Circularity Assessment Protocol
Timor-Leste

University of Georgia

Circularity Informatics Lab

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MERCY CORPS

New Materials Institute
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- Jules Keane, Country Director – Mercy Corps Timor-Leste
- Graziela Xavier, Circular Economy Program Manager
- Devi Lolita Monis Esperito Santo, Senior MERL Officer
- Adelia Duarte, Enumerator
- Agilda Castanheira, Enumerator
- Zelia Fatima Soares, Enumerator
- Cipriano Mota de Araujo, Enumerator
- Manuel Gregorio Pinto, Enumerator
- Donasio Sarmento Soares, Enumerator
- Theotonio Paiva Soares, Enumerator
- Joao Paulo Dias do Rego, Enumerator

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Jambeck Circularity Informatics Lab

Location:
The University of Georgia
Athens, GA, USA 30602

Contact:
Dr. Jenna Jambeck
jjambeck@uga.edu

Contributing Authors:
Kathryn Youngblood, Chever Voltmer, Graziela Xavier, Jules Keane, and Jenna Jambeck

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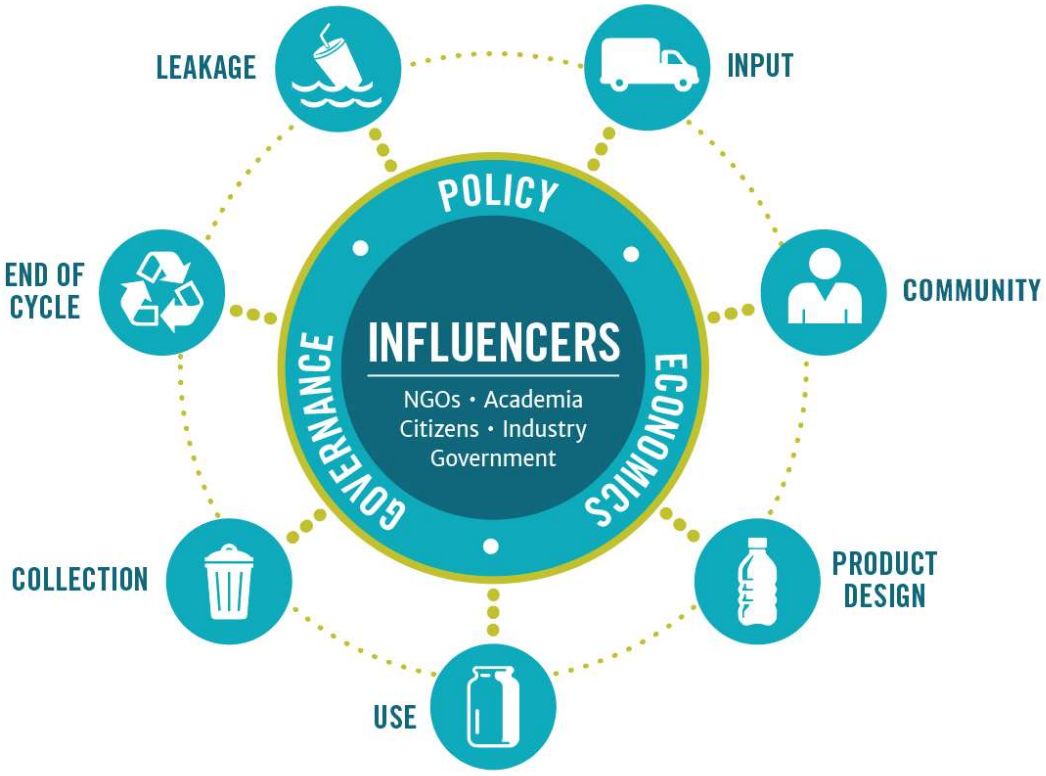
Amau Iramu, Unsplash

Policy Brief

Developed by the Circularity Informatics Lab at the University of Georgia, the Circularity Assessment Protocol (CAP) is a standardized assessment protocol to inform decision-makers through collecting community-level data on plastic usage. Grounded in materials flow and systems thinking concepts, the CAP uses a hub-and-spoke model to holistically characterize how consumer plastic flows into a community, is consumed, and flows out, either through waste management systems or leakage into the environment. The model, shown below, is comprised of seven spokes: input, community, material and product design, use, collection, end of cycle, and leakage. At the center, the system is driven by policy, economics and governance with key influencers including non-governmental organizations, industry, and government.



Field work was conducted in September 2024 by the local implementation partner, Mercy Corps. This CAP project was sponsored by the World Bank.

Background

Timor-Leste faces a number of challenges unique to newly constituted nations – establishing a myriad of institutions, developing a body of laws and regulations, building capacity, and integrating into the broader global framework. At the same time, the Government of Timor-Leste must also address similar

issues as every other nation, including the scourge of plastic pollution and the promotion of a circular economy. Given the country's unique ocean resources as part of the Coral Triangle biodiversity hotspot, preventing plastic pollution in this context is critical and necessary to furthering a blue economy.

This complex problem requires concerted action by governments, the private sector, consumers, and civil society. While all actors must contribute, governments have a special responsibility – and opportunity – to foster solutions. Governments can incentivize and accelerate the pace of change through their policy interventions. They can mobilize both internal and external resources to support solutions. They can also leverage policies to catalyze the private sector contributions needed to solve the problem. Crucially, only governments have the authority to ensure the policies they create are enforced fairly and consistently to achieve the policy goal.

The Government of Timor-Leste has taken admirable steps to craft some of the laws and regulations required to reduce plastic pollution. In some cases, the next step is to develop additional rules and regulations to support existing laws. In other cases, all that is necessary is enforcing regulations already on the books. Still other cases will require strategic investments to deliver results. However, investments in a more circular economy offer the opportunity to deliver not just environmental, but also economic and social returns. Based on the CAP data, high-priority interventions to deliver maximum impact could include the following areas.

Reduction Efforts

Decree Law 37/2020 contains provisions that prohibit the "release for consumption any packaging or object made of non-recyclable, non-biodegradable, or non-degradable single-use plastic for 13 items." However, the ban is in force for only two of 13 proposed items (single-use bags and foam takeout containers) and CAP data indicates that single-use items are still widely available for purchase and frequently littered. In the short-term, finalizing and implementing regulations for the other 11 items, as well as increasing inspections, monitoring, and other enforcement measures, simplified by Timor Leste's compact size, could have an immediate impact.

As noted in the CAP research, the cost differential between single-use and reusable options is modest for some items, which could even generate savings for consumers in the medium term. Reuse is supported by language in the law that requires bags and packaging "to be designed in such a way that they can be reused for the same or different purposes." Beverage containers could be a promising area to focus on in the short term, as the infrastructure to support a deposit return scheme already exists in the country, which would also generate employment. The government could also support reuse and recycling by prioritizing such products in its own procurement programs, as is already being done in a limited way with recycled pavers.

Other medium- and long-term reduction efforts may need to be done as part of broader initiatives and would require some strategic investment. For example, a targeted initiative to introduce water refilling stations or reusable water bottles to reduce single-use water bottles, which CAP data indicates frequently leak into the environment, could deliver environmental and public health benefits simultaneously. Such initiatives could roll out at schools, offices, and other public places first in a joint program with the Ministry of Health.

