PRINT ISSN 1119-8362
Electronic ISSN 2659-1502

Full-text Available Online at
https://www.ajol.info/index.php/jasem
http://www.bioline.org.br/ja

J. Appl. Sci. Environ. Manage.
Vol. 27 (3) 433-442 March 2023

Current Situation of Municipal Solid Waste Generation in Ca Mau City, Vietnam

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ABSTRACT: The study was implemented to assess the current generation, collection and management status of municipal solid waste in 8 Ward and Ly Van Lam Commune, Ca Mau city. The household survey method was applied by randomly interviewing 60 households, 10 collectors and 2 managers in August 2022. The results recorded that the average MSW generation rate in the study area was 0.60 kg/person/day. The total amount incurred in Ly Van Lam Commune was 70.70 kg/day, lower than 8 Ward (83 kg/day). The MSW in the study area was mainly biodegradable organic and recyclable waste, accounting for 69.22% and 24.44% of the total waste. Meanwhile, others and hazardous waste accounted for a low proportion. The classification of MSW at source had not been carried out synchronously in the study area, the collection rate was only 68.33% and it was treated at the garbage treatment plant in Ca Mau city. In areas where garbage had not been collected, people treated MSW by burning, burying, or disposing of it into the environment. Most people in the study area had quite good awareness of MSW, but there was still limited awareness in some households about the impacts of MSW. Therefore, it was necessary to strictly handle violations that cause environmental pollution, improve traffic routes and guide people to separate waste at source to raise people's responsibility in solid waste management.

DOI: **https://dx.doi.org/10.4314/jasem.v27i3.5**

Cite this paper as: GIAO, NT; ANH, NH; NHI, PTH (2023). Current Situation of Municipal Solid Waste Generation in Ca Mau City, Vietnam. *J. Appl. Sci. Environ. Manage.* 27 (3) 433-442

Dates: Received: 01 January 2023; Revised: 28 January 2023; Accepted: 08 March 2023
Published: 31 March 2023

Keywords: management; municipal solid waste; waste component; waste minimization

The process of industrialization and modernization is taking place strongly in Vietnam. The increasing demand for production and consumption leads to increased emissions in the production and consumption process, leading to pollution. Environmental pollution is gradually becoming difficult to control. The increase in the volume of municipal solid waste (MSW) and hazardous components in MSW is one of the important causes of environmental pollution (Vien and Huyen, 2018). The amount of MSW generated nationwide in 2019 was 64,658 tons/day, up to 46% compared to 2010, while the current MSW collection rate is only 60-80%, the other is released freely into the environment (Phuong et al., 2021; MONRE, 2020). The composition of MSW is very diverse; organic components usually account for the highest proportion in MSW, followed by inorganic components and other components such as non-biodegradable waste, e-waste, and hazardous waste (HW) (Vien et al., 2022). MSW is also the main cause of disrupting the ecological balance, polluting water, soil and air sources, causing diseases to plants and animals, loss of beauty and potential risks to public health (Khang, 2020). Therefore, MSW management is one of the challenges facing local governments. Ca Mau is now a grade-II city and the capital of Ca Mau province in the Mekong Delta. The natural area of the city is about 249.63 km^2 and the population in 2019 was 226,358 people (DONRE, 2020). In recent years, the economic growth of Ca Mau city has changed positively and shifted towards gradually increasing service and industrial activities and gradually decreasing agricultural production activities. Economic growth and increasing population lead to a significant increase in waste in the daily life of local people. The increasing amount of MSW

increases the cost of treating polluted waste. In Ca Mau, there is only one waste treatment plant that is always overloaded (DONRE, 2020). For effective MSW management, the most important thing is to have access to accurate data on the generation and composition of MSW (Suma et al., 2019). In addition, the community's participation and awareness are also the important factors for the success of the MSW management program (Thien, 2021). On that basis, this study was carried out to make statistics on the current generation situation, assess the collection activities, the management of MSW in Ca Mau city.

