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Description of the post-consumer plastic packaging value chain in a commune from a rural district of HCMC: Implications for EPR implementation



Abbreviations

DSW: Domestic Solid Waste

EPR: Extended Producer Responsibility

HDPE : High Density Polyethylene

LDPE: Low Density Polyethylene

LEP: Law of Environmental Protection

MONRE: Ministry of Natural Resources and Environment

PA: Polyamides; natural (silk) or artificial (nylon) polymer

PE: Polyethylene

PET: Polyethylene terephthalate

PLA: Polylactic acid; thermoplastics derived from lactic monomers extracted from natural sources

PMMA: Polymethyl methacrylate or acrylic; thermoplastic

POM: Polyoxymethylene; thermoplastic

PP: Polypropylen; thermoplastic

PRO: Producer Responsibility Organization

PS: Polystyren; thermoplastic

PVC: Polyvinyl Chloride; thermoplastic

RC: Recyclables Collectors

VEPF : Vietnam Environmental Protection Fund

VND: Vietnam Dong, Vietnamese currency

WC: Waste Collectors

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I. Introduction

A. Pilot project brief description

The pilot project ‘**Enhancing plastic packaging collection, sorting and recycling**’, implemented by IRD and HAU, is funded by the ‘Rethinking Plastics – Circular Economy Solutions to Marine Litter’ project of the European Union and the German Federal Ministry for Economic Cooperation and Development (BMZ). ‘Rethinking Plastics’ is implemented by the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH and Expertise France.

The pilot project aims to increase the collection, sorting and recycling of plastic packaging in Ho Chi Minh City, Vietnam, to reduce its environmental leakage. To reach this objective, it works on determining **how much** and **what kind** of plastic is collected, **how** and **by whom** it is transferred and processed or when it is leaked into the environment. Finally, it assesses if and how the plastic waste is recycled and what would be needed to enhance recycling. In addition, the project investigates how segregation at household level can be improved. A better cooperation between all stakeholders will enhance the understanding of the plastic value chain and related data. Involved stakeholders therefore include producers and consumers, as well as collectors, businesses, transporters of packaging and recyclers. With these data and experiences, the pilot project can contribute **knowledge** about suitable options for a legal framework for Extended Producer Responsibility (EPR) for packaging, which is currently being developed by the Ministry of Natural Resources and Environment in Vietnam.

Originally, the Activity 2 of the pilot project aimed to assess and reinforce the efficiency of systematic waste sorting-at-source by conducting a baseline during a three weeks survey, a sorting at source awareness campaign and a final survey to evaluate the effectiveness of the campaign. Because of the **covid-19 pandemic** in Vietnam, this activity was reduced and instead of conducting two surveys, baseline and evaluation, the project team was able to conduct only one survey that can be considered as a **baseline, representative of the post lockdown-period due to covid-19 pandemic**. Also, the original plan was to conduct the surveys at three districts, charactering the rural, urban and sub-urban context. In regards to the pandemic situation and the advice of the local authorities, we focused only on a **rural district**. The project team therefore focused on a deeper **understanding** of the **current organization of a commune of a rural district** and formulated **recommendations** for the packaging sector in relation to the implementation of EPR in Vietnam.

B. EPR scheme in Vietnam: Law of Environmental Protection

In Vietnam, a **Law of Environmental Protection (LEP)** was approved in 2020 and the **Decree No. 08/2022/ND-CP** issued on 10 January 2022, details the articles of the Law on Environmental Protection on waste management in chapters 5 and 6. According to this regulation, manufacturers and importers of products and packages (Table 1) in order to conduct commercial activities in the Vietnamese market **must undertake the responsibility to recycle such products and packages** according to the required recycling rates and specifications. Manufacturers and importers that choose the form of recycling may organize the recycling in the following forms (LEP Article 54, Point a, Clause 2):

- a) carry out the recycling by themselves;
- b) hire a recycling unit to carry out the recycling;
- c) fully authorize a third party (Producer Responsibility Organization, PRO) to organize the recycling.

Manufacturers or importers that choose to make financial contributions to the Vietnam Environmental Protection Fund (VEPF) to support the recycling of products and packages are not required to carry out these forms of recycling (LEP Article 54, Point b, Clause 2). In that case, the EPR Vietnam Office selects and signs a contract with a recycling unit in the form approved by the National EPR Council to take over the recycling for manufacturers and importers. The VEPF is responsible for paying the recycling costs under the contract signed with the recycling unit.

The compulsory **recycling rate** of each type of product or package is determined based on the life-cycle, the disposal rate and the recycling rate of each type of product or package; on national recycling targets, environmental protection requirements, and the socio-economic context. The compulsory recycling rate is defined as the ratio of the minimum volume of products and packaging that shall be recycled in accordance with the mandatory recycling specifications to the total volume of manufactured products and packaging that are put on the market and imported in a year (Decree No. 08/2022/ND-CP).

The recycling must have appropriate environmental permits. Manufacturers and importers that carry out the recycling by themselves as well as the recycling units hired by the manufacturers or importers to carry out the recycling have to comply with these requirements. A PRO must meet specific conditions, too.

The report on recycling results of the manufacturer, importer or PRO, submitted to the EPR National Portal Office, must be certified by an audit firm in accordance with the law on independent audits.

Table 1: Extraction of plastic packaging products from the Appendix XXII list of products and packaging, which must be recycled with recycling rate and recycling recruitments (Attached to Decree No. 08/2022/ND-CP).

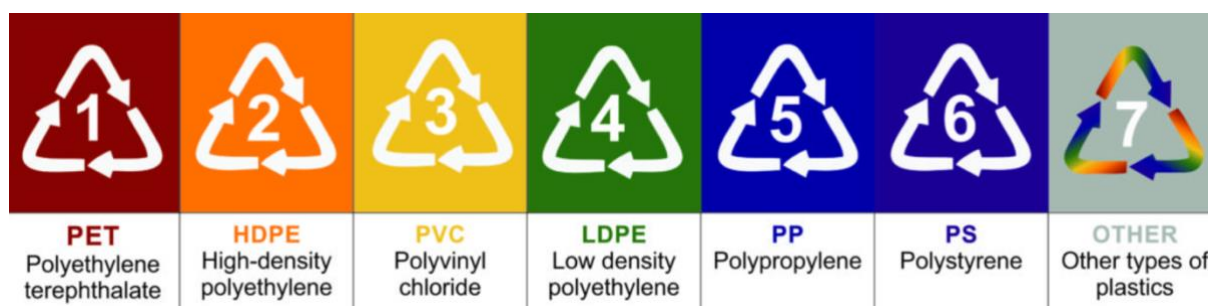
Product catalog, Packaging	Required recycling rate for first 3 years	Mandatory recycling (Minimum 40% recovery by weight of product, packaging to be recycled according to the required recycling rate) Selected recycling solution:
A.1. Paper packaging		
A.2. Metal packaging		
A.3. Plastic packaging		
A.3.1. Rigid PET packaging	22%	1. Producing recycled plastic beads used as production materials for industries. 2. Manufacture of other products (including PE fibers). 3. Chemical production (including oil).
A.3.2. Hard HDPE, LDPE, PP, PS packaging	15%	1. Producing recycled plastic beads as production materials for industries. 2. Manufacture of other products (including PE and PP fibers). 3. Chemical production (including oil).
A.3.3. Rigid EPS packaging	10%	1. Producing recycled plastic beads as production materials for industries. 2. Manufacture of other products. 3. Chemical production (including oil).
A.3.4. Rigid PVC packaging	10%	1. Producing recycled plastic beads as production materials for industries. 2. Manufacture of other products. 3. Chemical production (including oil).

