



RENATA SIMATUPANG FOR USAID EGSA

# PLASTIC AND RECYCLING INDUSTRY OUTLOOK IN INDONESIA

An Assessment on Capacity and Capability

Economic Growth Support Activity, September 2022

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An Assessment on Capacity and Capability

Contracted under 7200AA18D00010 Task No. 72048719F00006

Economic Growth Support Activity, September 2022

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- Plastic Associations:
  - The Indonesian Olefin, Aromatic and Plastic Industry Association (INAPLAS)
  - The Indonesian Woven Polyolefin Manufacturers Association (GIATPI)
  - The Indonesian Upstream Plastic Industry Association (APHINDO)
- Plastic Recycling Associations:
  - The Indonesian Plastics Recycling Association (ADUPI)
  - The Indonesian Association of Waste Entrepreneurs (APSI)
  - The Indonesian Plastic Recyclers (IPR)
- Tarpaulin Manufacturers:
  - PT Unggul Karya Semesta
  - PT Sami Surya Perkasa
  - PT Hesheng Plastic Industrial
- Plastic Recycling Experts:
  - Dr. Asmuwahyu Saptorahardjo
  - Mr. Arif Abidin, Plastic Pay
- Ministry of Industry
  - Director of Upstream Chemical Industry and Pharmacy – Mr. Saiful Bahri
- Ministry of Environment and Forestry
  - Director of Waste Management – Dr. Ir. Novrizal Tahar

## EXECUTIVE SUMMARY

USAID assigned the Economic Growth Support Activity (EGSA) with a formative study or market research focusing on the capacity and capabilities in producing heavy-grade plastic sheeting in Indonesia. The heavy-grade plastic sheeting is one of the commodities utilized by the USAID Bureau for Humanitarian Assistance (BHA) for disaster assistance and is currently being produced in the United States (US).

Indonesia is known as one of many countries that is prone to natural disasters. Similarly, other countries in Southeast Asia are also prone to disasters due to their proximity to the “ring of fire” volcanic belt, rapid rate of deforestation and deteriorating watershed, forest fires, and tropical cyclones. To strengthen USAID’s disaster response in the region, BHA is exploring options to deliver disaster relief in a more cost and time efficient manner while contributing to USAID’s global effort to reduce plastic waste and ocean plastic pollution. Therefore, this study will explore Indonesia’s capacity and capability to produce the plastic sheeting used by USAID disaster relief assistance for temporary shelter for victims, including the use of plastic waste as a part of the raw material composition.

The objective of this research is to assess Indonesia’s capacity to produce shelter-grade plastic sheeting (rolls and/or tarpaulins), which would be comparable to the product that is currently produced for USAID BHA in the US. Moreover, the research will assess the country's capability to recycle used plastic sheeting and profile of waste generated to inform USAID’s decision making for moving plastic sheeting production to Indonesia.

A team of two consultants was provided by EGSA to conduct the research. In conducting the research, the team employed qualitative participatory research methodology with four data collection approaches, namely literature review, key informant interviews (KII), in-depth interviews, and on-site observations at manufacturers’ factories. This report covers the research work between July 1, 2022, through September 12, 2022.

Data was collected and analyzed using a qualitative and semi-structured questionnaire. The data sources include documents, key-informant interviews, and field observation of plastic manufacturers. A total of 35 pieces of literature was reviewed and 23 interviews were conducted.

## SUMMARY CONCLUSIONS

The following are the main conclusions of this research, presented on a question-by-question basis.

### QUESTION I

**What is the current state of plastic sheet manufacturing in Indonesia? How likely can it be produced, who are the key players and what is the production capacity?**

Indonesia currently has 13 plastic sheeting manufacturers that produce tarpaulin with varied mechanical and physical properties. The production capacity is around 2,600 tons of tarpaulins every month. Therefore, it is very likely to produce plastic sheeting in the form of tarpaulin in Indonesia.

The raw material for plastic sheeting is produced by the largest petrochemical company in Indonesia called PT Chandra Asri Petrochemical Tbk, located in Serang, Banten. All of the petrochemical companies that support plastic sheeting manufacturers are organized by the Indonesian Olefin,

Aromatic, and Plastic Industry Association (INAPLAS), the largest upstream plastic association in the country.

The Ministry of Industry's directorate of downstream chemical and pharmaceutical industry has implemented several regulations to support the tarpaulin industry, such as ensuring the use of local materials (*Tingkat Komponen Dalam Negeri/TKDN*) and ensuring the availability of the raw materials needed.

The 13 local tarpaulins manufacturers have been providing nation-wide demand of tarpaulins such as outdoor covering, protective items, and temporary shelters.

## **QUESTION 2**

**What is the current state of recycling capabilities in Indonesia? What is the profile of plastic waste generated from plastic sheet production, and which type would be economically viable to recycle given the current demand and cost?**

The plastic recycling industry in Indonesia has existed for decades as small-scale industries producing low quality household amenities such as buckets, water dippers, plastic bags, and brooms. According to the Indonesian Association of Waste Entrepreneurs (APSI), the capacity of the plastic recycling industry was around 2 million tons per year in 2019, while the recycling industry only supplied around 1.1 million tons due to the shortage of segregated plastic waste. Furthermore, only 10% of plastic waste was recycled in 2019 and mostly in the form of rigid plastic, polyethylene terephthalate (PET), high density polyethylene (HDPE), low density polyethylene (LDPE), and polypropylene (PP). Meanwhile, flexible plastics are commonly burned or dumped as they are not economically feasible to be recycled.

Based on our interviews with the three tarpaulin manufacturers that can meet USAID BHA specification requirements, the manufacturers use HDPE plastic waste with different formulations; PT Sami Surya Perkasa uses post-industrial plastic waste with up to 15% composition, PT Unggul Karya Semesta uses post-industrial plastic waste with up to 25% composition, and PT Hesheng Plastic Industrial uses post-consumer plastic waste with up to 50% composition. The aforementioned percentage of waste is based on the company's analysis on economic viability determined by each company's demand and cost.

The main challenges faced by the recycling industry include the price dependency on virgin plastic price fluctuation, low segregation rate from households, unfavorable perception towards recycled products, low capacity of local governments in creating effective municipal waste management systems, and no incentives given to the recycling industry.

## **QUESTION 3**

**Does Indonesia have the capability and technology to manufacture plastic sheeting using some recycled content, particularly with HDPE or similar high-density plastic? What is the capacity?**

Indonesia is capable of and has the technology for manufacturing plastic sheeting using recycled content with the capacity of approximately 880 tons per month from three different tarpaulin manufacturers. Based on interviews with the tarpaulin manufacturers, the use of recycled plastic is not a widespread practice due to its complex supply chain and inconsistent quality of recycled plastic. The major concern for using recycled plastic is the level of impurities that can cause negative



effects to the mechanical properties of products, such as tensile strength, tear strength, and durability.

The machinery used for virgin HDPE plastic does not differ from those used for recycled HDPE plastic, therefore this should not inhibit the ability of manufacturers to produce plastic sheeting with HDPE recycled content. The issue lies in the pre-treatment requirement to ensure that the quality of recycled HDPE plastic meets the standards for cleanliness and consistency. One manufacturer, PT Hesheng Plastic Industrial, stated that they could use up to 50% of post-consumer HDPE plastic waste in the form of plastic bottles, plastic bottle lids, and other types of plastic waste. The manufacturer purchases recycled plastic flakes from local waste collectors and combines it with virgin HDPE plastic to produce tarpaulins.

## **RECOMMENDATIONS AND NEXT STEPS**

USAID might want to consider conducting additional research on market feasibility, financial feasibility, business processes, and enabling environment of Indonesia's regulatory framework to fully inform its decision on moving plastic sheeting production to Indonesia. The results of the research can be presented in a workshop where key stakeholders can provide ideas and identify action plans to meet the needs of USAID. USAID's EGSA team can facilitate the workshop, as well as work with the Mission to develop an action plan towards meeting USAID BHA objectives. Additional recommendations are as follows:

1. Many informal waste management sectors involve child labor and human trafficking (Sasaki et al., 2019). Developing a traceability system will be necessary to verify the origin of the plastic waste collected. While acquiring plastic waste from the informal sector contributes to improving the livelihood of scavengers, it is important to ensure that no harmful economic and social practices occur in the value chain.
2. A complete life cycle assessment needs to be conducted to understand the whole effect on the environment from acquiring, processing, using, and especially disposing polythene tarpaulins. While acquiring recycled material can potentially reduce carbon emission by 30%, a scenario of disposing the tarpaulins needs to be considered. No previous research has been conducted on the impact of using ultraviolet (UV) inhibitors and flame-retardant additives to the capability of recycling tarpaulins.
3. Consider providing mosquito insecticide as an additive in plastic sheeting. Many studies showed a positive association between climate change and mosquito-borne disease risk, especially in tropical countries such as Indonesia (Franklinos et al., 2019). Spraying canvas tents with residual pyrethroid insecticide is an established method of malaria vector control in tented refugee camps. Advances in technology enable polythene sheeting to be impregnated with pyrethroid during the manufacturing process. Previous work has shown that top-sheets and blankets treated with residual pyrethroid can be a useful tool against malaria and cutaneous leishmaniasis (Rowland et al., 1999).

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## ACRONYMS

ABS	Acrylonitrile Butadiene Styrene
ADUPI	The Indonesian Plastics Recycling Association
APHINDO	The Indonesian Upstream Plastic Industry Association
APSI	The Indonesian Association of Waste Entrepreneurs
BHA	Bureau for Humanitarian Assistance
CAGR	Compound Annual Growth Rate
COVID-19	Corona Virus Disease
CS	Cable Set
CSR	Corporate Social Responsibility
EPR	Extended Producer Responsibilities
F&B	Food and beverages
GIATPI	The Indonesian Woven Polyolefin Manufacturers Association
HDPE	High-Density Polyethylene
INAPLAS	Indonesian Olefin, Aromatic, and Plastic Industry Association
IPR	The Indonesian Plastic Recyclers
KII's	Key Informant Interviews
LDPE	Low-Density Polyethylene
LLDPE	Linear Low-Density Polyethylene
MSW	Municipal Solid Waste
PET	Polyethylene Terephthalate
PP	Polypropylene
PPN	<i>Pajak Pertambahan Nilai</i> (Value Added Tax)
PS	Polystyrene
PVC	Polyvinyl Chloride
P3DN	<i>Peningkatan Penggunaan Produksi Dalam Negeri</i>
TKDN	<i>Tingkat Komponen Dalam Negeri</i>
TPS	<i>Tempat Pembuangan Sampah Sementara</i>
USAID	United States Agency for International Development
UV	Ultraviolet

## **I. BACKGROUND**

USAID assigned the Economic Growth Support Activity (EGSA) with market research focusing on the capacity and capabilities in producing a heavy-grade plastic sheeting in Indonesia. This heavy-grade plastic sheeting is one of USAID Bureau of Humanitarian Assistance (BHA) commodities utilized for disaster assistance to provide temporary cover for damaged roofs and walls, as well as other emergency applications as appropriate. USAID BHA currently uses a type of High-Density Polyethylene (HDPE) for this plastic sheeting, which is produced in the United States (US).

Indonesia is known as one of many countries that is prone to natural disasters. Similarly, other countries in Southeast Asia are also prone to disasters due to their proximity to the “ring of fire” volcanic belt, rapid rate of deforestation and deteriorating watershed, forest fires, and tropical cyclones. To strengthen USAID’s disaster response in the region, BHA is exploring options to deliver disaster relief in a more cost and time efficient manner while contributing to USAID’s global effort to reduce plastic waste and ocean plastic pollution. Therefore, this study includes a question to explore the use of plastic waste as part of the raw material composition.

This study is designed in phases with the final objective of informing USAID/BHA on the feasibility of moving the production of heavy-grade plastic sheeting from the US to Indonesia. The first phase of this study is structured to explore Indonesia’s capacity to manufacture plastic sheeting with USAID BHA standards and capability to recycle the waste generated. The results from this phase will inform USAID/BHA’s decision on moving plastic sheeting production, and the necessity to conduct follow-on studies on market and financial feasibility aspects of producing plastic sheeting in Indonesia which are not addressed in this study.

## **2. SCOPE AND ACTIVITY PURPOSE**

The purpose of this research is to assess Indonesia’s capacity to produce shelter-grade plastic sheeting (tarpaulins) which would be comparable to those that are produced for USAID BHA in the US.

The objectives of this research are as follows:

1. Assessing the capacity to produce plastic sheeting according to USAID BHA standards in Indonesia.
2. Assessing Indonesia's plastic recycling capabilities.
3. Assessing the capability to manufacture plastic sheeting using some recycled content.

This research will identify existing technology, capacity, and capability to produce plastic sheeting with some recycled content in Indonesia. The research findings and recommendations will inform USAID/BHA about:

1. The condition, status, and technology in producing plastic sheeting in Indonesia to meet USAID specifications and safety requirements, and
2. Relevant information for decision-making on next steps.

### 3. RESEARCH METHODOLOGY

#### 3.1 METHODOLOGY

The authors used a qualitative participatory research methodology with four different data collection approaches consisting of literature reviews, online interviews, in-depth interviews, and field observations that were conducted for three months from July to September 2022. The methodology is further detailed in Table 1.

TABLE 1. RESEARCH METHODOLOGY			
OBJECTIVES	OPERATIONAL VARIABLES	APPROACHES	ANALYSIS METHOD
Assess the capacity of producing plastic sheeting in Indonesia	Current conditions, key players, supply chain, value chain, regulations, and technology	1. Literature review 2. Key-informant Interviews 3. In-depth Interviews	Descriptive analysis
Assess Indonesia's recycling capabilities	Current conditions, key players, supply chain, value chain	1. Literature review 2. Key-informant Interviews 3. In-depth Interviews	Descriptive analysis
Assess the capability of manufacturing plastic sheeting using some recycled contents	Regulations, technology, and recycling capacity	1. In-depth Interviews 2. Observations	Descriptive analysis

First the authors conducted desk research and literature reviews to assess the capacity of plastic sheeting and plastic recycling industries, supply chain, value chain, existing regulations, and technology used by the industries in Indonesia. Upon identifying the key players in both plastic and recycling industries, the authors conducted key informant interviews (KII) with the board of directors from industry associations and relevant stakeholders. The key findings gathered from the literature reviews and KII were analyzed using a descriptive analysis method to respond to the research questions as follows:

1. What is the current state of plastic sheet manufacturing in Indonesia? How likely can it be produced, who are the key players and what is the production capacity?
2. What is the current state of recycling capabilities in Indonesia? What is the profile of plastic waste generated from plastic sheet production, and which type would be economically viable to recycle given the current demand and cost?
3. Does Indonesia have the capability and technology to manufacture plastic sheeting using some recycled content, particularly with HDPE or similar high-density plastic? What is the capacity?

To answer the research questions, the authors conducted a data collection approach with detail framework as shown in Table 2.