MATERIALS AND METHODS

Study Area: Ca Mau city consists of 17 communes and wards (10 wards and 7 communes): 1 Ward, 2 Ward, 4 Ward, 5 Ward, 6 Ward, 7 Ward, 8 Ward, 9 Ward, Tan Xuyen Ward, Tan Thanh Ward, An Xuyen Commune, Tan Thanh Commune, Tac Van Commune, Ly Van Lam Commune, Dinh Binh Commune, Hoa Thanh Commune and Hoa Tan Commune. Ca Mau city has low-lying terrain easily flooded by high tides and heavy rains. In addition, the terrain of Ca Mau city has many divided canals, and some households living near the canals habitually discharge MSW into the canals. This has caused difficulties in collecting MSW, significantly affecting the environment, causing stench and causing disease. Most of the waste in the area has yet to be classified, all collected in the landfill from easily degradable organic waste to non-biodegradable inorganic waste. However, the collection and construction of landfills and waste treatment in Ca Mau city are relatively secure (DONRE, 2020).

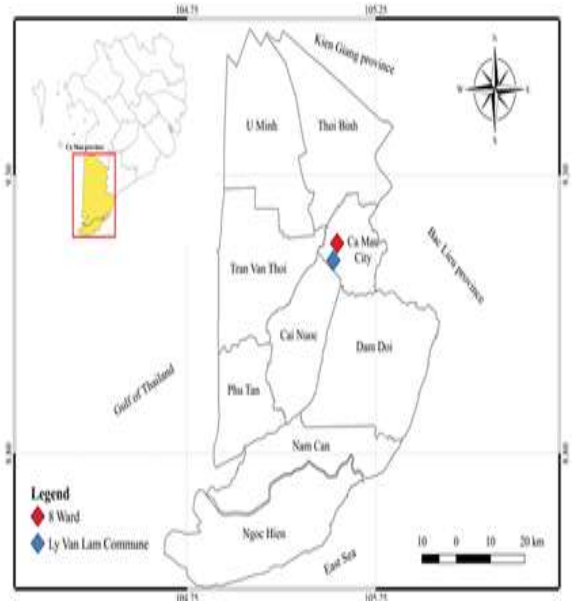

Fig 1. Map of survey location

Data collection: The study conducted a survey and interview in 8 Ward and Ly Van Lam Commune of Ca Mau city in August 2022. 8 Ward is an urban area and is the center of Ca Mau city, so it has a high population density and a lot of production and business activities. Meanwhile, Ly Van Lam Commune is a rural area with low population density, mainly focusing on aquaculture and agricultural production activities. Secondary data and information are collected and inherited from articles related to domestic and foreign MSW and legal documents regulating MSW. Randomly interviewed three survey subjects, including households (30 questionnaires/area), waste collectors (5 questionnaires/area) and managers of the City Department of Natural Resources and Environment (2 questionnaires) and a total of 72 questionnaires. The interview form consists of two parts: part 1 asks about general information (name, age, occupation, address, income) and part 2 is information about MSW (segregation at source, containers, collection).

Quantification and classification of MSW component: Sampling was carried out in 10 households, each area representing 5 random households. Each household is provided with 1 plastic bag to contain all the waste generated during the day. MSW samples were collected at 5:00 p.m every day for 7 consecutive days. After each sample collection, a plastic bag will be provided for the next day. After collecting the sample, the MSW is poured onto the canvas and classified, calculating the weight percentage of each component. Classification is carried out according to the guidance of the Law on Environmental Protection 2020 and based on pilot models for classification of MSW being piloted in a number of localities across the country, with adjustments to suit local conditions. The proposed classification model of MSW at source for Ca Mau city is as follows: organic group, recyclable group, hazardous group and others (Figure 2).

Fig 2. Classification model

Data processing: The data on the current status of use, disposal, classification and management of MSW are treated with Microsoft Excel 2019 software to make descriptive statistics and graphs. In addition, the study determined and calculated the generation coefficient, composition and volume of MSW according to the formulas (1), (2) and (3).

$$\text{GR (kg/person/day)} = \frac{\text{Weight of MSW}}{\text{Number of household}} \quad (1)$$

$$\text{MSW (\%)} = \frac{\text{Weight of MSW each type}}{\text{Total weight}} \text{ x } 100 \quad (2)$$

Weight of MSW (kg/day) = GR x population in the year (person) (3)

