

Initial Survey of Composition, Generation, and Proposing Management Solutions for Domestic Solid Waste in Cai Khe Ward, Ninh Kieu District, Can Tho City, Vietnam

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Abstract— This study was carried out to survey the composition and amount of domestic solid waste generated and management work in Cai Khe ward, Ninh Kieu district, Can Tho city. Households and staff in Cai Khe ward were interviewed to collect information on management assessment while waste collection tools were placed in the households to calculate generation rate and waste composition. The research results showed that the rate of domestic solid waste generation of the household and individual were 0.74 kg/household/day and 0.2 kg/person/day, respectively. Domestic solid waste in the study area has a variety of composition, of which organic waste accounted for the highest proportion (72.7%), plastic component accounted for 13.4%, and glass took up 2.7%, hazardous waste occupied 1.4% and other components accounted for 3.6%. Currently, only 90% of domestic solid waste was properly collected. Odor and leachate remained the problems during waste collection and transportation. In overall, the management of domestic solid wastes in Cai Khe ward is relatively good. In order to ensure a clean and beautiful environment in the study area, the environmental management agency should continue to propagate to raise people's awareness of environmental protection, creating favorable conditions for sorting wastes at source for the improvement of solid waste collection, transportation, and treatment facilities.

Keywords— domestic solid waste, organic waste, waste sorting, collection, Ninh Kieu.

I. INTRODUCTION

The country develops in the direction of industrialization and modernization, but the urbanization process takes place strongly everywhere in terms of scale, quantity, and quality of life of people increasingly improved. The higher people's living standards, the higher the demand for social products, which means an increase in domestic waste. Domestic waste generated in the process of eating, living and consumption of people, being discharged into the environment exceeds the ability of the environment to self-clean, leading to a polluted environment. Along with the development of the country, in recent years, Can Tho city has affirmed its role as a central city of the Mekong Delta and recognized by the Prime Minister as Class I city in June 24, 2009. With its

convenient location and abundant potential, the city has continuously accelerated economic development, production and business activities, trade and urbanization in order to improve life and spiritual material for the people in the area. But in parallel with the growth of the city, at present, the amount of solid waste from people's daily lives will increase and the garbage classification is still very limited, the awareness of the people is not high in littering. The amount of waste is relatively large while the investment budget is still difficult. Most of the waste is directly discharged to the environment, if there is a collection, only the mixture can be transported to the landfill, which is the cause of serious pollution, affecting human health. Composition, generation, and separation of waste at source play an important role in the effective

collection, treatment and management of domestic solid waste. The study selected Cai Khe ward, Ninh Kieu district, Can Tho city to investigate these issues, providing important information for the environmental managersto conduct more in-depth studies, thereby solving urban environmental management issues.

II. METHODOLOGY

Information on the current situation of generation, collection, transportation and solid waste management in Cai Khe ward, Ninh Kieu district, Can Tho city was collected by interviewing the households. The questionnaire content included general information about the interviewee such as gender, age, education level, occupation; information on current situation, source separation, collection time, impacts of solid waste on environment and health, assessment of current status of solid waste management in the study area. To assess the rate of generation and composition of solid waste, thirty households in the surveyed area were selected for providing plastic bags to store all solid waste in the family. Each day the placed plastic bags were collected at 5:00 PM to classify and calculate solid waste composition and rate of generation of solid wastes. Waste separation was conducted in accordance with the guidance of the Department of Natural Resources and Environment of Ho Chi Minh City. Specifically, organic waste includes easily biodegradable waste including uneaten food, vegetables, tubers, fruits, leaves, twigs and recalcitrant including nylon

bags, straws, bottles, glasses, plastic jars; inorganic wastes includes glass, bottles and jars; toxic wastes includes battery, light bulb, rubber, empty pesticide bottles; and other waste includes soil, stone, rubble. The interview data were imported into Excel spreadsheets (Microsoft Excel 2016, Microsoft, USA) to aggregate, calculate percentages and present data in the form of simple tables and charts. The following equation was use to estimate the amount of domestic solid wastes in Cai Khe ward to the year of 2025.

Euler's equation: $N_{i+1}^* = N_i + r.N_i.\Delta t$, in which N_i : initial polulation (persons); N_{i+1}^* : population one year later; r : population growth rate (%/year); Δt : time (year).