A.3.5. Other hard plastic packaging	10%	1. Producing recycled plastic beads as production materials for industries. 2. Manufacture of other products. 3. Chemical production (including oil).
A.3.6. Soft material single packaging	10%	1. Producing recycled plastic beads as production materials for industries. 2. Manufacture of other products. 3. Chemical production (including oil).
A.3.7. Soft multi-material packaging	10%	1. Producing recycled plastic beads as production materials for industries. 2. Manufacture of other products. 3. Chemical production (including oil).
A.4. Glass packaging		

C. Overview of plastic recycling activity in Vietnam

Plastics are usually classified according to their heating properties, i.e. thermosets or thermoplastics (Nguyễn Thị Truyền and al., 2022) or to their resin identification code, i.e. 1: PET; 2: HDPE; 3: PVC; 4: LDPE; 5: PP; 6: PS; and 7: others (Table 2). Their ability to be recycled varies between **polymers**: PET, HDPE and PS are considered as commonly recyclable; PP, PVC, LDPE are considered as sometimes recyclable and the others as difficult to recycle (Nguyễn Thị Truyền and al., 2022).

Table 2: Resin identification code of main plastic (table adapted from molygran.com)



In Vietnam, **mechanical recycling** is the main recycling line observed. Mechanical recycling, based on plastic waste grinding, washing, separation, drying, re-granulating and compounding, is the simplest and most common method used to recycle PE, PET and PP. Detailed information on the technology and equipment required to perform mechanical recycling are fully described in the Handbook for Recyclers (Nguyễn Thị Truyền and al., 2022).

D. Post-consumer plastic packaging value chain: definition of terms

Actors in the **post-consumer plastic packaging value chain** are the waste generators, collectors, aggregators, transporters, and processors/recyclers. This post-consumer value chain definition is inspired by the one of [GA Circular](#) established for PET value chain in Southeast Asia (GA Circular, 2019) and by the observation of Hanoi Architectural University during their consultancy project with Expertise France (Nguyễn Thái Huyền and al., *to be published in 2022*). For the purpose of this activity, the definitions are specified accordingly as

'post-consumer plastic packaging value chain', but it can also be defined more generally for all recyclable materials.

- The **waste generators** are defined as the generators of the plastic packaging waste; they can be individuals as households or collective as schools, offices, restaurants, goods stores, hotels and residential buildings. By definition, they consume products with plastic packaging and throw the packaging away, some of them sorting the waste, others not. Their interest is to dispose of the waste easily.
- The **collectors** are defined as **waste collectors (WC)** and **recyclables collectors (RC)**; the WC are collectors from the public companies (e.g. Citenco), from the private companies, or from the cooperatives. The RC are collectors belonging to an organization or individuals, collecting and or purchasing the recyclable waste; they are the *người thu mua*, named in HCMC *ve chai*. The WC collect the waste directly from waste generators and bring it to gathering sites and transfer stations for landfill or recycling (Kieu Le et al., 2016). RC collect and/or buy the waste directly from waste generators or at gathering sites and sell them to aggregators. RC seek to find/buy large quantities and easily recyclable material from waste generators and to sell them at a good price to aggregators. Their constraints are spatial planning, the availability of the resources, the distance to travel, to buy and sell the resources, their cooperation with waste generators and aggregators, and the recovery of these resources by the WC.
- **Gathering points/Transfer stations:** Gathering points refer to temporary storage points for all types of waste after collecting domestic solid waste from waste generators or street cleaning. Gathering points are located on the road and on the grounds of large waste generators (e.g. markets, apartment buildings, parks). Transfer stations refer to temporarily domestic solid waste gathering and storage for trans-shipment onto vehicles and for transport to waste treatment facilities. They can have the capacity to either only serve the needs of one district, in that case they have specific operation time and are handled by the City People Committee, or to serve inter-district needs, in this case they operate continuously and are handled by DONRE (decision No. 09/2021/QD-UBND).
- The **aggregators** (i.e., *cơ sở phế liệu*) are the informal or formally registered businesses involved in buying materials from collectors, aggregating high quantities of plastic packaging and selling it to processors and/or recycling factories. Their size may vary from 20m² to more than 2,400m². In the framework of the COMPOSE's project (March 2020), 723 aggregators were identified in HCMC, 180 companies being registered in the Yellow Pages as buying and selling recycled materials. The aggregators need to keep and improve an inflow and outflow of recyclable material in their warehouse. They select the recyclable materials in which they are interested depending on the financial benefits they can make from the sale of the resources. They depend on the volume of material flowing in from the RCs. Further challenges are the storage of the resources and the selling price and volume going out to recyclers/processors, meaning the adaptation of their interior space and their ability to be flexible and integrate new actors into their network of processors/recyclers (e.g. public, private or informal).

- The **transporters** are individuals who transport the plastic packaging from the aggregators to the processors/recyclers, either punctually among other materials or permanently by buying the plastic packaging from the aggregators and selling them to the processors/recyclers. Their main effort is to be maintained in the value chain and increase their income. Their constraints are the volume of resources to transport and the distance to travel to the processors/recyclers.
- The **processors/recyclers** are informal or formally registered businesses engaged in the process of converting the recovered plastic packaging into flakes. **Processors** either export this material or sell it to a local recycler. The **recycler** is an informal or formally registered business engaged in the process of converting the flakes into usable applications. The finished product is either exported or sold locally. They are interested in getting constant quality and fluxes of resources at a low price, to sell the recycled products and thus to keep or increase their income.

E. Domestic solid waste management in HCM City

Ho Chi Minh City (HCMC), a megacity of **8.6 million inhabitants** (GSO, 2019), is divided in 16 urban districts (i.e. *quận*) and 5 rural districts (i.e. *huyện*) and 1 sub-city). HCMC is characterized by contrasted population density, from a low density level, e.g. 110 inhabitants km⁻² in the Can Gio district, (GSO, 2019) to a high density level, e.g. 51,000 inhabitants km⁻² in district 4 (GSO, 2019). The waste management in HCMC involves highly heterogeneous actors, including the public sector with 22 units (e.g. CITENCO) and the private sector with 21 cooperatives, 182 private companies and 1500 collecting groups (DONRE 2018). This highly complex system collected 9,100 tons of domestic solid waste per day in 2017 (DONRE, 2018). In 2014, the domestic solid waste of HCMC contained 65-90% of organic material, **86% of the total solid waste was landfilled** at two major landfill sites (Phuoc Hiep and Da Phuoc), and the residual of 14% was recycled (Verma et al., 2016). In April 2017, the People Committee of HCMC launched the sorting at source program Decision 1832/QĐ-UBND (2017-2020), classifying **three types of domestic waste: organic, recyclable and others**. Since 2019, the People's Committee of Ho Chi Minh City has implemented a program to separate domestic solid waste at source according to Decision No. 12/2019/QĐ-UBND dated May 17, 2019, classifying into 03 waste groups: Biodegradable organic group, Reusable, recyclable group and the other group. Up to now, the People's Committee of Ho Chi Minh City continues to implement the program of separating domestic solid waste at source according to Decision No. 09/2021/QĐ-UBND dated May 4, 2021, classifying into 02 waste groups: reusable and recyclable waste group and the remaining waste group. Detailed information on the domestic solid waste organization in HCMC and its specific features compared to other Vietnamese cities are highlighted in the report Nguyễn Thái Huyền et al. (to be published in 2022).