Where R = generation rate

RESULTS AND DISCUSSION

Demographic characteristics in Ca Mau city: The survey shows that of 60 interviewed, 46.67% have upper secondary education, accounting for the highest percentage (Table 1). The people with lower secondary and primary school qualifications accounted for the same proportion, with 26.67%. The majority of people with primary school education are the elderly, while those with lower secondary education are usually farmers in the study area. In terms of age, the majority of interviewees were between 31 and 45 years old (36.67%). Next, the age groups from 46 to 60 years old and over 60 years old had the rate of 30.00% and 18.33%, respectively, and the age group from 18 to 30 accounted for the lowest rate (15.00%). In addition, the group of business persons has the highest proportion, accounting for 48.33% and most of them are family business households in the study area. Next is the housewife group (18.33%); farmer group (13.33%); group of workers (10%); civil servants (6.67%) and the lowest group is the self-employed, accounting for 3.33%.

Table 1. Demographic characteristics in the study area

	Characteristics	Frequency	Percent
Educational Background	Primary School	16	26.67%
	Secondary School	28	46.67%
	High School	16	26.67%
Age	18 – 30 years old	9	15.00%
	31 – 45 years old	22	36.67%
	46 – 60 years old	18	30.00%
	> 60 years old	11	18.33%
Career	Staff	4	6.67%
	Business	29	48.33%
	Farmer	8	13.33%
	Worker	6	10.00%
	Housewife	11	18.33%
	Free jobs	2	3.33%

Information on surveyed households on the current situation of MSW generation in Ly Van Lam Commune (5 households) and 8 Ward (5 households) in Ca Mau city is presented in Table 2. According to Decree No. 07/2021/ND-CP has defined the multi-dimensional poverty line for 2021 - 2025 into 4 levels, including poor, average, comfortable and rich. The survey results show that the total number of households representing the poor, average, comfortable and rich are 2 households, 3 households, 3 households and 2 households, respectively. Meanwhile, the average number of people in the study area ranges from 2.50 to 4.33 people/household. Previous studies showed that the average number of people in households was 4.3 people/household (Murakoshi et al., 2017; Tien & Pitts, 2019). Most of the average number of people in households in the study area is 3.7, higher than the national census statistics (Vietnam General Statistics Office, 2015).

Table 2. Characteristics of households collecting samples

Classification	Number of households	Average number of people per household
Poor	2	2.50
Average	3	4.00
Comfortable	3	4.33
Rich	2	4.00

Current status of generation and composition of MSW in Ca Mau city

Current status of MSW generation in Ca Mau city: The results of estimating the weight of MSW generated by interviewing 10 households in the study area are presented in Table 3. The results show that the average amount of MSW generated per household in the study area fluctuates from 2.00 to 2.40 kg.

The average amount of MSW in 8 Ward and Ly Van Lam Commune are 0.7 and 0.4 kg/person/day, respectively. In addition, it can be seen that the number of people in 8 Ward (3.20 people) is smaller than in Ly Van Lam Commune (4.40 people) but the total weight of MSW generated (83.00 kg) is higher than in Ly Van Lam Commune (70.70 kg).

The difference in the amount of waste between regions may be due to each family's economic conditions and occupations (Tiu et al., 2020). In addition, because Ly Van Lam Commune has agricultural production activities, a part of MSW such as leftovers and spoiled food is reused.

The average weight of MSW generated in Rach Gia city, Kien Giang province (2.69 kg/household/day) and in Vinh Chau town, Soc Trang province (2.29 kg/household/day) was higher than that in the study area (Ngan, 2021; Phuc, 2021).

Table 3. Weight of generation waste in households

District	Number of households	Total weight (kg)	Average weight (kg/household/day)	Weight per capita (kg/person/day)
8 Ward	3.20	83.00	2.40	0.70
Ly Van Lam Commune	4.40	70.70	2.00	0.50
Average	3.80	76.80	2.20	0.60

The weight of MSW generation by day of the week in households in Ca Mau city is shown in Figure 3A. The results show that the weight of MSW generation varies significantly between the days of the week, ranging from 1.82 to 3.05 kg/household/day. The weight generated was lowest on Monday to Thursday (1.82 - 2.00 kg/household/day) and gradually increased on Friday and Saturday with 2.39 and 3.05 kg/household/day, respectively. After that, the amount of waste tends to decrease on Sunday with 2.36 kg/household/day. The rate of MSW generation by day of the week and by the economic condition of households is shown in Figures 3B and 3C. The results show that the generation rate of MSW is significantly different between the days of the week, ranging from 0.48 to 0.80 kg/household/day. The lowest incidence rate was also on Monday to Thursday (0.48 - 0.53 kg/household/day) and increased on Friday and Saturday with 0.63 and 0.80 kg/household/day, respectively. After that, the rate of MSW generation gradually decreased on Sunday with 0.62 kg/household/day.

