

## **CHARACTERISTICS OF HOUSEHOLD SOLID WASTE IN HUE CITY**

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### **ABSTRACT**

This paper examined the characteristics of household solid waste with a hope of contributing to the improvement of solid waste management in Hue city. The study was conducted by collecting, classifying and measuring household solid waste from 62 households in 7 consecutive days. A structure questionnaire was also used in the interviews with survey households to collect data on their demographic characteristics. The results show that the household solid waste was generated evenly on a daily basis with an amount of  $286 \pm 171$ g/person/day during the weekdays. The composition of household domestic solid waste was divided into 17 different groups; of which, the two groups representing the largest amount were food waste (56.35 %) and garden waste (10.89 %). Hazardous waste accounted for a very small proportion (only 0.26 %). The detailed composition ratio of food, garden waste, nylon, paper, plastic, porcelain, etc. and mixed stuff were defined at 56.35 %, 10.89 %, 8.93 %, 3.22 %, 3.22 %, 3.02 %, etc. and 10.23 %, respectively.

*Keywords:* characteristics, waste generation, household solid waste, Hue city.

### **1. INTRODUCTION**

The economic growth has been occurred, accompanied with the improvement of income, the amount of solid waste has been increasing. In Vietnam, the amount of urban solid waste has also increased rapidly over time, from 6.4 million tons (2003) to 12.8 million tons (2008) [1]. The rapid increase in amount and in composition complexity of urban solid waste (in which, household solid waste has a significant contribution); has caused the great pressure on solid waste local management. Solid waste, if not properly managed, will cause environmental pollution such as bad odor, disappearance of urban beauty, leakage, soil pollution, water pollution, etc. [2].

Household solid waste is solid waste generated from daily human activities. Sources of generation include households, residential areas, restaurants, hotels and office agencies, etc. [3]. This study focuses only on household solid waste.

There is a fact that the information on the composition, weight, generation coefficient and some other characteristics from urban solid waste in general and household solid waste in particular in Vietnam is rather limited and this situation is the same as Hue city. The information presented in the report on the National Environmental Report on Solid Waste (2011) is rather sketchy and statistically based on some reports from local agencies. There is one research on characteristics and generation sources of household solid waste in Mekong Delta conducted by N.P. Thanh and et al. And Can Tho city is one case study [4]. N.P. Thanh and et al. also conducted another research on characteristics and composition of household waste of Hue city in 2010 [5]. There are some other studies on audits of solid waste of households, hotels and markets in order to apply the bioremediation in Vietnam and Laos by Philip H. Byer and et al. [6].

Although there are previous studies about this issue, the impact factors on characteristics and generation weight have much been changed, it means that the specifics must be changed. Therefore, this study aims to add and update the data, compare and evaluate to the previous research results, contributes to the efficiency improvement of solid waste management in Hue city.

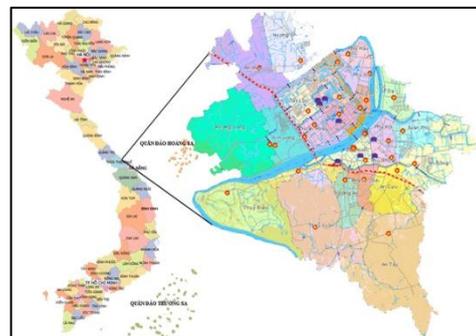
## 2. METHODOLOGY

### 2.1. Overview of research area

Hue City is a first class city of Thua Thien Hue province, a center of culture, economics of the province. Hue monument complexes were recognized as World Cultural Heritage in 1993 [7]. Hue city is located in the Central Vietnam, 650 km from Ha Noi capital in the north and 105 km from Da Nang city in the south. The location of Hue city is shown in Figure 1 and the basic information of Hue city is presented in Table 1.

*Table 1.* Information of Hue city

Items	Value	Unit
Number of wards	27	ward
Natural area	71.1	km <sup>2</sup>
Population	354,124	person
Number of household	86,195	household
Population density	4980	person/km <sup>2</sup>
Household size	4.1	person/household



Source: [8]

*Figure 1.* Map of Hue city.

### 2.2. Survey of household solid waste

This study randomly selected 62 households in 17 wards of Hue city to conduct a survey on the amount and composition of household solid waste. The generation amount of solid waste of households during 7 consecutive days is calculated. The distribution of household size (number of person/household) is sampled as shown in Table 2.