F. Objectives

Under the pilot project, two surveys were conducted in Long Thoi commune to 1) **describe and map the spatial distribution of waste stakeholders** and 2) **describe the types of plastic sorted and collected by the domestic solid waste organisation**.

More precisely, the aim was to characterize the type of plastics (by polymer) in a rural district and to analyse the plastic's transfer along the post-consumer plastic packaging value chain.

The implementation of the EPR scheme in Vietnam will rely on an efficient and traceable recyclable waste collection system. Currently, the domestic solid waste organization and especially the recyclable waste organization is complex and involves many stakeholders from the public and the private sector as well as cooperatives and informal workers without business license. It is thus important to fully describe and understand the plastic flow, including types, stakeholders, and transfer, to provide adapted recommendations and prepare the transition towards the EPR implementation. Those recommendations are based on the observed gaps, constraints, and advantages of the current system.

II. Methodology developed for the survey

A. Mapping of stakeholders in Long Thoi Commune

In May 2021, two pilot project team members realized a **mapping of Long Thoi Commune** during three weeks. They met the different stakeholders of the post-consumer plastic packaging value chain and mapped the **territorial occupation** of the **waste generators** (households, retail shops, supermarkets, open markets, schools, offices), **waste collectors**, and **aggregators**.



Figure 1: Location of Ho Chi Minh City, Nha Be district and Long Thoi commune in Vietnam.

B. Plastic waste audit

From 16th December 2021 to 6th January 2022, the pilot project team organized the waste audit of the post-consumer plastic packaging value chain at Long Thoi commune, just after the lockdown of the City and still under covid-19 restrictions and epidemic period. Various stakeholders of the plastic value chain were surveyed, but not all types due to the covid-19 situation:

- 24 waste generators: 2 supermarkets, 2 retail shops, 20 households
- 1 gathering point
- 2 aggregators

The **PlasticGO** smartphone application was used to register daily information on plastic quantity, quality and fate and a portable NIR Spectrometer, named **microPHAZIR**, was used to determine the type of polymer.

The surveyor team was composed of five collaborators and two agents of the People Committee of Long Thoi who supported the waste generators to measure the **waste quantity** using a portable scale, the **sorting** using the guide conceived for the survey to sort easily the basic products, and the **reporting** of the data on PlasticGO. Another pilot project team member also measured the **waste quality**, i.e. the plastic polymers, using the MicroPHAZIR tool.

During the three weeks, for each surveyed stakeholder the following activities were conducted:

- Plastic packaging waste was **sorted** from the domestic waste
- Plastic packaging was **categorized** using the guide into PET, PE, PP, PS, PVC, Others
- Each plastic packaging type was **weighted**
- For households the **destination** of each plastic packaging type was recorded on PlasticGO:
 - Given to waste collectors
 - Given/sold to recyclable collectors
 - Trashed in waterways
 - Burnt
- For collectors and aggregators the **price** of purchased plastic types and sold plastic types were recorded.

1. PlasticGO smartphone Application

PlasticGO is a smartphone application designed by the pilot project team and TOCOM JSC to register daily information on quantity, quality and fate of the collected plastics. The assessment of plastic packaging waste flows from waste generators to aggregators is addressing many stakeholders along the value chains and covers different waste categories. For this reason, the acquisition of data should be well organized, practical, user friendly, and fast and should limit the errors due to data processing (to learn more on PlasticGO see Factsheet M2).



Figure 2: Logo of PlasticGO app.

The plastic can be categorized by the users as PE, PET, PP, PS, PVC or others. A guide with pictures of main plastic packaging used by households was produced to help the waste generators to categorize (Figure 3; Annex 1). Three types of users are defined: waste generators, collectors, and aggregators. Each user can monitor the weight, the date, the fate, and the price of purchased and sold plastic.

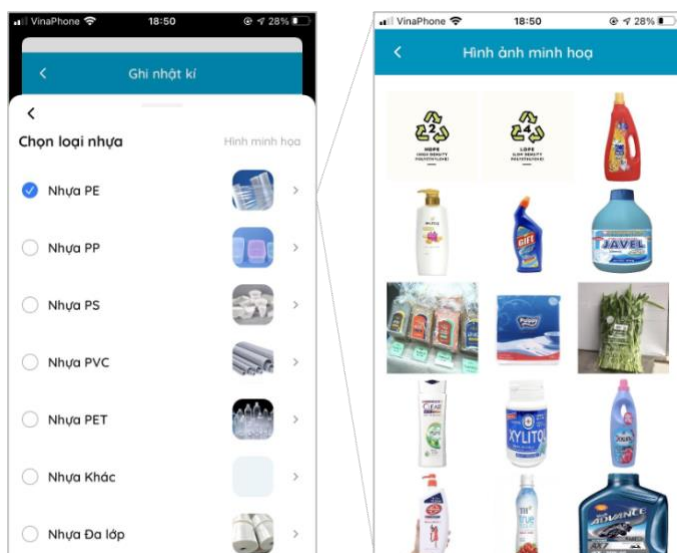


Figure 3: PlasticGo app, screenshot of guide of plastic packaging categorization for PE plastic (see more in Annex 1).

2. MicroPHAZIR measurement

The **microPHAZIR tool** (Figure 4) allows to easily identify the plastic polymer composition in waste. This tool is portable, easy to use, reliable, and fast. The principle is based on the fact that each polymer has a specific fingerprint on the infra-red absorption spectrum. The machine, via a non-destructive near infra-red analysis, compares the fingerprint of the sample to the known polymer fingerprints of its library and evaluates the “matching” coefficient. Within three seconds, the polymer can be identified. (To know more on microPHAZIR see Factsheet M1)



Figure 4: microPHAZIR Analyser tool by Thermo Scientific.

The matching coefficient varies from 0.1 to 0.99. A high matching coefficient value (> 0.8) is attesting a reliable measure and identification. A lower matching coefficient value is attesting of a less reliable identification. As we are measuring plastic waste, many parameters can decrease this matching coefficient: the presence of dust or moisture, the presence of labelling and ink on the packaging, the color of the plastic (the color depends on added additives which may influence the signal), the fact that waste is often crumpled. Thus, even if the matching coefficient was lower than 0.8, the results were considered as acceptable (case to case validation was performed) and were put in ‘Other’ category when the matching was very low.

III. Mapping of stakeholders

A. Mapping of waste collectors, recyclable collectors and aggregators at Long Thoi Commune

In Long Thoi commune, the domestic solid waste organization is managed by the Environmental and Hygiene Unit under the People’s Committee of Long Thoi Commune, the People’s Committee of Nha Be District and the People’s Committee of HCMC. The responsibility of each administrative level along the domestic solid waste collection and transfer is summarized in Figure 5.