**TABLE 2. DATA COLLECTION APPROACHES**

TYPE OF APPROACHES	OPERATIONAL VARIABLES	SOURCES OF DATA	OUTPUTS
Literature review	<ul style="list-style-type: none"> <li>a. Current condition</li> <li>b. Key players</li> <li>c. Supply chain</li> <li>d. Value chain</li> <li>e. Technology</li> <li>f. Regulations</li> <li>g. Sustainability</li> </ul>	<ul style="list-style-type: none"> <li>• Academic journals</li> <li>• Government press releases</li> <li>• General and trade press</li> <li>• Published reports</li> <li>• Directories</li> </ul>	<ul style="list-style-type: none"> <li>• Draft of plastic and recycling industry outlook</li> <li>• List of plastic industry associations</li> <li>• List of plastic recycling industry associations</li> <li>• List of plastic recycling experts</li> </ul>
Key-Informant Interviews (KII)	<ul style="list-style-type: none"> <li>a. All data gathered from literature reviews</li> <li>b. USAID technical requirements</li> <li>c. USAID test specifications</li> </ul>	<ul style="list-style-type: none"> <li>• 3 plastic industry associations</li> <li>• 3 plastic recycling industry associations</li> <li>• 2 experts</li> </ul>	<ul style="list-style-type: none"> <li>• Updated plastic and recycling industry outlook</li> <li>• Potential tarpaulin manufacturers</li> </ul>
In-depth Interviews	<ul style="list-style-type: none"> <li>a. All data gathered from the KII</li> <li>b. USAID technical requirements</li> <li>c. USAID test specifications</li> </ul>	<ul style="list-style-type: none"> <li>• 13 potential tarpaulin manufacturers</li> </ul>	<ul style="list-style-type: none"> <li>• Updated plastic and recycling industry outlook</li> <li>• Updated tarpaulin manufacturers</li> </ul>
Observations	<ul style="list-style-type: none"> <li>a. All data gathered from the in-depth interviews</li> <li>b. USAID product specifications</li> <li>c. USAID safety requirements</li> </ul>	<ul style="list-style-type: none"> <li>• 3 selected tarpaulin manufacturers</li> </ul>	<ul style="list-style-type: none"> <li>• Updated plastic and recycling industry outlook</li> <li>• List of tarpaulin manufacturers that meet the requirements</li> </ul>

The authors carried out literature reviews on eighteen academic journals, six official documents from international organizations, four official websites, four published reports, and one corporate website. The aim of the literature review was to (1) summarize and analyze previous research, theories and evidence on plastic manufacturing and recycling in Indonesia, (2) provide a firm foundation and understanding of plastic manufacturing and recycling, (3) identify the existing technology to produce heavy grade plastic sheeting, (4) determine the key actors of plastic manufacturing and recycling, and (5) provide a critical outlook of the current plastic recycling ecosystem and regulations.

After gathering all data from the desk research, the authors conducted key informant interviews (KIIs) with the relevant stakeholders as mentioned below. The KIIs were done online for 60 minutes each and interview question guidelines were prepared for each list (see Annex 1-3). The objectives of the KIIs are (1) to validate the data gathered from the literature review, and (2) to identify potential tarpaulin manufacturers. The key informants were as follows:

1. Plastic Associations:
  - a. The Indonesian Olefin, Aromatic and Plastic Industry Association (INAPLAS)
  - b. The Indonesian Woven Polyolefin Manufacturers Association (GIATPI)
  - c. The Indonesian Upstream Plastic Industry Association (APHINDO)
2. Plastic Recycling Associations:
  - a. The Indonesian Plastics Recycling Association (ADUPI)
  - b. The Indonesian Association of Waste Entrepreneurs (APSI)

- c. The Indonesian Plastic Recyclers (IPR)
- 3. Tarpaulin Manufacturers:
  - a. PT Unggul Karya Semesta
  - b. PT Sami Surya Perkasa
  - c. PT Hesheng Plastic Industrial
- 4. Plastic Recycling Experts:
  - a. Dr. Asmuwahyu Saptorahardjo (plastic industry expert recommended by the National Research and Innovation Agency/BRIN)
  - b. Arif Abidin from Plastic Pay
- 5. Ministry of Industry
  - a. Director of Upstream Chemical Industry and Pharmacy – Saiful Bahri
- 6. Ministry of Environment and Forestry
  - a. Director of Waste Management – Dr. Ir. Novrizal Tahar

During the KII, the informants recommended thirteen potential manufacturers that currently produce plastic tarpaulins. The recommended manufacturers were then called for in-depth interviews as the third stage of data collection.

The in-depth interviews were also conducted online for 60 minutes each and an interview guideline for the manufacturers was also prepared (Annex 4). The aim of the in-depth interviews was to: (1) validate the data gathered from literature review and KIIs, and (2) discuss their tarpaulin specifications, price ranges, and capability in producing heavy-grade plastic sheeting based on USAID BHA's technical requirements and test specifications.

To analyze the data gathered from the in-depth interview, the authors utilized a two-by-two matrix diagram to filter manufacturers by their capability to meet USAID BHA standards. Each axis was divided into two sections; (1) manufacturers that use black woven HDPE with white LDPE coating, and (2) manufacturers that produce heavy grade tarpaulins at a minimum size of 2x6-meters.

The result of the in-depth interviews was a list of manufacturers that are able to produce tarpaulins that meet USAID's technical requirements and test specifications. The last data collection method was field observations of three tarpaulin manufacturers that matched USAID BHA tarpaulin specification. The observations were conducted onsite for about 120 minutes in each manufacturer, and an observation checklist was prepared (Annex 5). The aim of the observation was (1) to validate the data gathered from the previous data collection methods, (2) to discuss USAID BHA's technical requirements and test specifications, (3) to have a record of all the machinery needed, and (4) to get a sample of the tarpaulins produced.

### **3.2 ASSESSMENT LIMITATION**

The scope of this research is limited to exploring Indonesia's capacity to manufacture plastic sheeting with USAID BHA standards and capability to use some recycled content. Additional research on market feasibility, financial feasibility, and enabling environment will be needed to fully inform USAID's decision on moving the production of plastic sheeting to Indonesia.

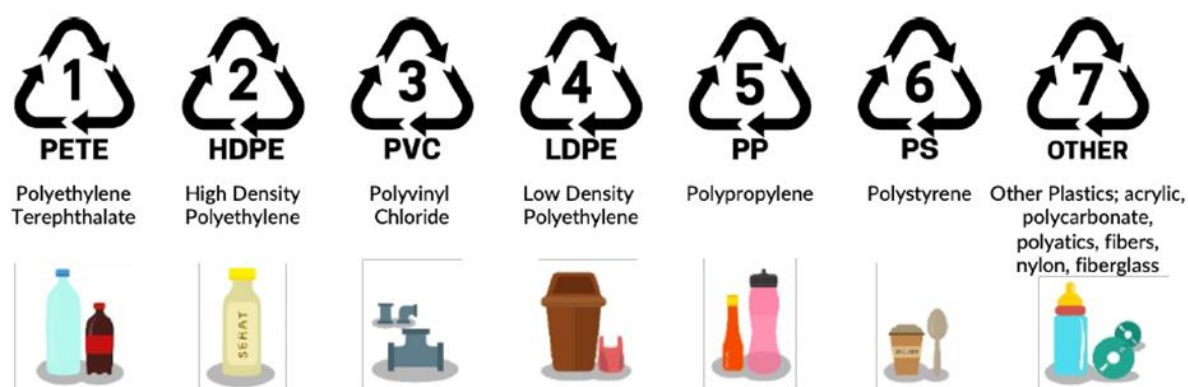
## 4. ASSESSMENT FINDINGS AND DESCRIPTIVE ANALYSIS

### 4.1 PLASTIC INDUSTRY OUTLOOK

The Indonesian plastic industry continues to see business opportunities amidst challenges caused by the COVID-19 pandemic. The pandemic has driven the Indonesian plastic industry to renew its commitment to carry out a sustainable strategy for future growth. Indonesia's economy is expected to grow by 5% in 2022 and 5.2% in 2023 as domestic demand continues to recover, with the manufacturing sector being the biggest contributor to the country's economic growth (Asian Development Bank, 2022). The production of plastic products continues to increase due to high demand from end-user industries such as packaging, electrical, electronics, and construction, which drives the Indonesian plastic market. Indonesia's demand for plastic has increased from the packaging sector. According to the recent market report from Mordor Intelligence (2022), the Food and Beverage (F&B) packaging sector is proven to be the largest user of plastic in Indonesia, accounting for 65% of the total plastic consumption. The packaging industry in Indonesia was valued at USD 9.6 billion in 2020. Plastic products are widely used by industries such as the F&B packaging industry.

According to their chemical structure and thermal behavior, there are 7 types of plastic that are available in the market as depicted in Figure 1.

Figure 1. Types of Packaging Plastic



Source: Plastic Oceans International, 2021

1. **Polyethylene Terephthalate (PET)** is a type of plastic that is lightweight and durable. This type of plastic is mostly used to produce drink bottles (water, soda, etc.) and food packaging. This is a single-use type of bottle and should not contain hot water.
2. **High Density Polyethylene (HDPE)** is a strong and rigid type of plastic. It is usually used to produce shampoo bottles, liquid soap bottles, and shopping bags. This type of plastic is not reusable.
3. **Polyvinyl Chloride (PVC)** is a type of hard plastic used for electrical cables, drinking cups, and water pipes. PVC is not recommended to be used in producing F&B packaging as it is comprised of substances that can disrupt the digestive system.
4. **Low Density Polyethylene (LDPE)** is a type of hard and strong plastic that is easily formed in high temperatures. This type of plastic is mostly used to make bags, bottles, storage boxes, and toys. This type of plastic is very safe to use for F&B packaging. LDPE is difficult to destroy but can be recycled into household furniture and trash cans.



5. **Polypropylene (PP)** is a type of plastic that is easily formed at high temperatures, flexible, hard, and resistant to fat. Due to the nature of this plastic, it is used to produce food containers, plant pots, drug bottle caps, and straws.
6. **Polystyrene (PS)** is a type of plastic that is easily formed in high temperatures and is very stiff at room temperature. Polystyrene can be found in plastic tools, cable set (CS) boxes, and plastic cups. This plastic is the primary material of Styrofoam. This type of plastic is unfavorable to use as it is a single-use plastic, hard to decompose in soil, and can release toxic gas when burned.
7. Other types of plastic produced with label 7 are made from a mixture of two or more types of plastics, which indicates that the resin is unknown. This type of plastic is commonly used in the F&B industry.

Recent data from the Ministry of Industry shows that HDPE is by far the most produced commodity in the Indonesian upstream plastic industry, accounting for 46% of the total plastic production (see Table 3), followed by PP (31%), PVC (11%), and PS (7%). According to the Ministry of Industry, Indonesia produced an annual total of 586,000 tons of HDPE and 197,000 tons of PET (Ismawati et al., 2022) in 2020. The two largest HDPE manufacturers in Indonesia are PT Chandra Asri Petrochemical Tbk and PT Lotte Chemical Titan Nusantara. Additionally, most plastic manufacturers at the upstream level are concentrated in Java Island.

While HDPE is produced locally, Indonesia still relies on imports from Singapore, Japan, and South Korea to procure LDPE due to lower demand compared to other types of plastic. However, according to INAPLAS, PT Chandra Asri Petrochemical Tbk plans to manufacture LDPE in 2027.

**TABLE 3. UPSTREAM PLASTIC MANUFACTURERS IN INDONESIA**

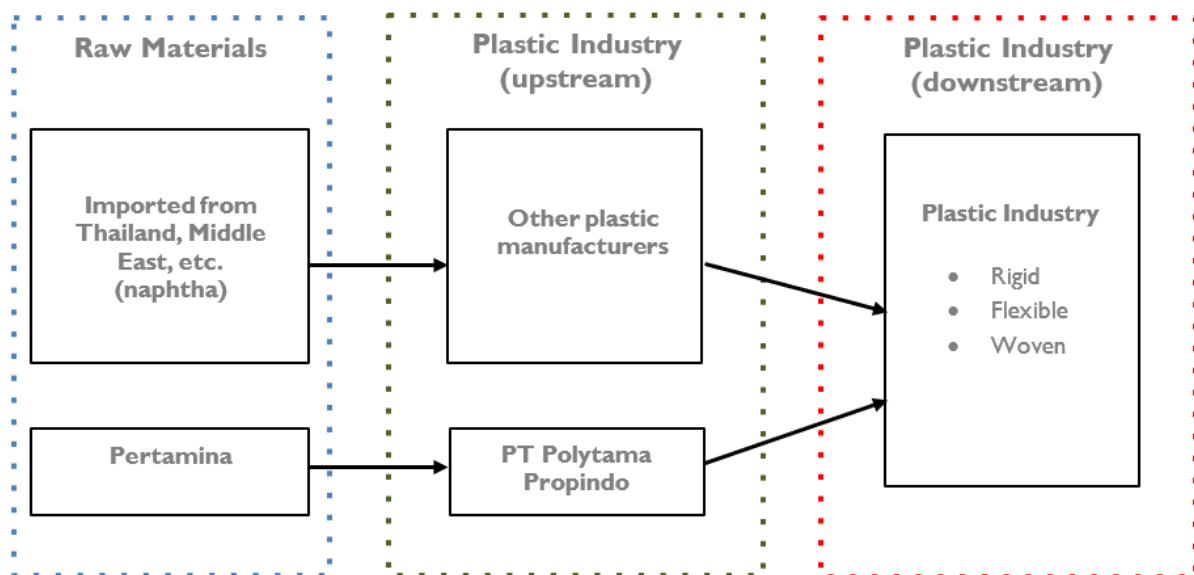
TYPE OF PLASTIC	TOTAL PRODUCTION (%)	MANUFACTURERS	LOCATION
Polyethylene (HDPE)	46%	PT Chandra Asri Petrochemical	Serang, Banten
		PT Lotte Chemical Titan Nusantara	Cilegon, Banten
Polypropylene (PP)	31%	PT Chandra Asri Petrochemical	Serang, Banten
		Pertamina UP III	Plaju, South Sumatra
		PT Polytama Propindo	Balongan, West Java
Polyethylene terephthalate (PET)	12%	PT Indorama	Cilegon, Banten
		PT Toray Indonesia	Tangerang, Banten
		PT Petnesia Resindo	Tangerang, Banten
Polyvinyl Chloride (PVC)	11%	PT Eastern (Mitsubishi) Polymer	DKI Jakarta
		PT Standard Toyo Polymer	Serang, Banten
		PT Asahimas Subentra Chemical	Cilegon, West Java
		PT Satomo Indovyl Polymer	Merak, Banten
Polystyrene (PS)	7%	PT Polychem Lindo Inc.	Merak, Banten
		PT Styron Indonesia (Ex. PT Dow Chemical Indonesia)	Merak, Banten
		PT Arbe Styrimdo	Serang, Banten
		PT Maspion Polystyrene	Sidoarjo, East Java

Source: Ministry of Industry, 2019

The supply chain of the Indonesian plastic industry is comprised of the upstream industry which consists of pellet producers, to the downstream industry which consists of plastic production for end users. The upstream industry mostly relies on imported raw materials (see Figure 2). According to a plastic expert interview respondent, the Indonesian plastic industry uses naphtha-based (oil-based) raw materials, which are mostly imported from Thailand and the Middle East. Meanwhile, the only local raw material is sourced from state-owned oil company PT Pertamina, which only distributes to its subsidiary PT Polytama Propindo. After the raw materials are processed in the upstream industry, the plastic pellets are distributed to the downstream industry that are classified in three separate types of industries, namely rigid, flexible, and woven plastics. As mentioned before, flexible plastics such as food packaging dominates the production of the upstream plastic industry.

Since the only local source of crude oil has been prioritized for fuel, the upstream plastic industry does not have enough resources to produce raw materials. Indonesia's over-reliance on imported raw materials is a challenge for the local upstream plastic industry. One key informant stated that the reliance on imported raw materials presented the risk of relatively higher prices of local plastic products compared to imported plastic products from China and India, thus hindering the growth of the domestic upstream plastic industry.

