KKU Res.j. 2015; 20(1) : 34-41
http://resjournal.kku.ac.th

Comparison of Solid Waste Composition between Regular and Weekend Programs at Nakhon Ratchasima Rajabhat University

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Abstract

At present, solid waste management is one of core environmental problems in Thailand, particularly establishment for education. According to Nakhon Ratchasima Rajabhat University (NRRU), one type of higher education institutions provides weekend programs with rapid increase for the number of students. In addition, Nakhon Ratchasima as a province has produced the highest quantity of solid waste in the northeastern region and is located at the center of numerous higher-education institutions offering weekend programs. The objective of this study was to compare the solid waste composition and accuracy of solid waste separation in the Solid Waste Separation Project proceeded by NRRU in both regular and weekend programs. The results of the study showed that the quantity of solid wastes in the university generated during various activities from regular and weekend programs was 2,332.50 and 1,695.28 kilograms/day, respectively. With respect to the size of the population in the weekend program and the regular program respectively, the solid waste generation was 0.141 and 0.278 kilograms/person/day. It indicated that the solid waste generation of the weekend program per person per day was higher than the regular program at 97.2%. The first three components of solid waste in both the regular and weekend programs were found in food waste, plastics and paper representing 84.10%, 7.45%, and 4.22% respectively in the regular programs and 73.29%, 12.02% and 5.33% respectively in the weekend study programs. On the investigation of accuracy of solid waste separation at the university, it was sorted by the designated color of bin in both regular and weekend programs. The average accuracy was found at 0.542% and 1.26% for non-biodegradable waste, 16.45% and 13.10% for organic waste and 11.03% and 11.61% for recycled waste respectively and (N/A) for Hazardous waste in the regular programs or low accuracy at 0.066% in the weekend programs.

Keywords : *Solid waste, Garbage, Higher education institutions, Solid waste management, Garbage segregation*

1.Introduction

At present, the solid waste problem has worsened with the growth of urban society and on impact of changes in population lifestyles. In Thailand, a large quantity of solid waste nationwide per day has been increasing. In the northeastern region, the province of Nakhon Ratchasima produced the highest amount of solid waste, 12.94% (6). As an educational institute, Nakhon Ratchasima Rajabhat University is located in the northeastern region which provides in regular and weekend programs. In general, the number of higher-education institutions providing particular programs has been increasing nationwide. For this reason, a comparative study is on solid waste composition in higher education institutions providing weekend programs. This study was conducted to compare the percentage composition and the accuracy of solid waste separation in the Solid Waste Separation project between the regular and weekend programs providing basic knowledge about solid waste management in the specific higher education institute. This information can be used as guidelines for efficient solid waste management and is relevant to the 11th National Economic and Social Development Plan (A.D. 2012 - 2016) affecting into a green society(5) which results in an environmentally-friendly lifestyle and sustainable development for the country.

2. Materials and methods

This research compared the solid waste composition and accuracy of solid waste separation in the Solid Waste Separation Project conducted by Nakhon Ratchasima Rajabhat University which provides in regular and weekend programs

2.1 Sampling

In accordance with the field data collection guidelines for the MSW evaluation (7), solid waste was examined from each of the bins in the university in the schedule of solid waste management for one semester (March to June, 2013), and locations of bins in Nakhon Ratchasima Rajabhat University as shown in (Figure 1.)

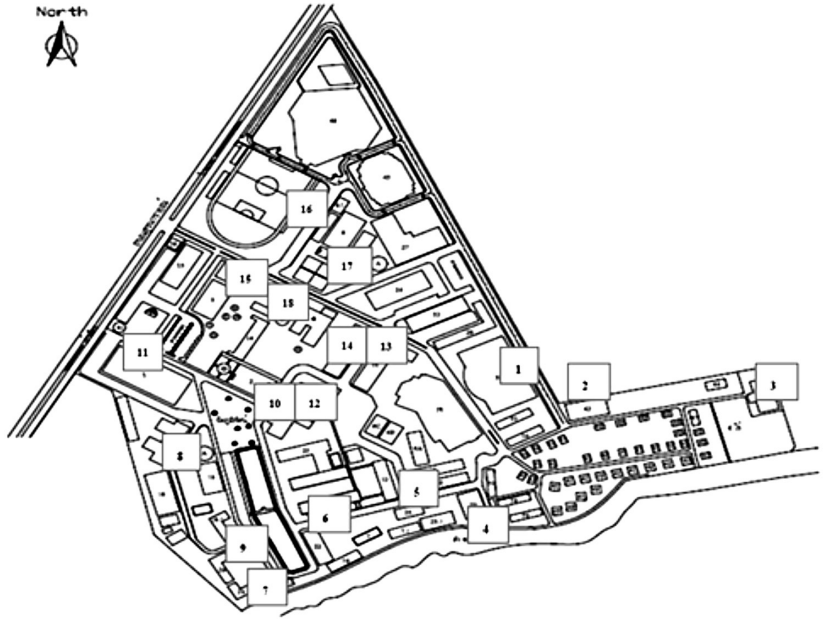

Figure 1. Locations of bins at Nakhon Ratchasima Rajabhat University

- Collection of solid waste was produced by regular study programs: Tuesdays and Thursdays
- Collection of solid waste was produced by weekend study programs: Saturdays and Sundays