III. RESULTS AND DISCUSSION

3.1 Solid waste generation rate

The research results showed that the daily amount of garbage generated by the households was the highest at 1.5-2 kg/day and the lowest was less than 0.5 kg/day. The amount of waste generated by each household was different depending on occupation, income level and living and production habits of the households. However, this difference is mainly due to the level of income, a higher standard of living, eating, and household activities generate more waste. Figure 1 showed that the amount of waste generated per day: <0.5kg/day accounted for 40%, 0.5-1kg/day accounted for 46.67%, 1-1.5kg/day accounted for 6.67%, and 1.5-2kg/day accounted for 6.67%.

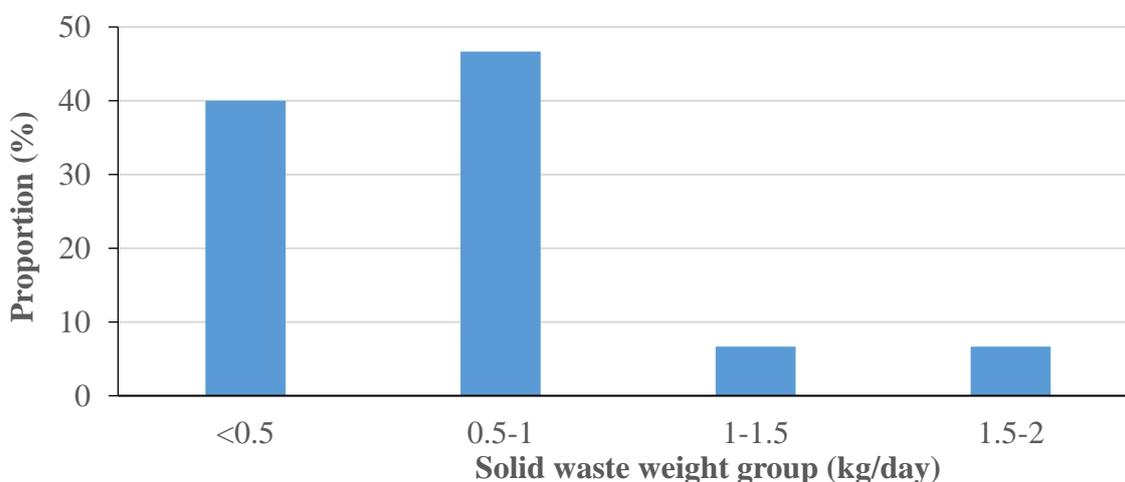


Fig.1: The mean weight of solid waste generated

The solid waste generation in Cai Khe ward was presented in Table 1. It was found that, on average, each household in Cai Khe ward discharged about 0.74kg/household/day and 0.2kg/person/day. The highest

amount of waste per capita was 0.23kg/person/day and the lowest was 0.12kg/person/day (table 1). The urban solid waste generation per capita increases with living standards. According to the 2011 environmental report, the average

domestic solid waste generated per capita for urban areas nationwide was about 0.75kg/person/day in 2007. In 2008, according to the Ministry of Construction, the solid waste generation was 1.45 kg/person/day that was much larger than in that in rural areas (0.4 kg/person/day). However, according to reports of the local environmental authorities, the mean domestic waste generation rate was less than 1kg/person/day. The inconsistent statistics of urban

domestic solid waste generation are one of the challenges for calculating and forecasting urban solid waste emissions in Vietnam. In the current study, the average volume of waste per capita of the households in the sampling area was relatively low at 0.2 kg/person/day, due to small-scale sampling, more in-depth studies are needed to obtain more presentative data.

Table1. Domestic solid waste generation in Cai Khe ward

Household (HH)	Members in HH	Total amount of solid waste (kg/week)	Amount of solid waste per HH (kg/HH/day)	Amount of solid waste per capita (kg/person/day)
A1	2	3.22	0.46	0.23
A2	3	4.82	0.69	0.23
A3	3	3.04	0.43	0.14
A4	7	10.7	1.53	0.22
A5	3	4.4	0.63	0.21
A6	7	10.91	1.56	0.22
A7	4	5.63	0.8	0.2
A8	4	5.85	0.84	0.21
A9	2	2.84	0.41	0.21
A10	4	3.43	0.58	0.12
A11	2	2.69	0.38	0.19
A12	2	2.8	0.42	0.2
A13	3	2.98	0.49	0.14
B1	3	4.93	0.6	0.2
B2	3	4.09	0.58	0.19
Mean	3.47	4.82	0.74	0.2

3.3 Solid waste composition

The composition of the domestic solid wastes at Cai Khe ward was indicated in Table 2. As could be seen that the solid waste in the ward has a diversity of components in which organic waste accounted for the highest proportion (72.7%), plastic components accounted

for 13.4%, glass for 2.7%, hazardous waste for 1.4% and other wastes for 3.6%. If separation at source was done well, the amount of organic wastes would be separated and treated by biological methods, which could reduce the amount of wastes transported to the landfills and reuse and recycle could be strongly facilitated.