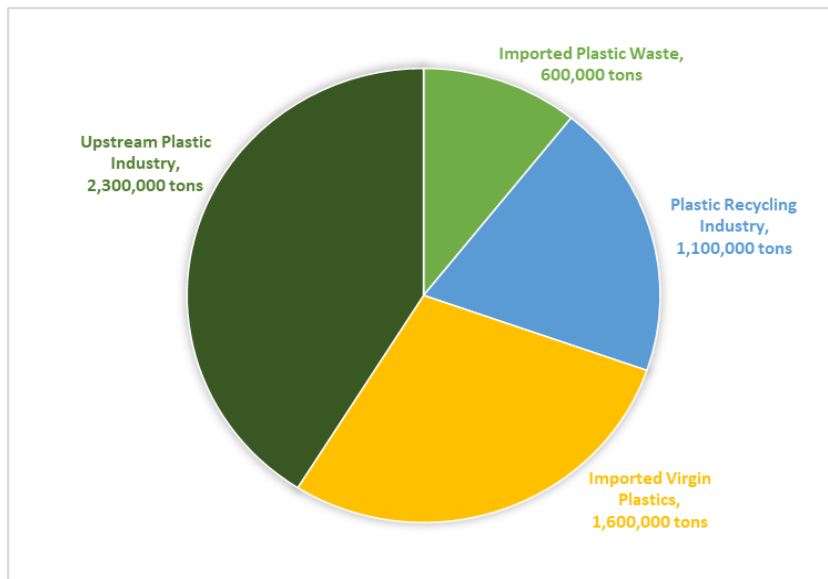
Figure 2. The Supply Chain of Plastic Industry in Indonesia



Source: Author's compilation, 2022

According to the respondent at the Ministry of Industry, the national demand for plastic raw material amounted to 5.6 million tons annually in 2019, while the domestic upstream industry could only produce 2.3 million tons of virgin plastic. "To fill the needs of the downstream plastic industry, we imported around 1.6 million tons of virgin plastic every year. Meanwhile, the plastic recycling industry contributes to 1.1 million tons of recycled plastic per year," he said. To fill the gaps and increase the utility of the plastic recycling industry, Indonesia imported around 600,000 tons of plastic waste every year (Lingga, 2019). In contrast, Indonesia generates a significant amount of plastic waste. Therefore, in theory, Indonesia can close the 600,000 tons gap by improving waste management in the country.

Figure 3. The Upstream Plastic Industry Supply in 2019



Source: Ministry of Industry, 2019

#### 4.1.1 CHALLENGES IN THE PLASTIC INDUSTRY

The growing demand for plastics could result in the Compound Annual Growth Rate (CAGR) increasing to 3.7% between 2022-2030 (Mordor Intelligence, 2022). Despite the huge demand, the country still struggles to fulfill its national demand for plastic. As previously discussed, the Indonesian plastic market mostly relies on imported raw materials for plastic production from Middle East, Thailand, and China. Thus, the plastic industry's over-reliance on imported raw materials has resulted in higher priced local plastic products compared imported plastic products from China and India. Additionally, since Indonesia's oil production is prioritized for fuel, the petrochemical industry does not have enough resources to produce raw materials for plastic industry.

The petrochemical industry is the key supplier for upstream sectors, especially in the plastic industry. This situation motivates the Ministry of Industry to encourage development projects conducted by the petrochemical industry, with domestic and foreign investment values reaching USD 31 billion (Antara, 2022). The investment was intended to strengthen commodities in the upstream chemical sector to substitute imported petrochemical products, such as ethylene, propylene, butadiene, PE, and PP. This is important for the development of the downstream plastic industry. Further updates on the development projects are still expected as the government aims for Indonesia to become the largest petrochemical producer in Southeast Asia in 2030.

Aside from the investment, the Ministry of Industry also established a program called Increased Use of Domestic Products (*Peningkatan Penggunaan Produksi Dalam Negeri*) that aims to increase utilization of domestic products to improve industrial efficiency to compete in the international market. The use of domestic products is one of the government's key components to increase the utilization of domestic products and services. In the plastic industry, the use of local materials (*Tingkat Komponen Dalam Negeri/TKDN*) plays an important role in reducing dependence on imported raw materials.

The petrochemical industry will experience more challenges in the future due to the current geopolitical situation, since the political turmoil between Russia and Ukraine caused price fluctuations of oil as raw material for plastic production. The price of naphtha (oil resource) has increased since the beginning of February 2022, with European polymer manufacturers expecting

olefin monomer prices to rise by 7-10% (Plastic Portal EU, 2022). The most recent report from INAPLAS shows that the price of raw materials for plastics has incrementally increased from USD 1,300 per ton as of January 2022 (CNBC Indonesia, 2022), resulting in price hikes on 4 plastic materials such as:

- LDPE : USD 1,800/ton
- HDPE : USD 1,500/ton
- LLDPE : USD 1,500/ton
- PP : USD 1,530/ton

The Indonesian plastic industry also still lacks technological modernization. According to a respondent, the existing petrochemical manufacturers including PT Chandra Asri, Indonesia's largest integrated petrochemical company, have not adopted newer production technology. Indonesian manufacturers still use older technology that use naphtha as their main raw material, while other countries such as Thailand and South Korea have moved forward with greener technology that use natural gas as their main raw material. The ability of current manufacturers to upgrade their technology is hindered by the need to replace machinery at a large scale.

In terms of environmental aspects, there are several consequences to the increasing demand for plastics in Indonesia. Around 61% or 4.2 million tons of post-consumer plastic waste was found to pollute the environment and ocean, while only about 10% of total plastic waste being recycled and the remainder ending up in landfills (National Plastic Action Partnership, 2020). Landfills are typically located close to communities, leading to toxic wastewater seeping into nearby farmland and hindering the growth of crops. Key players in the plastic industry need to implement circular business models to prevent more plastics toxic waste from polluting the environment.

In terms of industry size, the Indonesian Ministry of Industry recorded an annual total production capacity of 5 million tons from plastic producers. The Ministry of Industry further reported some raw materials have been manufactured from recycled plastic waste by the existing plastic recycling industry. The plastic recycling industry has supplied 16% of raw materials for the upstream plastic industry, which accounts for approximately 1.2 million tons per year of the total annual demand of 7.2 million tons. Although this can contribute to decreasing the dependency on imported raw materials, it still cannot fulfill the annual demand of 7.2 million tons of plastic.

## **4.2 PLASTIC RECYCLING INDUSTRY OUTLOOK**

As the fourth most populous country in the world with over 270 million people, Indonesia is also the second-largest plastic polluter in the world behind China (Ministry of Environment and Forestry, 2021). One of the reasons is the development gap between the fast-growing urban population and the provision of basic services and infrastructure, primarily inadequate solid waste management. The waste management sector in Indonesia is significantly underfunded in terms of investments and operations. The local government allocates USD 5-6 per capita/per annum for solid waste management, which is much lower than the international benchmark of USD 15-20 per capita/per annum (World Bank, 2019). Therefore, at the current development rate, the increase of solid waste management infrastructure will not be able to keep up with the amount of waste generated.

Municipal solid waste (MSW) management in Indonesia relies on the conventional collect–transport–dispose system that involves both formal and informal sectors. The main stakeholder in charge of managing MSW is a local government institution. However, the government's waste collection combines all types of waste together and does not provide plastic waste separation.

According to the Ministry of Environment and Forestry, the plastic recycling industry is dominated by small-medium recycling centers accounting for around 1,590 businesses that employed approximately 177,000 people in 2019. The formal sector consists of municipal agencies and formal businesses such as waste banks and waste management startups, whereas the informal sector consists of individuals, groups, and small businesses engaging in activities that are not registered and are not formally regulated. For solid waste activities, the informal sector refers to recycling activities that are conducted by scavengers and waste collectors (Sembiring and Nitivattananon, 2010).

Based on data from the Ministry of Environment and Forestry (2021), plastic waste accounted for 17.2% or 11,782,000 tons of the total 68.5 million tons of waste generated in Indonesia in 2021. Plastic waste was the second major type of waste generated in the country as outlined in Table 4.

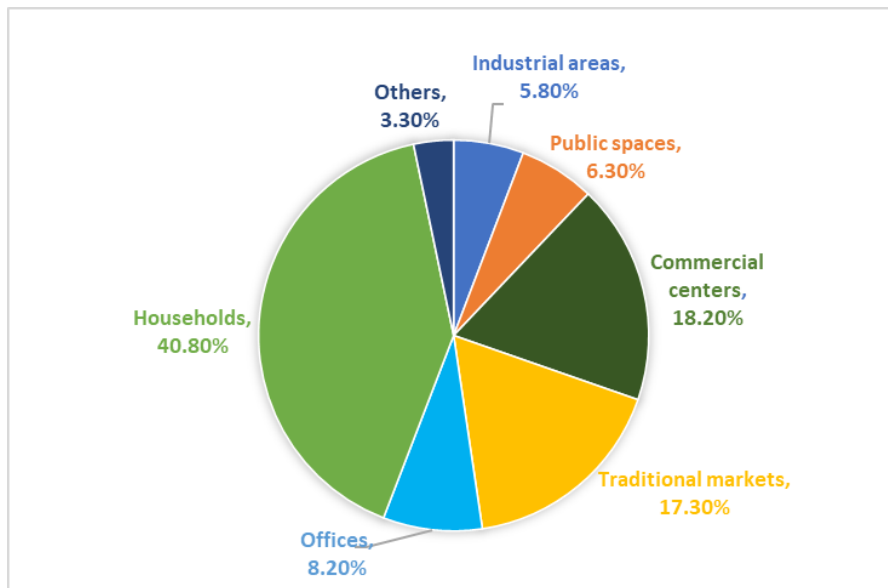
**TABLE 4. WASTE COMPOSITION IN INDONESIA IN 2021**

TYPE OF WASTE	COMPOSITION	AMOUNT (TONS)
Food waste	40.5%	27,742,500
Plastic waste	17.2%	11,782,000
Other organic waste	13.1%	8,973,500
Paper waste	11.4%	7,809,000
Metal waste	3%	2,005,000
Fabric waste	2.6%	1,781,000
Glass waste	2.4%	1,644,000
Rubber and leather waste	1.8%	1,233,000
Other types of waste	8.1%	5,548,500
<b>TOTAL</b>	<b>100%</b>	<b>68,500,000</b>

Source: Ministry of Environment and Forestry, 2019

The rapid growth of industries and Indonesia's population in turn increases waste production at the national level, which leads to a serious problem for handling MSW. According to the Ministry of Environment and Forestry (2021), the largest source of MSW in Indonesia comes from households, which account for 40.80% of waste, followed by commercial centers at 18.20% as outlined in Figure 4.

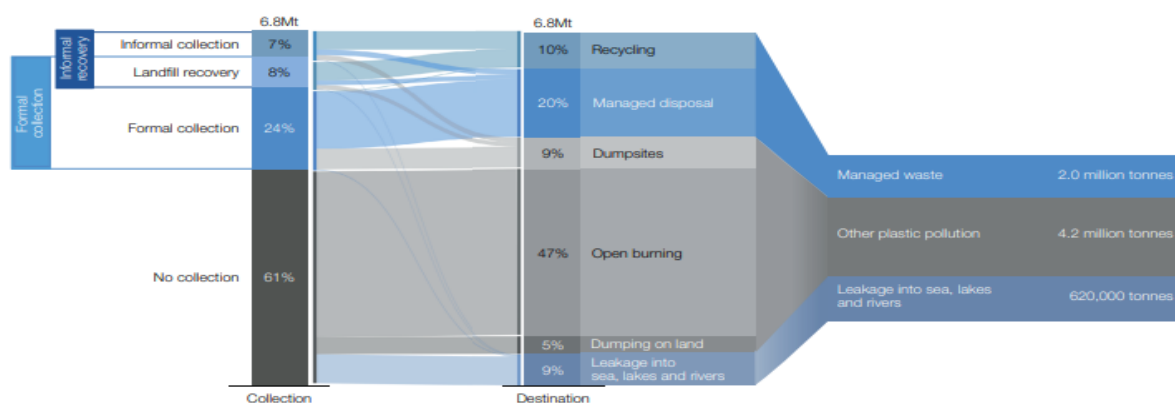
Figure 4. The Source of Solid Waste in Indonesia in 2021



Source: Ministry of Environment and Forestry, 2019

As solid waste generated from households was found to be the main source of waste accounting for 40.80%, the key to MSW management in Indonesia is to organize household waste. Until now, most households do not separate their waste. Temporary dumping sites (*Tempat Pembuangan Sampah Sementara/TPS*) are established to reduce hauling distances for collection trucks to deliver waste to landfills. These sites are categorized as depots. Apart from scavengers looking for valuable waste, there is no intermediate treatment before transferring to waste trucks. According to the World Economic Forum (2020), only 10% of plastic in Indonesia waste was recycled. Meanwhile, 47% of valuable plastic waste was burned, 4% was buried in landfills, and 9% of plastic waste was dumped into the sea, lakes, and rivers.

Figure 5. Waste Collection in Indonesia



Source: World Economic Forum (2020)

There are three recycling methods for solid plastic waste (Horodytska et al., 2018). The first method is mechanical recycling. This process consists of separating, sorting, baling, washing, grinding, compounding, and palletizing the plastic waste. Recycling using this process can be configured using closed and open loops that would provide a different final version of the recycled product. The closed loop process produces products that have properties similar to the original material that can



be used as raw materials with high added value. The process is carried out by an extrusion method. Meanwhile, the open loop process produces products that have more labor properties than the original material that are only suitable for specific applications such as tarpaulins, garbage bags and pipelines. This process is carried out through various stages of cutting, washing, drying, printing, and re-granulating that require human resources.

The second method is chemical recycling, which involves breaking the polymer structure (Horodytska et al., 2018). The aim of this method is to extract genuine monomers or other valuable chemicals. Chemical recycling can be done by chemo lysis, pyrolysis, fluid catalytic cracking, hydrogen technologies, Catalytic Pressure-less Depolymerization process, and gasification combined with methanol production. The last method is energy recovery carried out by incinerating plastic waste to produce electricity and district heating with efficiency above 90%. This process is usually done for plastic waste that cannot be recycled.

The price of recycled plastics is not determined by production costs as it would be in an efficient market. Instead, the price of recycled plastics is linked to the price of virgin plastics in the long run. Virgin plastic prices are related to the price of crude oil. The price range in waste banks depends on the type of plastic and location that it's generated. Rigid plastic waste has a higher value due to their chemical makeup, level of viscosity, and melt flow index. According to ADUPI, plastic cups made of rigid PP is the most precious plastic waste valued at USD 0.47 per kilogram (kg) in the Kertabumi waste bank in Jakarta. On the other hand, any kind of flexible plastic has a very low value.

The price of plastic waste is also determined by the location where it is produced as most recycling centers are concentrated in Java Island. For example, rigid PET has a value of USD 0.34 per kg in Jakarta but has a slightly lower value in Sumatra (USD 0.25 per kg) and Kalimantan (USD 0.22 per kg), as outlined in Table 5. The price difference accounts for cover transportation fees incurred to deliver the plastic waste to recycling centers in Java Island. Flexible plastic that already has a low value in Jakarta will not be accepted in Sumatra and Kalimantan as its value would not cover the transportation fee. Transporting plastic waste requires an upfront cost and minimum volume of waste. Therefore, recycling plastic waste is economically inefficient in some areas. Table 5 illustrates the prices of post-consumer plastic waste from three waste banks to waste collectors in three different islands.

