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INVESTIGATE THE EFFICIENCY OF RECOVERY OF RECYCLABLES FROM HOUSEHOLD WASTES IN DAU TIENG TOWN, DAU TIENG DISTRICT, BINH DUONG PROVINCE

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ABSTRACT

The purpose of this paper is to present some results of an investigation of the efficiency of recovery of recyclables from household wastes in Dau Tieng town, Dau Tieng district, Binh Duong. Main methods used in the study are solid waste analysis, sociological investigation and estimation. Interviewed participants include households, scrap purchasing enterprises, scrap buyers (individuals) and solid waste collection employees. The result shows the efficiency of recovery of recyclables from household wastes in Dau Tieng town is quite high with 77.99 %. The major component of the recyclables consists of plastic, glass, paper, aluminum, iron and steel. The amount of recyclable materials lost in the recovery process in studying area is 258.52 kg/day, equivalent to 1,310,696 VND each day.

Keywords: Dau Tieng town, efficiency of recovery, household wastes, recyclables.

1. INTRODUCTION

Household waste is one of the concerned environmental issues today. Selection of domestic waste treatment technologies having high efficiency, less expensive and not causing adverse effects on the environment in the future is always the pressure on managers of environment. Therefore, the best way is to reduce domestic waste at source. Recycling domestic waste is considered as one of the effective measures in reducing solid waste. Recycling household waste not only contributes to environmental protection, but also helps us recover materials to avoid wasting resource.

However, in most areas, recycling this resource is currently not implemented fully, causing huge losses. Besides the recycling efficiency is not high, it is also due to unsatisfactory recovery stages. Currently, there is no study on statistic of recyclables recovered from household solid wastes.

This is a very important task because it helps make a database for solid waste management in localities.

In recent years, along with developing of the country, Dau Tieng town having natural area of 29.88 km² and including 8 quarters also has made tremendous achievements in economic and social development. That is the cause of increasing amount of solid waste affecting people and the environment around the area. With a population of 19,998 people (in 2015), the amount of household waste generated will be relatively large.

From the above issues, in this paper, we refer to the research "Investigate the efficiency of recovery of recyclables from household wastes in Dau Tieng town, Dau Tieng district, Binh Duong province" in order to assess the status of recovering recyclables from household wastes and help to contribute effective solutions for solid waste management in this area**.**

2. MATERIALS AND METHODS

2.1. Method of solid waste analysis

Sampling was carried out at 374 households from 01 Jan 2015 to 15 Mar 2015[1] in order to analyse component of solid waste in the studying area. Each household is sampled continuously for 7 days a week, one time daily, at the end of day. Using the following formula to calculate the sample size [3]:

$$n = \frac{N}{1 + N \times e^2}$$

where: n is the required sample size (number of sampled households); N is the total number of households in Dau Tieng town (5579 households); e is the standard error of measurement, often get e = 0.05.

After acquiring the needed sample size, the researchers carried out sampling at every quarter. Sample size calculation in each quarter is based on the proportion between the number of representation households (trade, small production and non-business) and the total number of households in the quarter (see detail in Table 1).

Table 1. The sample sizes of the research.

No.	Characteristic of representation housholds	Total number of households in Dau Tieng town	Proportion of each the representation	Sample sizes at Dau Tieng town	Sample sizes at each quarter
1	Trade	1209	0.217	81	10
2	Small production	26	0.006	2	1
3	Non-business	4344	0.779	291	36
Total		5579	-	374	47

[1] Living activities of households often little change, therefore the time sampling of solid wastes at households which is only one time a year is enough to gain the studying result.

Method of implementation: solid waste components are classified in two groups: recyclables and non-recyclables. Recyclables includes paper, plastic, glass, metal, etc.; and non-recyclables consists of food, garden rubbish, wood, ash, brick, etc. [2, 4]. Then, weigh and calculate a ratio of each component expressed in terms of % by weight. Repeat 3 times, take the average value [5].

2.2. Sociological investigation method

Direct interview or survey questions was conducted for 347 households, 24 scrap buyers (3 persons per quarter), 8 solid waste collection employees (1 employee per quarter) and 2 big-scale scrap purchasing enterprises. The interview content is expressed as follows:

- For household: forms of storage, collection; how to treat household waste, especially attend to recycling activities.
- For scrap buyer: source (households, markets, offices, stores, etc.), composition and weight of purchased recyclables.
- For solid waste collection employee: source (households, markets, offices, stores, etc.), composition and ratio of collected household waste; weight and composition of recyclables recovered in the collection process.
- For scrap purchasing enterprise: source (living activities, industry, agriculture, etc.), composition and weight of purchased scraps; price of purchased recyclables.

