Current Status of Domestic Solid Waste Management at Commune/Ward Level in Thai Nguyen City, Vietnam (Case Study in Tan Thanh Ward)

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ABSTRACT: The study focuses on researching the current status of domestic solid waste management at the commune/ward level of Thai Nguyen City with a case study in Tan Thanh ward. The study interviewed and surveyed 245/629 households in Tan Thanh ward around issues related to domestic solid waste management in the locality. Along with that, the study has determined that the domestic solid waste generation coefficient of Tan Thanh ward is 0.4kg/day/person. The study also forecasts that by 2030, the total amount of domestic solid waste generated in Tan Thanh ward will be 2,665.2 kg/day. From the current status and forecast studies, the study has proposed solutions to improve the efficiency of household solid waste management in Tan Thanh ward and small localities in Thai Nguyen city.

KEYWORDS: Tan Thanh ward, Thai Nguyen city, domestic solid waste, management, forecast

I. INTRODUCTION

The generation of domestic solid waste in residential areas is considered one of the urgent problems that need to be resolved. Waste that is not collected and treated will cause many negative impacts on the environment and people's lives. Domestic solid waste management in Vietnam has made many strides in recent times. Many regulations and policies on domestic solid waste management have been issued to improve the efficiency of domestic solid waste management in localities.

Thai Nguyen is a province located in the Northeast region of Vietnam, about 75km from the capital Hanoi. Thai Nguyen is considered one of the economic, cultural, educational and medical centers of the Northern midland and mountainous region. Thai Nguyen province has 3 cities, 6 districts with 178 communes, wards and towns [1].

Tan Thanh is a ward located in the southeast of Thai Nguyen city with a natural area of 2.35km^2. The ward includes 7 residential groups with a population of 5,706 people (2023) [2]. Currently, the ward has 2 elementary schools, 1 middle school and 2 preschools. Although Tan Thanh ward has a favorable geographical location and natural conditions for socio-economic development, the ward's household waste management is facing great challenges. Population increases, living standards improve, leading to an increasing amount of household solid waste. Markets, shops, and services to serve the people are also quite abundant, causing an increasing risk of waste generation... Therefore, the management of household solid waste here is an urgent issue.

There have been many studies related to domestic solid waste management in the world and Vietnam. Some studies such as the study by S. Khan et al. (2023), Prajapati et al. (2021), Rawat and Davery (2018) [3,4,5]. However, there has been no predictive assessment research at the commune/ward level in Thai Nguyen city. Therefore, it is very necessary for this research to be carried out

II. METHODOLOGY

Collect, analyze and process data: The study collected and synthesized data related to the research issue in Thai Nguyen city and Tan Thanh ward. The data includes: natural, socio-economic conditions; environmental management, domestic solid waste in the locality. The data will be analyzed and processed for research.

Fieldwork, survey: The study uses 2 forms to survey:

+ In-depth interviews: Conducted with subjects who are managers and waste collection staff in the ward.

+ Interviewing people using questionnaires: In Tan Thanh ward, the study selected 3 groups to conduct the survey. Those groups are group 4, group 5, group 7. The number of survey votes is selected based on the Slovin formula [6]:

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

Note: n: Number of household to be surveyed

N: Total number of households in study area (629 households)

e: Allowed error. Choose e = 5% (95% confidence level).

From the Slovin's formula, the study randomly selected 245 households to conduct the survey.

Based on the population of each group, the number of votes to conduct the survey for each group will be determined at the rate: (245/629)x100=0.39%.

The number of households surveyed in each group is shown in Table 1.

Table 1. The number of households surveyed in Tan Thanh ward

Group	Number of households	Number of surveyed households
4	232	90
5	229	89
7	168	66
Total	629	245

Investigate to determine the generation coefficient and composition of domestic solid waste:

+ Determine the coefficient of household waste generation: Trash bins are distributed to households. Weigh the waste after 1 day. This is repeated for 1 week.

Domestic solid waste generation coefficient = (weight of household solid waste/number of people)

+ Determine the composition of domestic solid waste: At each group, domestic solid waste collected from households will be concentrated and mixed together. Then, manually classify into categories: (1) Solid waste that can be reused and recycled (paper, glass bottles, plastic, cardboard, metal...); (2) Food waste (vegetable rolls, fruit peels, leftover rice...); (3) Other household solid waste (hair, medicine, cigarette butts...).

Composition % for each type of household solid waste = (Weight of each type/total amount of waste)

* Forecast population and estimate generated domestic solid waste:

- Population forecast to 2030: Base and formula: $P = P_0 (1+r)^n$

P: Population of the year to be calculated

P_0: Population of the base year

r: population growth rate

n: difference between the year to be calculated and the year taken as the base

- Estimated volume of household solid waste generated in 2030: On the basis of population forecast in 2030, the study estimates the volume of household solid waste generated by 2030 through applying the formula:

Estimated emission volume in 2030 = Estimated population in 2030 * Emission coefficient (kg/day/person).