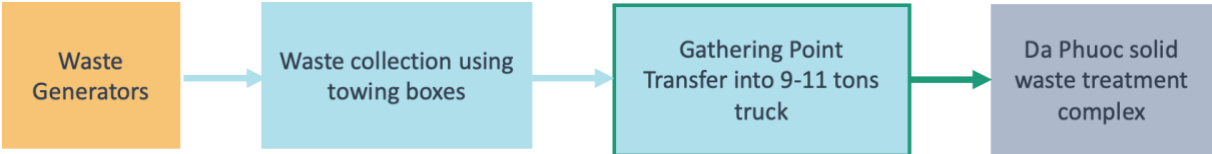


Figure 5: Domestic solid waste organization in Long Thoi Commune. The waste generators are presented in yellow, the segment under the responsibility of Long Thoi Commune is in blue, the segment under the responsibility of Nha Be District is in green and the segment under the responsibility of HCMC is in grey.

Long Thoi commune is divided into five domestic solid waste collection areas managed by a **cooperative** and one area located in the industrial park and managed by the private company Green Environment Company (Figure 6). The cooperative has **five waste collectors** in charge of the daily collection, working two shifts a day (informations obtained before covid-19 pandemic in May 2021).

Long Thoi commune: DSW collectors & transporters, gathering point and aggregators

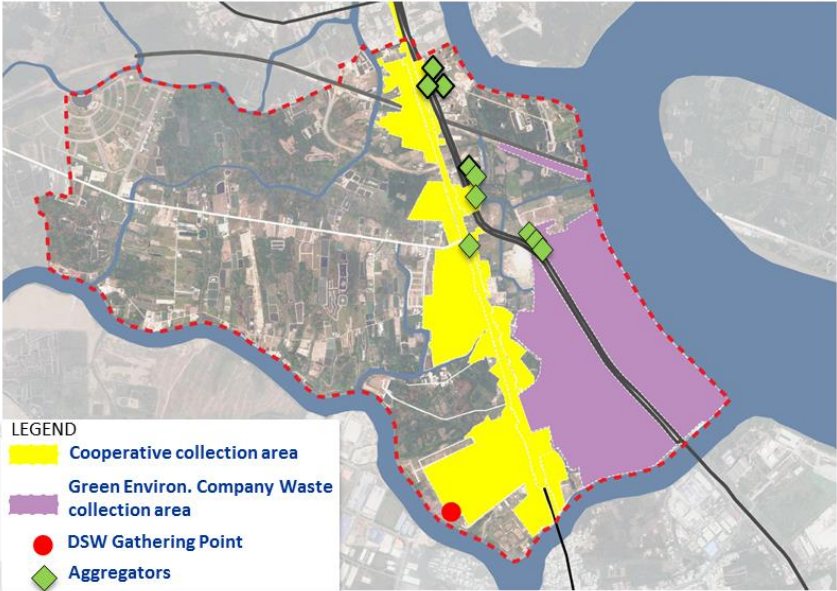


Figure 6: Mapping of the domestic waste collection area under the responsibilities of the cooperative and the Green Environmental Company, of the gathering point, and the aggregators at Long Thoi Commune.

After collection, the waste collectors gather the domestic solid waste at the **gathering point**, also handled by the cooperative, located at the end of alley 512, Nguyen Van Tao Street, hamlet 1, Long Thoi commune, Nha Be district, Ho Chi Minh city (10.638537, 106.727364). The waste is gathered in about 31 **towing boxes** of 100-200 kg per box. The Nha Be utility, from the public company, is then in charge to squeeze and transport the waste daily (at 11pm or 4-5 am) in a **truck** of 9-11 tons to the **Da Phuoc landfill**.

At the **gathering point**, **recyclable collectors** are also sorting the waste and purchasing the recyclable waste to the waste collectors of the cooperative. The recyclable waste is then further sold to aggregators.

In Long Thoi Commune, nine aggregators were identified in May 2021 along Nguyen Van Tao Street and the Street number one. The specifications of each aggregator are detailed in Table 3. All aggregators were purchasing different kind of recyclable waste, and at least two different types. The purchased plastic was categorized as plastic bags, household plastic, PET plastic, colored plastic, and hard plastic.

Table 3: Aggregator specifications at Long Thoi Commune (P: purchasing; NP: not purchasing; NA: not answered).

General information						Purchased Recyclable Waste										
Identification	Foundation year	Surface area	Aggregator status	Employees living on site	Familiar RC	Paper	Carton	Metal	Aluminium	Copper	Can	Plastic bag	Household plastic	PET Plastic	Colored plastic	Hard plastic
Ag-1	NA	80	NA	2	5	P	P	P	P	P	P	P	P	P	P	P
Ag-2	2019	90	NA	2	6	P	P	P	P	P	P	P	P	P	P	P
Ag-3	2019	50	NA	2	6	NP	NP	P	P	P	P	0	P	P	P	P
Ag-4	2019	60	license	3	7	P	P	P	P	P	P	P	P	P	P	P
Ag-5	NA	120	NA	3	NA	P	P	NP	NP	NP	NP	NP	NP	NP	NP	NP
Ag-6	2019	70	NA	2	NA	P	P	P	P	P	P	P	P	P	P	P
Ag-7	2019	50	NA	2	5	P	P	P	P	P	P	P	P	P	P	P
Ag-8	2016	45	NA	2	NA	P	P	P	P	P	P	P	P	P	P	P
Ag-9	NA	30	NA	2	NA	P	P	P	P	P	P	P	P	P	P	P

B. Mapping of waste generators

The mapping of Long Thoi Commune evidenced several types of waste generators of domestic solid waste (Figure 7):

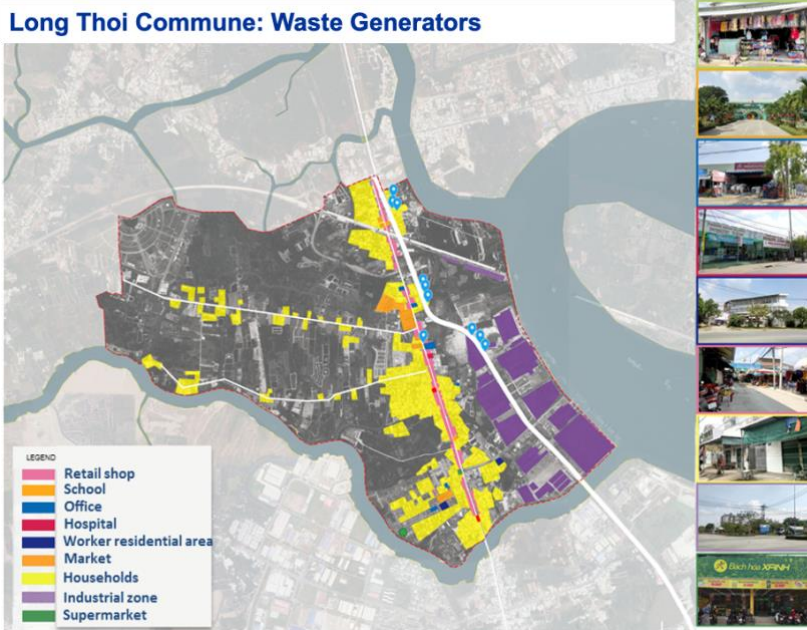


Figure 7: Mapping of waste generators at Long Thoi Commune.

