

Assessment of the Current State of Domestic Solid Waste Management in Vinh Loc Town, Vinh Loc District, Thanh Hoa Province, Vietnam

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ABSTRACT: This study focuses on assessing the current state of domestic solid waste management (DSWM) in Vinh Loc Town, Vinh Loc District, Thanh Hoa Province, amidst rapid urbanization and socio-economic development. Using sociological survey methods with 3,031 households and 350 businesses, combined with secondary data analysis, the study reveals that the locality faces significant challenges in DSWM, particularly in waste segregation at the source. With an annual DSW generation of 2,693.51 tons and a collection rate of 2,680.05 tons/year, only 66.7% of households practice waste segregation at source despite the high collection rate. The study analyzes factors affecting the efficiency of waste segregation. It proposes suitable solutions to enhance DSWM effectiveness locally, contributing a scientific basis for policy planning and implementing effective DSWM solutions.

KEYWORDS: Domestic Solid Waste; Waste Segregation at Source; Environmental Management; Urbanization; Waste Collection

1. INTRODUCTION

Currently, alongside socio-economic development and accelerating urbanization, environmental pollution caused by domestic solid waste (DSW) is a significant challenge for localities nationwide. According to statistics from the Ministry of Natural Resources and Environment, the total DSW in Vietnam's urban areas in 2023 was over 13 million tons/year, accounting for about 55% of the total DSW generated nationwide. Notably, the composition of non-biodegradable waste, such as single-use plastics, is rapidly increasing, posing difficulties for DSW treatment activities [2]. Recent studies on DSWM in various localities highlight significant challenges. Nguyen T.T.T et al. (2023) indicated that in Phu Tho ward, Thu Dau Mot city. However, the DSW collection rate reached 92%, and waste segregation at source remains limited due to inadequate infrastructure and low public awareness [3]. Similarly, research by Nguyen V.P et al. (2022) in the Cau Giay district showed low efficiency of the source segregation model, with only about 45% of households following the correct procedure [4].

In Long Bien ward, Hanoi, Pham T.T et al. (2023) found that 58% of households rated waste management as poor, and 35% rated it as average. The main reasons identified were the lack of a specialized segregated collection system and the absence of incentive mechanisms for residents to participate in source segregation [5]. However, some successful DSWM models have been implemented in certain localities. For instance, Le V.H. et al. (2022) study on the DSW source segregation model in Yen Dinh district, Thanh Hoa, achieved positive results through technology application and community participation [1]. Tran T.V.A et al. (2021) also proposed comprehensive solutions for DSW segregation and collection in urban areas, needing synchronous implementation from policy to practice [6].

Implementing Decision No. 13/2022/QĐ-UBND of the Thanh Hoa Provincial People's Committee detailing the management of DSW for households and individuals, Vinh Loc district has deployed various solutions to improve DSWM efficiency. However, according to the Vinh Loc District People's Committee report, waste segregation at source has not achieved the desired effectiveness, with only 66.7% of households participating (equivalent to 16,545/24,792 households district-wide) [10].

As the administrative center of the district, Vinh Loc Town has a high population density (1,760 people/km²) and large domestic wastewater volume (6,206 m³/day) and faces numerous challenges in environmental management generally and waste segregation at source specifically. According to the 2024 environmental report by the Vinh Loc District People's Committee, DSW generation reaches 2,693.51 tons/year in the town area alone, with a collection rate of 2,680.05 tons/year. Despite the high collection rate, DSW treatment still has shortcomings, especially in source segregation [7]. Researching the current situation and proposing suitable solutions for source segregation in the town is crucial.

Based on these reasons, "Assessment of the current state of implementing domestic solid waste segregation at source in Vinh Loc town, Vinh Loc district, Thanh Hoa province, Vietnam" is conducted to: (1) Assess the current state of solid waste management in the town; (2) Assess the current state of domestic solid waste segregation at source and analyze factors affecting its efficiency; (3)

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Propose solutions to enhance the efficiency of domestic solid waste segregation at source suitable for the local conditions. The research results will contribute scientific and practical bases for policy planning and implementing effective DSWM solutions in Vinh Loc town specifically and Vinh Loc district generally.