Other refill programs could incentivize "bring your own container" programs for commonly repackaged goods like rice, sugar, and beans. Refill or bulk purchasing programs may enable both waste reduction and more cost-effective purchasing for households, serving to mitigate the poverty tax on small-format goods. Enabling economic conditions to support households buying in bulk could also be implemented at the local level, such as through local bulk buying cooperatives.

Extended Producer Responsibility (EPR)

Decree Law 37/2020 mandates that "any operator developing, manufacturing, or processing plastic products shall be subject to the principle of extended producer responsibility." This includes mandated "changes to the design of the plastic object," an obligation to "accept the return of the plastic product after it has been used" with responsibility for its disposal, and the creation of an environmental tax to transfer the "costs of waste management onto this initial producer of the waste or onto the current or previous holders of the waste."

In addition to a basic legal framework, Timor-Leste also has a number of producers who are already familiar with EPR from other markets. As a result, an EPR program could be set up relatively quickly, generating needed resources for collection, sorting, and disposal. If deemed useful, such a program could launch as a voluntary initiative, transitioning to a mandatory program after an initial trial period. Another option to implement the polluter pays principle could be an expanded tax on plastic imports, directed towards a central fund the government uses to manage collection, sorting, and end-of-life. As a first step, the Government could begin charging businesses in Timor-Leste for waste collection, which would not only generate funds for waste management but also reduce incentives for burning or dumping.

At a minimum, the government could allocate the established environmental tax on plastic products to support efforts for better waste management rather than for general funding purposes. Ideally, this tax would be calibrated to reduce the cost differential between single-use plastics and their reusable alternatives where applicable and could be applied at the ports of entry using existing customs infrastructure

Source Segregation

Although there is no legal framework or infrastructure to support waste segregation at source currently, the high proportion of organic waste, evidence of contamination even in the modest amounts of waste currently segregated, and the fact that the country has only one landfill all support prioritizing waste segregation at the earliest possible opportunity.

CAP interview data suggests that there is support on the ground for implementing such a policy and that some communities are already separating organic and inorganic waste. In the short term, the government could build on this activity by providing support for communities to implement low-cost low-tech local composting where there is interest. In the medium term, implementing source segregation and proper composting of organic waste on a broader scale would require some strategic investment to build out the infrastructure and educate the public. Given that business activity is concentrated, broader waste segregation could roll out at first at hotels, shops, and offices, followed by schools and other institutions, with households being brought into the program later.

A source segregation initiative would likely save money in the medium-term by preserving space in Timor-Leste's sole landfill. It would also improve the quality and recyclability of both organic and inorganic waste, provide needed materials for Timor-Leste's agricultural sector, and reduce methane emissions.

Targeted Campaigns

CAP data indicates that environmental awareness is still evolving in Timor Leste, and that expanding awareness around the impacts of plastic pollution on ocean health is a key goal to protect Timor-Leste's unique ecosystems. This is an area where sustained government engagement could deliver systemic change over time. There is a need for both general and specific awareness raising. In the short term, the government could build on ongoing efforts in schools to educate children on Timor Leste's outstanding natural resources and the need to protect them. In the medium term, the government could convene an interagency group from the Ministry of State Administration, the Ministry of Tourism and the Environment, and the Ministry of Health to develop a suite of materials around the environmental, health, and flooding risks posed by plastic pollution and be funded by the budgets of all three.

Ideally, some of the resources could be developed specifically for use by local leaders. Waste management in Timor Leste is a local responsibility and one way to deliver results rapidly would be to help local leaders fulfill this function more effectively, especially as some expressed an interest in doing so during the CAP interview process. In particular, the government could build on the tradition of "tara bandu," a Timorese natural resource management model that rests on communal agreement to define social norms, behaviors, and practices in a social contract. The government could develop a toolkit for community use that includes both general materials on plastic pollution and environmental protection, but also specific resources for communities that wish to pursue their own source segregation, reduction, and recycling initiatives to build local capacity.

The CAP data also revealed the opportunity for place-based campaigns. For example, the lower litter densities found in Ataúro Island combined with the area's tourism potential could be the basis for a specific campaign to protect this environmentally sensitive area. The campaign could include specific components for residents, businesses, and tourists. Materials emphasizing the connection between environmental protection and developing the local eco-tourism economy might resonate best with residents, while businesses might be receptive to an eco-certification program for reducing plastic use, managing waste, and cleaning up the local environmentally sensitive areas that they could use in their marketing materials. Tourists could be reminded of their responsibility to protect the country's precious environmental resources.

Finally, there is an opportunity to design campaigns around specific items. For example, cigarette (butts, packaging) waste features prominently in CAP leakage data. A public relations campaign, combined with the placement of specific receptacles for cigarette waste – perhaps in combination with designated smoking spaces and waste receptacles– in public areas could be a relatively simple way to tackle this prevalent form of litter. Similar campaigns could be designed for other specific litter items, such as bottle caps.

Implementation

Institutionally, responsibility for implementation would fall primarily to the Ministry of State Administration (MSA). The MSA is responsible for public services, infrastructure development, and the oversight of national waste management, including providing technical assistance and budgetary support to local governments for these purposes. This responsibility could be shared with the Ministry of Tourism and the Environment, which exercises oversight on matters of environmental management including the existing SUP ban, including pollution control and environmental education (as well as climate change and biodiversity). In some instances, the Ministry of Health could also play a role. Developing a collaborative taskforce on plastic was recommended by stakeholders in CAP interviews to enable more cooperation between agencies on awareness campaigns and coordination across different departments working on waste, environment, and health, such as LMBO, the Ministry of Tourism and Environment, the Ministry of Public Works, and village leadership.

There are other allies outside of the government that could be recruited to help. The Plastic Upcycling Alliance, a partnership between the United States Agency for International Development (USAID), the Korea International Cooperation Agency (KOICA), Mercy Corps, the Caltech Construction Company, and Heineken to advance plastic recycling could be a valuable collaborator to advance circular economy initiatives, especially EPR. The ecotourism sector in Timor-Leste is nascent but has enormous potential. Ecotourism firms could be enlisted to advance initiatives (such as reduction, reuse, refill), particularly in less populated or ecologically sensitive areas. The Catholic Church, while a less traditional partner, has become increasingly engaged on environmental issues globally and may be willing to support public outreach and education campaigns through its channels. Finally, Timor-Leste's informal waste workers could be critical in designing and rolling out source segregation programs.

There are a number of options for funding improved waste management and a more circular economy. Spending the full allocated budget for waste management is a good starting point. This funding can be augmented in a number of ways: Directing revenues from the plastic tax to the issue instead of general funding could provide support for better recycling and more reuse programs. A functional EPR program, as is increasingly becoming the norm elsewhere, would ensure that the polluter pays and would support better collection and end-of-life management for plastics. Instituting fees on businesses for waste collection would not only raise funds, but also reduce incentives for burning or dumping waste. A tourist tax could help fund specific programs in ecologically sensitive areas.

Conclusion

Building on the already established legal framework, the government of Timor-Leste can leverage the country's compact size, manageable number of stakeholders, and limited ports of entry to improve its circular economy relatively quickly. Many of the suggested measures have a very modest cost and some would actually generate their own funds for implementation. The benefits would be significant: easing pressure on the government's budget through the "polluter pays" principle; protecting the environment; providing the agricultural sector (the country's largest source of employment) with high quality compost, supporting the ecotourism sector; preserving space in the country's sole landfill; and reducing methane emissions that contribute to climate change. Other co-benefits include improving a number of health metrics (such as air pollution), reducing the risk of flooding, generating new jobs and industries, and reducing dependence on imports. Building on existing initiatives and supporting local efforts could ease capacity issues and generate wider public support for protecting Timor Leste's environment and future.