- The compositions of household solid waste groups are shown in Table 3 and referenced from [2]. The components of household solid waste are classified right at household, then

weighted and recorded the data by electric scale. The time of sampling and sorting in household is at the end of each day, there is consensus with the households prior to conducting the practical survey at that time.

Table 2. Distribution of household size selected in the research.

Household size	Number of person/household					
	$\leq 2$	3	4	5	6	$\geq 7$
Number of household	5	7	27	15	6	2
% surveyed household	8.06	11.29	43.55	24.19	9.68	3.23
<i>Average: 4.21 persons/household; standard deviation: 1.13 persons/household</i>						

Table 3. Components of classified groups.

Component	Examples	Image	Component	Examples	Image
Food waste	Waste related to food and food processing: rice waste, vegetable, tea waste, etc.		Garden waste	Leaves, branches, grass, etc.	
Paper	A <sub>4</sub> paper, books, notebooks, etc.		Wood	Wood, etc.	
Carton paper	Carton paper, paper container, etc.		Glass	Glass bottle, glasses, etc.	
Plastic	Types of plastic such as bottle of shampoo, chair, plastic boxes,...		Aluminum	Can, spoon, pan, etc.	
Nylon	Nylon plastic bag, etc.		Iron	Iron can, nails, net, etc.	
Textile	Rags, old clothes, etc.		Other metals	Other metals such as steel, copper wire, etc.	
Rubber	Rubber items		Hazardous	Battery, lamp, medicine, etc.	
Leather	Shoes, bags made by leather or fake leather, etc.		Ceramics, sand,...	Ceramics, grave,...	
			Miscellaneous	Others cannot be separated.	

**2.3. Parameters calculation**

- The amount of household solid waste generated per person per day is calculated by the following formula:

$$\text{Amount of household solid waste generated} = \frac{\sum_1^7 \text{Amount of household solid waste of research households}}{\sum_1^{62} \text{number of person of each household} \times 7} (\text{g/person/day})$$

where 7 is the number of research days; 62 is the number of research household.

- Percentage of components is also calculated similarly to the amount of generation, the rate of group weight and total average amount of household solid waste in 7 research days.

- After completion of the data collection, each household responded to the questionnaire with the following contents: number of person/household, age, education level of household members, income, expense cost-related such as water fee, electricity fee.

**3. RESULTS AND DISCUSSION**

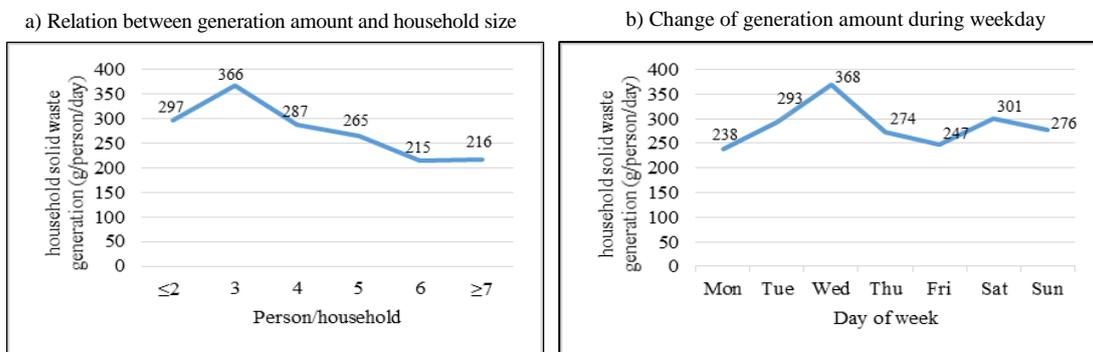
**3.1. Amount of household solid waste generated from households**

The results of survey of 62 households (261 persons), the total amount of collected, classified solid waste is 504.16 kg/day. Number of total samples is 434 (62 households in 7 days). In which, the average generation amount is calculated as  $286 \pm 171$  g/person/day. This amount is different among households, ranging from  $41 \pm 33$  g/person/day to  $712 \pm 392$  g/person/day. This difference depends on factors such as size of household, consumption habits, income, etc.

Compared to other studies (Table 4), the amount of solid waste generation in Hue City is equivalent to that of Can Tho City in 2010. Therefore, compared to the results of the study in Hue City in 2010, the amount of generation has been increased (286 g/person/day compared to 258 g/person/day), this is suitable to the local socio-economic development trend.