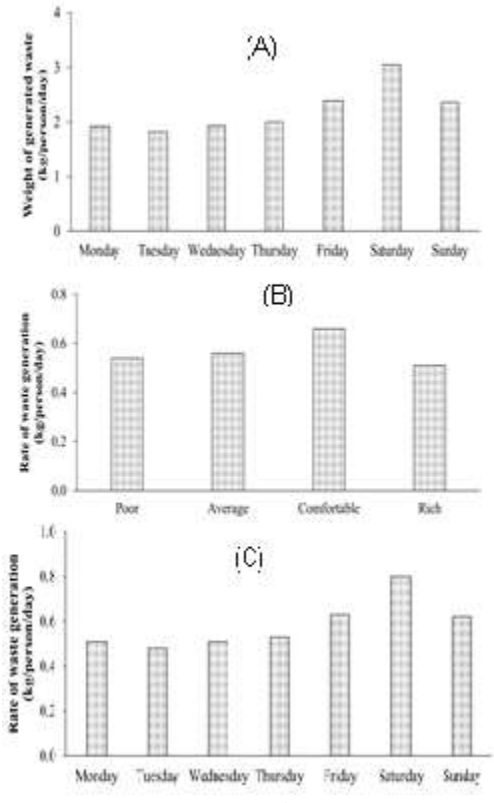

Fig 3. Weight and rate of waste generation

Previous studies have also demonstrated that the rate of MSW generation tends to increase on weekends (Ngan, 2021; Thien, 2021). This may be because on weekends, the majority of family members are often at home and organize family gatherings, making consumption demand and food consumption more, leading to higher waste increases. Therefore, effective solutions are needed to increase the frequency of MSW collection on weekends. Figure 3C shows that the MSW generation rate of 10 households where garbage bags are placed is not significantly different between those with rich, comfortable, average and poor economic conditions. The highest rate of waste generation is in households with comfortable incomes at 0.66 kg/household/day. Many studies have demonstrated the relationship between MSW generation and demographic and economic conditions (Zia et al., 2017; Lan *et al*., 2020). However, in this study, the lowest rate of waste generation was recorded in rich incomes households (0.51 kg/household/day). The average MSW generation rate in Vietnam is 0.7 kg/household/day for urban areas and 0.4 kg/household/day for rural areas (Schneider et al., 2017). Compared with Vietnam's average MSW generation rate, the MSW generation rate in the study area is higher than the national average emission rate for rural areas.

MSW component in Ca Mau city: The results of the classification and determination of MSW composition in 8 Ward and Ly Van Lam Commune are presented in Table 4. As suggested above, the MSW composition in the study area is classified into 4 groups: organic group, recyclable group, hazardous group and others. The results show that organic ingredients (leftover food) accounted for the largest proportion of MSW in 8 Ward and Ly Van Lam Commune. In which, Ly Van Lam Commune has a lower rate of food waste (68.58%) compared to 8 Ward (69.76%). This may be because that this is a rural area, so people often take advantage of leftovers for family pets. Previous studies also showed that organic ingredients in the provinces of Kien Giang, Bac Lieu and Soc Trang accounted for the highest proportion compared to other ingredients in MSW (Ngan, 2021; Phuc, 2021; Thien, 2021). The group of leftovers is a group of easily biodegradable organic waste, which is a very good input source for composting or as nutrition for increased activities for agricultural production, contributing to reducing pressure for MSW treatment.