Key Findings and Opportunities

INPUT

Findings: While extended producer responsibility (EPR) is conceptually established by setting forth the polluter pays principle under Decree Law 37/2020, no implementation of EPR has yet been attempted in Timor-Leste. Across all communities and categories, there are large multinational corporations importing FMCG products into Timor-Leste, mostly originating from other Southeast Asian countries including Indonesia, Malaysia, and the Philippines. FMCG surveys also identified beverage brands produced locally in Timor-Leste, from seven different parent companies.

Opportunities:

- As most plastics are imported, control measures could be implemented at ports of entry. The Department of Pollution Control under the Ministry of Environment and Tourism is already working with the Customs Authority to limit the import of plastic bags, which could be expanded to other unnecessary and single-use plastic (SUP) products under the SUP ban.
- In the short-term, explore specific EPR implementation details in Timor-Leste, including obligated producers and importers, regulated products and packaging, collection targets, and government capacity to implement. This could be supported by development partners and leverage regional learnings.
- Given Timor-Leste's compact size, implementing an EPR program may not be a huge cost and could generate additional investment and jobs.
- EPR could be piloted as a voluntary program, while enlisting industry to develop appropriate targets for various products, developing the domestic recycling industry, and increasing monitoring and administrative capacity. This will establish the groundwork for successful, mandatory EPR in the long term.
- Multinational corporations – of which there are many importing to Timor-Leste – have more capacity and are often quick to adopt EPR schemes, so providing guidance around voluntary EPR standards may be an effective starting place to collaborate with industry and to support recycling.
- Another option to implement the polluter pays principle could be a tax on plastic imports, directed towards a central fund held by a transparent, accountable organization to manage collection, sorting, and end-of-life.
- Local production capacity for beverages means deposit return schemes (DRS) are within the technical capacity of existing corporations in Timor-Leste in the short-term. In addition to the established import tax on plastic preforms, further incentives like subsidized collection infrastructure (e.g. reverse vending machines) could encourage local beverage companies to consider refill.

Findings: Stakeholders feel there are inconsistent levels of awareness among the community around plastic pollution and that current efforts at awareness-raising are falling short. Human health was a significant concern for stakeholders related to plastic pollution, but there were differing opinions on whether environmental protection and ocean conservation was an important topic to community members. The perception that Timorese people are not aware of their own resources – like surrounding coral reefs – is contrasted with significant efforts at engaging youth in ocean conservation by the Land and Maritime Boundary Office (LMBO). In general, the discrepancies between policies on paper in Timor-Leste and the implantation of policies in reality was a key theme across interviews. Interviewees also spoke to the need for broader collaboration across stakeholder groups, especially within the government. Stakeholders pointed out that many waste challenges are complex and multi-faceted, such as plastic bottle litter driven by lack of access to clean drinking water. Stakeholders felt plastic pollution was preventing tourism expansion and highlighted that improving waste management practices now is critical to establish a pathway to cope with increased waste volumes associated with tourism.

COMMUNITY

Opportunities:

- In the short term, consistent, adequately funded campaigns through media platforms are needed to further awareness around plastic pollution in Timor-Leste's sensitive ecosystem and promote behavior change around waste management. Awareness raising efforts should be expanded to communities outside of Dili and should include regular surveys to monitor effectiveness.
- Targeted messaging should encourage youth to champion environmental stewardship. The LMBO Future Youth Ambassadors and the "My Sea, My Timor" programs are great steps in this direction that could be expanded.
- Storytelling focused first on the human health consequences of plastic pollution may resonate with stakeholders' existing concerns. Protecting marine life, preserving soil health, and preventing flooding are relevant environmental messages and could be woven into an integrated campaign. Expanding awareness around the impacts of plastic pollution on ocean health should be a target to protect Timor-Leste's unique ecosystems.
- In the medium-term, the government could strengthen the SUP regulation by finalizing the list of banned items and socializing the alternatives. Involving local leadership in the implementation of these national policies, such as by developing toolkits for policy socialization, could help promote widespread enforcement.
- A collaborative taskforce on plastic could break down silos within government ministries and enable more cooperation between agencies on awareness campaigns and coordination across different departments working on waste, environment, and health, such as LMBO, the Ministry of Tourism and Environment, the Ministry of Public Works, and village leadership.

- Tara bandu (a traditional Timorese communal agreement) related to plastic pollution could promote a native natural resources management model and encourage more local leadership engagement on waste management. The Ministry of Agriculture and Fisheries could facilitate local-level conversations needed around plastic waste and ocean conservation to encourage village leadership to establish tara bandu for waste, especially in areas outside Dili.
- Capacity building at the local level, including training for waste segregation and composting, could support local authorities to better manage waste in their communities. Existing training materials available from partners like the World Bank, USAID, UNEP, and the International Solid Waste Association could be translated and adapted to the local context.
- Locally made compostables, like palm leaf products, should be specified as viable alternatives in messaging and socialization around the SUP bans.
- Access to clean drinking water through refill stations in institutions like offices and schools could support waste reduction and human health.
- Tourism could be a catalyst for more environmentally friendly business practices, which could be supported by a voluntary eco-friendly business certification program. Existing resources like the Pacific Asia Travel Association's *Plastic Free Toolkit for Tour Operators* could be translated to provide guidance to industry as eco-tourism expands.
- A tourist tax or eco-fee could help subsidize additional waste management capacity needed to address tourism.

PRODUCT DESIGN

Findings: Across all three communities, the most common packaging type is multilayer film, especially prevalent for shampoo, laundry detergent, chips, and candy, but other more widely recycled materials like aluminum, HDPE, and PET are also in use. Many restaurants and food vendors across all three communities use hard plastic and paperboard for single-use food-ware. Yet, many are also not offering takeaway food and instead offering in-house dining with reusable dishware like ceramic or glass, especially in Ataúro. Straws are an exception where restaurants are using single use food-ware to in-house dining. Repackaging is happening in all stores and is common for goods like sugar, rice, cooking oil, fried foods (banana, casava, chips, cookies), beans, fruits (apple, grapes, oranges) and salted fish.

Opportunities:

- There is an opportunity to recycle some common packaging types – notably PET, HDPE, and aluminum, which are all high-value recyclables collected and exported in other island markets.
- Aluminum is a common packaging type for beverages and is already collected to export as a recyclable. The existing SUP ban could be used to promote aluminum packaging for imported beverages.

- With some restaurants still using reusable food-ware for in-house dining, there is an opportunity to encourage this existing waste-reducing practice through policy or incentives, such as mandating reuse for in-house dining or working with food establishments on an eco-certification program.
- Almost all restaurants are using plastic straws ware for both takeout and in-house dining – a straw on-request policy may eliminate some of this waste, without increasing cost to businesses.
- Refill or bulk purchasing programs may enable both waste reduction and more cost-effective purchasing for households. Incentivizing refill with "bring your own" containers can allow for flexible purchasing quantities. Creating enabling economic conditions to support households buying in bulk, such as local bulk buying cooperatives, may also reduce packaging waste.