Table 2. Composition of solid wastes in the study area

No.	Component	Weight (kg/day)	(%)
1	Organics	0.480	72.7
2	Paper	0.480	7.2
3	Plastic	0.089	13.4
4	Glass	0.018	2.7
5	Batteries, light bulbs	0.009	1.4
6	Others	0.024	3.6
	Total	0.661	100

3.4 Current status of solid waste management

3.4.1. Classification

At present, Cai Khe ward has implemented the work of classifying solid waste at source. However, after conducting interviews with 30 households, it was found that households mainly classify between things that can be sold or reusable and those that cannot be sold. With toxic and difficult to decompose wastes such as batteries, blades, wrap, ... are still disposed of with daily household wastes. Due to the new solid waste classification currently applied, people have not done well, they still have the habit of not sorting waste at source. The amount of non-biodegradable and toxic wastes is still disposed of with organic wastes, so the treatment of solid waste is not yet effective, adversely affecting the quality of the surrounding environment.

3.4.2 Storage

Domestic solid waste from generated sources is stored in containers. The survey results showed that households storing garbage in plastic containers accounted for 63.33%, using plastic wrap to store household waste accounted for 36.67%. Household waste is stored in a 240 liter garbage can located on the roads. Once a day, the garbage will be collected by specialized vehicles.

3.4.3 Collection, transport and fee

In Cai Khe ward, there are 17 garbage collectors with one large and 11 small special-use vehicles for garbage collection in small alleys. The process of garbage collection in Cai Khe is in the form of both manual and motorized. In public buildings such as markets, shopping centers, large trash bins are arranged, all waste is dumped into the waste bins and the large garbage collecting truck arrives and collects the bins. For households, each household's waste is placed in a location in front of the house, a small vehicle will be used to go to each house to collect garbage. These small vehicles are gathered at transfer stations, then large vehicles come to collect and transport to landfills or disposal sites. In Cai Khe ward, garbage collection time is usually at 16:00, with a frequency of once a day. Waste collection fee is considered as a fee to offset part or all of the investment cost for waste collection, transportation and treatment in the locality. This fee is spent on activities such as the organization and operation of the waste collection, transportation and treatment unit according to the technical process of the authorized agency. The current collection fee ranges from 10,000-20,000 VND/month/household. People have not paid the waste treatment fee. This is also the reason for the lack of funds to effectively treat domestic solid wastes.

3.4.4 Solid waste treatment

Cai Khe ward does not organize the treatment of domestic solid waste. All waste, after being collected, will be gathered to the centralized waste treatment site of Can Tho city. In terms of planning, Can Tho city has a waste treatment plan as follows:

Zone 1 is the solid waste treatment area in Phuoc Thoi and Thoi An wards, O Mon district, with an area of about 47.0 ha, a treatment capacity of about 1,500 tons/day. This area processes domestic, construction, industrial and conventional solid waste, septic tank sludge and sewer sludge, medical solid waste using modern, advanced technology. Priority is given to recycling, renewable energy in accordance with technological conditions and ensuring environmental safety. This plant will treat solid waste within the area of Ninh Kieu, Binh Thuy, O Mon districts and surrounding areas. It is also treating hazardous medical solid waste for the whole city.

Zone 2 is the solid waste treatment area in Truong Xuan commune, Thoi Lai district, with an area of about 30.0 ha. The solid waste treatment capacity of this plant is about 750 tons/day and about 1,000 tons/day by 2030. This plant handles domestic and construction solid waste, sludge from septic tanks and sewage sludge; hazardous medical solid waste treatment; hazardous industrial solid waste. In addition, this area also supports the post-treatment landfill for the solid waste disposal complexes in the city. The treatment scope of this solid waste treatment facility includes Cai Rang district, Thoi Lai district, Phong Dien district and surrounding areas; at the same time, to support solid waste disposal complexes throughout the city.

Zone 3 is the solid waste treatment area in Thanh Quoi commune, Vinh Thanh district, with an area of about 15.0ha, about 40.0ha by 2030. Treatment capacity of the plant in the first phase is about 400 tons/day and about 1,000 tons/day by 2030. This plant will treat domestic and construction solid waste, sludge from septic tanks and sludge from the drainage system; conventional industrial solid waste. The scope of the plant's treatment is Thot Not district, Co Do district, Vinh Thanh district and surrounding areas.