- **Households**



Households are concentrated along Nguyen Van Tao Street, and the adjacent smaller streets. The domestic waste from households is gathered in front of each house, and collected by the **WC** of the **cooperative** daily. Households are **sorting at source**. Recyclable waste including plastic is purchased by **RC** and sold to aggregators.

Figure 8: Picture of households at Long Thoi Commune.

- **Retail shops**



The survey included a coffee shop, clothing store, food store, and a grocery store. They are mainly concentrated on Nguyen Van Tao Street. The domestic waste is collected by the **WC** of the **cooperative**. The retail shops are operating **sorting at source** for recyclable waste, which is purchased by **RC** and sold to aggregators.

Figure 9: Picture of retail shop at Long Thoi Commune

- **Schools**



The commune has currently ten schools, including kindergartens, primary schools, secondary schools, vocational training centers, and international schools. The domestic solid waste of the schools is handled by the **WC** of the **cooperative**. Mostly, schools are operating **sorting at source** and recyclable waste including plastics is collected and purchased by the **RC** and sold to aggregators.

Figure 10: Picture of school at Long Thoi Commune

- **Residential area for workers**



The collective housing area for workers from factories and the industrial zone of the commune has a dedicated domestic solid waste area, which is handled by the **cooperative**. The residential area operates **sorting at source** of recyclable waste, including plastic, which is collected by **RC** and sold to aggregators.

Figure 11: Picture of worker residential area at Long Thoi Commune

- **Local open markets**



There are two local markets in the commune: the Bai Choi market, the larger one, and the Bai Hut market. The domestic solid waste is gathered in front of the market and is collected by the **WC** of the **cooperative** daily in the early afternoon. **Sorting at source was not** observed.

Figure 12: Picture of Local open market at Long Thoi Commune

- **Supermarkets**



The commune has two small supermarkets. The waste is **not sorted** at source and the domestic solid waste is collected by the **WC** of the cooperative.

Figure 13: Picture of supermarket at Long Thoi Commune

- **Offices**



The commune has few offices. The waste is generally **not sorted** and the domestic solid waste is collected by the cooperative.

Figure 14: Picture of office at Long Thoi Commune

IV. Post-consumer plastic packaging value chain at Long Thoi Commune

The observations of the post-consumer plastic packaging value chain at Long Thoi Commune are described for each level of the value chain: waste generators, collectors and aggregators.

A. Waste generators

1. Households

a) Waste composition

The waste composition, based on the sorting and weighting made by the **households** using the PlasticGo App and the guidelines for basic products, evidenced that **half of the plastic mass sorted by the households is PE, PET and PP**: PE represented 28%, PET 21% and PP 8% (Figure 15).

Unidentified plastics (i.e. others), PVC and PS represented 43% of the mass of plastic wasted by households. We remind that unidentified plastics gather plastic unidentified by households, meaning they could not read the resin identification code on the packaging and were not in the plastic book guide that we prepared).

Knowing that PE, PET, PP are the most interesting plastics for recycling, it is interesting to note that **57% of the plastic mass wasted by the households is of interest for the recycling sector.**

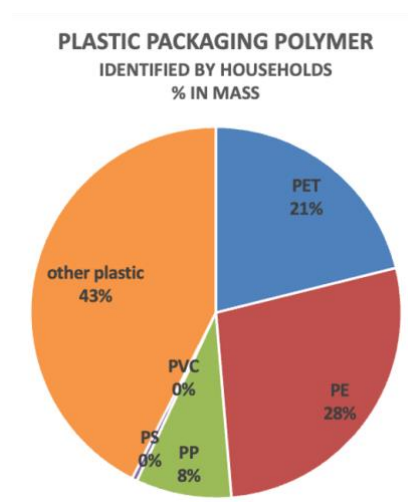


Figure 15: Type of polymers of plastic packaging identified by households during the three weeks survey at Long Thoi commune. The results are expressed in mass percentage of respective polymer category.

The plastic packaging composition was also analysed using the microPHAZIR. A total of 565 plastic packaging items were identified by microPHAZIR in households during the three weeks survey (Figure 16).

Similar observations were obtained: PE (27%), PET (27%) and PP (6%) are the most abundant plastic types (in counts) in household domestic waste. **60% of the plastic count tested at households are of interest for the recycling loop (including PE, PET, PP, PS, PVC).**

The category 'other plastics' represents 32% of plastic counts. This category is composed of various polymers or unidentified with low matching coefficient polymers (including PMMA, PA, POM, PLA).

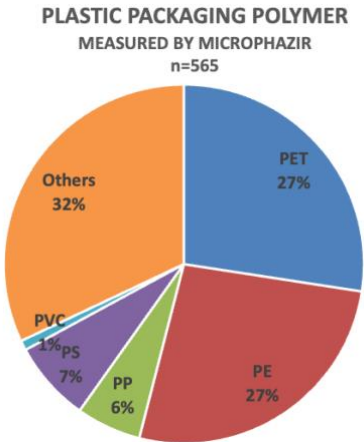


Figure 16: Type of polymers of plastic packaging measured by microPHAZIR during the three weeks survey at households of Long Thoi commune. The results are expressed in count percentage of respective polymer category.

b) Destination of the plastic waste

The destination of the plastic waste stored in households was asked to the inhabitants for each type of waste via the PlasticGO smartphone application (Figure 17).

It is interesting to note that **almost all sorted plastic packaging was given to waste collectors**. Few waste generators admitted to trash or to burn the waste. More precisely:

- **PET (93%), PE (90%), PP (77%) are mostly sold to recyclable collectors**
- **Few sorted PET (5%), PP (1%), PP (23%) enter the domestic solid waste collection system** managed by the cooperative and the Public Company of Nha Be District
- **PS (63%) and other plastics (67%) are mostly given to waste collector of the cooperative**

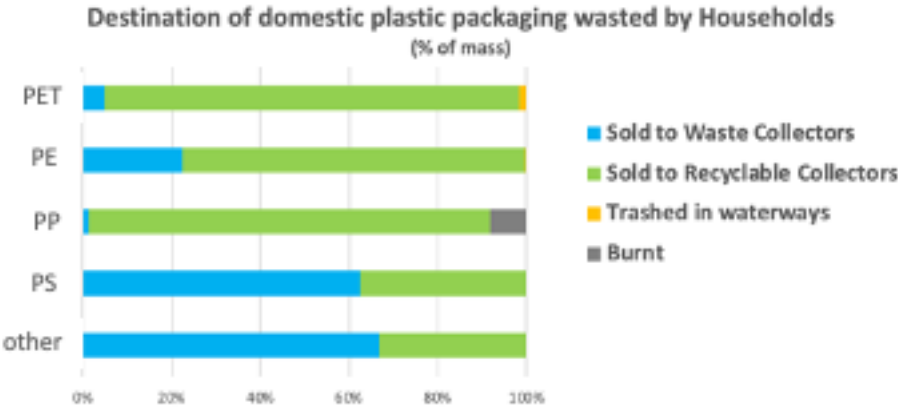


Figure 17: Destination of domestic plastic packaging waste at household per sorted plastic type recorded by PlasticGO App.

2. Retail shops

The plastic packaging composition at retail shops was qualified using the microPHAZIR. A total of 47 plastic packaging items was measured at two retail shops over the three weeks survey (Figure 18).