**TABLE 5. VALUE OF POST-CONSUMER PLASTIC WASTE IN WASTE BANKS**

TYPE OF PLASTIC WASTE	EXAMPLE	VALUE IN WASTE BANK (USD/KILO)		
		KERTABUMI, JAKARTA	GOLDEN, SUMATRA	RAMLI, KALIMANTAN
Rigid PP - Transparent	Plastic cup	0.47	0.29	0.22
Rigid PET - Transparent	Plastic water bottle	0.34	0.25	0.14
Rigid HDPE - Color	Plastic shampoo bottle	0.27	0.19	0.12
Flexible HDPE - Color	Plastic bag	0.027	0	0
Rigid LDPE - Color	Plastic detergent bottle	0.27	0.19	0.12

**TABLE 5. VALUE OF POST-CONSUMER PLASTIC WASTE IN WASTE BANKS**

TYPE OF PLASTIC WASTE	EXAMPLE	VALUE IN WASTE BANK (USD/KILO)		
		KERTABUMI, JAKARTA	GOLDEN, SUMATRA	RAMLI, KALIMANTAN
Flexible LDPE - Color	Shiny grocery bag	0.027	0	0
Rigid PVC - Color	Pipe and toys	0.07	0.06	0.05
PS	Styrofoam	0	0	0
Other	Acrylic	0	0	0
Multi-Layered Plastic	Coffee sachet	0	0	0

Source: Author's compilation, 2022

Some plastics such as styrofoam or multi-layered plastic are classified as non-recyclable using mechanical recycling methods due to their chemical structure. Although there are many small initiatives to recycle these types of plastic with chemical recycling or energy recovery, the benefits are insignificant and does not enhance the circular economy.

Currently, only rigid plastics are widely recycled and included in the circular economy. Meanwhile flexible plastics are commonly burned or dumped as they are not economically feasible to be recycled. Based on an interview with ADUPI, one of the reasons that plastic labels are not profitable as recycled materials were due to its economic scale. According to ADUPI, only 10 kg of plastic labels can be collected from 0.5 tons of plastic bottles. Meanwhile, a minimum of 1 ton of plastic waste is needed to be profitable for recycling processes. Therefore, 50 tons of plastic bottles are needed to meet the minimum amount of plastic labels required to start the recycling process. Additionally, it takes 344 sacks to contain the minimum amount of the plastic labels needed, which takes up a lot of storage space. Scavengers usually remove plastic labels from PET bottles and HDPE caps and dispose of them in the landfill.

The recycling industry in Indonesia has been operational for decades without receiving significant exposure due to a growing negative view of products that are made from waste. Most recycled products such as buckets, water dippers, broom heads and plastic bags that are currently available in the market have never been published as recycled products.

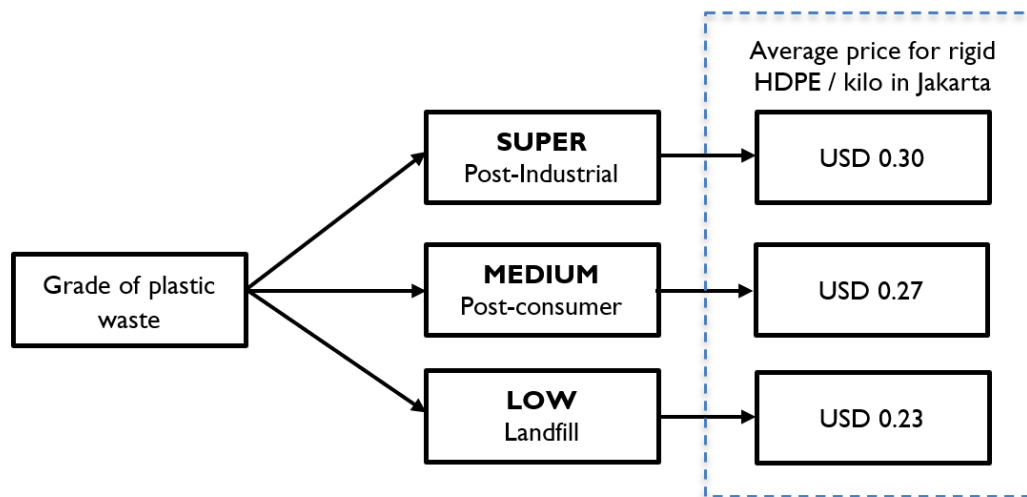
The value of plastic waste varies for different types of plastic depending on their chemical makeup, level of impurities, and location. APSI has devised a classification to categorize plastic waste into 3 grades: post-industrial (super grade), post-consumer (medium grade) and landfill (low grade) as explained in Figure 6. Post industrial waste is the waste generated during the manufacturing process, while post-consumer is waste produced by the end consumer. Each grade represents the source of waste collected, its level of impurities, and its value. An increase in the concentration of contaminants causes a decrease of impact strength values at various levels due to the immiscibility of the polymer constituents.

The prices shown on Figure 6 indicate the amount paid to big waste collectors for different grades of plastic. According to our interview with IPR, a waste collector can purchase medium grade rigid HDPE from waste banks in Jakarta for around USD 0.27, however, the price will increase by around 10% if they purchase super grade rigid HDPE from manufacturers. On the other hand, a waste

collector can purchase low grade rigid HDPE at a much lower price from scavengers in Bantar Gerbang landfill.

Scavengers cannot sell the collected waste for a higher price due to its high level of impurities. Due to this, a waste collector needs to spend money for washing and cleaning the plastic waste collected. Although this grading system does not determine how the waste will be recycled, all plastic waste that is classified as recyclable will be processed through the mechanical recycling method.

Figure 6. The Grade of Plastic Waste



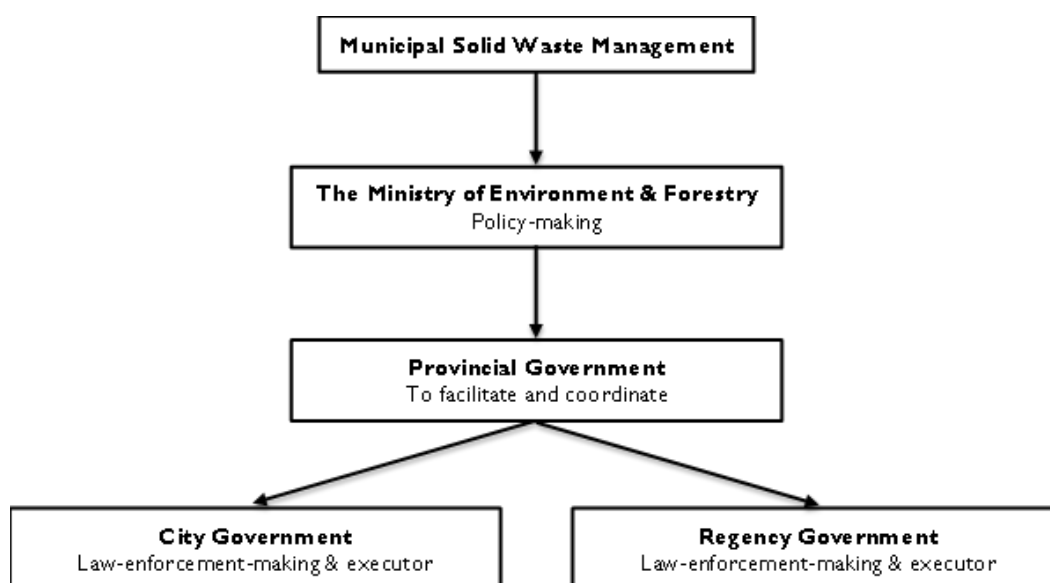
Source: Author's compilation, 2022

#### 4.2.1 REGULATIONS

The Government of Indonesia has shown immense commitment to waste management by setting a national target of 30% waste reduction and 70% waste management by 2025, including 70% reduction of ocean plastic waste by 2025 (Presidential Regulation Number 35/2018).

Since the issuance of Solid Waste Management Law Number 18/2008, there have been many waste management laws and regulations introduced at the national, regional, and city levels, with some addressing plastic pollution as part of the broader issue. Figure 7 shows a summary of national waste management regulators in Indonesia as of August 2020.

Figure 7. The Regulators of Waste Management in Indonesia



Source: Author's compilation, 2022

A large portion of mismanaged waste came from the district level and rural areas due to a lack of waste collection infrastructure, capacity of local government, and geographical challenges. Rural areas have a waste collection rate of only 10-50%, which is typically burned. Urban areas perform better with a waste collection rate of 50-95%.

#### 4.2.1.1 SOLID WASTE MANAGEMENT LAW NUMBER 18/2008

Solid Waste Management Law Number 18/2008 is a foundational law for waste management in Indonesia focused on using the Reduce Reuse Recycle paradigm. To implement this paradigm, the central and regional governments are given the authority to establish waste management policies and strategies (Chotimah et al., 2021). The Law sets an ambitious target to end all open dump waste disposal by 2013. However, this goal was not achieved as the Ministry of Environment and Forestry recorded 167 open dump waste disposal facilities that are still in operation (Dewanti, 2020). Although there were no specific regulations targeting plastic waste, the Law gives disincentives to producers using production material that is not easily processed naturally, cannot be reused, and/or cannot be recycled and are not environmentally friendly.

#### 4.2.1.2 MINISTRY OF ENVIRONMENT AND FORESTRY'S REGULATION NUMBER 75/2019 ON ROADMAP TO WASTE REDUCTION BY PRODUCERS

The Ministry Environment and Forestry regulation Number 75/2019 on Extended Producer Responsibilities (EPR) is designed to guide and facilitate producers to implement their EPR on reducing waste generated from their goods, packaging, and services in regard to plastics, paper, aluminum cans, and glass. The EPR applies to brand owners, manufacturers, importers, retailers, and the food and beverage service industry, among other producers. The regulation contains three components as detailed below:

- A. To prevent and limit the potential of waste generation as much as possible by implementing a sustainability practice through re-designing products and packaging, phasing out single-use plastics, eliminating unnecessary and excessive packaging, making packaging more recyclable and

reusable, creating packaging out of more recycled content, and producing more durable, returnable, rechargeable, and refillable goods,

- B. To take back post-consumer products and packaging for reuse, and
- C. To take back post-consumer products and packaging for recycling.

Despite the introduction of various solid waste management policies and regulations over the years, Indonesia still needs to significantly strengthen its enforcement on proper waste management practices. According to a World Bank report (2018), there is virtually no enforcement or minimum enforcement of solid waste laws and standards from city-level violations to individual polluters. Multiple studies have identified that the root cause is the “absence of effective method for managing plastic waste” (Rahmawati et al., 2021). For example, the Indonesian government applied a plastic bag levy policy in 23 regions in 2016 as part of the implementation of Solid Waste Management Law Number 18/2008. The plastic bag levy policy requires supermarket customers to pay IDR 200 (USD 0.015) per piece of plastic used, including Value Added Tax (*Pajak Pertambahan Nilai/PPN*). The money collected was managed by the retail stores as part of its Corporate Social Responsibility (CSR). However, the policy was revoked in less than eight months due to the country’s “weak legal basis” (Addahlawi et al., 2019).

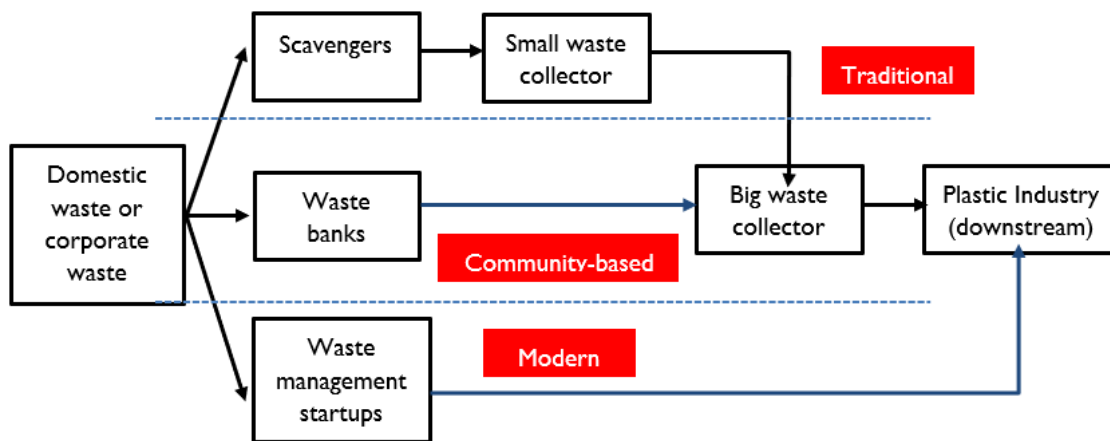
There are several measures that can be taken to promote higher recycling rates in Indonesia, such as imposing separation at the source, integrating informal activities (scavengers) with formal waste management and municipality collection, providing a material recovery facility at final disposal sites using sorting technology to recover plastics, and using alternative technology such as chemical recycling or thermal treatment to treat plastic waste that is not readily recycled through mechanical recycling (Kristina et al., 2018).

As there is a large proportion of plastic waste residue, Indonesia must provide improved facilities and enforce rules for its citizens to conduct separation at the source. Such facilities and rules could include different trucks that collect different types of waste on different days and designated bags for sorting waste, similar to practices in Japan. Such collection efforts could be conducted in collaboration with scavengers or based on waste bank collection systems, since waste bank clients prefer their waste to be picked up by waste bank staff rather than voluntarily delivering it themselves (Kamaruddin et al., 2022).

#### 4.2.2 SUPPLY CHAIN

The plastic waste recycling business involves complex supply chains and a lot of middlemen involved in the process, resulting in confusion among the downstream plastic industry to procure plastic waste at a reasonable price. Based on our interviews with plastic manufacturers, they unaware of where to purchase recycled plastic and how much it costs. On top of that, Indonesia’s recycling industry relies heavily on the informal sector. This causes a lack of reliable data and management systems, which leads to Indonesia’s inability to design a robust supply chain system. Figure 8 illustrates a simplified version of the plastic waste supply chain in Indonesia.

Figure 8. The Supply Chain of Recycled Plastic



Source: Author's compilation, 2022

In general, solid waste generated from households and corporations are collected by three entities: scavengers, waste banks and waste management startups. There are advantages and disadvantages for each of the plastic waste collection schemes. The biggest players are scavengers as informal waste collectors. However, waste banks and waste startups have been on the rise over the past five years. Waste banks and waste startups play an important role in revolutionizing the system by providing waste management access to hundreds of thousands of people and shorten the supply chain by directly selling the collected waste to big waste collectors or even recycling manufacturers. One of the distinct differences between formal and informal collectors is that formal collectors can verify the source of the waste and are free from social issues such as child labor and human trafficking that sometimes occurs with informal collectors (Sasaki et al., 2019).

Traditional or informal waste management is prevalent in Indonesia, consisting of scavengers, intermediates, dealers or grinders, and recyclers (Kustanti et al., 2020). The prevalence of scavengers is due to the need to earn an income. The scavenger collects valuable plastic waste found on the streets, residential areas, commercial areas, depots, and landfill sites. The scavengers then sell the plastic waste to small waste collectors that further sort and clean the waste. At this stage, there are usually multiple waste collectors of various sizes, which complicate and lengthen the supply chain. A small waste collector sells the treated waste to a big waste collector that conducts further processing of the waste up to the preparation stage of converting waste into raw materials, such as grinding plastic waste or pressing bottles. A big waste collector then sells the waste to the downstream plastic industry.

Some waste banks in Indonesia emerged due to concerns from the local community about waste management in their residential areas, while others were initiated by the local government to encourage waste sorting by households at the source. In Asia, the wide use of waste banks has been identified only in Thailand and Indonesia (Putri et al., 2018). According to the Ministry of Environment and Forestry, in 2019 there were 11,330 waste banks across Indonesia serving around 419,2014 households and collecting around 431,807 tons of waste every month.