3.5 Assessment of solid waste management in Cai Khe district

The management of domestic solid wastes in Cai Khe is relatively good, the collection rate is about 85-90%. However, the proportion of solid waste that is not collected still accounting for 10-15%, mainly on households living along canals (Cai Khe market), dumping rubbish directly into canals, and burning at home. These habits cause

unsanitary conditions and affect public health. The research results showed that about 20% of people are still dissatisfied with the waste management because the waste

collection is slow, the smell and leachate arising from the garbage gathering point polluteing the environment of the area.

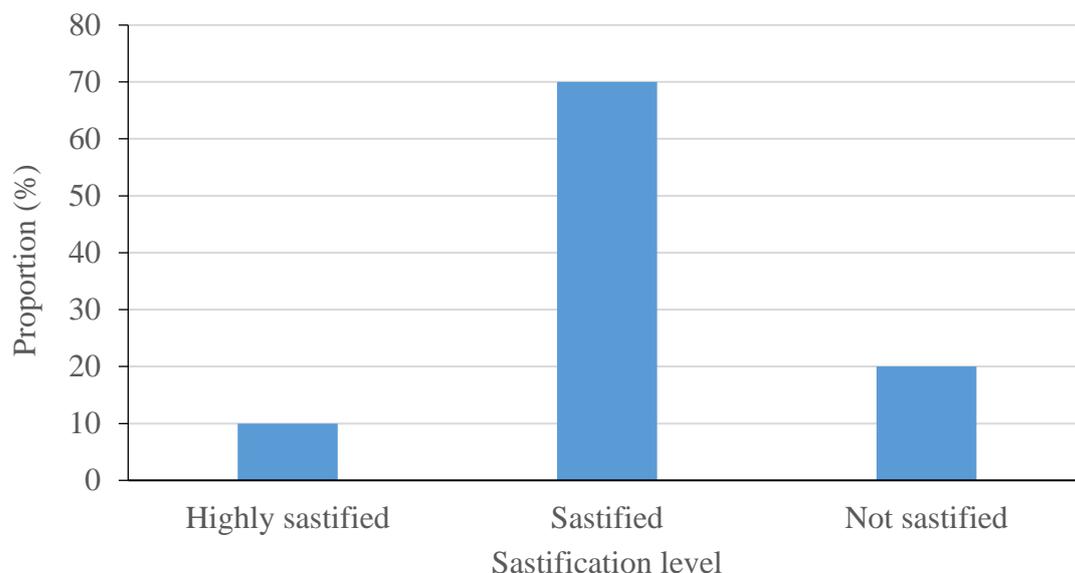


Fig.3: Sastification levels of the households regarding solid waste management in the study area

3.6 Prediction of solid waste generation in the study area

Based on the local population and annual population growth rate to calculate the current domestic waste volume and estimate the future generation volume. The average population growth rate of Cai Khe ward in

2016 was 3.19%. Based on data collected the population growth rate over the previous years (from 2010 to 2015), it is predicted that the coming period until 2025 will remain at the growth level of 3.19%. It is possible to forecast the population of Cai Khe ward until 2025 as in Table 3.

Table 3. Population of Cai Khe ward in 2025

Year	Population growth rate (%)	Predicted polulation (persons)
2016	3.19	21,931
2017	3.19	22,631
2018	3.19	33,202
2019	3.19	33,294
2020	3.19	33,387
2021	0,28	33,480
2022	0,28	33,574
2023	0,28	33,668
2024	0,28	33,762
2025	0,28	33,857

Table 4. Expected solid waste in Can Khi in 2025

Year	Population	Rate of solid waste generation (kg/person/day)	Collection proportion (%)	Predicted solid waste (tons/day)	Predicted solid waste (tons/year)
2016	33,018	0.2	90	5.943	2169.2
2017	33,110	0.2	90	5.960	2175.4
2018	33,202	0.2	90	5.976	2181.2
2019	33,294	0.2	90	5.993	2187.4
2020	33,387	0.2	90	6.001	2190.4
2021	33,480	0.2	90	6.026	2199.5
2022	33,574	0.2	90	6.043	2205.7
2023	33,668	0.2	90	6.060	2211.9
2024	33,762	0.2	90	6.077	2218.1
2025	33,857	0.2	90	6.094	2224.3

The forecast results show that the amount of domestic solid waste in Cai Khe up to 2025 is 6.094 tons/day or 2224 tons/year. It is necessary to have a strategic solution to well manage a large amount of domestic solid waste generated.