PE and PP are the **most abundant** plastic waste polymers measured at retail shops (17% and 15% respectively). PET is less abundant and represents 9% of the counted plastics. Overall, **45% of the plastic tested and wasted at retail shops is of interest for the recycling sector**. It is important to highlight that no sorting at source is performed at surveyed retail shops.

The other plastics represent a percentage of 55%. They are composed of PA, PMMA, PLA and of unidentified polymers with low matching coefficient.

PLASTIC PACKAGING POLYMER AT RETAIL SHOPS
BY MICROPHAZIR
N=47

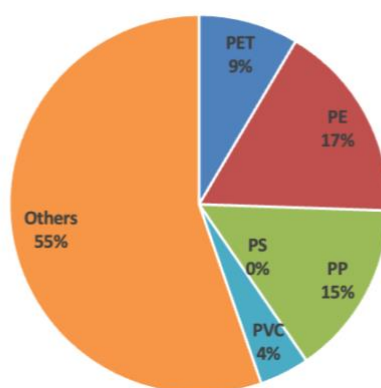


Figure 18: Type of polymers of plastic packaging measured by microPHAZIR during the three weeks survey at retail shops of Long Thoi commune. The results are expressed in count percentage of respective polymer category.

3. Supermarkets

The plastic packaging composition at supermarkets was qualified using the microPHAZIR. A total of 84 plastic packaging items was measured at two supermarkets over the three weeks survey (Figure 19).

PE is the most abundant plastic waste polymer and represented **37%** of the waste. PP, PVC, and PET are less abundant and represent respectively 11%, 8% and 6% of the counted plastics. Overall, **63% of the plastic tested at supermarkets are of interest for the recycling sector**. It is important to highlight that no sorting at source is performed at the surveyed supermarkets.

The other plastics represent a percentage of 37% and are composed mostly of PA (15%), PMMA, and POM.

PLASTIC PACKAGING POLYMER AT SUPERMARKET
MEASURED BY MICROPHAZIR
N=84

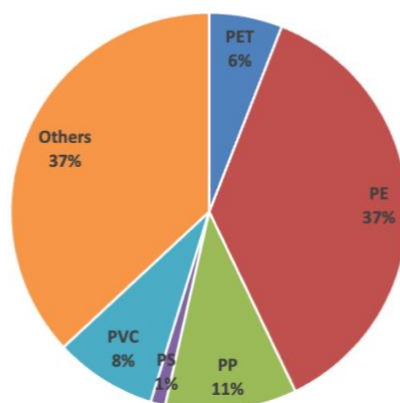


Figure 19: Type of polymers of plastic packaging measured by microPHAZIR during the three weeks survey at supermarkets of Long Thoi commune. The results are expressed in count percentage of the respective polymer category.



Summary

- » The plastic identification and polymer sorting (PET, PE, PP, PS, PVC) by households themselves is difficult, even using the resin identification code or the plastic user guide that we conceived based on most popular plastic waste. Therefore, a sorting of plastic polymer is not recommended for sorting-at-source by waste generators.
- » The plastic polymer identification by microPHAZIR is a reliable tool which present limitations when the waste is dirty, crinkled or covered by labels. The polymers identified with low matching coefficient can thus be important and were represented in the category 'others'.
- » Households, retail shops and supermarkets have specific plastic packaging waste composition, which is due to their specific use:
 - Households wasted in counts mainly PET (27%) and PE (27%)
 - Retail shops and supermarkets wasted mainly PE (17% and 37% respectively) and PP (15% and 11% respectively)
- » Households are selling the valuable plastic waste to recyclable collectors, when they are not collected by waste collectors
- » The part of valuable and easy to recycle plastic packaging is high at waste generators showing the necessity to sort the waste at the waste generator level by trained waste collectors in order to achieve the recycling rate defined in the Decree No. 08/2022/ND-CP.

B. Gathering points and recyclable collectors

In Long Thoi Commune, the gathering point, located at the South of the Commune, is gathering all the domestic waste collected daily by the WC of the cooperative. Before the transport of the waste to the landfill, the domestic waste is sorted by the RC. The RC are purchasing the recyclable and valuable waste from the WC and are later on selling them to aggregators. Therefore, when RC are sorting and purchasing the recyclable waste at gathering points the domestic waste sent to the landfill should contain few valuable recyclable waste, including plastics.

The RC have specific criteria to characterize the valuable and recyclable plastics. The criteria are based on the plastic's:

- **Application:** bottle and plastic bag are considered as more valuable (even if for recyclers, plastic bags are non-valuable plastics)
- **Color:** transparent plastics are more valuable than colored plastics
- **Touch:** the RC evaluate the quality by touching it, the feeling of valuable or non-valuable plastic is based on their sense and their past experience
- **Cleanliness:** dirty plastics are less valuable.

The purchase price of plastic depends thus on those criteria and is **defined by RC**. Households and WC rarely bargain the price. During the survey, RC purchased plastics made of **PET, PE, PP** from gathering points and households. They did not buy PS, PVC, and multilayers.

Nevertheless, the purchase price varied daily, showing a **price volatility**. The price for **PE and PET varied from 4,500 VND per kg to 6,000 VND per kg** while the price for **PP varied from 4,000 VND per kg to 6,000 VND per kg** (Figure 20).

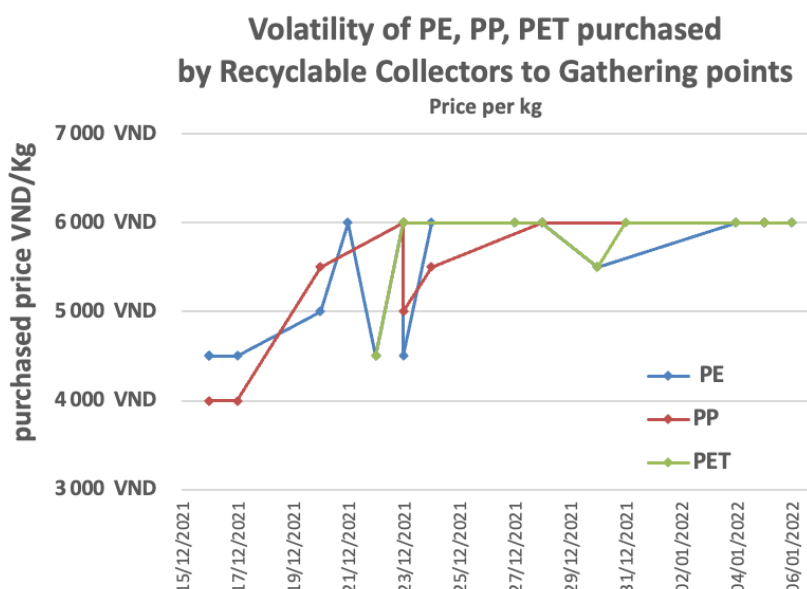


Figure 20: Purchased price volatility of PE, PP, PET during the survey. Plastics were purchased by recyclable collectors to waste collectors at gathering points. Data were achieved by PlasticGO app.

The **price volatility** is linked to the selling plastic price between RC and the aggregators. RC are **adjusting daily** the purchased plastic price: they try to buy at the lowest price to make **profit** and have a good income. The RC **do not have book accountancy** to record the

transactions, all is based on their memory. Households and WC are not aware of the market price volatility.