USE

Findings: Alternatives to single-use plastic are not widely available in any of the three communities. Reusable products typically cost between 2 – 4 times as much as SUP. Given this low multiple, after only 2-4 uses, reusable products cost less than their single-use counterparts. The ban on single-use bags seems to be more widely implemented in Dili than either Liquiçá or Ataúro. Boxes from packaged goods are a significant source of waste for most businesses but may be repurposed to carry groceries in lieu of reusable bags.

Opportunities:

- There are already alternatives to some single-use plastics available, but they are small in number. Programs like sustainable buying cooperatives, eco-friendly product guides, or collaboration with existing distributors could enable more availability of alternatives to SUP.
- Boxes – a common store waste product due to packaged imports – were offered in lieu of reusable bags in some stores. Boxes were also reused as chicken coops, while plastic bottles were reused as floats for seaweed aquaculture. Encouraging existing forms of reuse as important and valid forms of complying with the SUP ban during socialization of the policy may encourage further expansion of these practices.
- The SUP bag ban is unequally implemented – the policy is not thoroughly enforced in local marketplaces and in communities outside of the capital. Continued socialization and enforcement, integrating village leadership, is needed to reach communities outside Dili.
- Some compostable plastics were seen marketed as alternatives to SUP in stores. These should not be promoted without investment in industrial composting facilities in Timor-Leste.

COLLECTION

Findings: Ataúro Island has limited collection systems; most residents manage their own waste through burying or burning. In Liquiçá, there is a municipal truck collecting waste weekly and transporting it to the Tibar landfill, which is owned by Dili municipality. Reaching more rural areas outside of the city center remains a challenge. There is no cost for waste collection to the community, and many commercial businesses also utilize the public waste bins for disposal. Despite the existing collection system, 40% of the 20 local businesses interviewed in Liquiçá reported burning as their primary waste management method. Dili is in the process of expanding and modernizing their collection system, increasing capacity to over 1,000 collection points. Waste generation in Dili is estimated at about 330 tons/day. Currently, unless contracting with a private hauler, residents (and businesses using public waste bins) are not paying for collection, despite the legal framework to charge for waste collection established under the Decree Law for Solid Waste Management: Number 2/2017. Caltech offers both waste and recycling collection as a paid service to businesses. They also have a drop-off site for recyclables, where it is no-cost to bring material. They accept all plastics except PVC, including PET bottles, as well as paper and cardboard; glass; metals; and e-waste. Another method of collection currently leveraged across all three communities is cleanups. Village officials in both Ataúro and Liquiçá report weekly cleanups, and in Dili, a cleanup crew of around 300 people work to clean the main roads.

Opportunities:

- Source separation at the collection stage would facilitate cleaner waste streams that would enable both composting and recycling.
- While municipal budgets currently allow for no-cost collection, a sustainable collection model will rely on consistent financing. This transition could start with charging commercial entities or requiring them to contract private haulers, which may also encourage reduced waste generation. Adequate controls for illegal dumping must be addressed as charges begin.
- Separation of commercial waste from the public system could be coupled with incentives like free recycling drop off points or organic waste collection to incentivize large commercial waste producers to segregate waste.
- Investment in smaller, more flexible forms of transportation like waste motorbikes is needed to collect waste in narrow streets, alleyways, or outside of cities, which would also generate employment.
- Government support for collection hubs through public-private partnerships with recyclers could support the recycling industry in Timor-Leste. It is unrealistic to expect a nascent recycling industry to fund collection of recyclables at scale without government support.
- Collection programs in institutions like schools and offices are cost effective and could increase awareness of recycling.
- As SWM systems develop in Timor-Leste, there is an opportunity to structure contracts with waste management operators to bring private waste

companies into partnership and align incentives on reduction, such as contracts based on the quantity of households rather than weight.
- Cleanups are already occurring in communities across Timor-Leste and could be further encouraged as public awareness tools.

Findings: On Ataúro Island and in other small and rural communities throughout Timor-Leste, most residents are managing their own waste through burying or burning. Of 23 local business interviewed on Ataúro Island, 43% reported burning as their primary method of managing their waste. Both Liquiçá and Dili bring their waste to the Tibar dumpsite, owned by Dili municipality. Currently, the dumpsite is undergoing remediation to construct an engineered landfill bringing its capacity to 10 years. There are no tipping fees for depositing waste at the dumpsite, even for other municipalities or private businesses. Tibar does not accept construction and demolition waste or hazardous waste. The recycling company Caltech is estimated to process just under one ton of waste per day. Caltech produces pavers made from HDPE plastic and glass, as well as plastic board from mixed plastics. The recycled pavers were recently used in a large public works project.

END OF CYCLE

Opportunities:

- There is an opportunity to reduce open burning by capturing and managing waste generated outside of Dili, such as through a transfer station system. Transfer station locations should be optimized for convenience and community ease-of-use while protecting environmentally sensitive areas. Creating a solid waste management system is especially important on Ataúro Island if the island is central to future eco-tourism increases.
- Remediating the Tibar landfill and operating it as a sanitary landfill is a positive step, though more sanitary landfill capacity will need to be generated in the future and in other geographies.
- The Tibar landfill does not accept hazardous or construction and demolition (C&D) waste. These waste streams often contain plastic or chemical additives that can have negative environmental impacts. Establishing end points for hazardous waste (such as storage for export) and C&D waste (such as a C&D landfill) is an important medium-term goal.
- Establishing tipping fees at the landfill could align economic incentives with waste reduction, as long as measures are in place to prevent illegal dumping.
- Decentralized, small-scale composting could enable waste reduction before transport to the landfill, saving landfill space while creating a useable end-product for Timorese agriculture.
- While small-scale cottage industry recycling efforts (such as crafted jewelry and baskets) are unlikely to facilitate waste processing at a large scale, these efforts could be leveraged as effective and impactful awareness-raising tools for both the local population and tourists to Timor-Leste.

- Some processing of recycled plastics – like collaborating with private recyclers to subsidize the purchase of equipment for extruding recycled plastic string – may provide local craftsmen the raw materials to make eco-friendly, recycled products while decreasing manual processing of waste.
- Suggested tools to support recycling in Timor-Leste include offsetting shipping costs for the export of recyclable materials, establishing marketplaces for recyclers to sell their products, and using government procurement to support recyclers.

LEAKAGE

Findings: Food-related plastic packaging was the most common category of litter items in all three communities (34-36% of littered items). Average litter densities were highest in Dili, followed by Liquiçá, with Ataúro Island having the lowest average litter densities. Compared to other cities that have completed CAPs, the average litter density per square meter in both Liquiçá and Dili is relatively high, similar to locations like Pune, India, which has a population of nearly 7 million, and the Maldives, which has around 2 million tourists per year. The higher litter densities already observed in the absence of high populations of residents or tourists highlight that the waste management systems are not fully capturing existing waste.