III. RESULT AND DISCUSSION

3.1. Current status of domestic solid waste generation in Tan Thanh ward

- Origin of household solid waste generation:

The results of the investigation and actual survey show that the source of domestic solid waste in Tan Thanh ward is mainly due to daily activities (such as cooking, preparing and processing food,...); Dispose of plastic bags, plastic items, old and broken household items, electronic waste...; Waste from

markets, trading places, restaurants, eateries, cultural areas, schools, factories... The results of surveying and weighing trash in 3 groups (4, 5, 7) in Tan Thanh ward are shown in table 2.

Table 2. Amount of household waste generated in households in Tan Thanh ward

Group	N	Average amount of waste generated (kg/household/day)		
		D	K	W
4	10	1.3	1.6	1.38
5	10	1.2	1.9	1.4
7	10	1.6	2.0	1.71
Total	30	1.36	1.83	1.49

Note: N: Number of households weighing trash

D: Average amount of trash on weekdays

K: Average amount of trash on weekends

W: Average amount of trash for the week

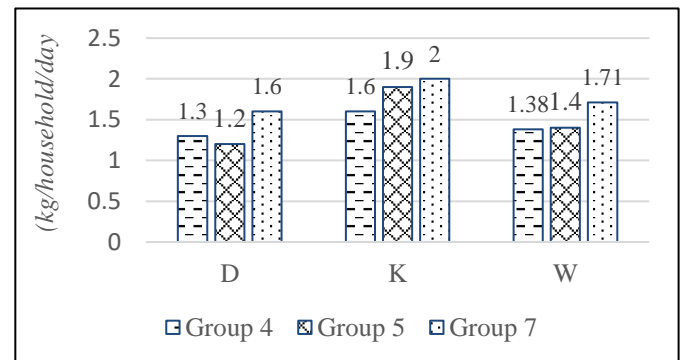The amount of waste generated in the households of the groups is shown in Figure 2.

Figure 2. Chart of the average amount of waste generated in households in Tan Thanh ward

The results show that group 7 has the highest amount of waste with an average of 1.71 kg/day/household, followed by group 5 (1.4 kg/day/household), and the lowest is Group 4 (1.38 kg/day household). In general, the average amount of trash generated on weekdays in all 3 groups is less than the average amount of trash generated on weekends. The reason is that on weekdays, people often go to work and are rarely at home, so the amount of waste is also less. On weekends, people are off work and children don't go to school, so the amount of trash generated is also higher. Besides, people often choose weekends to clean the house and gather with family, so the amount of waste generated is also larger.

- Volume and composition of solid waste generated:

Survey results at households show that the amount of waste from business households often contains many plastic bags, because different types of plastic bags are used during the purchasing and trading process. The amount of food waste is

mainly found in agricultural households. Some agricultural waste is used by people as food for animals (such as vegetable rolls, vegetable leaves, leftovers...). The proportion of household solid waste components of the ward is shown in table 3.

Table 3. Percentage of domestic solid waste in Tan Thanh ward

Group	N	W	Percentage of household waste (%)		
			R	F	O
4	10	1.38	21.7	57	20.3
5	10	1.4	28.5	42.8	28.6
7	10	1.71	23.3	29.2	47.4
Total	**30**	**1.49**	**24.5**	**43**	**32.1**

Notes:

    N: Number of households weighing trash

    W: Average amount of trash for the week (*(kg/household/day)*

    R: Solid waste can be reused and recycled

    F: Food waste

    O: Other household solid waste

Solid waste that can be reused and recycled accounts for 24.5%. These types of trash are usually new plastic bags, plastic bottles, cardboard, beer and soft drink cans. Some people reuse or recycle into household items. Some are collected and sold to scrap collectors. The amount of food waste in all 3 groups is quite large (43%). In agricultural households, this waste will be used in animal husbandry and as fertilizer, so less food waste is generated in the environment than in households doing other industries.

3.2. Current status of household waste management in Tan Thanh ward

* Waste collection, classification and treatment:

In each group of Tan Thanh ward, there is 1 garbage collector and 1 garbage truck. Collection work is carried out every afternoon. After collection, domestic waste is brought to the collection site and transported to the waste treatment plant for treatment according to regulations. Currently, in Tan Thanh ward, 35% of households do not use garbage collection services.

Investigation results show that local waste has been collected centrally. In residential groups, trash bins are placed at many different points. Workers collect directly by cart to the waste gathering place. The waste will then be taken to Da Mai Solid Waste Treatment Plant. In addition, in households in deep alleys, collection is difficult, people handle it themselves using simple methods (such as burying or burning). However, this is considered an unsafe treatment measure and has a negative impact on the surrounding environment (soil and air pollution...) Waste classification activities at households have

not been paid attention. People only keep trash that still has value (new plastic bags, plastic bottles, etc.). The remaining different types of trash are put together in the household trash. This causes many difficulties for the collection and treatment department. Especially in non-agricultural households, food waste is not utilized but discarded directly, causing waste. Waste collection and treatment methods in 3 groups of Tan Thanh ward are shown in table 4.