Summary

- » Recyclable collectors play a key role in domestic solid waste management, even their informal status. They participate actively to the decreasing plastic waste sent to landfills and leaked to the environment
- » RC are sorting and purchasing recyclable waste at households and gathering points and are selling them to aggregators.
- » RC have their own criteria to categorize valuable and non-valuable plastic, which may differ from the criteria of recyclers.
- » RC depend on the plastic market price and its price volatility.
- » RC have no accountancy. Therefore, it is impossible to monitor the recyclable plastic waste managed by RC.

C. Aggregators

Plastic categorization and definition

Nine aggregators are located in Long Thoi Commune and are purchasing the recyclable wastes, including plastics. They buy the plastics that seem valuable to them and easy to sell to recyclers. Aggregators have their **own definition** to categorize the recyclable plastic waste. They did not follow any training to sort the waste and their categorization does not rely on polymer types or the plastic's application. It is only based on their **past-experience** and they categorize the plastic into "**living**" plastic or "**dead**" plastic:

"Living" plastic: valuable plastic

- Plastic bags 'nylon': high economical value (even if they are not for recyclers)
- PET bottle: high economical value
- Colored soft plastic (bottles)
- Colored hard plastic: low economical value, half the price of the PET bottle

"Dead" plastic: low value plastic

- Homogeneous hard black plastic
- Remaining plastics.

The aggregators are sorting the plastic waste in pile according to the above categories. To sort the dead versus the living plastics, aggregators are placing them in water: the living plastic will float on the surface while the dead plastic will sink. Sometimes, some living plastic made of HDPE sinks. In that case, aggregators are using salty water to conduct the plastic flotation test.

The status of **valuable** and **non-valuable plastic** depends also on the aggregators' **own criteria**, based on their past-experience.

Valuable plastic:

- Often used by households
- Available in large quantity
- Simple plastic composition
- Technically easy to recycle
- Can be recycled in different products

Low valuable plastic:

- Technically difficult to recycle
- Complex composition with low rate of recyclable plastic
- Costly to recycle
- Not purchased by recyclers

The plastic packaging composition at the aggregators' sites was measured by microPHAZIR over a total of 903 plastic packaging over the three weeks survey (Figure 21).

PE, PP and PET are the **most abundant** plastic waste polymer but they are not dominating the waste composition in count, only 54% of the sorted plastic waste in count with respectively 28%, 14% and 12% of the counted plastics. **Non-recyclable and difficult-to-recycle plastics are found** at aggregators: 9% are PS, 4% PVC, and other plastic represent 33% of the counts (including PMMA, PA, POM and unidentified polymers).

PLASTIC PACKAGING POLYMER AT AGGREGATORS
MEASURED BY MICROPHAZIR
n=903

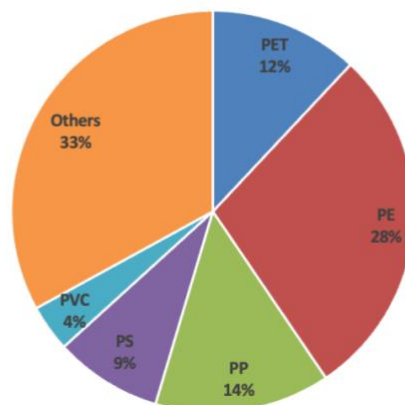


Figure 21: Type of polymers of plastic packaging measured by microPHAZIR during the three weeks survey at aggregators of Long Thoi commune. The results are expressed in count percentage of the respective polymer category.

The representativity in counts of PE, PP and PET was surprising. In fact, knowing the sorting performed by the RC and by the aggregators themselves, we were looking for a higher rate of easily recyclable plastics at aggregators. We were also not expecting to measure bio-based plastics (PLA, PA).

This 'low representativity' may be due to the **various definitions and categorizations** of **what a recyclable plastic is** along the value chain. The definition differs at the three steps of the value chain studied: households, recyclable collectors and aggregators. It is also due to the

lack of technology to perform the sorting: the sorting is always manual and based on touch or visual inspection.

Price volatility

The price volatility of **PE, PET and PP** were recorded during the three weeks survey using PlasticGO app. Similar trends were observed for the three polymers (Figure 22).

Both purchased price and selling price are **fluctuating daily** and the market defines the price. Aggregators are daily in contact with recyclers and transporters and are daily negotiating the prices. The median profit observed for all polymers is of 25%.

Nevertheless, we have a low confidence on price values given by aggregators. At first, surveyed aggregators have no accountancy. Secondly, we can notice that the purchased price given by aggregators are similar to the price purchased by recyclable collectors to waste generators & gathering points, meaning that the RC will not do any profit on the transaction. We rather assume that, according to their absence of business status, aggregators are reporting lower purchasing and selling prices but that the profit made can be realistic.

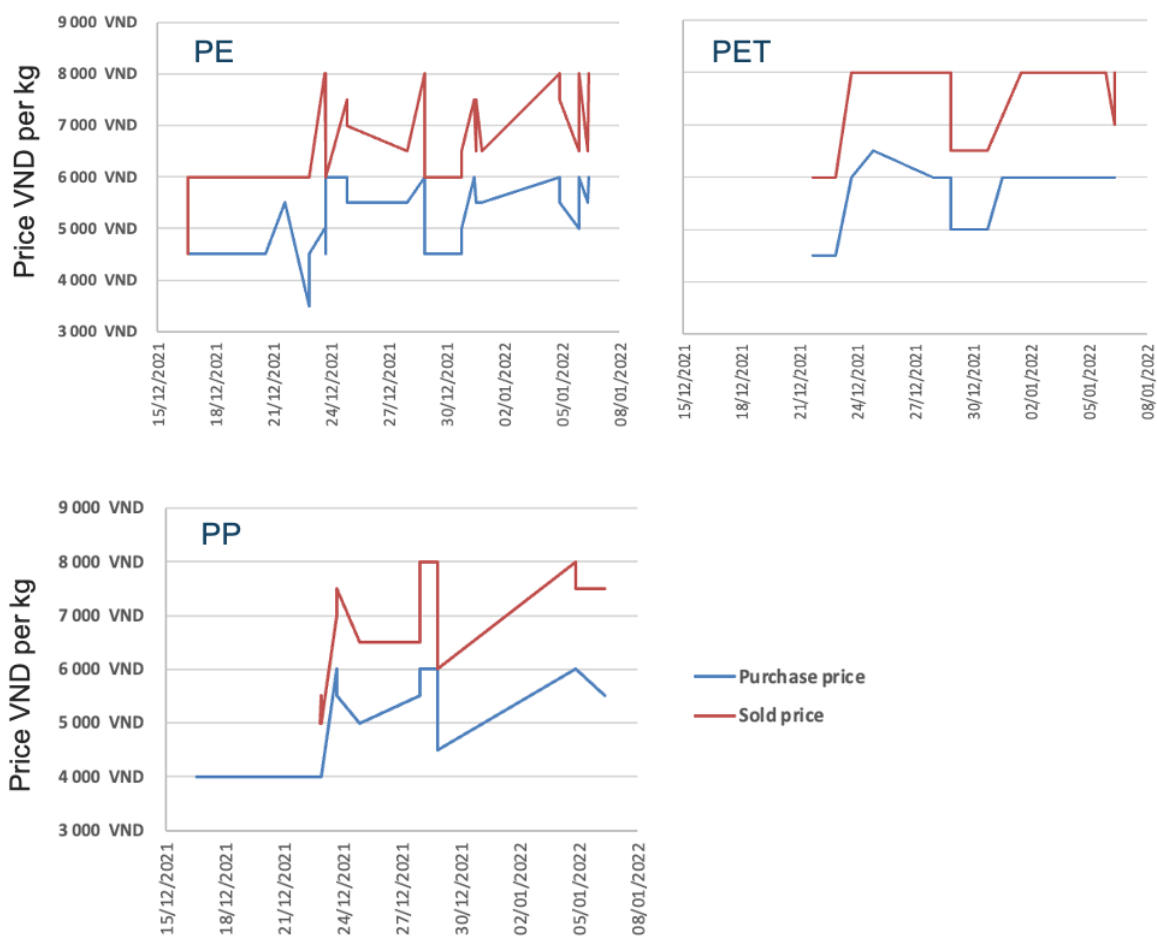


Figure 22: Price volatility in VND per kg of PE, PET and PP recorded at aggregators during the three weeks survey with PlasticGO app.