Opportunities:

- Plastic bottles were a common litter item in all three cities. Expanding access to clean drinking water on the islands or collaborating with local water bottling companies to offer refill programs – even using already widespread refillable jugs – may facilitate waste and litter reduction related to bottles.
- Since bottles are so prevalent in the litter, there is an opportunity to collect and recycle plastic bottles, which are often made of high value PET. Subsidies could support export.
- Aluminum cans were in the top 10 litter items in Ataúro, but not in Liquiçá or Dili where they are being collected for export. Establishing a viable recycling pathway for cans, perhaps through partnering with businesses like hotels to aggregate cans in one location and moving to Dili when a sufficient quantity is obtained, may discourage littering of these items.
- Plastic grocery bags are still prevalent in litter, re-emphasizing the need for further enforcement of the SUP bag ban and promotion of reusable bags or other alternatives like boxes in local markets and areas outside of the capital.
- Cigarettes were prevalent in the litter in transects in Dili and Liquiçá. Awareness campaigns could educate the public on the negative environmental consequences of cigarette butt litter.
- High litter densities in Ataúro highlight the importance of intervening to prevent plastic pollution and improve waste management in Ataúro Island before further development of the tourism industry.

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Introduction

The Democratic Republic of Timor-Leste comprises the eastern half of the island of Timor, as well as the exclave of Oecusse and the islands of Ataúro and Jaco. Timor-Leste occupies 14,950 square km (about half the area of Belgium) with a population of 1.3 million, of which an estimated 352,000 inhabit the capital city of Dili.

One of the world's youngest countries, the people of Timor-Leste suffered from decades of strife – first as a Portuguese colony until 1975 and then under Indonesian occupation. The UN was brought in to quell the conflict and administered the region from 1999 through independence in 2002.

As a result, the country faces multiple development challenges. The World Bank estimates that 42% of the population lives below the poverty line, with 2023 GDP per capita of $1,648. Most of the population is engaged in agriculture, with coffee the dominant crop. Mung beans are also cultivated, as are spices (cinnamon and nutmeg), cocoa, and various subsistence crops.

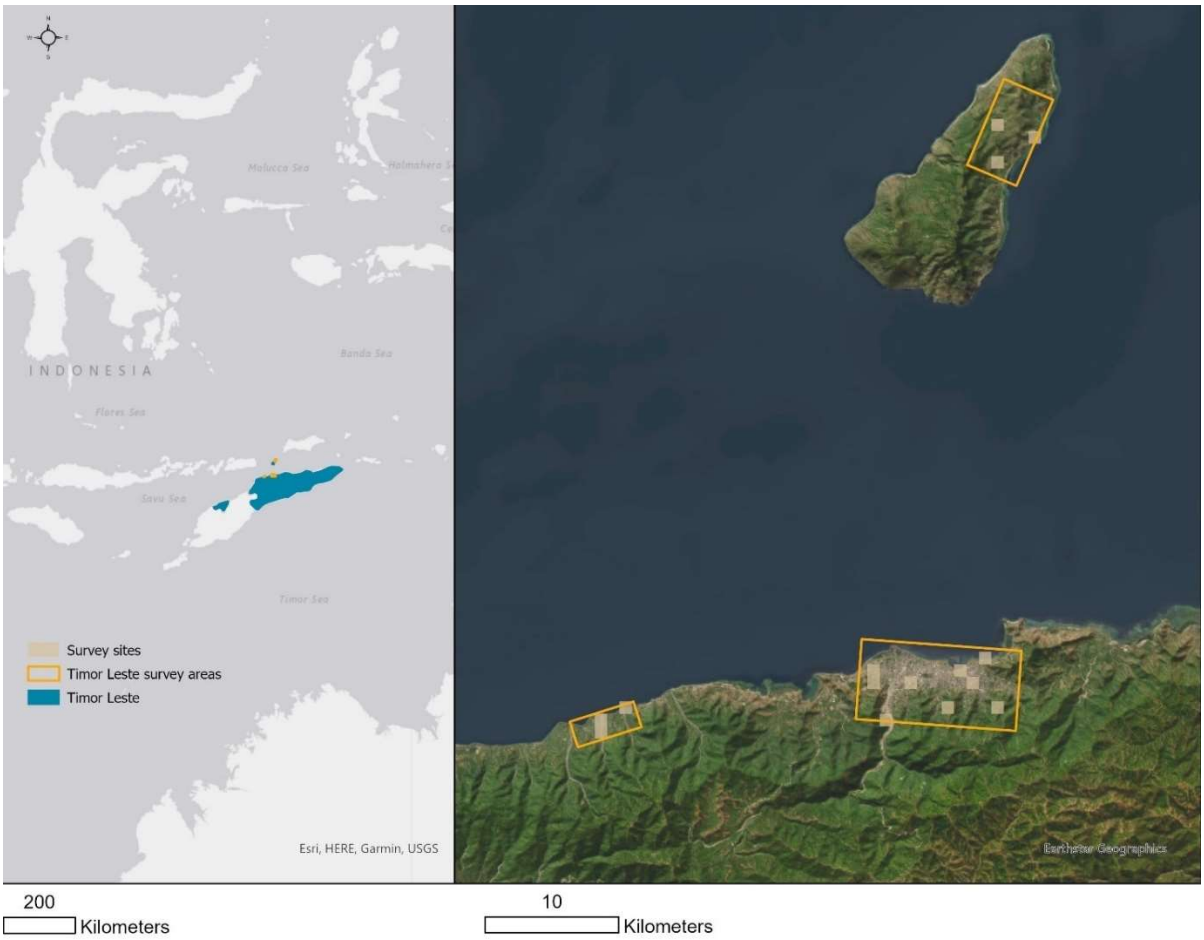
However, offshore oil production accounts for most economic activity, generating 90% of the government's budget revenues. Timor-Leste maintains a Petroleum Fund, a sovereign wealth fund established to manage the country's oil revenues for the long-term benefit of its citizens. The Fund had a balance of $18.45 billion in March 2024, which equates to 11 times the country's 2023 GDP.

Timor-Leste is part of the Coral Triangle biodiversity hotspot, which covers 1.6% of the ocean but contains 76% of its coral species, 37% of the world's reef fish species, and the world's largest mangrove forests. This rich but fragile ecosystem offers significant ecotourism potential. Given Timor-Leste's unique ocean resources, preventing plastic pollution in this context is critical.

The Government of Timor-Leste has taken some steps to address plastic pollution including:

- Decree Law 26/2012 for Basic Environmental Law establishes the principles and regulations for environmental protection, sustainable use of natural resources, and environmental management, which includes the goal of reducing environmental pressures throughout the lifecycle of natural resource usage.
- Decree Law 2/2017 for Solid Waste Management establishes the standards for solid waste management and promotes environmental protection and sustainable development. The Decree-Law stipulates regulations for collection, transport, treatment, and disposal of waste, designating municipalities as the responsible implementing entities. The law also highlights the necessity of public education campaigns on environmental protection, waste reduction, and disposal.
- Decree Law 37/2020 regulates the sale, production, and import of bags, packaging, and other plastic products. The Decree-Law prohibits the use of non-recyclable, non-biodegradable, or degradable single-use plastics. The Decree-Law also establishes the principle of extended producer responsibility (EPR), which transfers the costs of waste management onto the initial producers of the waste or the current or previous holders of the waste.