2. RESEARCH METHODS

Method of Document Analysis and Synthesis: To conduct this study, the authors collected secondary documents from Vinh Loc District People's Committee, National Environmental Status Report 2023 – Rural Environment, status and solutions, and scientific documents on waste and waste segregation and treatment. The documents focus on some demographic and social characteristics of Vinh Loc Town, Vinh Loc District, Thanh Hoa Province: the amount of domestic waste and its impacts, and domestic waste segregation at source. These documents were analyzed and synthesized to build the research overview and ensure the most accurate results.

Sociological Survey Method: The sociological survey method primarily used was interviews, applied to all 3,031 households in the town and 350/378 businesses in Vinh Loc Town. The authors used an open-ended questionnaire focusing on waste segregation at source, with the following contents:

- + Residents know how to segregate domestic waste.
- + Residents know the corresponding colours of waste containers.
- + Residents know the collection days and times.
- + Residents know the penalty level for households disposing of waste improperly.
- + Residents use the provided waste containers.
- + Residents practice domestic waste segregation at the source, and the number of households segregate correctly.

Additionally, the authors surveyed the difficulties and recommendations of residents regarding domestic waste segregation at source in Vinh Loc Town.

Data Processing Method: The authors used this method to synthesize survey results to assess the current implementation status and community awareness regarding domestic waste segregation at source. The chosen support tool was Excel software.

3. RESEARCH RESULTS

3.1. Situation of Domestic Waste Collection and Treatment at Source in Vinh Loc Town, Vinh Loc District

The Vinh Loc District People's Committee has included the target of collecting and treating domestic solid waste in implementing Plan No. 75/KH-UBND dated March 30, 2023, regarding the implementation of Decision No. 13/2022/QĐ-UBND dated March 2, 2022, of the Provincial People's Committee promulgating detailed regulations on domestic solid waste management for households and individuals in Thanh Hoa province; Guidance Document No. 870/UBND-TNMT dated April 5, 2023, guiding the implementation of waste segregation at source, measures for collection and treatment of domestic waste in the area; and Document No. 3833/UBND-TNMT dated November 27, 2023, on implementing Document No. 17655/UBND-NN dated November 21, 2023, of the Thanh Hoa Provincial People's Committee on implementing waste segregation at source.

- Regarding the collection and transportation of domestic solid waste, 100% of communes and towns in Vinh Loc District have contracts with Phat Vinh Loc Urban Environmental Services Co., Ltd. for collection and transportation to the centralized treatment facility in Vinh Hoa commune for processing.

- Regarding the treatment of domestic waste: 13/13 communes and towns have developed plans for collection and treatment and signed contracts for solid waste treatment with Bimivina Production and Trading Joint Stock Company for incineration technology treatment. The estimated volume by October 15, 2024, is about 9,902.52 tons.

- Currently, 13/13 communes and towns in the district have implemented waste segregation at source according to Plan No. 75/KH-UBND dated March 30, 2023, implementing Decision No. 13/2022/QĐ-UBND dated March 2, 2022, of the Provincial People's Committee. According to the registration appendix for 2024 and the implementation results of the communes and towns, 111 villages and neighbourhoods have registered to implement waste segregation at source, with 16,545/24,792 households participating, achieving 66.7%.

Results of implementing the target for collection and treatment of domestic solid waste from January 1, 2024, to December 31, 2024, according to the targets allocated in Decision No. 5050/QĐ-UBND dated December 28, 2023, of the Provincial People's Committee. The Vinh Loc District People's Committee ensures the allocated targets are met, specific data are as follows:

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Table 1. Targets and results of solid waste collection and treatment in the first 10 months of 2024.