The group with the second largest proportion is the recyclable group, with an average value of 24.44% (Ly Van Lam Commune: 22.22%; 8 Ward: 20.12%). In which, plastic and paper account for the highest proportion in the group with 11.32% and 5.80% for Ly Van Lam Commune, 11.87% and 4.28% for 8 Ward, respectively. The presence of plastic, paper, glass, etc. wastes indicates that recycling of wastes is not practiced in the study area. Although plastic and paper are recyclable wastes, the ability to recycle these wastes is limited due to low economic value and outdated recycling technology (Salhofer et al., 2021; Thien, 2021). Improper disposal of plastic waste can clog sewers system, pollute the environment by taking a long time to decompose, and threaten aquatic life (Amanidaz et al., 2019). Research in Da Nang and Thai Binh also shows that in MSW, plastic and paper account for a relatively high proportion of recyclable waste (11.31% and 10.43%) (Hung et al., 2020; Toan et al., 2021).

Table 4. Waste component in Ly Van Lam Commune and 8 Ward

Waste categories		Ly Van Lam Commune (%)	8 Ward (%)	Average (%)
Organic	Leftovers	68.58	69.76	69.22
Recyclable	Paper	5.80	4.28	4.98
	Glass	1.70	0.60	1.11
	Plastics	11.32	11.87	11.62
	Metal	3.40	3.37	3.38
	Rubber and leather	1.27	1.57	1.43
	Fabric	1.77	2.05	1.92
Hazardous	Batteries	0.21	0.06	0.13
	Drugs	0.78	1.20	1.01
	Masks and diapers	1.77	1.39	1.56
Others	Terracotta, ceramic, concrete	3.4	3.86	3.64

Other components that should also be considered are hazardous wastes accounting for 2.70% of the total weight of MSW in the study area and are mainly found in batteries, masks, and drug packaging. Household hazardous wastes usually account for only 1-4% of the total amount of MSW, but they pose many potential environmental and human health risks. In addition, if the group of hazardous wastes is not classified but stored with ordinary waste, the entire waste will become HW (Letcher & Slack, 2019). Ly Van Lam Commune has a higher proportion of hazardous wastes (2.76%) than 8 Ward; the component that accounts for the highest proportion in the hazardous group is masked (1.56%). The Covid-19 outbreak in recent years has increased the number of masks released into the environment and caused environmental pollution if not disposed of properly (Limon et al., 2022). Followed by drug packaging, mainly plant protection drugs, health protection drugs (1.01%), and batteries (0.13%). Most pesticide packaging is made of refractory plastic, so improper disposal of the pesticide packaging into the environment will damage the soil structure (Jin et al., 2018). Batteries are also hazardous wastes that pollute the environment if they are not properly disposed of, collected and treated. When exposed to the environment, the heavy metals contained in the battery will leak into the soil, water and air environment, causing serious pollution to organisms and human health (Li et al., 2019). Household hazardous wastes are usually treated together with MSW by burning or burying them. However, burning household hazardous wastes in conditions of low temperature and lack of oxygen will produce many dangerous gases, and the general handling may increase the possibility of danger to the environment and human health. Letcher & Slack, 2019). The remaining group of waste is mostly inert materials (terracotta, ceramic, concrete), accounting for 3.64%. For those who need it, it can be treated on-site by leveling. As for households that do not need, after sorting, they will be collected and transported to the factory for treatment. Research in Phu Tan district, Ca Mau province also noted that the group of inert materials usually accounts for a low percentage (0.9%) (Tiu et al., 2020). In general, the MSW composition in the study area has the highest organic waste group,

followed by the recyclable and reusable group, and the hazardous waste group accounts for a relatively low proportion. Therefore, waste treatment and segregation at source is the most important work in MSW management in the study area. From the current situation of generation and composition of MSW, it can help to improve the classification and collection of MSW and reduce the pressure on MSW treatment.

Current status of MSW management in Ca Mau city

Current status of MSW classification at source: Ca Mau city has not implemented a program to classify MSW at source and most people in the study area contain MSW in plastic bags (65%), plastic baskets (16.67%), or foam boxes (10%). The number of people storing MSW in garbage cans with lids is very low, accounting for only 8.33% (Figure 4A). This can damage the urban landscape and cause environmental pollution when there are few hygienic trash cans. The survey results also show that only 53.33% of households have garbage classification; the rest do not do it (Figure 4B).