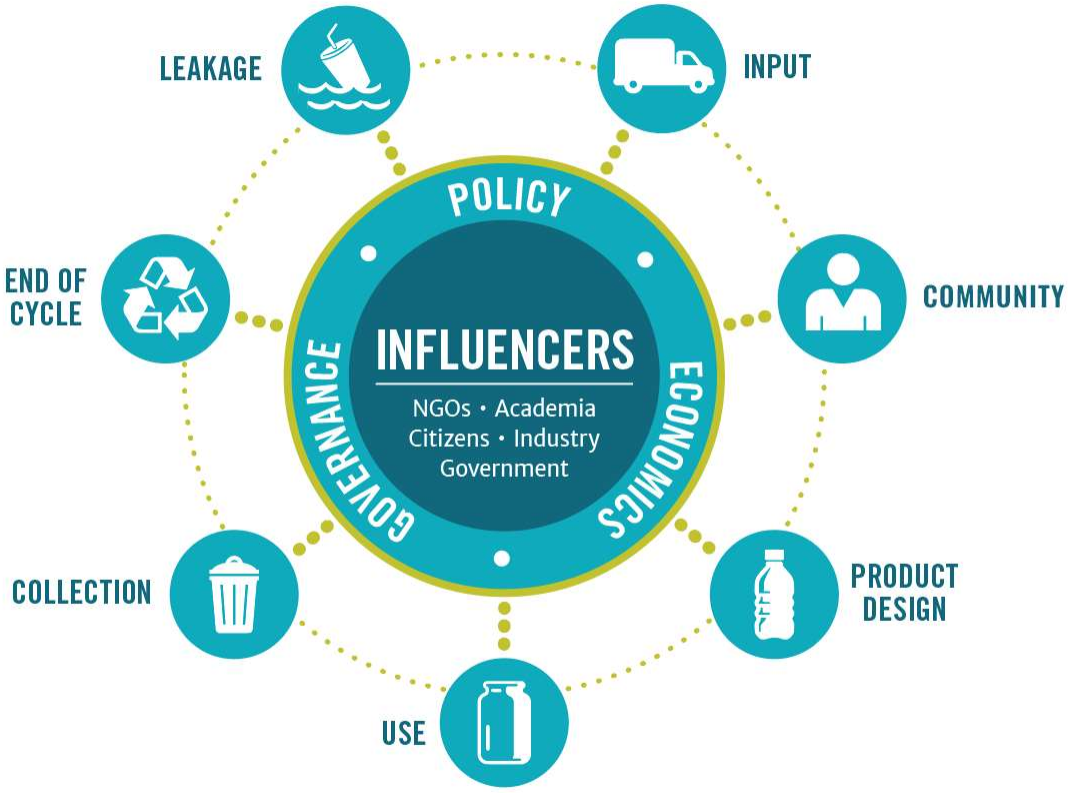
Figure 1: Overview map of survey area in Timor-Leste, including Ataúro Island, Liquiçá, and Dili



To understand circular systems in Timor-Leste and identify opportunities to reduce plastic pollution, the Circularity Assessment Protocol (CAP) was conducted across three communities – Ataúro Island, Liquiçá, and Dili (Figure 1). The Circularity Informatics Lab (CIL) at the University of Georgia (UGA) developed the CAP in 2018, which is a standardized assessment protocol used to collect community-level data to inform decision-makers (Figure 2). The CAP characterizes seven community components:

1. **Inputs** – What products are sold in the community and where do they originate?
2. **Community** - What conversations are happening and what are the stakeholders' attitudes and perceptions about plastic and waste management?
3. **Product design** - What materials, formats, and innovations are found in products, particularly packaging and to-go food-ware?
4. **Use** – What are the community trends around use and reuse of product types?
5. **Collection** – How much and what types of waste are generated? How much is collected and what infrastructure exists? Does everyone in the community have access to collection?
6. **End-of-cycle** – How is waste disposed? What is the fate of waste once it is properly discarded? How is it treated?
7. **Leakage** - What waste ends up in the environment? How and why is it getting there?

Figure 2: Circularity Assessment Protocol (CAP) hub-and-spoke model.



CAP field work was conducted in September 2024 by the local implementation partner, Mercy Corps.[1] This CAP project was sponsored by the World Bank. This CAP report is split into the following sections, which include results and discussion of each: Input, Community, Product Design, Use, Collection, End of Cycle, and Leakage, followed by Opportunities. The intent is for the data in this report to inform ongoing stakeholder engagement around solutions to strengthen the circular economy and waste management in Timor-Leste.

[1] Mercy Corps. https://www.mercycorps.org/where-we-work/timor-leste

Sampling Strategy

In order to randomly sample various locations in a city, the CAP typically identifies a 10 x 10km area over the city (with the center of the city in the center of the area). To accurately classify areas across Timor-Leste, the surveyed area was divided across three communities: Ataúro Island (4 km x 7 km, 28 km^2, Figure 3), Liquiçá (2 km x 5 km, 10 km^2, Figure 4), and Dili (6 km x 12 km, 72 km^2, Figure 5), in consultation with on-the-ground project partners from the World Bank. Within each area, the ambient population is sectioned into tertiles (three groups) (Figure 3). Ambient population count can be described as "where people go" and "societal activity" — it is not population density of where people live. These three areas typically form samples of different land uses, etc.

Typically, three 1 x 1 km areas for surveying are randomly selected within each population tertile using NOAA's Sampling Design Tool, resulting in a total of nine 1km2 areas for surveying. In this case, one site in each population tertile was selected in Ataúro Island and Liquiçá, and two sites were selected in each tertile in Dili. In total, 12 sites were surveyed, three in Ataúro Island, three in Liquiçá, and six in Dili.

Additionally, stores and restaurants were surveyed to understand popular brands, packaging design, and available alternatives across all three communities. Ten stores and ten restaurants were surveyed each in Ataúro Island and Liquiçá; twenty stores and twenty restaurants were surveyed in Dili.

Figure 3: Population tertiles and survey sites in Ataúro Island, Timor-Leste.

