Our interviews which were conducted among the canteens of six universities in Songjiang district demonstrated that all the canteens we visited outsourced the wasted food to sanitation companies and in particular the canteens of DHU and SISU use electrical conveyer belts when collecting and classifying wasted food. Additionally, the amount of wasted food in the canteen of SUIBE is reduced through planned sales. Through literature research, several feasible models to dispose food waste can be learned such as the ecological footprint method which can minimize food waste by estimating the purchase amount. Last but not least, the dietary structure can be improved by increasing the food diversity and containing food ingredients that have lower ecological footprint, which is also an effective way to cut down the expenses of outsourcing the food waste disposal and reduce the impact on the environment and composting.

Based on the data analyzed from the questionnaires, the subjective percentage of food waste in average is merely 15.03%. Nevertheless, in accordance with the exclusive interview taken in the first canteen of ECUPL, where food waste on average amounting to 15 to 20 bins occurs every day, there emerges a conspicuous gap between the actual food waste and students' subjective recognition of food waste. These incompatible results may ascribe to students' lack of awareness and insufficient attention to food waste. In that case, for the purpose of filling this gap, it is urgent and essential to find some suitable and eco-friendly approaches to food waste disposal and improve students' consciousness on this issue.

6. Conclusion

The purpose of this study is to find solutions to alleviating the serious food waste and enhance student's awareness of resource-saving. The result represents that the actual food waste in universities is much higher than students had once realized due to a single case of personal waste. Therefore, an environmental protection model called EMPRC is concluded to reduce the food waste in schools. The five important steps are education, the dietary structure, planned sales, recycling and composting.

Step 1 Education

Educational curriculum about environmental protection, such as waste classification and circular economy, should be implemented on campus to enhance the awareness of students, which is the fundament of reducing food waste. Relevant examinations and appraisals are also necessary to conduct regularly based on the effect of the implementation of EMPRC.

Step 2 Meal structure

As for the executives of school canteens, it is essential for them to improve the dietary structure and quality. A well-designed diet should include meat and vegetarian dishes, protein, dietary fiber and other nutrition. Good taste and the food diversity should also be ensured so that students will have more alternatives when eating and thus leave less.

Step 3 Planned sales

The executives of canteens should plan the sales of food according to the previous figures recorded and the formula above so that they can ensure the controllable amount of waste. This step can strengthen the effect of controlling food waste from the root on the basis of Step 2.

Step 4 Recycling

Furthermore, after cutting food waste from the origin, recycling is supposed to be actualized to treat the existing food waste. Because of the limited ability of university canteens in disposing food waste, they are suggested to outsource the work to the specialized companies which have expertise in recycling.

Step 5 Composting

Provided that funds and idle site are available to universities, composting is an efficient and eco-friendly approach to solve the food waste happened inside the school and set aside the expenses.



Diagram 3. EMPRC model

Executives of canteens can assess the level of food waste after the implementation of the five steps to evaluate its effect. Based on the new amount of food waste, the executives should report the result and give feedback to the teaching department, which will make adjustment of the education publicity and courses in the light of improvement status. Subsequently, the improved education will be carried out and after that a new round of the five steps will be taken. The model is expected to strengthen environmental awareness and discipline behaviors of all parties, thus improving food waste condition.

What's worth mentioning is that our future research should control the setting of the questionnaire in order to allow the researchers to do further analysis and the exclusive interviews should be conducted more deeply to get more useful information.

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