Target solid waste collected, treated in 2024 (%)	Breakdown		Results solid waste collected, treated from 01/01/2024 to 15/10/2024	Breakdown					
	Incineration rate (%)	Landfill rate (%)		Generated volume (Tons)	Collected, treated volume (Tons)	Collection, treatment rate (%)	Breakdown		
							Incineration rate (%)	Landfill rate (%)	Recycling rate (%)
98.5	82	9		12.162,7	11,992.5	98.6	82.2	8	8.3

Table 1 shows that the target set for the Vinh Loc District government at the beginning of 2024 was to collect and treat 98.5% of the total solid waste, with 82% treated by incineration and 9% by landfill. According to the Report on the results of implementing the target for collection and treatment of domestic solid waste from January 1, 2024, to October 15, 2024, per Decision No. 5050/QĐ-UBND dated December 28, 2023, of the Provincial People's Committee, Vinh Loc District generated 12,162.7 tons of solid waste, of which 11,992.5 tons were collected and treated, achieving 98.6%. Collected domestic solid waste was treated by incineration and landfill methods, with 82.2% treated by incineration at the Quang Bieu Domestic Solid Waste Treatment Facility in Vinh Hoa commune, operated by BIMIVINA Joint Stock Company; 8% treated by landfill at the landfill site... and 8.3% recycled. According to the Environmental Report of Vinh Loc Town People's Committee dated January 9, 2025 (table 2), the situation of domestic solid waste collection and treatment in Vinh Loc District and Vinh Loc Town in 2024. The entire district generated 16,504.701 tons of domestic solid waste, with collection and treatment reaching 98.7%. Vinh Loc Town generated 2,693.51 tons, accounting for 16.3% of the entire amount of DSW in the district, with a collection rate of 99.5%.

Table 2. Results of DSW collection, transportation, and treatment in Vinh Loc District and Vinh Loc Town in 2024

No	Waste type	Generated Volume (Tons/year)	Collected, Transported Volume (Tons/year)	Treated Volume (Tons/year)
Entire Vinh Loc District				
1	Domestic Solid Waste	16,504.701	16,290.14	16,290.14
Vinh Loc Town				
2	Domestic Solid Waste	2,693.51	2,680.05	2,680.05

3.2. Situation of Implementing Domestic Waste Segregation at Source in Vinh Loc Town, Vinh Loc District

According to Decision 13/2022 of the Thanh Hoa Provincial People's Committee issued on March 2, 2022, effective from March 15, 2022, a comprehensive legal framework for domestic solid waste (DSW) management in the province was established. This document demonstrates a systematic approach to DSW management, classifying waste into three main groups: ordinary DSW, hazardous DSW, and bulky DSW. Ordinary DSW is further divided into subgroups, including recyclable waste (such as paper, plastic, metal, and nylon bags), which households segregate and store separately. Food waste (leftover food, tea leaves, coffee grounds) is segregated by households and individuals into separate green bags ensuring no odor or leachate escapes into the environment. For combustible waste (leaves, branches, pictures, wood) and inert waste (glass, ceramics), specific methods for storage and disposal are defined. Commune/town People's Committees arrange equipment in residential areas/points for storage, ensuring they are not punctured or torn, printing the words "Inert Waste" for residents to segregate and dispose of inert waste. For hazardous waste, including Batteries, accumulators, broken fluorescent lamps, and broken/damaged thermometers, Commune People's Committees arrange one black container with a lid per neighbourhood/residential point, printed with the letters CTNH (Hazardous Waste) for residents to segregate and dispose of.

Bulky DSW includes large-sized solid waste such as cabinets, beds, mattresses, tables, sofas, pictures, tree roots, trunks, and large branches. Waste generators must make their own arrangements with DSW collection and transportation units to collect and transport bulky solid waste to receiving and treatment sites. While waiting for the collection and transportation unit, waste generators are responsible for storing and preserving it, not placing it on sidewalks, roads, or public areas.