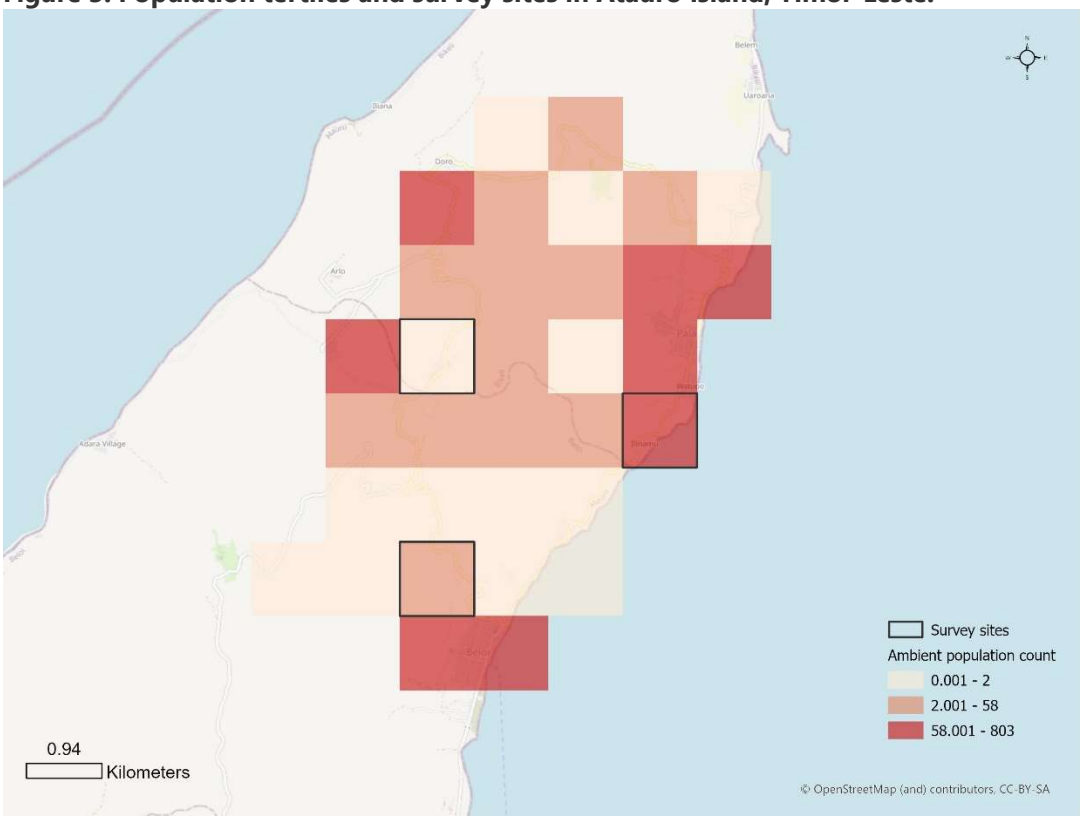


Figure 4: Population tertiles and survey sites in Liquiçá, Timor-Leste.

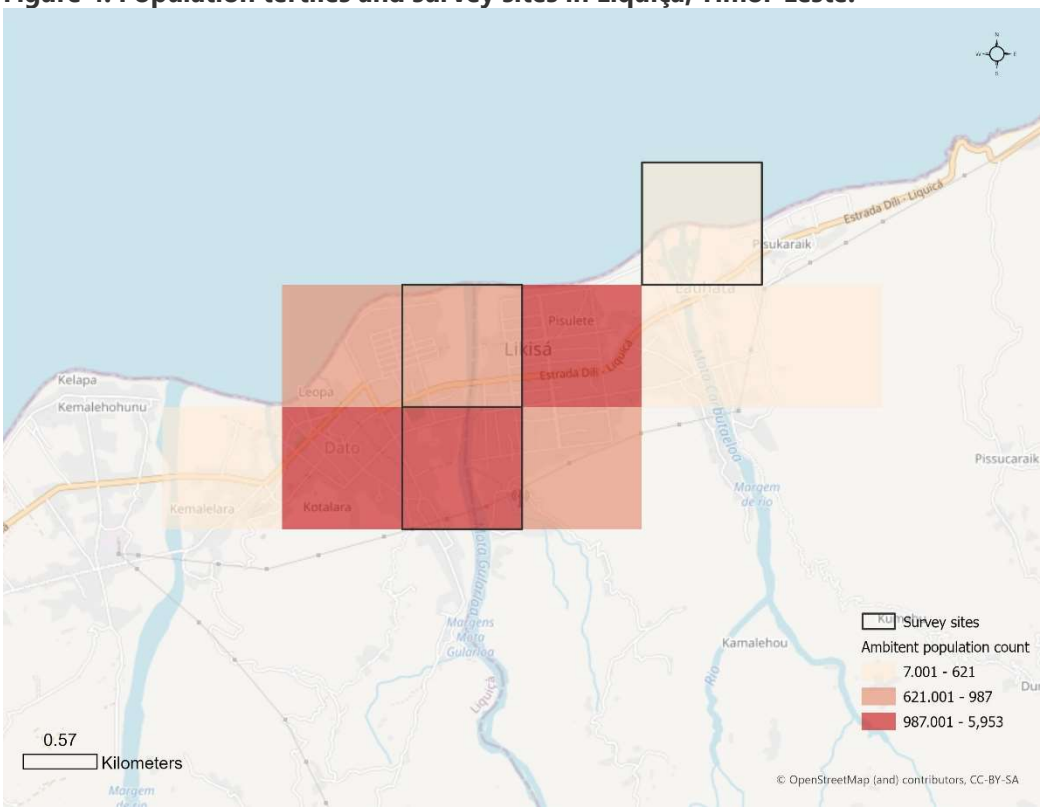
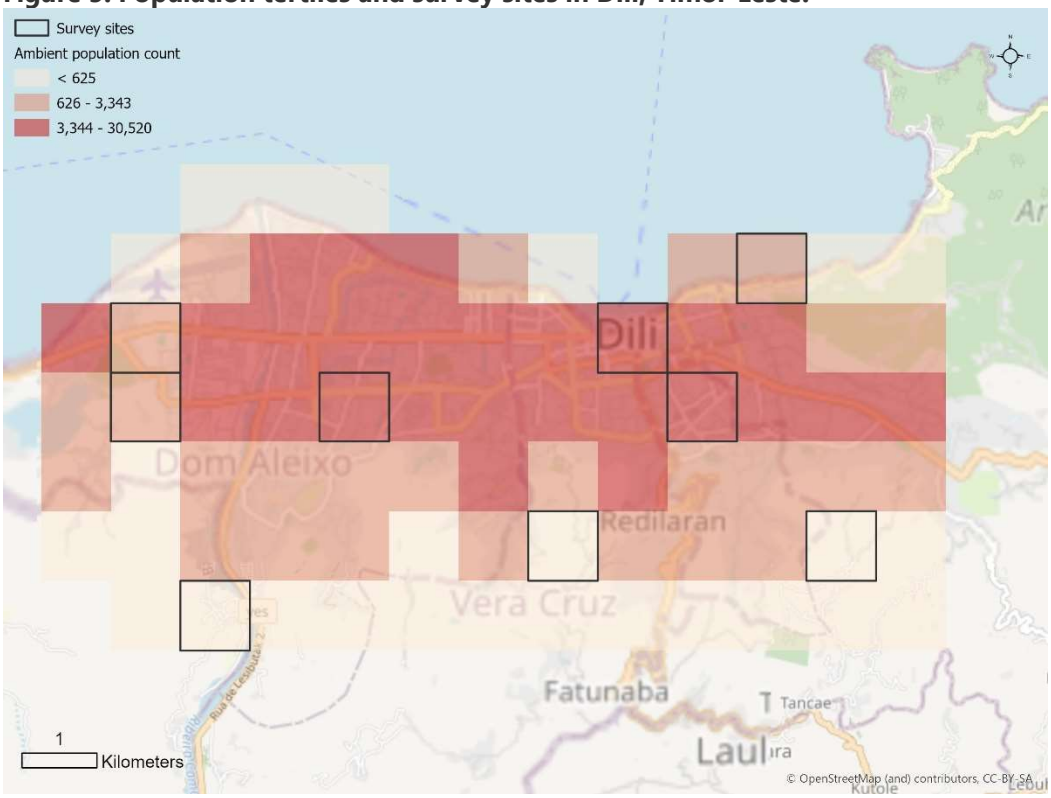


Figure 5: Population tertiles and survey sites in Dili, Timor-Leste.



Input

To get a snapshot of the scope, and source of common plastic packaged items that are entering Timor-Leste, surveys of brands of fast-moving consumer goods (FMCG) in three popular categories – beverages, candy, and chips – were taken within the survey area in each community. The team selected ten convenience or grocery shops to sample in both Ataúro Island and Liquiçá, and twenty stores to survey in Dili. In each store, all brands of FMCG packaged in single-use plastic (SUP) were recorded, along with the parent company if available on the product packaging. For other brands, parent companies were determined using desktop research. Parent company distances provided in the analysis below are intended to estimate the distance in kilometers between the approximate parent company headquarters location and the city in which the product was sold in Timor-Leste.