At waste banks and waste management startups, individuals sort their waste and deposit it in exchange for money. Most waste management startups and waste banks rely on communal collection from receiving waste from clients to weighing, sorting, and selling the waste (Putra, et al., 2018). Waste banks and waste management startups require their registered clients to sort their waste at home based on waste classification established by each entity. The waste management



startups and waste banks weigh and calculate the value of the collected waste for their clients and resells it to waste collectors at a higher price to make a profit. The waste collectors then process the waste into recycled plastic pellets. However, the performance of waste management startups and waste banks heavily depend on voluntary client participation, which can cause problems if they lack clients to fulfill their intermediate waste quota or lack stable supply from their clients (Raharjo et al., 2018).

In urban areas, these types of formal waste management processes continue to be developed and are predicted to become a feasible option to improve the recycling rate and waste management in cities (Restuningdiah et al., 2021). However, despite several different efforts to recover plastic that are already being practiced, there is a lack of integration between the activities of recycling players in the informal sector and the formal sector. Therefore, the overall performance of plastic recycling is unknown. The plastic industry's dependency on imported virgin plastic material can potentially be reduced if recycled plastic product use is widely promoted in various sectors, such as automotive, infrastructure, property, etc.

According to the Ministry of Industry's directorate of downstream chemical and pharmaceutical industry, the government has set up fiscal incentives to support plastic recycling and is currently formulating more regulations to boost the industry. Furthermore, the ministry was planning to aid small and medium recycling businesses through providing access to bank loans. The ministry also proposes that the Ministry of Finance should abolish the 10 % value added tax (PPN) for the plastic recycling industry. "We are also formulating a regulation to encourage the use of recycled plastic (*Tingkat Komponen Daur Ulang*) in the beverage industry and other industries. We hope these measures will create more recycling businesses and have a multiplier effect to increase the number of waste collectors as well as junk shops," said the Director.

#### 4.2.3 CHALLENGES IN THE PLASTIC RECYCLING INDUSTRY

There are several factors that influence the price of recycled plastic. The first factor is the fluctuating price of global crude oil as plastic pellets are made from crude oil. When the price of crude oil decreases, the price of plastic pellets also decreases, resulting a decrease in the price of recycled plastic as well. The industry would rather use virgin plastic pellets than recycled plastic material due to its high quality. The second factor is the coalition of recycling players and their competitors in price formation. The third factor is the shape (pressed, grinded or flakes) and color of plastic bottle waste. The fourth factor is the quality of recycled material. If the quality of recycled material is low (containing dirt and contaminants), the material will be classified as second grade and the price will also be low. In the market, there is a price gap between unclean HDPE plastic waste (USD 0.21/kg) and clean HDPE plastic waste (USD 0.27/kg). The price of clean plastic bottle waste is 28% higher than unclean bottles.

The remaining unrecovered plastic waste at the source or plastic waste that becomes residue throughout the recycling scheme is herein referred to as plastic waste residue. Jati and Ardi (2020) have identified two factors that may cause plastic waste to become residue. The first is contamination from other materials. For example, it is difficult to recycle plastic waste mixed with leftover food; therefore, it is typically transported to landfills. The second factor is the low value of some plastics. Such plastics mostly consist of flexible or soft plastic, dominated by plastic labels, snack packaging plastic, and multi-layered plastic. Based on data from Sonia and Sunyowati (2020), only 10% of scavengers were willing to collect flexible or soft plastic waste at the source. Most of

the waste banks interviewed also mentioned that such plastics were not accepted by intermediaries due to the difficulty in recycling this type of plastic waste using mechanical recycling.

Plastic waste is usually not segregated after consumption, which increases its impurities and leads to the waste failing to meet industry standards. Based on our interviews with ADUPI, the impurities also make it difficult for manufacturers to produce recycled plastic of the same quality as virgin resin. Imported plastic scrap still account for the majority of recycling feedstock due to their considerably better quality than domestic post-consumer plastics (Alkhahar and Luthfia, 2020). Therefore, improving the quality of domestic post-consumer plastics is critical to creating more recycling opportunities in the country.

Furthermore, the public still has an unfavorable perception of products made from recycled plastic, with some regarding them as smelly, lower quality or otherwise inferior to products made from virgin plastic. These factors leave limited room for the growth in Indonesia's plastic recycling industry.

A comparison between Indonesia's recycling capacity and the amount of plastic waste collected in demonstrated a substantial gap that indicates how recyclable plastics are poorly managed. According to APSI, Indonesia's recycling capacity is around 2 million tons per year, while the recycling industry only supplied around 1.1 million tons in 2019. Thus, the plastic recycling capacity should be maximized by increasing plastic waste collection. Moreover, given the high plastic consumption, plastic waste has the potential to become a substitute for virgin plastics in plastic production. The latter can be achieved either by optimizing the processing capacity or fostering collaboration between different actors involved in the recyclable plastic waste management system.

However, since some plastic waste is not readily recycled using mechanical recycling, there may be a need to develop other recycling technology to manage plastic waste. Based on our interviews with APSI, mechanical recycling is the only mass-scale plastic recycling technology available in Indonesia. Alternative technologies commonly used to recycle plastic rely on thermal treatments (e.g., incinerators, pyrolysis, refuse paper and plastic fuel, and combustion of plastic in cement kilns) and chemical recycling (e.g., blast furnaces, coke ovens, and gasification) (Prisandani and Amanda, 2020).

#### **4.3 TARPAULIN INDUSTRY**

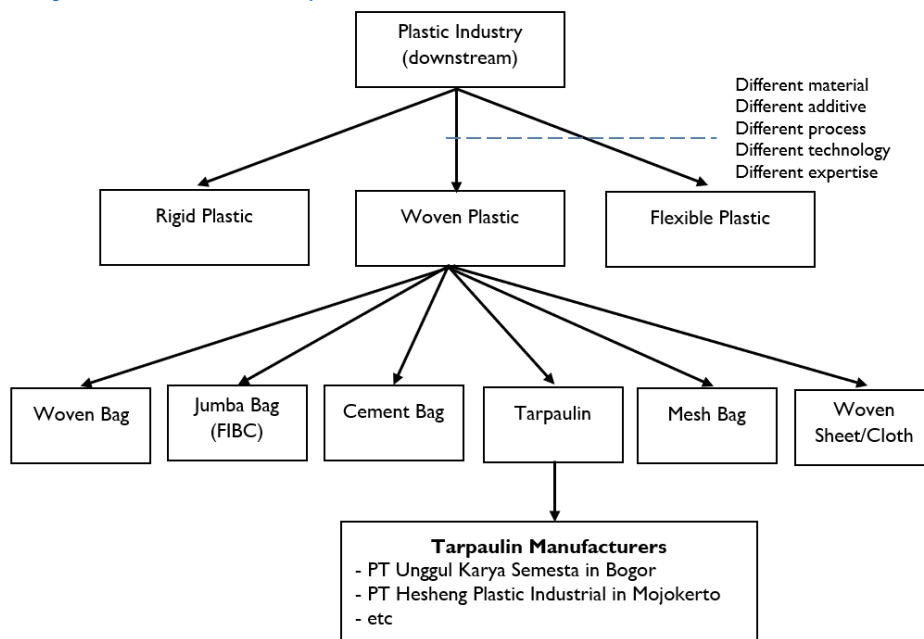
Plastic tarpaulins are one of the products that is made from woven plastic. The physical structure of the plastic tarpaulin is a core-weave matrix with 90 micrometer ( $\mu\text{m}$ ) thickness. In the last decade, plastic tarpaulins have replaced canvas as the utilitarian shelter for displaced populations in complex emergencies. This is because plastic sheeting is cheaper to produce, lighter to transport and easier to stockpile (Graham et al., 2002). Aside from plastic tarpaulins, the woven plastic industry produces various products such as woven bags, banners, cement bags, and woven cloth. According to our interviews with woven plastic manufacturers, woven bags are the most common product from this industry and is used for agriculture, mining, and food industry. The woven plastic industry differs from other downstream plastic industry throughout its whole manufacturing process, from raw material, additives, technology, and expertise. However, the woven plastic industry is the smallest downstream plastic industry in economic size compared to the flexible plastic industry and rigid plastic industry.

The use of recycled plastic in the tarpaulin industry is not common. Based on our interviews with tarpaulin manufacturers, most of them decline to use recycled content due to inconsistent quality, complex supply chain, and consumers' negative perception toward recycled products. The market

share of recycled products is small but expected to grow sharply in Indonesia as result of rapid use of resources and valorization of waste, which are potential strategies to overcome resource scarcity in the recycled plastic industry.

Figure 9 shows three different classifications of the downstream plastic industry, which are rigid plastic, flexible plastic, and woven plastic. Each industry has different materials, additives, processes, technology, and expertise. The woven plastic industry is the smallest downstream plastic industry by size and produces seven common woven products, including plastic tarpaulins.

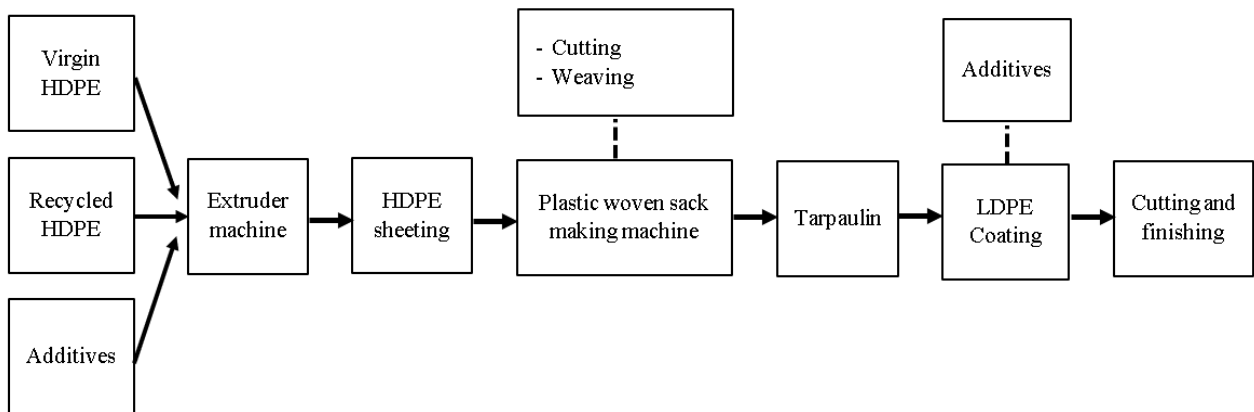
Figure 9. The Woven Plastic Industry



Source: Author's compilation, 2022

In the process of making tarpaulins, manufacturers need supplies of HDPE or PP plastics—both virgin and recycled plastics—which will be mixed with additives such as color pigments, UV inhibitors, and flame retardant. All materials are processed in an extruder machine to produce plastic sheeting, which will be cut and woven with machines that make plastic woven sacks to produce plastic tarpaulins. Following this, the tarpaulins will be coated with luminescence liquid LDPE. Additional additives such as color pigments, UV inhibitors and flame retardant can be mixed with the liquid LDPE before cutting and finishing. For more details, see Figure 10.

Figure 10. The Process of Tarpaulin Industry



Source: Author's compilation, 2022

### 4.3.1 THE RAW MATERIALS FOR PRODUCING TARPAULINS



Virgin HDPE pellets

IKBAL ALEXANDER FOR USAID EGSA

There are two common raw materials used to create plastic tarpaulin, namely plastic HDPE and plastic PP, while the lamination is made from LDPE. Some tarpaulin manufacturers prefer to use PP due to its lower price, while others utilize HDPE to create heavy-grade tarpaulins. The virgin HDPE and PP come in various forms such as liquid, powder, and pellets or granules. However, the one that is needed to produce plastic tarpaulin is in the form of pellets or granules that are translucent.

Other material that can be added is recycled plastic HDPE. The recycled material comes from large waste collectors who purchase rigid HDPE from scavengers or waste banks in the form of plastic bottles, plastic bottle lids, and other forms. All the plastic waste is grinded, washed and turned into recycled plastic flakes with various colors. The recycled plastic flakes will be further processed with a plastic pelletizing machine before being sold to plastic manufacturers. The tarpaulin manufacturer can combine the virgin HDPE and recycled HDPE at their preferred composition to produce tarpaulins.



Recycled Plastic HDPE Flakes (left) and Recycled HDPE Pellets (right)

IKBAL ALEXANDER FOR USAID EGSA

### 4.3.2 THE ADDITIVES

Additives are materials added during the manufacturing process to provide optimal performance of the material when molded and put into use. In tarpaulin production, additives are inserted after the main raw materials (virgin and recycled plastic) are combined. Additives are introduced to meet the manufacturer and customer's needs as well as specification requirements.

The first additive needed is a masterbatch, which is a solid additive for plastic used to add color. Masterbatch comes in the form of pellets similar to virgin HDPE and recycled HDPE.

USAID's technical specification for tarpaulin requires black pigments to generate black fiber woven HDPE. Several polymer coloring manufacturers have been identified as follows:

1. PT Surya Cipta Plasindo in East Java
2. PT Inter Lestari Polimer in Banten
3. PT Chemindo Interbuana in Banten



Color additive for plastic

IKBAL ALEXANDER FOR USAID EGSA



### 4.3.3 TARPAULIN MANUFACTURING PROCESS

The production starts with mixing of plastic granules enriched with additives such as masterbatch, UV inhibitors, and flame retardant. The next step is extrusion; the granule mix is melted and converted into sheets by an extruder and cut into yarn or tape.



The hopper (left), extrusion machine (middle), and tapes (right)

IKBAL ALEXANDER, MARIA MARGHARETA FOR USAID EGSA

The tape is integrated to increase its thickness and wound onto the bobbins. Next comes the weaving process where the plastic tape is mounted onto the frame of the loom to weave into plastic fabric. Automated looms such as circular weaving machines are used to weaving heavy-grade plastic fabric.



The circular weaving machine

MARIA MARGHARETA FOR USAID EGSA

The roll of plastic fabric is then transferred to the lamination machine where the fabric is laminated with LDPE on both sides. At this point, additives are used to determine the outer color of the tarpaulin and additional features are added such as UV resistance and flame retardant. The laminated fabric is sent to the welding and cutting section. The fabric is centrally welded if needed and cut into different sizes according to the requirements.

The hemming process is designed to add reinforcements to various sheet sizes to make them more durable. At this stage, ropes can also be stitched to the sheets and eyelets will be installed to tie the sheets to rope, ensuring different ways that the tarpaulin can be used. The tarpaulins are then ready to be folded, pressed, packed into bales, stacked, and shipped.





LDPE-coating machine

MARIA MARGHARETA FOR USAID EGSA

#### 4.3.4 REVIEW OF POTENTIAL TARPAULIN MANUFACTURERS

To identify tarpaulin manufacturers in Indonesia, multiple data collection approaches were conducted in this research, namely literature reviews, interviews with plastic industry associations, and interviews with the Ministry of Industry’s directorate of downstream chemical and pharmaceutical industry. The production of plastic tarpaulins in Indonesia recently experienced disruptions due to two main events, namely the abundance of Chinese tarpaulins that began in 2015 and the COVID-19 pandemic that began in 2020. The cheap Chinese tarpaulins flooded the market and disrupted the market price, while the pandemic caused a dramatic decrease in demand.