Operationally, the decision established a hierarchical collection system with collection frequency adjusted according to population density and the characteristics of each type of waste. Specifically, for densely populated areas and industrial zones, food waste collection is regulated at a minimum frequency of once a day, while in sparsely populated areas, the minimum frequency is once every two days. For waste with energy recovery potential, the collection frequency is regulated at a minimum of once every five days or longer, depending on local conditions and the volume of waste generated. This regulation reflects consideration of each type

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of waste's biodegradability and environmental risks. Domestic solid waste collection and treatment rate must reach 90% of the total domestic waste generated locally.

Regarding treatment methods, local authorities emphasize the principle of decentralization and resource optimization. For ordinary DSW, households should apply on-site treatment solutions such as composting organic waste, especially households with extensive gardens and centralized treatment systems for urban areas. For combustible waste, in remote areas with large land areas, utilization as cooking fuel is encouraged, while remaining areas are treated centrally by incineration, prioritizing energy recovery. Particularly for hazardous DSW such as batteries, accumulators, broken fluorescent lamps, and broken thermometers, the Provincial People's Committee requires a specialized treatment process through authorized units, reflecting the concern for environmental and public health risks.

Financially, local authorities propose a diversified model for DSW management, combining public funds (provincial, district, and communal budgets) with social contributions, ODA capital, and other legal funding from initiatives like programs, projects, and sponsorships, reflecting a broad resource mobilization strategy. Furthermore, the regulations specify stakeholder responsibilities, identifying households as key to the system's sustainability through their roles in source segregation and fee payment.

To assess the implementation of domestic waste segregation at source in Vinh Loc Town, the author considers the criteria: Number of households knowing how to segregate domestic waste, number of households knowing the corresponding colours of waste containers, number of households knowing the collection days, times, and penalty levels for improper waste disposal, number of households practicing domestic waste segregation at source, and the number of households segregating correctly.

Survey results on the implementation of waste segregation at source in Vinh Loc Town are as follows:

- 2030/3031 households were informed and know how to segregate domestic waste at source according to Decision No. 13/2022/QĐ-UBND, reaching a rate of 66.9% of households. Among those who know how to segregate, 1605/3031 households know the corresponding bag colours for each type of waste (combustible, non-combustible, recyclable), accounting for 80%. 165/350 businesses know how to segregate domestic waste at source according to Decision No. 13/2022/QĐ-UBND, reaching a rate of 47.1%.

- 2051/3031 households practice domestic waste segregation at source, reaching a rate of 67.7%. Among them, 1303/3031 households segregate correctly, accounting for 43%. The local government does not provide waste containers; residents proactively use their own packaging for waste segregation. Therefore, most households put biodegradable domestic waste into plastic bags. The survey found that among the 2021 households practicing segregation, 85% reuse plastic bags from shopping to contain biodegradable waste, then collect them into woven sacks (often feed sacks) to take to the village/hamlet waste collection point. Among the 350 surveyed businesses, 196 practice domestic waste segregation at source, reaching a rate of 56%. Among them, 117/350 businesses segregate correctly, accounting for 33.4%. Among these, 19.1% of businesses self-equip with commercially environmentally friendly waste segregation bags, corresponding to each type of waste (combustible, non-combustible, recyclable). The remaining 14.3% of businesses still use non-biodegradable plastic bags.

- The survey reveals a very positive reality in waste collection and treatment in Vinh Loc town. The locality has a public address system in villages and hamlets to disseminate the Communist Party's and local government's policies. As a result, 100% of interviewed households and businesses know the collection days and times for each type of domestic waste at source. 100% of households and businesses know the administrative penalties for individuals dumping waste improperly according to Plan No. 75/KH-UBND of Vinh Loc District.



Figure 1. Summary of the implementation of waste separation at sources in Vinh Loc town, Vinh Loc district, Thanh Hoa province.