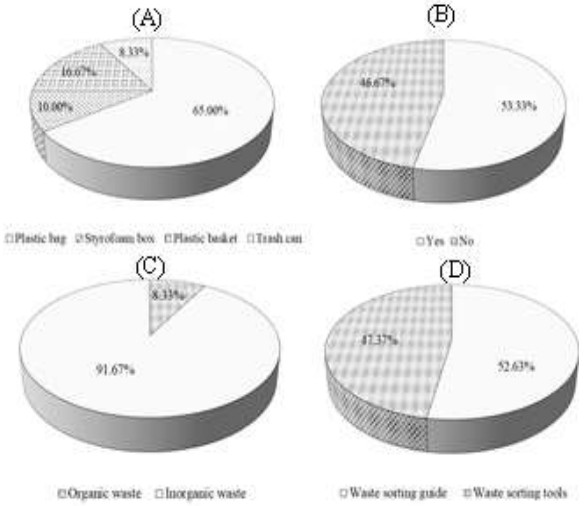

Fig 4. Current status of MSW classification at source

Due to the lack of knowledge and skills to separate waste at the source, households with waste segregation only sort it out spontaneously to use of recyclable waste. Therefore, the amount of waste is often put together in plastic bags by households and then thrown directly into the environment (especially for households in rural areas) or let the unit collects and make mass. The amount of MSW to be collected and treated is large and increases the cost of paying for the collection, transportation and treatment of MSW. Figure 4C shows that surveyed households mainly separate waste into inorganic and organic waste. However, the number of households that only classify inorganic waste for the purpose of selling scrap (plastic bags, plastic bottles, metal) accounted for 91.67% and only 1 household classified them into two categories. About 46.67% of the households that did not do the sorting thought that they would sort their waste at source when they were instructed to sort by the authorities and provided with sorting tools (Figure 4D). Previous studies also showed that the current status of waste separation at source is still very limited and in some provinces in the Mekong Delta, the program of waste separation at source has not been applied (Ngan, 2021; Thien, 2021).

Current status of MSW collection, transportation and treatment in Ca Mau city: Through a survey of 60 households in the study area, the number of households registered to collect garbage accounts for 68.33%. Figure 5 shows the rate of MSW collection at households in Ly Van Lam Commune (A) and 8 Ward (B). In Ly Van Lam Commune, only Xom Lon and Tan Hung hamlets have a collection rate of 100%, followed by Thanh Dien and Bao Son hamlets with a collection rate of 75%, Lung Dua hamlet of 50%, The lowest is Ong Muon hamlet with only 25% of MSW collection rate. In addition, Chanh hamlet does not have a MSW collection route due to its remote location and inadequate transportation system, so the collection has not been carried out (Figure 5A). Meanwhile, the clusters in the area of 8 Ward are all collected MSW with the collection rate of 100%, especially cluster 5 and cluster 6 have not been collected because the population is scattered and difficult to access (Figure 5B).

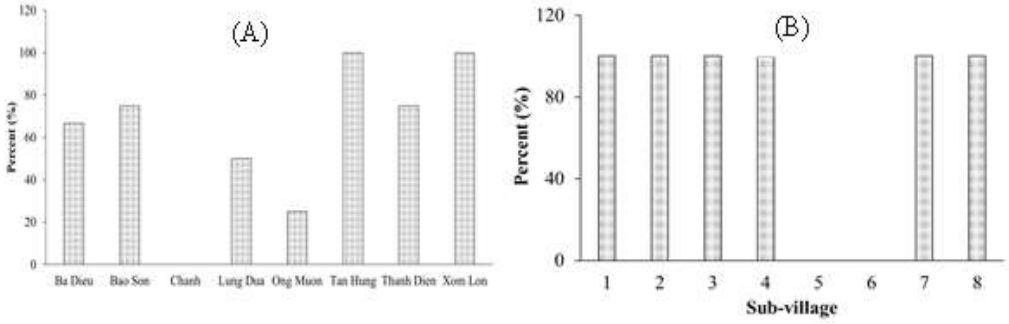

Fig 5. MSW collection rate in Ly Van Lam Commune (A) and 8 Ward (B)

Equipment for collecting and transporting waste is also invested in the study area, a total of 9 garbage compactors, 04 three-wheelers with trash cans, 05 hand tractors and 934 trash cans of all kinds, 2 garbage boats to specialize in collecting and transporting garbage to the treatment place. For different waste generation sources such as garbage in the river and garbage on the street, they are collected according to separate processes according to regulations of Ca Mau Provincial People's Committee (2021). For garbage in the river: is collected twice a day with the means of collection being a barge with a screen in front to pick up trash floating on the water. After that, the entire amount of garbage is collected into a 240L bin and transported ashore to wait for the garbage truck to collect and transfer to the treatment plant in Tan Xuyen Ward.