Through a combination of documentation, surveys, and interview analysis, the authors have combined a list of tarpaulin manufacturers in Indonesia that have survived the two disruptive events, as shown on Table 6.

**TABLE 6. LIST OF TARPAULIN MANUFACTURERS IN INDONESIA**

NAME OF MANUFACTURER	LOCATION (CITY)	PROVINCE
PT Unggul Karya Semesta	Bogor	West Java
PT Musimas Sejahtera Abadi	North Jakarta	DKI Jakarta
PT Murni Mapan Mandiri	Serang	Banten
PT Poliplas Group	Semarang	Central Java

**TABLE 6. LIST OF TARPAULIN MANUFACTURERS IN INDONESIA**

NAME OF MANUFACTURER	LOCATION (CITY)	PROVINCE
PT Gemah Makmur Sejahtera	Semarang	Central Java
PT Sami Surya Indah Plastik	Sukoharjo	Central Java
PT Sami Surya Perkasa	Sukoharjo	Central Java
PT Limmas Anugrah Plasindo	Nganjuk	East Java
PT Sinar Jaya Prima Perkasa	Nganjuk	East Java
PT Hesheng Plastic Industrial	Mojokerto	East Java
PT Mitory	Sidoarjo	East Java
PT Makmur Jaya Kharisma	Malang	East Java
PT Samjin Tarpaulin Industry	Pasuruan	East Java

Source: Author's compilation, 2022

Based on the data above, all tarpaulins manufacturers in Indonesia are concentrated in Java Island. Most tarpaulin manufacturers serve the domestic market for outdoor covering, protective items, and temporary shelters. Some manufacturers also export tarpaulins to the US, Australia, Europe, etc. Tarpaulins that are widely available in local market are usually small, blue, and low grade without UV inhibitors and flame retardant.

After conducting in-depth interviews with the 13 tarpaulin manufacturers and focusing on USAID's technical requirements and test specifications (see Annex 5), the authors eliminated 10 tarpaulin manufacturers that did not pass the qualifications for further observations. Table 7 provides justifications of the 10 tarpaulins manufacturers that do not meet USAID specifications. Main reason for the elimination is most of the manufacturers only produce 1.2-meter wide tarpaulins made of PP instead of HDPE. Additionally, some of them only produce blue tarpaulins and one of them can only produce tarpaulins weighing 145 g/m<sup>2</sup> and 175 g/m<sup>2</sup>. Moreover, the quality of their tarpaulins is unlike those produced by the selected potential manufacturers as most of them are low quality tarpaulins used by street vendors and building contractors to cover trucks.

**TABLE 7. LIST OF UNQUALIFIED TARPAULIN MANUFACTURERS**

NAME OF MANUFACTURER	REASON (S)
PT Musimas Sejahtera Abadi	Only produce 1.2 meters-wide tarps, therefore cannot fulfill the requirement for maximum 2 panels to make the 4x6 meter sheets.
PT Murni Mapan Mandiri	Only produce 1.2 meters-wide tarps, therefore cannot fulfill the requirement for maximum 2 panels to make the 4x6 meter sheets; only produce blue tarps.
PT Poliplas Group	Only use PP as raw material.
PT Gemah Makmur Sejahtera	Only use PP as raw material.
PT Sami Surya Indah Plastik	Only produce 1.2 meters-wide tarps, therefore cannot fulfill the requirement for maximum 2 panels to make the 4x6 meter sheets.

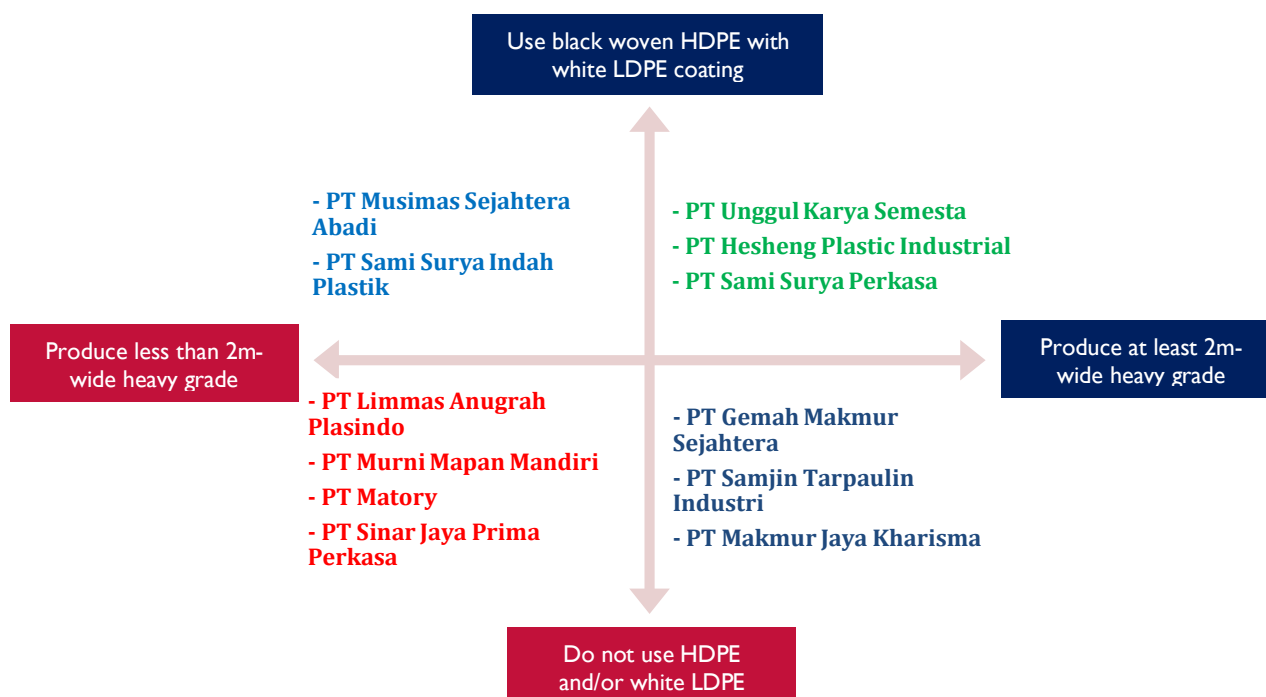
**TABLE 7. LIST OF UNQUALIFIED TARPAULIN MANUFACTURERS**

NAME OF MANUFACTURER	REASON (S)
PT Limmas Anugrah Plasindo	Only produce 1.2 meters-wide tarps, therefore cannot fulfill the requirement for maximum 2 panels to make the 4x6 meter sheets; only produce blue tarps.
PT Sinar Jaya Prima Perkasa	Only produce low quality, 1.2 meters-wide tarps.
PT Mitory	Factory is closed.
PT Makmur Jaya Kharisma	Only produce tarps weighing 145 g/m <sup>2</sup> and 175 g/m <sup>2</sup>
PT Samjin Tarpaulin Industry	Only produce low quality, 1.2 meters-wide tarps.

Source: Author's compilation, 2022

The research team used a matrix (Figure 17) with two parameters to distinguish manufacturers that use black woven HDPE and white LDPE coating and manufacturers that produce 2x6 meters heavy-grade tarpaulin. After interviewing the thirteen manufacturers, the research team classified them in this matrix and found that three out of thirteen manufacturers passed both parameters. As a result, the research team determined that PT Unggul Karya Semesta, PT Hesheng Plastic Industrial, and PT Sami Surya Perkasa are potential manufacturers.

Figure 11. The Matrix of Tarpaulin Manufacturers



The result of the observations shows that the three manufacturers can produce tarpaulins that meet the USAID's technical requirements and test specifications. However, further specifications need to be discussed and agreed upon with USAID BHA before a final decision is made. The specifications that need to be clarified are the UV inhibitors and flame retardant. All the manufacturers do not have the facility to test UV resistance and flame-retardant as there is no demand for this type of testing in the Indonesian market.

All three manufacturers produce customized tarpaulins with certain terms and conditions. The customization encompasses the color, width, length, and strength. The three manufacturers are as follows:

**TABLE 8. LIST OF POTENTIAL TARPAULIN MANUFACTURERS**

NAME OF MANUFACTURERS	LOCATION	PROVINCE
PT Unggul Karya Semesta	Bogor	West Java
PT Sami Surya Perkasa	Sukoharjo	Central Java
PT Hesheng Plastic Industrial	Mojokerto	East Java

Source: Author's compilation, 2022

#### 4.3.5 REVIEW OF QUALIFIED MANUFACTURERS

An observation checklist was developed to help the research team in identifying each component of USAID's technical requirements and test specifications. The observation checklist also included space for additional information to elaborate on why each component was checked or unchecked. The results of the observations are outlined in Table 9 below.

**TABLE 9. PRODUCT SPECIFICATIONS AND REQUIREMENTS**

	PT UNGGUL KARYA SEMESTA	PT SAMI SURYA PERKASA	PT HESHENG PLASTIC INDUSTRIAL
<b>TECHNICAL REQUIREMENTS</b>			
<b>Material for sheeting</b>	Yes	Yes	Yes
Woven HDPE black fibers laminated on both sides with white LDPE coating			
<b>Material for the reinforced attachment points</b>	Yes	Yes	Yes
45 mm(+/-5mm) heat sealed hemmed edge. Reinforcement eyelets: Aluminum eyelets or equivalent (non-corrosive), reinforced with black plastic corner. One reinforced eyelet on each corner and at 1m intervals around edge	They need an explanation on the black plastic corner	They need an explanation on the black plastic corner	They need an explanation on the black plastic corner
<b>Panels</b>	Yes	Yes	Yes
Only one welding allowed, in the middle of the sheet, length wise	They produce 2x100 meters	They produce 2x100 meters and 4x50 meters	They produce 2x100 meters and 4x100 meters
<b>UV Inhibitor and Flame retardant</b>	Yes	Yes	Yes
Sufficient material application of both to meet or exceed grab tensile strength	They need an explanation on the	They need an explanation on the	They need an explanation on the flame-retardant additive

**TABLE 9. PRODUCT SPECIFICATIONS AND REQUIREMENTS**

	PT UNGGUL KARYA SEMESTA	PT SAMI SURYA PERKASA	PT HESHENG PLASTIC INDUSTRIAL
after UV weathering and flame retardancy test values shown below	flame-retardant additive	flame-retardant additive	
<b>Flame retardant; ENI 3823+A</b> Minimum class D, s2, d2 Minimum time to reach large wing external edge: 4minutes (LFS)	They need explanation on the flame-retardant additive and formulation	They need explanation on the flame-retardant additive and formulation	They need explanation on the flame-retardant additive and formulation
<b>Coating Color</b> White on both sides	Yes	Yes	Yes
<b>Opacity</b> Measured under ISO 13468-1. Values should be measured respectively from 350 to 750nm, and from 750 to 2500nm wavelength	Yes But they need an external test lab for assessment	Yes But they need an external test lab for assessment	Yes But they need an external test lab for assessment
<b>Dimensions</b> Width: 4-meter standard size, discrepancy ±1% net width Length: 6-meter standard size, discrepancy ±1% net length	Yes They produce 2x100 meters	Yes They produce 2x100 meters and 4x50 meters	Yes They produce 2x100 meters and 4x100 meters
<b>Weight</b> 190g/m <sup>2</sup> ±5%	Yes	Yes	Yes
<b>Instruction sheet</b>	Yes	Yes	Yes
<b>TEST SPECIFICATIONS</b>			
<b>Tear strength in plain sheet at state of origin</b> Minimum 100N under ISO 4674-1B 2003, with a test piece of 200x200mm as described in ISO 4674 annex B, in plain sheet	Yes	Yes	Yes
<b>Tensile strength in plain sheet at state of origin</b> Minimum 500N and 15% to 35% elongation in warp and weft in plain sheet under ISO 1421-1	Yes	Yes	Yes
<b>UV resistance of the plain sheet</b> The tarpaulin tensile strength under ISO 1421-1 after 1500 hours UV under ASTM G53/94 (UVB 313 nm peak) must be: Minimum 80% of the original value of the actual product, AND not less than 475N	They need an external test lab to assess	They need an external test lab to assess	They need an external test lab to assess

**TABLE 9. PRODUCT SPECIFICATIONS AND REQUIREMENTS**

	PT UNGGUL KARYA SEMESTA	PT SAMI SURYA PERKASA	PT HESHENG PLASTIC INDUSTRIAL
<b>Welding number and strength at state of origin</b> The tarpaulin tensile strength crossways at the place of the welding under ISO 1421-1 must be: Minimum 50% of the original value of the actual product, AND not less than 400N	They need an external test lab to assess	They need an external test lab to assess	They need an external test lab to assess
<b>Flammability test</b> Pass	They need an external test lab to assess	They need an external test lab to assess	They need an external test lab to assess

Source: Author's compilation, 2022

The results of the observations show that there are three issues that need further confirmation and discussion with USAID BHA, namely specification of black plastic corner and assessments for opacity, UV resistance, strength, and flame retardant. All manufacturers require external parties to conduct tests on the strength, UV resistance, and flammability as they do not have in-house test facilities. All manufacturers also state that they cannot produce a small amount of sample tarpaulin, but orders can be produced at the minimum order size (between 5,000 – 6,000 unit of sheets sized 4x6 meter).

Only one manufacturer, PT Sami Surya Perkasa, has experience in producing tarpaulins that pass the required tests for export purposes. To complement the above-mentioned data, an additional list of questions was given to gather more detailed information about the capacity and capability of each tarpaulin manufacturer. The results are as follows:

**TABLE 10. ADDITIONAL INFORMATION ON QUALIFIED TARPAULIN MANUFACTURERS**

ADDITIONAL INFORMATION	PT UNGGUL KARYA SEMESTA	PT SAMI SURYA PERKASA	PT HESHENG PLASTIC INDUSTRIAL
<b>Year of Establishment</b>	1989	2006	2019
<b>Capacity (ton/month)</b>	250	30	600
<b>Minimum order (pieces)</b>	5,000	6,000	6,000
<b>Production time (days)</b>	21	30	45
<b>Current recycled contents (%)</b>	Up to 25% (Post-industrial)	Up to 15% (Post-consumer)	Up to 25% (Post-industrial)
<b>Estimated price (USD/piece)</b>	13.70 (Excluding flame retardant, tax, and delivery)	10.13 (Excluding UV resistance, flame retardant, tax, and delivery)	25.36 (Excluding tax and delivery)
<b>Investment origin</b>	Indonesia	Indonesia	China

**TABLE 10. ADDITIONAL INFORMATION ON QUALIFIED TARPAULIN MANUFACTURERS**

ADDITIONAL INFORMATION	PT UNGGUL KARYA SEMESTA	PT SAMI SURYA PERKASA	PT HESHENG PLASTIC INDUSTRIAL
<b>Experience in producing tarpaulin for disaster relief</b>	OXFAM, World Vision, and the Ministry of Social Affairs  (Different technical specification from BHA)	No experience, but they export tarpaulins to the U.S., Europe, and Australia	No, but the main factory in China produced similar products for the Chinese government

Source: Author's compilation, 2022

In terms of the price, each manufacturer offers different prices with different terms and conditions. However, based on our interviews with PT Hesheng Plastic Industrial, an estimated price component for a 4x6-meter heavy-grade tarpaulin is presented in Table 11.