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Thus, the survey results of 3031 households in Vinh Loc town show the picture of implementing DSW segregation at source in Figure 1 as follows:

- 100% of households and businesses are aware of the need to collect and treat DSW thanks to the propaganda and education efforts of local authorities at all levels, especially communication through the public address system down to the villages and hamlets. However, a significant gap between awareness and actual practice leads to uneven implementation. The rate of implementing domestic waste segregation at source only reaches 67.7% for households and 56% for businesses.

Many households do not practice DSW segregation at source due to several reasons:

- + Firstly, members within each household have an uneven awareness of DSW segregation at the source. Many multi-generational households have members aged >60 who are often conservative and do not follow the segregation process, leading to the unsustainable effectiveness of waste segregation.
- + The implementation of waste segregation at source is still formalistic, not yet substantial, and lacks sustainable habit formation. Some households are hesitant, considering waste segregation time-consuming and troublesome. Lack of funding for implementing and maintaining propaganda activities, mobilizing people to practice waste segregation.
- + During the implementation of domestic waste segregation, residents encounter some difficulties, such as not remembering all segregation methods, some households newly moved in were not previously informed; workers do not collect certain types (like bulky items: broken beds, cabinets, tables, chairs, mattresses); insufficient bags, residents do not know where to buy biodegradable bags; difficulty segregating due to small living space, non-combustible waste smelling if stored for too long
- + Some non-combustible waste components can cause odours (seashells, snail shells), so residents dispose of them together with daily combustible waste;
- + Waste collection times are unsuitable for some households, especially those with special working hours (shift work, trading);
- + Some households do not habitually accumulate waste indoors, often putting waste out on the roadside or near their houses before collection time, leading to improper disposal times. Although the locality has administrative fines for improper waste disposal, inspection and supervision are infrequent, and synchronous coordination among departments is lacking, thus failing to implement deterrent administrative penalties for residents.
- + One of the significant current difficulties is the limited funding for investment in source segregation. The cost of purchasing household waste segregation equipment is relatively high, so many households do not buy equipment like containers in green–orange–red colours. Not being provided with segregation tools inconveniences residents. Therefore, reusing non-biodegradable plastic bags to contain segregated waste does not thoroughly solve the problem of DSW pollution treatment locally.

3.3. Proposing Some Orientations to Enhance the Efficiency of Domestic Waste Collection, Treatment, and Segregation at Source in Vinh Loc Town, Vinh Loc District

Vinh Loc Town has performed exceptionally well in collecting domestic waste at source. Preparations for implementing domestic waste segregation are coordinated by the District People's Committee and the Town People's Committee. However, waste segregation at source still faces many shortcomings during implementation. In coordination with the Vinh Loc Town People's Committee, the research team proposes some solutions to enhance domestic waste segregation at source as follows:

Solutions on mechanisms and policies: In the current context, perfecting the system of management documents plays a key role in domestic solid waste (DSW) management. Priority should be given to issuing inter-sectoral coordination regulations, clearly defining the coordination mechanism between departments and functional units in DSW management. Concurrently, develop a document system detailing each relevant party's responsibilities in implementing waste segregation at source [2].

Regarding financial mechanisms, investment capital sources can be diversified by mobilizing from the state budget combined with socialization sources. Develop a mechanism for collecting fees for DSW collection, transportation, and treatment services, ensuring the "polluter pays" principle while having support policies for poor and near-poor households [10].

Solutions on techniques and technology: To enhance the efficiency of DSW management, focus on upgrading infrastructure towards synchronization and modernization. Investment in specialized collection and transportation systems should be implemented according to planning, ensuring suitability with local practical conditions. Waste collection points need to be built according to standards, ensuring environmental hygiene requirements [8].

In the Industry 4.0 revolution, applying information technology in managing and monitoring the waste collection process is an inevitable trend. Research and apply advanced waste treatment technologies suitable for local conditions. Building a DSW management database system will enhance management efficiency [2].