2.2 Data Analysis

For the data analysis, conventional inferential statistics were used as follows:

1. The percentage of solid waste composition was calculated based on the weight (kg) from the field data collection. The data were divided into two sets: the data from the regular programs and the weekend programs.

The obtained data were compared to consider the level of significant differences of solid waste composition between regular studying programs and weekend programs by means of paired sample t-test (3).

2. The percentage of accuracy of solid waste separation was calculated based on the colors of the bins, which included:

Green bins – Organic waste
Yellow bins – Recycled waste
Red bins – Hazardous waste
Blue bins – Non-biodegradable waste

The data were compared to consider the level of significant differences of the accuracy in solid waste separation according to the colors of the bins by means of paired sample t-test (3) between the regular programs and weekend programs.

3. Results and discussion

The composition of solid waste was produced by the regular study programs and weekend programs at Nakhon Ratchasima Rajabhat University, covering an area of 175 rai (280,000 Sq Mts) and containing 22,591 students was examined for the full fiscal year of 2013. For the number of students, there were 16,497 students in the regular programs and 6,094 students in the weekend programs (Formation of Internal Control System and Risk Management Board, Nakhon Ratchasima Rajabhat University, 2012). The composition of solid waste was produced by regular and weekend programs in classification as shown in Figure 2 and Figure 3, respectively.

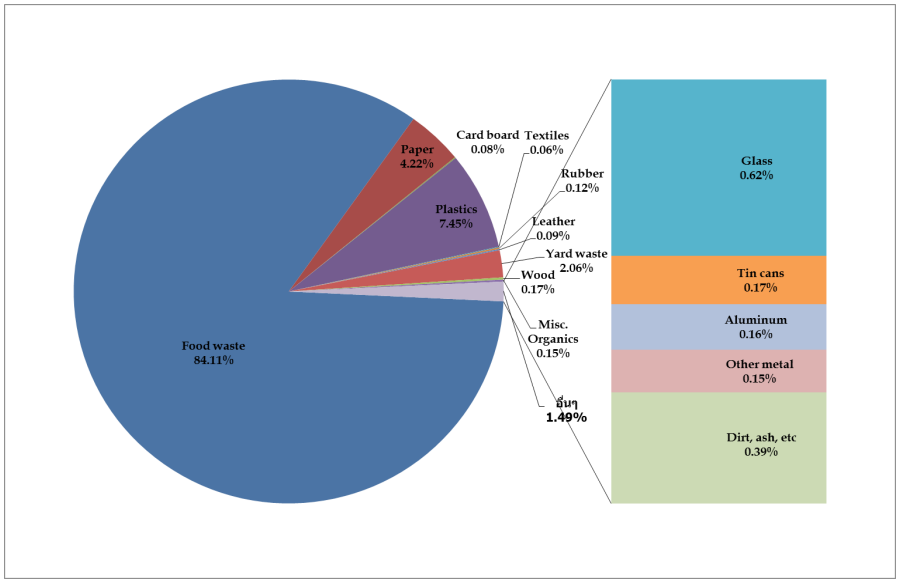

Figure 2. Percentage of solid waste produced by activities in the regular study programs classified by types of solid waste