**TABLE 11. ESTIMATED PRICE COMPONENTS**

COMPONENTS	PRICE (USD)
HDPE	4.33
LDPE	2.89
Masterbatch Color	3.32
Additives UV Inhibitor	0.96
Additives Flame Retardant	9.22
<b>Total Raw Materials</b>	<b>20.72</b>
Eyelets 18/30mm	0.73
Label A4	0.24
Rope 5mm 20m	0.61
Sack-packing / 10 pcs	0.03
<b>Total Accessories</b>	<b>1.61</b>
<b>Cost-making</b>	<b>3.04</b>
<b>TOTAL</b>	<b>25.36</b>

Source: Author's compilation, 2022



The estimated total cost of a 4x6 heavy grade plastic tarpaulin is USD 25.36, comprised of the total price of materials (USD 20.71), total cost of accessories (USD 1.61), and cost-making (USD 3.04). However, this is only a rough estimation excluding stocking, tax, and delivery costs.

Each manufacturer requires different terms and conditions to produce customized heavy-grade tarpaulins such as minimum order, time of production and estimated price. To draw final conclusions in meeting USAID BHA specifications for tarpaulin production, further discussions are needed to answer questions raised from the manufacturers listed below:

1. According to USAID’s specifications, the tarpaulins must be standard sizes of 4-meter width and 6-meter length, with only one welding allowed (in the middle of the sheet). During observations of the potential manufacturers, some of them produce 2 sizes of tarps: 2-meters and 4-meters in length. Can the manufacturer combine the supplies of tarpaulins with 2-meter tarps (with a welding) and 4-meter tarps?
2. In the specification, the reinforcement eyelets must be made of aluminum reinforced with black plastic corners. What does a “black plastic corner” mean? How does it look like?
3. What is the percentage of additives that USAID requires for UV resistance and flame retardance?
4. What percentage of recycled contents would USAID require?
5. Does USAID have any desired specification or brands for additives?

Based on our interviews with the manufacturers, most of them did not have any experience using flame retardant additives as there is no demand for this feature in the domestic market. However, this research has identified several chemical companies that can provide such additives and further consultation, as listed in Table 12.

**TABLE 12. LIST OF ADDITIVE MANUFACTURERS**

NAME OF COMPANIES	TYPE(S) OF ADDITIVES	LOCATION
PT Clariant Indonesia	Flame retardant	Bogor, West Java
PT Intera Lestari Kimia	UV and Flame retardant	Tangerang, Banten
PT Toray International Indonesia	Flame retardant	Tangerang, Banten
PT Lotte Chemical Titan	Flame retardant	Cilegon, Banten
PT Dunia Kimia Jaya	Flame retardant	Cikarang, West Java
PT Polypackindo Utama (Wellon)	Flame retardant	Tangerang, Banten

Source: Author’s compilation, 2022

Based on USAID’s technical requirements, there are several tests that cannot be done by each manufacturer, including UV resistance and flame retardant. Therefore, resources could be channeled for external test lab to generate the required data. Table 13 provides the list of external test labs located in Java Island:

**TABLE 13. LIST OF EXTERNAL TEST LABS**

NAME OF LABORATORY	NOTE
Euro Lab Laboratory Services	Private sector
Science Laboratory and Certification	Private sector
Balai Pengujian Mutu Barang	Under the Ministry of Trade
Balai Besar Standardisasi Pelayanan Industri Kimia Kemasan	Under the Ministry of Industry

Source: Author's compilation, 2022

## 5. CONCLUSIONS

Overall, Indonesia produces plastic sheeting amounting to 2,600 ton per month by 13 tarpaulin manufacturers concentrated in Java Island. The industry face challenges with the fluctuating price of global crude oil, complex supply chain of recycled plastics, the COVID-19 pandemic, and the abundance of Chinese tarpaulins. Indonesia's technical capacity in producing plastic sheeting meets USAID specification requirements and can produce plastic sheeting with some recycle content. However, further data from USAID BHA on current demand and cost is needed to answer questions regarding the economic viability of plastic sheeting production. The following are the main conclusions of this assessment, presented on a question-by-question basis, as well as recommendations.

### QUESTION 1

**What is the current state of plastic sheet manufacturing in Indonesia? How likely can it be produced, who are the key players and what is the production capacity?**

Indonesia currently has 13 plastic sheeting manufacturers that produce tarpaulin with varied mechanical and physical properties. The production capacity is around 2,600 tons of tarpaulins every month. Therefore, it is very likely to produce plastic sheeting in the form of tarpaulin in Indonesia.

The raw material for plastic sheeting is produced by the largest petrochemical company in Indonesia called PT Chandra Asri Petrochemical Tbk, located in Serang, Banten. All of the petrochemical companies that support plastic sheeting manufacturers are organized by INAPLAS, the largest upstream plastic association in the country.

The Ministry of Industry's directorate of downstream chemical and pharmaceutical industry has implemented several regulations to support tarpaulin industry, such as the use of local materials (TKDN) and ensuring the availability of the raw materials needed.

The 13 local tarpaulins manufacturers have been providing nation-wide demand of tarpaulins such as outdoor covering, protective items, and temporary shelters.

## QUESTION 2

**What is the current state of recycling capabilities in Indonesia? What is the profile of plastic waste generated from plastic sheet production, and which type would be economically viable to recycle given the current demand and cost?**

The plastic recycling industry in Indonesia has existed for decades as small-scale industries producing low quality household amenities such as buckets, water dippers, plastic bags, and brooms. According to APSI, the capacity of the plastic recycling industry was around 2 million tons per year in 2019, while the recycling industry only supplied around 1.1 million tons due to a shortage of segregated plastic waste. Furthermore, only 10% of plastic waste was recycled in 2019 and mostly in the form of rigid plastic, PET, HDPE, LDPE, and PP. Meanwhile, flexible plastics are commonly burned or dumped as they are not economically feasible to be recycled.

Based on our interviews with the three tarpaulin manufacturers that can meet USAID BHA specification requirements, the manufacturers use HDPE plastic waste with different formulations; PT Sami Surya Perkasa uses post-industrial plastic waste with up to 15% composition, PT Unggul Karya Semesta uses post-industrial plastic waste with up to 25% composition, and PT Hesheng Plastic Industrial uses post-consumer plastic waste with up to 50% composition. The aforementioned percentage of waste is based on the company's analysis on economic viability determined by each company's demand and cost.

The main challenges faced by the recycling industry include the price dependency on virgin plastic price fluctuation, low segregation rate from households, unfavorable perception towards recycled products, low capacity of local governments in creating effective municipal waste management systems, and no incentives given to the recycling industry.

## QUESTION 3

**Does Indonesia have the capability and technology to manufacture plastic sheeting using some recycled content, particularly with HDPE or similar high-density plastic? What is the capacity?**

Indonesia is capable of and has the technology for manufacturing plastic sheeting using recycled content with the capacity of approximately 880 tons per month from three different tarpaulin manufacturers. Based on interviews with the tarpaulins manufacturers, the use of recycled plastic is not a widespread practice due to its complex supply chain and the inconsistent quality of recycled plastic. The major concern for using recycled plastic is the level of impurities that can cause negative effects to the mechanical properties of products, such as tensile strength, tear strength, and durability.

The machinery used for virgin HDPE plastic does not differ from those used for recycled HDPE plastic, therefore this should not inhibit the ability of manufacturers to produce plastic sheeting with HDPE recycled content. The issue lies in the pre-treatment requirement to ensure that the quality of recycled HDPE plastic meets the standards for cleanliness and consistency. One manufacturer, PT Hesheng Plastic Industrial, stated that they could use up to 50% of post-consumer HDPE plastic waste in the form of plastic bottles, plastic bottle lids, and other types of plastic waste. The manufacturer purchases the recycled plastic flakes from local waste collectors and combines it with virgin HDPE plastic to produce tarpaulins.

## 6. RECOMMENDATIONS AND NEXT STEPS

USAID might want to consider conducting additional research on market feasibility, financial feasibility, business processes, and enabling environment of Indonesia's regulatory framework to fully inform its decision on moving plastic sheeting production to Indonesia. The results of this research can be presented in a workshop where key stakeholders can provide ideas and identify action plans to meet the needs of USAID. USAID's EGSA team can facilitate the workshop, as well as work with the Mission to develop an action plan towards meeting USAID BHA objectives. Additional recommendations are as follows:

1. Many informal waste management sectors involve child labor and human trafficking (Sasaki et al., 2019). Developing a traceability system will be necessary to verify the origin of plastic waste collected. While acquiring plastic waste from the informal sectors contributes to improving the livelihood of scavengers, it is important to ensure that no harmful economic and social practices occur in the value chain.
2. A complete life cycle assessment needs to be conducted to understand the whole effect on the environment from acquiring, processing, using, and especially disposing polythene tarpaulins. While acquiring recycled material can potentially reduce carbon emission by 30%, a scenario of disposing the tarpaulins needs to be considered. No previous research has been conducted on the impact of the using UV inhibitors and flame-retardant additives to the capability of recycling tarpaulins.
3. Consider providing mosquito insecticide as an additive in plastic sheeting. Many studies showed a positive association between climate change and mosquito-borne disease risk, especially in tropical countries such as Indonesia (Franklinos et al., 2019). Spraying canvas tents with residual pyrethroid insecticide is an established method of malaria vector control in tented refugee camps. Advances in technology enable polythene sheeting to be impregnated with pyrethroid during the manufacturing process. Previous work has shown that top-sheets and blankets treated with residual pyrethroid can be a useful tool against malaria and cutaneous leishmaniasis (Rowland et al., 1999).

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# ANNEX I – INTERVIEW QUESTIONS FOR ASSOCIATIONS

## PLASTIC INDUSTRY ASSOCIATIONS

### GENERAL QUESTIONS

- Current Condition
  - How is the current condition of the plastic industry in Indonesia?
  - How is the growth of the Indonesian plastic industry?
  - How much has the plastic industry contributed to the national GDP?
  - What are the biggest concerns in the industry?
  - What are the current trends in the market?
  - Is there any new technological advancement? If any, what are they?
- Industry Size
  - How big is the market for the plastic industry?
  - How is the demand-supply balance?
  - How is the demand pattern and supply pattern?
- Regulation
  - Is there any regulation imposed by the government?
  - If there is, how do you think it will influence the industry?
  - What is the regulatory bottleneck?
  - Do you think there is something that the government needs to regulate for this industry?
- Sustainability
  - How does the plastic industry contribute to sustainable development (e.g., stopping plastic pollution, enhancing circular economy, curbing greenhouse gases)?

### SPECIFIC INDUSTRY

- Key Players
  - Who are the leading actors in the plastic industry?
  - How is the competition among plastic manufacturers?
- Supply Chain
  - Could you please explain the supply chain of the plastic industry? Who are the stakeholders?
  - How does industry procure raw materials? What are the challenges?
- Value Chain
  - Could you please explain the value chain of the plastic industry?
  - What kind of plastic does this association use?
  - What are the most demanded raw materials for plastics in the market?
  - What is the difference between the export price and domestic price?
  - Can this industry replace virgin plastic with recycled plastic as material?
- Technology
  - What kind of technology has the industry not possessed but actually very important to upgrade the industry's capacity and capability?
  - Do you think the current technological advancement in the plastic industry has helped to fulfil the national demands? (\*)

### ASSOCIATION

- How many members do you have in this association?
- What is the focus and specialization of this association?
- What are the requirements to join this association?
- What makes this association different from other associations?

### USAID PRODUCT'S SPECIFICATIONS

- Do you have any members that use woven HDPE and LDPE as their material?
- Do you have any members that produce heavy-grade plastic sheeting?

- Do we have the technology to produce plastic sheeting with this kind of specification? If yes, who has it?
- If not, what do you need to be able to produce the required plastic sheeting?
- How much investment do you need to be able to produce the required plastic sheeting?
- Is there any other industry that asks for this kind of plastic sheeting?
- How much do you think the price range is to produce plastic sheeting?

## PLASTIC RECYCLING INDUSTRY ASSOCIATIONS

### GENERAL QUESTIONS

- Current Condition
  - How is the current condition of the plastic recycling industry?
  - How is the growth of Indonesian plastic recycling industry?
  - What are the biggest concerns in the industry?
  - What are the current trends in the market?
  - What kind of recycled plastic is currently trending in the market?
  - Is there any new technological advancement? If any, what are they?
- Industry Size
  - What is the economic and market size for this industry?
  - How is the demand-supply balance?
  - How is the demand pattern and supply pattern?
- Regulation
  - Is there any regulation imposed by the government?
  - If there is, how do you think it will influence the industry?
  - What is the regulatory bottleneck?
  - Is there any incentive given by the government? Is it working?
  - Do you think there is something that the government needs to regulate for this industry?
- Sustainability
  - How does the industry contribute to sustainable development (e.g., stopping plastic pollution, enhancing circular economy, curbing greenhouse gases)?
  - How do you think we can increase recycling rate in Indonesia?

### SPECIFIC INDUSTRY

- Key Players
  - Who are the main actors in the industry? Small medium enterprises? Big corporations?
  - How is competition among waste management companies?
- Supply Chain
  - Could you please explain the supply chain of the plastic recycling industry? Who are the stakeholders?
  - How does the industry procure the material? What are the challenges?
  - Between formal and informal waste collectors, which one collects more waste? How about their prices? Do you think they are expensive?
  - What kind of industry needs recycled plastic?
- Value Chain
  - Could you please explain the value chain of the plastic recycling industry?
  - What kind of plastic waste does this association use?
  - How do you differentiate valuable plastic waste and non-valuable plastic waste? Why are they valuable or not valuable?
  - Can plastic waste be used to produce high-quality products?
  - Does Indonesia import plastic waste? What kind of plastic waste and why does the country import them?
  - Does Indonesia export plastic waste? What kind of plastic waste and why does the country export them?

- What is the difference between the export price and domestic price?
- What is the cost difference between using plastic waste and virgin plastic to manufacture new products?
- Technology
  - What kind of technology has the industry not possessed but actually very important?
  - Is there any technology to recycle low-grade plastic waste? If not, why is that?
  - If yes, what can we produce from low-grade plastic waste?

#### ASSOCIATION

- How many members do you have in this association?
- What is the focus and specialization of this association?
- What are the requirements to join this association?
- What makes this association different from other associations?

#### USAID PRODUCT'S SPECIFICATIONS

- Do you have any members that use woven HDPE and LDPE as their material?
- Do you have any members that produce heavy-grade plastic sheeting?
- Do we have the technology to produce plastic sheeting with this kind of specification? If yes, who has it? If not, what do you need to be able to produce the required plastic sheeting?
- How much investment do you need to be able to produce the required plastic sheeting?
- Is there any other industry that asks for this kind of plastic sheeting?
- How much do you think the price range is to produce plastic sheeting?

## ANNEX 2 – INTERVIEW QUESTIONS FOR EXPERTS

### PLASTIC INDUSTRY EXPERTS

#### GENERAL QUESTIONS

- Current Condition
  - How is the growth of the Indonesian plastic industry?
  - How much has the plastic industry contributed to the national GDP?
  - What are the biggest concerns in the industry?
  - What are the current trends in the market?
  - What kind of plastic goods are currently trending in the market?
  - Is there any new technological advancement? If any, what are they?
  - What needs to be done to improve this industry?
- Industry Size
  - How big is the market for this industry?
  - How is the demand-supply balance?
  - How is the demand pattern and supply pattern?
- Regulation
  - Is there any regulation imposed by the government?
  - If there is, how do you think it will influence the industry?
  - What is the regulatory bottleneck?
  - Do you think there is something that the government needs to regulate for this industry?
  - How does the Industry Ministry's Regulation Number 55/2020 on Green Industry Standards for Plastic and Bioplastic Shopping Bags or Bags Industry, and the Environment and Forestry Ministry's Regulation Number 1/2021 affect the operation and production of Indonesia's plastic industry?
- Sustainability
  - How does the plastic industry contribute to sustainable development (e.g., stopping plastic pollution, enhancing circular economy, curbing greenhouse gases)?