The amount of garbage picked up daily is about 20 kg in 240L bins. Waste in the river is sourced from riverside markets and partly from the daily activities of households with houses on the river. However, the collection efficiency is not really high, only the floating garbage can be picked up but not the bottom submerged part. Garbage on the street will be collected by a team of street sweepers and stored in 240L bins. After that, workers will move the garbage containers to the collection point. The source of garbage on the street is mainly passing vehicles. In addition, roadside and sidewalk shops also generate a large amount of waste because most do not have their own garbage containers. However, the collection of MSW is concentrated in densely populated areas and major roads. In remote and remote communes, garbage collection has not yet been implemented due to difficulties in the transportation system. Households in remote areas mainly treat MSW by burning, burying it on-site or at landfills and spontaneously burning waste.

There is a waste treatment plant and a landfill in the study area. Ca Mau city waste treatment plant in Tan Xuyen Ward has a 200 tons per day capacity for centralized waste treatment of Ca Mau province. Ordinary MSW will be classified, for MSW containing plastic particles will be recycled. For biodegradable organic of MSW, Ca Mau waste treatment plant is treated with Vibio technology equipment. The remaining types of waste will be concentrated in a separate area for leveling, solidification, incineration and sanitary burial. The collection, transportation and treatment of MSW in the study area are recorded to reach 87% by 2020. Still, garbage collection has not met the requirements, partly due to the lack of equipment, human resources, and technical infrastructure (DONRE, 2020).

Community awareness

The levels of people's interest: The survey results on the level of interest of households in the study area for MSW are shown in Figure 6. The results show that the level of concern of the people in the waste problem around the living area is relatively high life. There are about 86.67% of the interviewees interested or less interested in waste issues such as when the garbage is collected, how much it costs, is the collection clean, *etc*. While the remaining 13.33% think they do not care about domestic waste issues (Figure 6A). In addition, when asked about the effects of MSW on the environment, the majority of people clearly understand the harmful effects of MSW when discharged into the environment (accounting for 93.33%) and only a few people still think that MSW is less or no impact on the environment (6.67%) (Figure 6B). Currently, information about the environment, especially MSW, is being transmitted very popularly through many forms such as the Internet, TV, radio, *etc.* to help people easily grasp the information. Thereby helping people to become more aware of their responsibility to protect the environment.

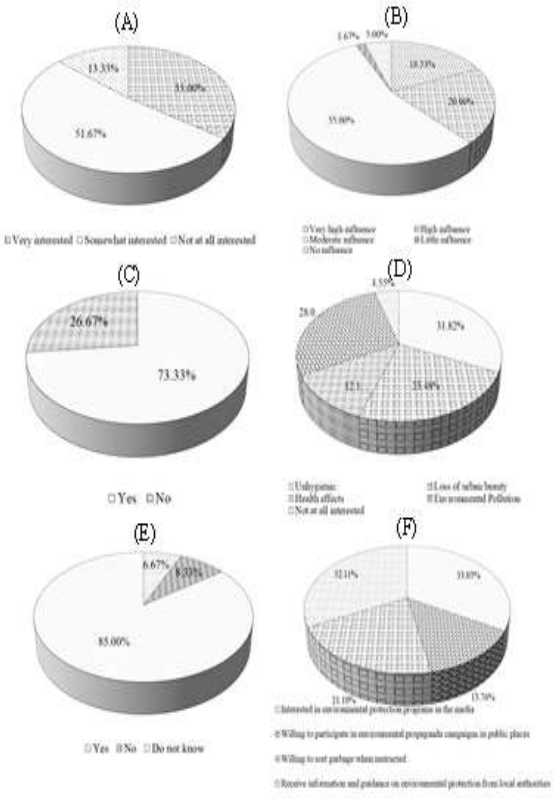

Fig 6. People's interest in MSW

Figure 6C shows that 73.33% of households interviewed in the study area perceive that MSW has significantly impacts on health, while the remaining 26.67% still think that MSW has no effect on human