Summary

- » Aggregators have their own definition and sorting of valuable and non-valuable plastics, which differ from the ones of the recyclable collectors and may differ from the definition and needs of recyclers.
- » PE, PP (14%) and PET were the most common polymers identified in count at aggregators.
- » Unexpectedly, difficult to recycle plastics were measured at aggregators.
- » Purchased and sold PE, PET and PP price volatility is important and fluctuate daily.
- » Aggregators have no accountancy: the monitoring of plastic waste transiting at aggregators cannot be realized.

II. Lessons learnt and recommendations

1. The **concept of EPR** and the contents of the decree were **unknown for all stakeholders**: DSW management, waste generators, collectors (DSW and recyclable), and aggregators



Recommendation

Training to present the EPR concept, the decree and the role of DSW is mandatory to achieve a successful EPR implementation.

2. The **sorting at source** of waste generators is still **scarce** and **inefficient**. During our survey, we noticed that the **motivation** for sorting at source can be improved by clear instruction with guidelines, personal or collective training and financial contributions (by selling the waste).



Recommendation

The EPR scheme should fund a **sorting at source campaign** to raise the awareness of the waste generators. The **EPR Office/Council** should also **advise** the domestic solid waste management departments of DONRE on different options of **waste sorting guidance**, in order to have sorting guidance, which are adapted to the Decree and which will contribute to reach the recycling target.

3. The **criteria** defining the categories of recyclable waste vary along the post-consumer plastic packaging value chain. Those criteria are not based on technical features linked to the recycling activity but rather on visual characteristics, i.e. format, cleanliness, colour, and physical nature defined by the sense of touch. This **lack of unified categorization** along the value chain and of **criteria relying on recyclability** is a **weakness** for the overall recyclability.



Recommendation

The categories of plastic packaging and products defined under the EPR scheme in the Appendix XXII should be the **reference** of **categorization** to be used by aggregators. **Aggregators should be trained** to use this categorization in order to reach the recycling targets set up by MONRE. **Recyclable collectors should** also be informed or even **trained** about this categorization in order to **collect the valuable packaging**.

4. The plastic waste composition of waste generators in a rural district contains **50% of recyclable plastic packaging**. The collection of the plastic waste is not **traceable** as it involves recyclable collectors and aggregators, and as plastic waste is sorted at gathering points and sold to recyclable collectors.



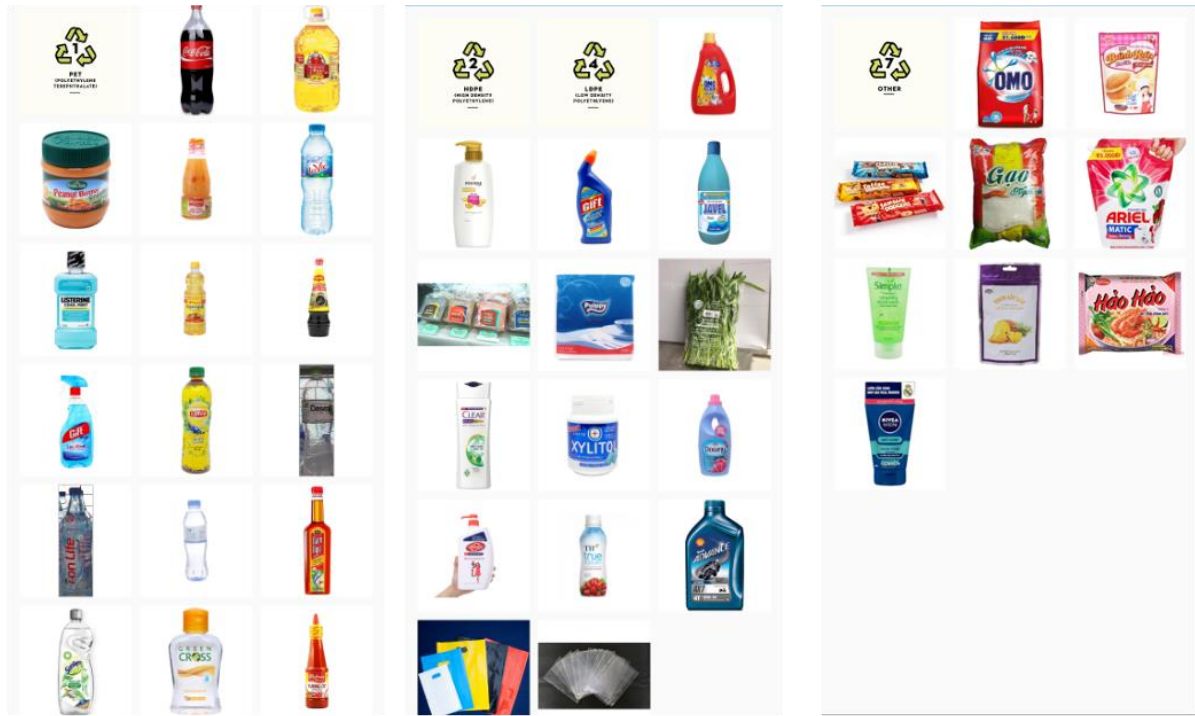
Recommendation

To fulfill the recycling target set up by MONRE, the collection of recyclable waste must be traceable and the volume of packaging recycled must be **auditable**, which is not the case **of the recyclable waste of the pilot site studied here**.

Currently, the boundary between the recyclable waste system and the remaining waste system is unclear and remains unclear. To reach the recycling target, this boundary must be clarified and the role and part of the value chain played by the informal sector must be traceable. Considerations on **how to make the recyclable waste traceable and auditable** should be expressed by MONRE in the next two years to achieve the recycling targets.

Annex 1:

Screenshot of PlasticGo app of plastic used daily by households and sorted by polymer category (1: PET; 2 and 4: PE; 3: PVC; 5: PP; 6: PS; 7: others), based on the logo put on the packaging.



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- Factsheet M1: identifying plastic packaging polymers in waste. Pilot Project: Enhancing plastic packaging collection, sorting and recycling in Ho Chi Minh City; Rethinking Plastics – Circular Economy Solutions to Marine Litter.
- Factsheet M2: PlasticGO: an app to facilitate waste audit. Pilot Project: Enhancing plastic packaging collection, sorting and recycling in Ho Chi Minh City; Rethinking Plastics – Circular Economy Solutions to Marine Litter.

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