2.3. Estimation method

The total weight of recyclables from household wastes generated per day in Dau Tieng town is estimated as the following formula:

$$\mathbf{W_G = W^T{}_G + W^{SP}{}_G + W^{NB}{}_G}$$

$$W^T{}_G = W^T \text{ x } N^T;\ W^{SP}{}_G = W^{SP} \text{ x } N^{SP};\ W^{NB}{}_G = W^{NB} \text{ x } N^{NB}$$

where, W_G is the total weight of recyclables from household wastes generated per day in Dau Tieng town;

$W^T{}_G$, $W^{SP}{}_G$ and $W^{NB}{}_G$ is respectively the total weight of recyclables from household wastes generated per day of all trade, small production and non-business households in Dau Tieng town;

W^T, W^{SP} and W^{NB} is respectively the average weight of recyclables from household wastes generated per day of each trade, small production and non-business household;

N^T, N^{SP} and N^{NB} is respectively the number of trade, small production and non-business households in in Dau Tieng town.

The total weight of recyclables from household wastes recovered[2] per day in Dau Tieng town is estimated as the following formula:

$$\mathbf{W_R = W_{R1} + W_{R2}} \qquad W_{R1} = W_L/2 \text{ x } R_{He}{}^{(*)} \qquad W_{R2} = W_L/2 \text{ x } R_{Hb}{}^{(**)}$$

[2] collected at scrap purchasing enterprises in the studying area.

where, W_R is the total weight of recyclables from household wastes recovered per day in Dau Tieng town;

W_{R1}, W_{R2} is respectively the total weight of recyclables from household wastes recovered per day from all solid waste collection employees and scrap buyers in Dau Tieng town;

W_L is the weight of recyclables from living activity source recovered per day in Dau Tieng town;

R_{He}, R_{Hb} is respectively the ratio (%) between the weight of recyclables generated from household living acitivies and the total weight of recyclables generated from living activities of all sources (households, markets, offices, stores…) recovered per day by solid waste collection employees and scrap buyers in Dau Tieng town.

Note: The investigation showed that solid waste collection employees and scrap buyers are two main groups recovering recyclables from household wastes in the studying area. Each group has recovered about 50% of recyclables from household wastes, and sold to scrap purchasing enterprises in the locality. This explains the ratio ½ used in the formula (*) and (**).

The efficiency of recovery of recyclables from household wastes is calculated as the following formula: $E = W_R / W_G \times 100$

The weight of recyclables lost[3] *per day is calculated as the following formula:* $W_L = W_G - W_R$ [1].

3. RESULTS AND DISCUSSION

3.1. Status of generation of recyclables from living activities at households

The total weight of domestic waste generated from households per day in Dau Tieng town is 10.332 tons (the author's survey data in 2015). In particular, the average weight of recyclables per day in trade, small production and non-business households is respectively 0.46 kg, 04 kg and 0.14 kg (see detail in Table 2). The component of recyclables from household wastes in Dau Tieng town is mainly plastic, steel, paper, glass and aluminum.

Table 2. Average weight and ratio of recyclables from living activities at households.

No.	Characteristic of representation housholds	Recyclables		Non-recyclables		Total weight (kg)
		Average weight (kg)	Ratio (%)	Average weight (kg)	Ratio (%)	
1	Trade	0.46	12.1	3.34	87.9	3.8
2	Small production	0.4	11.5	3.08	88.5	3.48
3	Non-business	0.14	10.8	1.16	89.2	1.3

(Source: The author's survey data in 2015).

[3] not collected at scrap purchasing enterprises in the studying area. In reality, a part of recyclables lost may be reused in households. However, authors has not invested and calculated them in detail.

The survey result conducted for 374 households in the studying area showed that 347/374 respondents (accounts for 92.71 %) replied "sell recyclables to scrap buyers" and only 27/374 respondents (accounts for 29.07 %) answered "not sell". Thus, the number of households selling scrap is relatively high. However, only 20.22 % of 347 households having answers "sell" makes use of all types of recyclables for selling. Therefore, a large amount of recyclable materials lost will affect the environment and damage the economy.