#### SPECIFIC INDUSTRY

- Key Players
  - Who are the leading actors in the plastic industry?
  - How is the competition among plastic manufacturers in Indonesia?
- Supply Chain
  - Could you please explain the supply chain of the plastic industry? Who are the stakeholders?
  - How does the industry procure raw materials? What are the challenges?
- Value Chain
  - How different is the exported plastics price and domestic plastics price?
  - Can this industry replace virgin plastic with recycled plastic as material?
- Technology
  - What kind of technology has the industry not possessed but actually very important?
  - Do you think the current technological advancement in the plastic industry has helped to fulfil the national demands?

#### USAID PRODUCT'S SPECIFICATIONS

- Do you know any manufacturers that use woven HDPE and LDPE as the material?
- Do you know any manufacturers that produce heavy-grade plastic sheeting?
- Do you think Indonesia has the technology to produce plastic sheeting that meets USAID's requirements?

### PLASTIC RECYCLING INDUSTRY EXPERTS

## GENERAL QUESTIONS

- Current Condition
  - How is the current condition of the plastic recycling industry?
  - What are the biggest concerns in the industry?
  - What are the current trends in the market?
  - What kind of recycled plastic is currently trending in the market?
  - Is there any new technological advancement? If any, what are they?
  - What needs to be done to improve this industry?
- Industry Size
  - What is the economic and market size for this industry?
  - How is the demand-supply balance?
  - How is the demand pattern and supply pattern?
- Regulation
  - Is there any regulation imposed by the government?
  - If there is, how do you think it will influence the industry?
  - What is the regulatory bottleneck?
  - Is there any incentive given by the government?
  - Do you think there is something that the government needs to regulate for this industry?
- Sustainability
  - How does the industry contribute to sustainable development (e.g., stopping plastic pollution, enhancing circular economy, curbing greenhouse gases)?

## SPECIFIC INDUSTRY

- Key Players
  - Who are the main actors in the industry?
  - Is there any competition among waste management companies?
- Supply Chain
  - Could you please explain the supply chain of your industry? Who are the stakeholders?
  - Where do you source plastic waste?
  - What kind of plastic waste do you look for?
  - Is it hard to source for HDPE and LDPE?
  - Between formal and informal waste collectors, which one collects more waste? How about their prices? Do you think they are expensive?
- Value Chain
  - Could you please explain the value chain of your industry?
  - Where do you sell plastic waste?
  - How do you differentiate valuable plastic waste and non-valuable plastic waste?
  - Can plastic waste be used to produce high-quality products?
  - Do you import plastic waste? What kind of plastic waste and why?
  - Do you export plastic waste? What kind of plastic waste and why?
  - What is the difference between export price and domestic price?
  - How do you segregate waste? How many categories?
  - How do you grade plastic waste?
  - What is the cost difference between using plastic waste and virgin plastic?
- Technology
  - What kind of technology has the industry not possessed but actually very important?
  - Is there any technology to recycle low-grade plastic waste? If not, why is that?

## USAID PRODUCT'S SPECIFICATIONS

- Do you know any manufacturer that uses woven HDPE and LDPE as the material?
- Do you know any manufacturer that produces heavy-grade plastic sheeting?
- Do you think Indonesia has the technology to produce plastic sheeting that meets USAID's requirements?

## ANNEX 3 – INTERVIEW QUESTIONS FOR GOVERNMENT

### PLASTIC INDUSTRY

#### GENERAL QUESTIONS

- Current Condition
  - How is the growth of the Indonesian plastic industry?
  - How much has the plastic industry contributed to the national GDP?
  - What are the biggest concerns of this industry?
  - What are the current trends in the market?
  - What kind of plastic goods are currently trending in the market?
  - Is there any new technological advancement? If any, what are they?
- Industry Size
  - How big is the market for this industry?
  - How is the demand-supply balance?
  - How is the demand pattern and supply pattern?
- Regulation
  - Is there any regulation imposed by the government?
  - If there is, how do you think it will influence the industry?
  - What is the regulatory bottleneck?
  - Do you think there is something that the government needs to regulate for this industry?
  - What are the parameters of the existing policies for the plastic industry in Indonesia (Industry Ministry's Regulation Number 55/2020 on the Green Industry Standards for Plastic and Bioplastic Shopping Bags or Bags Industry and the Environment and Forestry Ministry's Regulation Number 1/2021)?
- Sustainability
  - How does the plastic industry contribute to sustainable development (e.g., stopping plastic pollution, enhancing circular economy, curbing greenhouse gases)?

#### SPECIFIC INDUSTRY

- Key Players
  - Who are the leading actors in the plastic industry?
  - How is the competition among plastic manufacturers?
- Supply Chain
  - Could you please explain the supply chain of the plastic industry? Who are the stakeholders?
  - How does the industry procure raw materials? What are the challenges?
- Value Chain
  - How different is the exported plastics price and domestic plastics price?
  - Can this industry replace virgin plastic with recycled plastic as material?
- Technology
  - What kind of technology has the industry not possessed but actually very important?
  - Do you think the current technological advancement in the plastic industry has helped to fulfil the national demands?

#### USAID PRODUCT'S SPECIFICATIONS

- Do you know any manufacturers that use woven HDPE and LDPE as the material?
- Do you know any manufacturers that produce heavy-grade plastic sheeting?
- Do you think Indonesia has the technology to produce plastic sheeting that meets USAID's requirements?

## PLASTIC RECYCLING INDUSTRY

### GENERAL QUESTIONS

- Current Condition
  - How is the current condition of the plastic recycling industry?
  - How much plastic waste gets recycled?
  - What kind of plastic waste gets recycled?
  - What is the biggest challenge of waste management in Indonesia?
  - How can we improve plastic waste recovery
  - How to address unmanaged waste? No collection area?
  - How can we support the plastic recycling industry?
  - What are the biggest concerns of this industry?
  - What are the current trends in the market?
  - What kind of recycled plastic is currently trending in the market?
  - Is there any new technological advancement? If any, what are they?
- Regulation
  - Is there any regulation imposed by the government?
  - If there is, how do you think it will influence the industry?
  - What is the regulatory bottleneck?
  - Is there any incentive given by the government?
  - Do you think there is something that the government needs to regulate for this industry?
  - How effective is the decree 75-2019 Road map from producer?
  - What is plastic credit?
  - Is there any specific plan for the upcoming new capital city?
- Sustainability
  - How does the industry contribute to sustainable development (e.g., stopping plastic pollution, enhancing circular economy, curbing greenhouse gases)?

### SPECIFIC INDUSTRY

- Key Players
  - Who are the main actors in the industry?
  - How is competition among waste management companies?
- Supply Chain
  - Could you please explain the supply chain of the plastic recycling industry? Who are the stakeholders?
  - Between formal and informal waste collectors, which one collects more waste?
- Value Chain
  - Can plastic waste be used to manufacture high-quality products?
  - Does Indonesia import plastic waste? What kind of plastic waste and why?
  - Does Indonesia export plastic waste? What kind of plastic waste and why?
  - What is the cost difference between using plastic waste and virgin plastic to manufacture new products?
- Technology
  - What kind of technology has the industry not possessed but actually very important?
  - Is there any technology to recycle low-grade plastic waste? If not, why is that?

### USAID PRODUCT'S SPECIFICATIONS

- Do you know any manufacturers that use woven HDPE and LDPE as the material?
- Do you know any manufacturers that produce heavy-grade plastic sheeting?
- Do you think Indonesia has the technology to produce plastic sheeting that meets USAID's requirements?



## ANNEX 4 – INTERVIEW QUESTIONS FOR TARPAULIN MANUFACTURERS

### GENERAL QUESTIONS

- Current Condition
  - How is the current condition of the plastic recycling industry?
  - How is the growth of the Indonesian plastic recycling industry?
  - What are the biggest concerns in the industry?
  - What are the current trends in the market?
  - What kind of recycled plastic is currently trending in the market?
  - Is there any new technological advancement? If any, what are they?
- Industry Size
  - What is the economic and market size for this industry?
  - How is the demand-supply balance?
  - How is the demand pattern and supply pattern?
- Sustainability
  - How does the industry contribute to sustainable development (e.g., stopping plastic pollution, enhancing circular economy, curbing greenhouse gases)?

### SPECIFIC INDUSTRY

- Key Players
  - Who are the main actors in the industry?
  - How is competition among waste management companies?
- Supply Chain
  - Could you please explain the supply chain of the plastic recycling industry? Who are the stakeholders?
  - How do you procure the material? What are the challenges?
  - Between formal and informal waste collectors, which one collects more waste? How about their prices? Do you think they are expensive?
- Value Chain
  - Could you please explain the value chain of the plastic recycling industry?
  - What kind of plastic do you accept? Do you accept HDPE or LDPE?
  - What do you produce? What do you produce with HDPE and LDPE?
  - How much plastic do you recycle in a month?
  - What is valuable plastic waste? What is not? Why?
  - How do you segregate waste? How many categories?
  - How do you grade plastic waste?
  - Can plastic waste produce high-quality products?
  - Do you import plastic waste? What kind of plastic waste and why?
  - Do you export plastic waste? What kind of plastic waste and why?
  - What is the difference between export price and domestic price?
  - What is the cost difference between using plastic waste and virgin plastic to manufacture new products?
  - How much would you need to produce to be competitive with a virgin plastic material?
  - What is the biggest cost to manufacture new products with plastic waste; is it collections, logistics, or technology?
- Technology
  - What kind of technology has the industry not possessed but actually very important?
  - Is there any technology to recycle low-grade plastic waste? If not, why is that?
  - If yes, what can we produce from low-grade plastic waste?

#### USAID PRODUCT'S SPECIFICATIONS

- Do you have the technology to produce plastic sheeting with this kind of specification? If not, what do you need to be able to produce the required plastic sheeting?
- How much investment do you need to be able to produce the required plastic sheeting?
- Is there any other manufacturer that produces this kind of plastic sheeting?
- Is there any other industry that asks for this kind of plastic sheeting?
- How much do you think the price range is to produce?
- If you are able to produce the required plastic sheeting, how much is the capacity?

## ANNEX 5 – OBSERVATION CHECKLIST BASED ON USAID BHA TECHNICAL QUALIFICATION

FEATURES	REQUIREMENTS	CHECKBOX	NOTES
Material for the sheet	Woven high-density polyethylene (HDPE) black fibers laminated on both sides with white low-density polyethylene (LDPE) coating. Upon award of the contract, the contractor shall provide USAID with a sample of the material for review and confirmation. The contractor shall provide a copy of the test report of similar material from past productions, if available.	<input type="checkbox"/>	
Material for the reinforced attachment points	45 mm(+/-5mm) heat sealed hemmed edge. Reinforcement eyelets: Aluminum eyelets or equivalent (non- corroding), reinforced with black plastic corner. One reinforced eyelet on each corner and at 1m intervals around edge.	<input type="checkbox"/>	
Panels	Only one welding allowed, in the middle of the sheet, length wise.		
UV Inhibitor and Flame retardant:	Sufficient material application of both to meet or exceed grab tensile strength after UV weathering and flame retardancy test values shown below	<input type="checkbox"/>	
Flame retardant ENI 3823+AI	Minimum class D, s2, d2. Minimum time to reach large wing external edge: 4minutes (LFS)	<input type="checkbox"/>	
Coating Color:	White on both sides	<input type="checkbox"/>	
Opacity measured as minimum reflection and maximum transmission, in the range of visible light and near infrareds.	Measured under ISO 13468-1.  Values should be measured respectively from 350 to 750nm, and from 750 to 2500nm wavelength. The final result is the average of the averages in each range.  Minimum total reflection: 35%  Maximum total reflection: 50%  Maximum total transmission: 5%	<input type="checkbox"/>	
Dimensions	Width: 4-meter standard size, discrepancy $\pm$ 1% net width  Length: 6-meter standard size, discrepancy $\pm$ 1% net length	<input type="checkbox"/>	
Weight	190g/m <sup>2</sup> $\pm$ 5%	<input type="checkbox"/>	

Instruction Sheet USAID will provide the image of the instruction sheet for using the tarpaulin, following the award. Must be printed in color ink, A4 size sticker that is stuck and then glued onto tarp, near edge/hem, next to manufacturer info.




TEST	SPECIFICATION	CHECKBOX	NOTES
Tear strength in plain sheet at state of origin	Minimum 100N under ISO 4674-1B 2003, with a test piece of 200x200mm as described in ISO 4674 annex B, in plain sheet.	<input type="checkbox"/>	
Tensile strength in plain sheet at state of origin	Minimum 500N and 15% to 35% elongation in warp and weft in plain sheet under ISO 1421-1.	<input type="checkbox"/>	
UV resistance of the plain sheet, measured as remaining tensile strength after UV exposure	The tarpaulin tensile strength under ISO 1421-1 after 1500 hours UV under ASTM G53/94 (UVB 313 nm peak) must be: Minimum 80% of the original value of the actual product, AND not less than 475N.  To be tested in the plain sheet.	<input type="checkbox"/>	
Welding number and strength at state of origin	Only one welding allowed, in the middle of the sheet, length wise.  The tarpaulin tensile strength crossways at the place of the welding under ISO 1421-1 must be:  Minimum 50% of the original value of the actual product, AND not less than 400N	<input type="checkbox"/>	
Flammability test	Pass	<input type="checkbox"/>	

## Plastic Industry Associations

1. The Indonesian Olefin, Aromatic, and Plastic Industry (INAPLAS)  
The Indonesian Olefin, Aromatic, and Plastic Industry (INAPLAS) is the biggest plastic industry association that focuses on providing public policy and fiscal policy analysis on the Indonesian plastic market and supply chain. INAPLAS also engages in waste management, one of the projects they are involved in is the waste management project in Bali.
2. The Indonesian Woven Polyolefin Manufacturers Association (GIATPI)  
The Indonesian Woven Polyolefin Manufacturers Association (GIATPI), as a business association, has contributed for more than 45 years in building national industrial resilience, with members spread across Indonesia from the Sumatra Island to Java Island. Their members include producers of various plastic weaving products, such as woven bags, jumbo bags, tarpaulins, cement bags, mesh bags, geotextiles, plastic nets, etc., with domestic and foreign marketing covering ASEAN, European, and American countries.
3. The Indonesian Upstream Plastic Industry Association (APHINDO)  
The Upstream Plastic Industry Association (APHINDO) is an association that oversees the upstream industry and plastic supply chain from the upstream to the downstream industry.

## Plastic Recycling Industry Associations

1. The Indonesian Plastics Recycling Association (ADUPI)  
ADUPI is an association concentrated on the plastic recycling industry. Not only the industry, but ADUPI also focuses on improving businesses with brand owners, practitioners, and experts, especially in the plastic waste chain. There are around 500 members, both active and non-active, spread across Indonesia.
2. The Indonesian Plastic Recyclers (IPR)  
The Indonesian Plastic Recycler is an association consisting of 70 plastic recycling manufacturers. The association has been established for 3 years and has a close relationship with the Ministry of Industry and Ministry of Environment and Forestry.
3. The Indonesian Waste Entrepreneurs (APSI)  
The Indonesian Waste Entrepreneurs Association (APSI) is an association of entrepreneurs engaged in waste, transportation services, processing services, recycling material collectors, waste to energy operators, etc. APSI was founded in Jakarta on June 14, 2019, currently APSI members are 268 members, spread across various cities and provinces in Indonesia, APSI members themselves consist of small, medium, and large businessmen.