health. This proportion falls among the elderly in the study area due to difficulty in accessing media. Besides, most people know the harmful effects of littering indiscriminately on roads, rivers, ditches, canals, canals, etc.). At the same time, they also found that the place where the waste is located will be the residence of bacteria, flies, and mosquitoes that cause disease, lose the beauty of the area and the stench will affect the living process and health of the people. Although most of the population in the study area has a certain understanding of the harmful effects of MSW indiscriminately, if it is not collected and gathered in accordance with regulations as well as improper waste treatment, it will affect the impact on the environment and health, but still a small part of households is quite indifferent when others throw garbage indiscriminately and do not care about the effects of MSW (4.55%). This leads to 93.33% of people not knowing and thinking that there are no regulations of the local government on MSW and only about 6.67% of people know the regulations on MSW in the study area (Figure 6E). Although local authorities have issued regulations on MSW, because people have not really paid attention and the regulations have only stopped at the level of propaganda and mobilization, they are not really deterrent. In addition, out of a total of 60 interviewed households, only 33.03% of households are interested in information on environmental protection from the media and authorities.

However, it can be seen that the community's awareness of environmental protection is increasing day by day, especially the issue of waste and environmental sanitation is of great concern to everyone because this is a matter of nature close contact with people on a daily basis. Besides, there are 21.10% of households, for those who have not done garbage classification, are willing to sort garbage when there are instructions from the authorities. The rate of willingness to participate in environmental sanitation propaganda campaigns in public places is mostly agreed by young people, accounting for 13.76% of the total interviewed households. Elderly people often do not agree to participate because they think this is the obligation of organizations and authorities and do not have time to participate (Figure 6F).

In general, people in the study area have quite good awareness of the effects of MSW when not properly managed, at the same time, the knowledge and awareness of a few households is still quite limited and have not paid much attention to the harmful effects of MSW on the environment and health.

Recommendations: The survey results on people's recommendations to improve the management of MSW are shown in Figure 7. The results showed that 27.97% of the respondents wanted to handle the cases of littering at the wrong place with administrative penalty or public service. It shows that behavior and habits of littering indiscriminately, causing environmental pollution can be gradually changed through the increased application of regulations and laws and strict handling of violations. Besides, there were 43.36% petitions for MSW collection and transportation, including investment and improvement of traffic routes to increase the rate of MSW collection (23.78%) and upgrade equipment in collection and transportation (19.58%). These recommendations are mostly proposed by households that have not been able to carry out collection work due to their remote location and unsatisfactory transportation system, causing difficulties in accessing collection and transportation. CTRSH. In addition, 14.69% of the surveyed people think that it is necessary to propagate widely and regularly on the mass media to mobilize people to be aware of their responsibility to protect the environment by taking practical actions. At the same time, only 13.99% of people want guidance on the classification of MSW at the source. That shows some households are aware of the benefits of sorting MSW sources for the national economy, such as reducing the economic burden and costs for waste treatment, increasing the recycling rate and reduce consumption of input materials, *etc.*

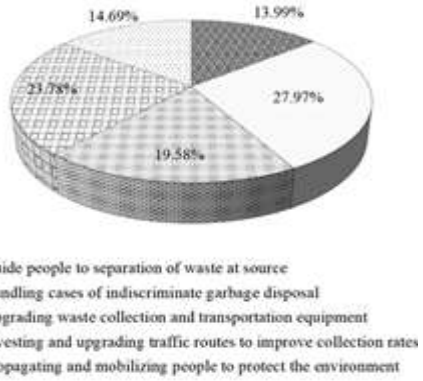

Fig 7. People's recommendations on MSW management

Conclusion: Municipal solid waste in Ca Mau city has an average generation coefficient of 0.60 kg per person per day. Urban areas account for a higher proportion of MSW generation than rural areas with total emissions in Ly Van Lam Commune and 8 Ward. The MSW is mainly biodegradable organic waste. The rate of MSW collection in the study area is 68.33% which is transported to the treatment plant. The remaining waste is treated by burning, throwing it directly into the environment, or burying it by local people. The

survey results also show that people in the two localities are quite aware of MSW. Further studies need to continue to expand the research scale in other places of Ca Mau province to have more general comparison data between urban and rural areas.

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