3.2. Status of recovery of recyclables from living activities at households

Recyclables recovered by scrap buyers: The weight of recyclables purchased from households in the region accounts for 98.84 % of the total weight of recyclables purchased by individuals. The ratio of the weight of recyclables purchased from the other sources (markets, offices, stores, etc.) is only 1.16 %. The average weight of recyclables purchased by scrap buyers is about 53.4 kg/day.

Recyclables recovered by solid waste collection employees: Employees usually recollect recyclables in solid waste collecting process, and sell to scrap purchasing enterprises in the region. The survey result presented that the rate of recyclables from households, stores, offices, markets and the other source (roads, public areas, etc.) is respectively 75.67 %, 13.03 %, 5.83 %, 3.33 % and 2.13 %. The average weight of recyclables recoverd by one solid waste collection employee is about 4kg/day.

Recyclables recovered by scrap purchasing enterprises: The investigation showed that all reclyclables in the studying area are sold to the 2 big-scale scrap purchasing enterprises. The survey results at these enterprises are described in the table 3.

Table 3. The big-scale enterprises's scrap purchasing in Dau Tieng town.

No.	Name of enterprise	Address	Weight (kg) and ratio (%) of recyclables purchased from different sources								Total
			Living activities		Industry		Agriculture		The others		
			kg	%	Kg	%	kg	%	kg	%	kg
1	Mrs. Ty	Quarter 5	651	95	6.85	1	6.85	1	20.55	3	685
2	Mr. Dung	Quarter 4B	399	95	0	0	4.2	1	16.8	4	420
Total			1050		6.85		11.05		37.35		1105

(Source: The author's survey data in 2015).

The table 3 showed that the rate of recyclables purchased from living activities, industry and agriculture, and the other sources is respectively 95 %, 1 % and 3-4 %. The total weight of recyclables recovered from living activities at the 2 above enterprises is 1050 kg/day. Materials purchased are mainly plastic, steel, paper, glass and aluminum. The survey results also showed that the average rate of these materials is respectively: 31 %, 46 %, 19 %, 2 % and 2 %.

3.3. Efficiency of recovery of recyclables from household wastes

The total weight of recyclables from household wastes GENERATED per day in Dau Tieng town:

$\mathbf{W_G = W^T_G + W^{SP}_G + W^{NB}_G} = W^T \times N^T + W^{SP} \times N^{SP} + W^{NB} \times N^{NB}$

= 0.46 x 1209 (kg/day) + 0.4 x 26 (kg/day) + 0.14 x 4344 (kg/day) = 1174.7 kg/day

The total weight of recyclables from household wastes RECOVERED per day in Dau Tieng town:

$\mathbf{W_R = W_{R1} + W_R} = W_L/2 \times R_{He} + W_L/2 \times R_{Hb} = 916.18$ kg/day

The efficiency of recovery of recyclables from household wastes in Dau Tieng town:

$E = W_R / W_G \times 100 = 916.18 / 1174.7 \times 100 = 77.99$ %

The weight of recyclables lost: $W_L = W_G - W_R = 1174.7 - 916.18 = 258.52$ kg/day, equivalent to 1.310.696 VNĐ/day (see detail in Table 4).

Table 4. Damages (per day) based on lost recyclables from household wastes in Dau Tieng town.

No.	Recyclables	Unit price (VND/kg)	Ratio (%)	Weight (kg)	Total (VND)
1	Plastic	6.500	31	80.14	520.910
2	Glass	500	2	5.17	2.585
3	Paper	2.500	19	49.12	122.800
4	Aluminum	25.000	2	5.17	129.250
5	Steel	4.500	46	118.92	535.140
Total			100	258.52	**1.310.696**

(Source: The author's survey data in 2015).

4. CONCLUSION

The research showed that the total weight of recyclables from household wastes generated per day in Dau Tieng town is 1174.7 kg/day. There are 2 big-scale scrap purchasing enterprises recovering all recyclables in the locality. They are the last unit of recovering recyclables in the process. Recyclables are currently not recovered thoroughly in Dau Tieng town. The total weight of recyclables from household wastes recovered per day in the area is 916.18 kg/day. The efficiency of recovery of recyclables is about 77.99%. Thus, Dau Tieng town is losing approximately 258.52 kg of recyclables from household wastes, corresponding to 1,310,696 VND each day.

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