3.7 Solutions to solid waste management

3.7.1 Law and policy

Master plan for solid waste collection and treatment has oriented investment in solid waste collection, transportation and treatment. Socio-economic development planning must be integrated with environmental protection contents. There should be a close coordination between all levels of sectors from cities, districts, wards, state agencies in the environment in the management of waste collection, transportation and treatment. There is a need to have a long-term plan for solid waste collection, transportation and treatment, defining specific goals and targets to be achieved in waste management and the tasks and solutions to be performed. Solid waste recycling has reduced a large amount of waste to be disposed of. Most of the recyclable waste is persistent or non-biodegradable such as nylon, glass bottles, materials PP, PE, ... Recycling and reuse activities are prioritized by the state when encouraging investment. However, recycling facilities need to be well managed because in fact they are all outdated and also one of the polluting facilities. Encouraging development also means close supervision. It is important to consider solving domestic waste issues a priority issue. The amount of waste is increasing in quantity as well as types, so it is necessary to improve the capacity of the management agencies. Develop a plan and establish a fund for a waste

separation program at source. Develop regulations on solid waste management in general and domestic solid waste in particular. Encourage participation of private companies in the field of environmental protection. The general direction is to combine state-owned enterprises with other private economic sectors to participate in solid waste management in general and domestic solid waste in particular. Joint venture with foreign direct investment, 100% foreign owned enterprise, in charge of solid waste treatment with high technology and large investment capital, modern and centralized recovery and recycling technologies.

3.7.2 Reduction at sources

Generation reduction is not only about reducing the amount of waste, but also about reducing the concentration and toxicity of the waste at the source. Reducing solid waste generation in industry includes reducing generation in the manufacturing process, producing products that generate less wastes, products that easily decompose when discarded, products with little or no hazardous waste, etc. Even changing daily consumption habits towards environmentally friendly products, products with less packaging, less active ingredients is also an effective solution to reduce solid waste generation. In addition, the waste reduction of a production process is also implemented by many different solutions, in which assessment of cleaner production is also a positive and effective solution in recent years. The application of cleaner production programs in factories and manufacturing enterprises increases the economic efficiency of their production processes by reducing

pollution at the source. In addition, other strategic solutions such as the imposition of disposal fees, waste treatment taxes for electronic waste, refrigeration, ... have been successfully applied in many developed countries but are not suitable for Vietnamese conditions where waste management and treatment solutions are only in improving process.

3.7.2 Reuse and recycle

Reuse and recycle are terms synonymous with reducing waste. Reuse is the reuse of products or materials without significant modification, which only need to be cleaned or repaired before reuse. Recycling is different from reuse in that it requires certain modification of the composition, physical, chemical, or biological properties of the waste to become a usable product. For industrial wastes, after being sorted at source, collected and transported to the solid waste treatment complex for treatment. In the treatment area, useful materials for recycling are classified, the hazardous wastes are treated according to solidification and stabilization technology, and burning. Strategic solutions to promote industrial reuse and recycling can take the form of an industrial waste exchange program. In this program, waste from one manufacturing industry but as raw material for another, can be communicated and exchanged for efficient and optimal use of resources before disposal.

3.7.3 Solid waste processing

It is the physical, chemical and biological transformation process of generated solid waste, improving the efficiency of the management system of recycled and reusing solid waste, using recycled products (compost) and recovering energy in the form of heat and biogas. The process of converting waste into an original product or a product that serves human life. This is the stage after classification has been done. Recyclable and reusable wastes are used as input to new product (recycled products) processes.

bags. The rate of garbage collection was about 90%. The odor and leachate were not well managed, causing pollution to the urban environment. The cause of this problem is probably the collection work is not effective and the awareness of household is still inappropriate. The effective management of domestic solid waste in Cai Khe requires the attention of the local authorities, the participation of the people. Therefore, community consensus is an important issue that needs to be addressed.

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IV. CONCLUSIONS

The findings showed that the rate of solid waste generation per household was 0.74 kg/household/day and for each individual was 0.2 kg/person/day. Domestic solid waste in the study area has various composition, of which organic wastes accounted for the highest proportion (72.7%), plastic components accounted for 13.4%, glass accounted for 2.7%, hazardous waste occupied 1.4% and other components took up 3.6%. The separation of waste at source has not been implemented. Tools to store domestic waste in households are mainly plastic bins and plastic