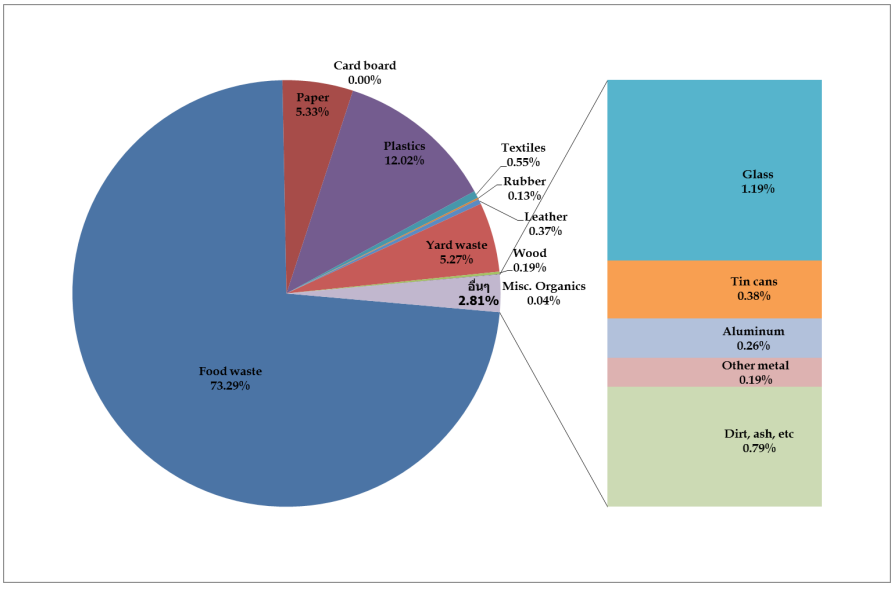

Figure 3. Percentage of solid waste produced by activities in the weekend study programs classified by types of solid waste

The total quantity of solid waste was produced by the regular study programs with the number of 2,332.5 kilograms/day. The first three components found in the solid waste were food waste, plastics and paper in the amount of 1,961.6, 173.8 and 98.4 kilograms/day, representing 84.10%, 7.45% and 4.22%, respectively.

The total quantity of solid waste was produced from the weekend study programs with the number of 1,695.28 kilograms/day. The first three components found in the solid waste were food waste, plastics and paper in the amount of 1,242.5, 203.7 and 90.3 kilograms/day, representing 73.29%, 12.02% and 5.33%, respectively.

From the analysis of the different composition of solid waste, it was produced by the regular programs and weekend programs in following results:

The percentage of solid waste composition produced by the regular program students and weekend program students with significant difference ($p \leq 0.05$) included textiles ($p = 0.003$), plastics ($p = 0.006$), aluminum ($p = 0.018$), food waste ($p = 0.020$), dirtash/etc. ($p = 0.032$), and tin cans ($p = 0.039$), as shown in Table 1.

The percentage of solid waste composition produced by the regular program students and weekend program students with no significant difference ($p > 0.05$) included glass ($p = 0.083$), leather ($p = 0.247$), paper ($p = 0.354$), cardboard ($p = 0.448$), other metal ($p = 0.527$), misc. organics ($p = 0.536$), wood ($p = 0.592$), rubber ($p = 0.608$), and yard waste ($p = 0.950$), as shown in Table 1.

Table 1. Percentage of solid waste composition at the university

Component		Regular	Weekend	p-value
Organic	Food waste	84.11	73.29	0.02
	Paper	4.22	5.33	0.354
	Card board	0.08	N/A	0.448
	Plastics	7.45	12.02	0.006
	Textiles	0.06	0.55	0.003
	Rubber	0.12	0.13	0.608
	Leather	0.09	0.37	0.247
	Yard waste	2.06	5.27	0.95
	Wood	0.17	0.19	0.592
	Misc. Organics	0.15	0.04	0.536
Inorganic	Glass	0.62	1.19	0.083
	Tin cans	0.17	0.38	0.039
	Aluminum	0.16	0.26	0.018
	Other metal	0.15	0.19	0.527
	Dirt, ash, etc	0.39	0.79	0.032

Regarding the solid waste sorted by the designed color of bin as mentioned above, the average or mean accuracy of the sorting types of solid waste from both the regular and weekend programs is presented in Table 2

According to the data shown in Table 2, a comparison of the capability of students regarding organic waste separation between the regular and weekend programs revealed 16.45% and 13.10%, respectively. The difference in the percentage of the accuracy of waste separation in the collected programs was not significant ($p = 0.236$).

Table 2. Percentage of each type of waste found in the green bins (organic waste)

Green Bin (%)				
Mean	Organic	Recycled	Hazardous	Non-biodegradable
Regular Programs	58.65 (16.45% of total)	39.65	N/A	1.70
Weekend Programs	51.81 (13.10% of total)	45.12	N/A	3.07

Likewise, a comparison of the students' capability to separate recycled waste, hazardous waste, and non-biodegradable waste is presented in Tables 3, 4 and 5, respectively. According to the data shown in Table 3, the capability to separate

recycled waste of the regular and weekend programs was 11.03% and 11.61%, respectively, with no significant difference (p=0.463). Regarding the difference in organic waste and recycled waste separation, the capability of the students to separate hazardous waste was at (N/A) in the regular study programs and the average accuracy at 0.066% in the weekend programs. Repeatedly, there was no significant difference (p=0.162). On the other hand, less accuracy in the non-biodegradable waste separation capability of the students in the regular and weekend programs was indicated at 0.542% and 1.26%, respectively. There was a significant difference (p=0.036).