*Table 4. Generation amounts reported by other studies.*

Generation amount (g/person/day)	Location	Time	Author
258±163	Hue City, Vietnam	2010	N.P.Thanh et al. [5]
285	Can Tho City	2010	Nguyen Phuc Thanh et al. [4]
530 - 630	Ho Chi Minh City	2014	Dieu T. M. Tran et al. [9]



*Figure 2. Impact factors on solid waste generation amount.*

The results in Figure (2a) show that the generation amount per capita basically decreases when the number of person in household increases. This can be explained that some compositions of household solid waste are common use among family members such as food containers, paper boxes, etc. However, the research results in Figure (2b) cannot determine the rule (relationship) between the amount of solid waste generation and the days of the week.

### 3.2. Component characteristics of household solid waste

Table 5. Component characteristics of household solid waste.

Components	Total amount of household solid waste in 62 households (g)	Standard deviation	Percentage	g/person/day
Food waste	40,583	462	56.35	155.49
Paper	2,319	40	3.22	8.88
Carton paper	1,020	22	1.42	3.91
Plastic	2,316	41	3.22	8.87
Nylon	6,432	98	8.93	24.64
Textile	708	23	0.98	2.71
Rubber	57	3	0.08	0.22
Leather	177	13	0.25	0.68
Garden waste	7,840	211	10.89	30.04
Wood	473	27	0.66	1.81
Glass	853	24	1.18	3.27
Aluminum	466	15	0.65	1.78
Iron	538	18	0.75	2.06
Other metal	19	1	0.03	0.07
Hazardous	185	10	0.26	0.71
Ceramics, sand, soil	2,175	175	3.02	8.33
Miscellaneous	5,861	152	8.14	22.46

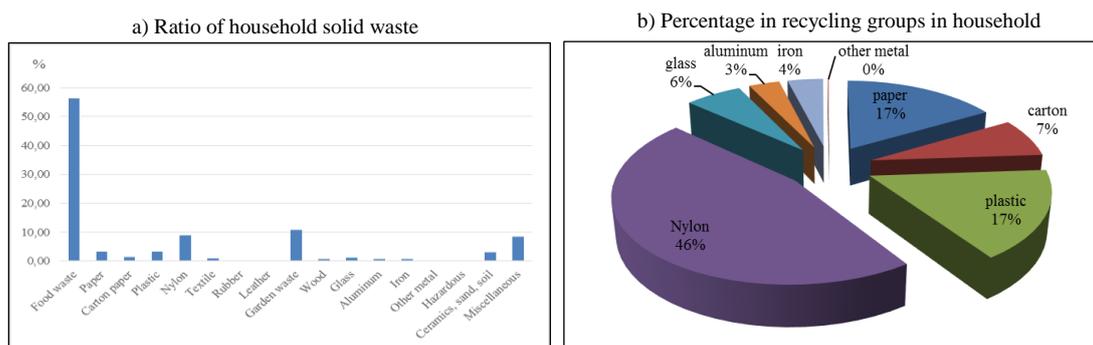


Figure 3. Ratio and recycling groups of household solid waste.

As seen in Table 5, food waste is the most common and accounts for the largest rate of household solid waste in Hue city (56.35 %), which is reasonable about the amount of solid waste in developing countries, then garden waste (10.89 %) and next is nylon (8.83 %). Paper and carton account for 3.22 % and 1.42 %, respectively of total generation. Mixture group accounts for large rate with percentage of 8.14 %, this group includes many components and un-classified in any

group such as chicken feathers, large animal bones, baby diapers, etc. Figure (3a) shows the difference of generation amount among groups of food wastes, garden waste and nylon.

The recyclable group accounts for 19.4 % of total household solid waste amount (excluding recyclable organic residues such as food waste, garden waste, miscellaneous group. Of which, the groups with largest ratio are nylon, plastic, paper with percentage of 46 %, 17 %, and 17 % respectively. The reason for the high amount of nylon is nylon appears in all households during the survey over the research days, in addition, nylon is commonly used to keep fresh food and water is contained in it so that the weight might be increased. The recycling groups are shown in Figure (3b).

#### **4. CONCLUSION**

The results of the research on 62 households over 7 days determined the generation amount of household solid waste in Hue city as  $286 \pm 171$  g/person/day, higher than that of 7 years ago ( $258 \pm 163$  g/person/day).

Among 17 different groups, the two groups making up the largest amount were food waste (56.35 %) and garden waste (10.89 %). Hazardous waste only accounted for a very small proportion of 0.26 %.

The amount of household solid waste per capita decreases when the number of person in household increases, and there is no noticeable difference on the amount of solid waste generation over weekdays.

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