Solutions on organization and implementation: Enhancing management capacity is an important task that needs priority implementation. Training and capacity building for management staff need to be conducted regularly and systematically. Develop a strict and scientific inspection and supervision process. In particular, establishing community environmental monitoring groups will increase public participation in environmental protection [2].

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Simultaneously, propaganda work needs to be strengthened by organizing campaigns on waste segregation at source. Building pilot models and launching emulation movements among residential areas will motivate people to participate actively [9].

Solutions for community participation: Mobilizing community participation plays a decisive role in the success of DSW management. Strengthen the role of mass organizations and promote the role of reputable individuals in the community. Building environmental volunteer groups will contribute to creating a spillover effect in the community [8].

Enhance community awareness through practical waste segregation activities and mass media propaganda. Integrating environmental protection content into community activities will help people approach the issue naturally and effectively [2].

In the 2024-2025 period, focus on completing basic infrastructure, piloting in key areas, and training core staff [CITE_BaoCaoMT2024]. Subsequently, the 2025-2030 period will focus on expanding the implementation scope across the entire area, perfecting the management and evaluation system, and replicating effective models [7].

Residents of Vinh Loc town are very interested in domestic waste segregation at source and have many suggestions to improve its efficiency, such as:

- Requesting the government to provide standard plastic segregation bags or recommend places to buy them, providing large-sized bags for businesses, additional paper containers, and bins and plastic bags for waste (for newly moved-in households).
- Having specialized waste trucks and not mixing different types of waste during collection.
- Each street should have large segregation bins at the entrance; waste collectors should have plans to collect types currently not collected (bulky items: broken beds, cabinets, tables, chairs, mattresses).
- Increase the collection frequency for non-combustible and recyclable waste in densely populated areas.

4. CONCLUSION

This study conducted a comprehensive assessment of the current state of domestic solid waste (DSW) management, particularly focusing on source segregation, in Vinh Loc town, Vinh Loc district, Thanh Hoa province. The results show that although the locality has achieved significant accomplishments in DSW collection with a very high rate (99.5% in the town) and effective propaganda on general regulations, collection schedules, and penalties (100% of surveyed subjects are aware), the implementation of waste segregation at source remains a significant challenge.

Analysis of survey data from 3031 households and 350 businesses reveals a significant gap between awareness and actual behaviour. The rates of households and businesses practicing waste segregation at source are 67.7% and 56%, respectively. However, the rate of correct segregation is significantly lower (43% and 33.4%, respectively). It indicates that compliance with the segregation process according to Decision 13/2022/QĐ-UBND is limited and not yet substantial. The lack of specialized waste containers and the common habit (85% of households) of using non-biodegradable plastic bags to contain segregated waste further increase the unsustainability of this activity.

The study also identifies key factors hindering the efficiency of source segregation, including habits not yet sustainably formed, psychological reluctance due to perceived complexity and time consumption, uneven awareness among generations within families, lack of funding for equipment investment and sustained propaganda activities, inadequate infrastructure (lack of suitable containers, collection points), inflexible collection times, and importantly, infrequent and irresolute inspection, supervision, and enforcement of penalties.

Based on these findings, the study proposes a series of synchronous and feasible solutions, focusing on four main groups: (1) Perfecting policy and financial mechanisms, ensuring inter-sectoral coordination and the "polluter pays" principle; (2) Improving technical infrastructure and applying technology in collection, transportation, and treatment; (3) Enhancing organizational implementation capacity, strengthening inspection, supervision, and building strict procedures; (4) Strongly promoting community participation through diverse propaganda, building pilot models, and promoting the role of mass organizations and volunteers.

The results and recommendations from this study provide important scientific and practical bases, supporting the local government of Vinh Loc town specifically and Vinh Loc district generally in policy planning and implementing more effective intervention measures, aiming to gradually improve and enhance the quality of DSW source segregation, contributing to the goal of sustainable environmental management in the area.

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