Table 3. Percentage of each type of waste found in the yellow bins (recycled waste)

Yellow Bin (%)				
Mean	Organic	Recycled	Hazardous	Non-biodegradable
Regular Programs	54.08	44.18 (11.03% of total)	N/A	1.74
Weekend Programs	51.82	45.19 (11.61% of total)	0.77	2.22

Table 4. Percentage of each type of waste found in the red bins (hazardous waste)

Red Bin (%)				
Mean	Organic	Recycled	Hazardous	Non-biodegradable
Regular Programs	55.92	42.60	N/A	1.48
Weekend Programs	44.52	51.76	0.40 (0.066% of total)	3.32

Table 5. Percentage of each type of waste found in the blue bins (non-biodegradable waste)

Blue Bin (%)				
Mean	Organic	Recycled	Hazardous	Non-biodegradable
Regular Programs	55.96	42.09	N/A	1.95 (0.542% of total)
Weekend Programs	47.82	48.28	N/A	3.90 (1.26% of total)

3.1 Discussion

As indicated in the solid waste composition, the first three components of solid waste were generated from the regular and weekend programs: food waste, plastics and paper. It can be correlated with the first three components of Thailand's municipal solid waste (MSW), representing 63.57%, 16.83% and 8.19% respectively (1). If the weekend study programs continue to grow until the number of students in the programs is close to the number of students in the

regular programs, the quantity of solid waste will be double because the regular programs showed 0.141 kilograms/person/day on average. However, the average quantity of solid waste from the weekend studies programs showed 0.278 kilograms/person/day that it found higher than the regular programs at 97.2%. The students in the weekend programs consumed "instant food" such as instant noodles in plastic containers, instant coffee in cans, fresh roasted coffee in cups and others from convenience shops as the schedules of the weekend programs providing a short duration for lunch breaks, unlike the regular study programs. Efficient solid waste management must be organized to respond to such expansion along with other measures and campaigns for solid waste separation. Therefore, it leads to efficient and effective solid waste management. This is consistent with studies that waste problems and solid waste management are a major environmental problem (2) and solid waste management of the university can be accomplished effectively by applying waste management measures, determining the problems via the study of waste components, receiving adequate budget, categorizing waste, and creating positive attitudes toward solid waste management in the university. (3) Additionally, the consumer buying behavior was influenced by four major factors: cultural, social, personal, and psychological features. Personal factors are included in terms of age and lifestyle, occupation, and economic status. (4) The weekend program students are all employed differed from those in the regular program in terms of age, income, and economic status as a result of the differences in buying behaviors.

4. Conclusion

The investigation of the solid waste quantity and composition at Nakhon Ratchasima Rajabhat University providing in regular and weekend programs was conducted for one semester (March to June, 2013). The findings were presented in the number of 2,332.5 and 1,695.28 kilograms/day with a generation rate of 0.141 and 0.278 kilograms/person/day as it found higher than the regular programs at 97.2%. As regards the study of solid waste composition, it was generated by regular and weekend programs. It showed food waste ($p=0.020$), plastics ($p=0.006$), textiles ($p=0.003$), tin cans ($p=0.039$), aluminum ($p=0.018$), and dirt/ash/etc. ($p=0.032$) which was significantly different at $p \leq 0.05$. However, the average quantity of solid waste (types of plastics, textiles, tin cans and aluminum) during the weekends was higher than the regular programs. It resulted from the consumption of "instant food "corresponding with the students in weekend programs in irregular periods related to short duration of lunch breaks and full-day study schedule since they were required to study only two days a week, compared to those in the regular programs with a five-days-a-week schedule. Regarding the accuracy of solid waste separation by the students in the regular and weekend programs, it showed an average accuracy of 16.45% and 13.10% for organic waste, 11.03% and 11.61% for recycled waste, (N/A) and 0.066% for hazardous waste, and 0.54% and 1.26% for non-biodegradable waste. Due to no prospect of progress, there were only 1.6 kilograms of hazardous waste throughout the semester. From the paired difference test of the average accuracy between the regular and weekend study

programs by means of paired sample t-test, only the average accuracy of using the non-biodegradable waste showed a significant level of difference ($p \leq 0.05$).

Recommendations

1) A study of the factors affecting the separation of waste by the students.

5. Acknowledgement

The authors would like to acknowledge the Institute of Research & Development, Nakhon Ratchasima Rajabhat University, and the Faculty of Science and Technology, Nakhon Ratchasima Rajabhat University, for support of this research.

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