Table 4. Methods of collecting and treating household waste from households in Tan Thanh ward

Methods of collection and treatment	Ratio (%)
Collect trash in the trash can in front of your house for collection staff to pick up	64.9
Buried in the garden	6.53
Dispose of trash directly into the environment	9.8
Burn the garbage	18.77
Total	100

The collection of fees for domestic solid waste is strictly implemented according to Decision No. 32/2021/QD-UBND dated June 28, 2021 of the People's Committee of Thai Nguyen province. Households pay fees for the collection of domestic waste. operates at the prescribed price. Specifically, for households and individuals: 8,000 VND/person/month; For small service business households (not yet required to pay tax): 35,000 VND/household/month (if waste volume < 1m^3) and 50,000 VND/household/month (if waste volume > 1m^3); With school units, business organizations and individuals (restaurants, motels, businesses, food and beverage service stores, fruit businesses, livestock slaughterhouses... and other businesses): 225,000 VND/household/month (if waste volume < 1m^3) and 310,000 VND/household/month (if waste volume > 1m^3).

* Problems in solid waste management in Tan Thanh ward

Waste has not been thoroughly classified at the source, so it is difficult to manage.

Propaganda activities on household waste are only initiated, not continuously implemented, have not fully conveyed the value and importance of environmental protection and have not achieved practical results. People's awareness is not high

3.3. Forecast of domestic solid waste generated in Tan Thanh ward by 2030

Based on the survey of households in Tan Thanh ward, determine the household waste generation coefficient according to the formula:

Garbage generation coefficient = average waste weight of households (kg/day)/average number of people per household (person).

In which:

Average waste weight of households is 1.49kg *(according to the calculated study)*

Average number of people per household = Total population/total number of households

As of 2023: Total population is 5706, total number of households is 1534

➔ Average number of people per household is: 5706/1534=3.72 people

➔ Garbage generation coefficient = 1.49/3.72= 0.4 *(kg/day/person)* (*)

Forecast of domestic solid waste generation to 2030:

- Population forecast to 2030:

Based on the formula: $P = P_0(1+r)^n$ (1)

In which: P: Population of the year to be calculated

P_0: Population of the base year (2023): 5,706

r: average annual population growth rate (%)

n: difference between the year to be calculated and the year taken as the base (n=7)

According to data collected through reports of the People's Committee of Tan Thanh Ward, the population of the ward in the last 5 years is shown in Table 5.

Table 5. Tan Thanh ward population in the period 2019-2023

Year	2019	2020	2021	2022	2023
Population	5135	5217	5302	5524	5706
Number of households	1471	1487	1499	1516	1534

Thus, the average annual population growth rate of the last 5 years is calculated as follows:

Population growth rate = [[(Population 2023- population 2019)/(Population 2019)]x100]/5

= [[(5706-5135)/5135]x100]/5= 2.224%

➔ Based on formula (1):

Expected population in 2030 = $5706(1+0.0224)^7 = 6663.12 \approx$ 6663 (people) (**)

- *Estimated volume of domestic solid waste generated in 2030:*

Based on the population forecast for 2030, the study estimates the amount of domestic solid waste generated by 2030 in Tan Thanh ward by applying the formula:

Emission volume = Population (**) x Emission coefficient (kg/day/person) (*)

Emission volume = 6663 x 0.4 = 2665.2 (kg/day)

Thus, domestic solid waste is a big challenge for Tan Thanh ward in particular and Thai Nguyen province in general. It is forecasted that by 2030, the amount of domestic solid waste could reach 2665.2 kg/day, which is quite a large number for a small locality. The combination of local authorities and cooperation from the community and businesses can provide sustainable solutions to contribute to a cleaner environment.

3.4. Recommendations to improve the efficiency of solid waste management in Tan Thanh ward

- Propaganda to raise people's awareness of environmental protection.

- Organize propaganda activities, launch environmental protection movements. Deploy documents and regulations on environmental protection on radio and loudspeakers of residential groups in the mornings or evenings of weekdays.

- Research and deploy a circular economic model locally. This model focuses on managing and regenerating resources in a closed cycle to minimize waste, recycle waste into new raw materials for production, thereby reducing negative impacts on the environment, protecting the ecosystem and human health, and making full use of resources. Accordingly, household waste can be carefully classified. It will then be reused, recycled or sold to recycling facilities. This minimizes the amount of household waste generated outside.

- Invest in smart waste treatment technology. Consider waste as a valuable resource.

IV. CONCLUSIONS

The study analyzed the management of domestic solid waste at commune/ward levels in Thai Nguyen province (a case study in Tan Thanh ward). The results showed that the management of domestic solid waste in the study area has been effective to a certain extent. However, there are still many shortcomings related to waste classification, collection and treatment. With forecasts of the expected amount of domestic waste by 2030, the study also made recommendations to reduce the amount of waste generated in the future

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