Ataúro

In total, ten stores were surveyed in Ataúro Island, where 148 convenience products packaged in single-use plastic were recorded, including 34 beverages, 65 candies, and 49 chips. These included ten unique beverage brands, 23 unique candy brands, and 20 unique chip brands.

Popular brands were determined by their presence in more than 50% of the stores surveyed. Popular brands, in order of the frequency of observances, across the three categories are listed below, with parent companies included in parentheses after the brand name.

- Beverage brands: **Aquase** (*Erindo Mandiri*), **Country Choice** (*Sinar Sosro*), **Gota** (*Gota Bebidas e Alimentos*)
- Candy brands: **Hot Hot Pop** (*Bronson Prima Industri*), **Big Babol** (*Perfetti Van Melle Indonesia*), **Tamarin** (*Mayora Indah*), **Kiss** (*Mayora Indah*), **Kopiko** (*Mayora Indah*), **Lazery Milk** (*Union Foods*)
- Chip brands: **Milko** (*Duta Pangan Nusantara*), **Kusuka** (*Arira Pangindo*), **Jitu Snack** (*Sumber Sari Pangan*), **Qtela** (*Indofood Sukses Makmur*)

The 10 recorded beverage brands were mapped to 10 beverage parent companies. The 23 candy brands were mapped to 13 parent companies, and the 20 chip brands were mapped to 14 parent companies. Observances of parent companies present more than 5 times in the 10 surveyed stores are charted by category below, along with the approximate number of employees (in thousands) as a proxy for company size (Figure 6, 7, and 8). An approximate number of employees was obtained from publicly available online sources such as the company website or LinkedIn page and is unlisted where not available.

Some parent companies (highlighted green) are owned by larger conglomerates or multinational companies. For beverages, Sinar Sosro is owned by the holding company Rekso, which owns several large companies in Indonesia including McDonald's Indonesia.[2] For candy companies, Perfetti Van Melle Indonesia is owned by Perfetti Van Melle, an Italian-Dutch multinational confectionary company.[3] Mayora

[2] Rekso. https://www.reksointernational.com/aboutus/
[3] Perfetti Van Melle. https://www.perfettivanmelle.com/services/faqs/

Indah is part of the Mayora Group, a multinational FMCG company based in Indonesia.[4] For chips, Indofood Sukses Makmur is owned by Indonesia's largest conglomerate, the Salim Group.[5]

Figure 6: Observances of beverage parent companies' stores (columns) and approximate number of employees in thousands (points), where available from public sources; multinational companies and conglomerates are shown in green.

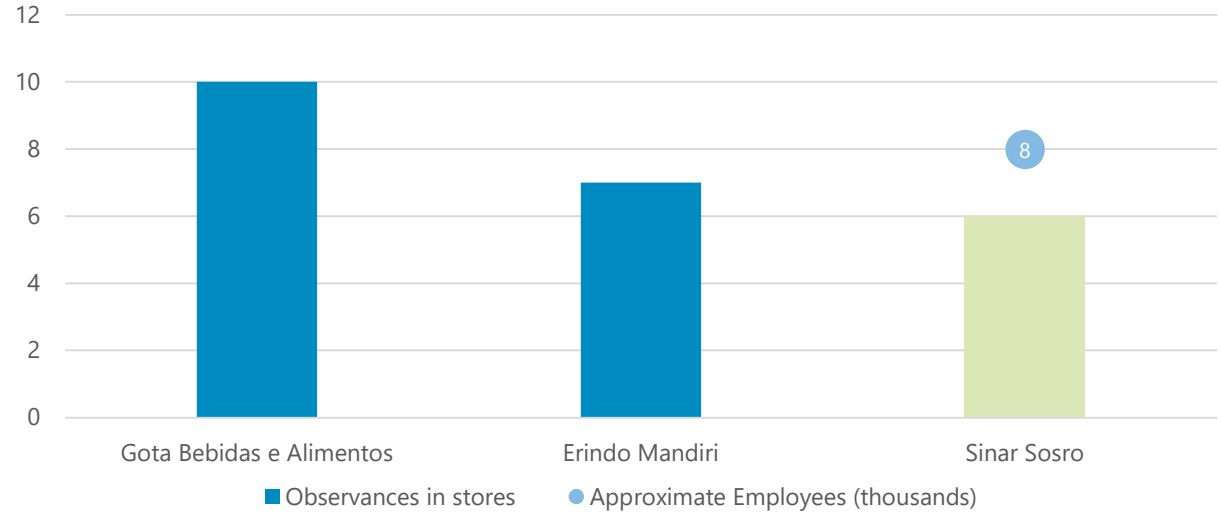
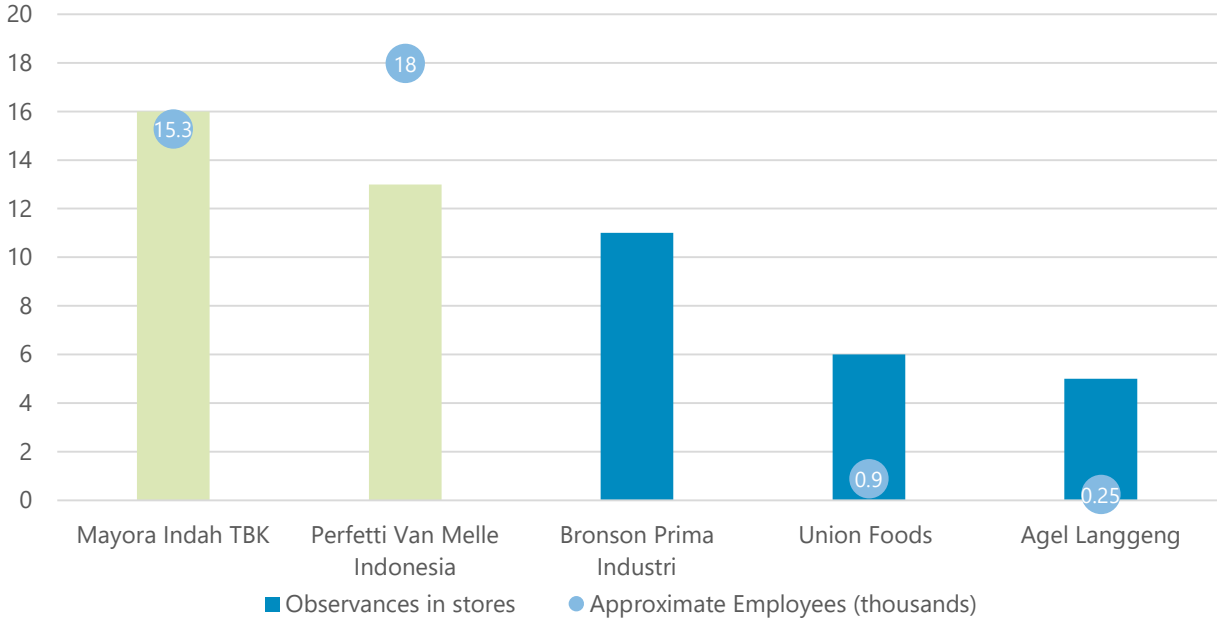


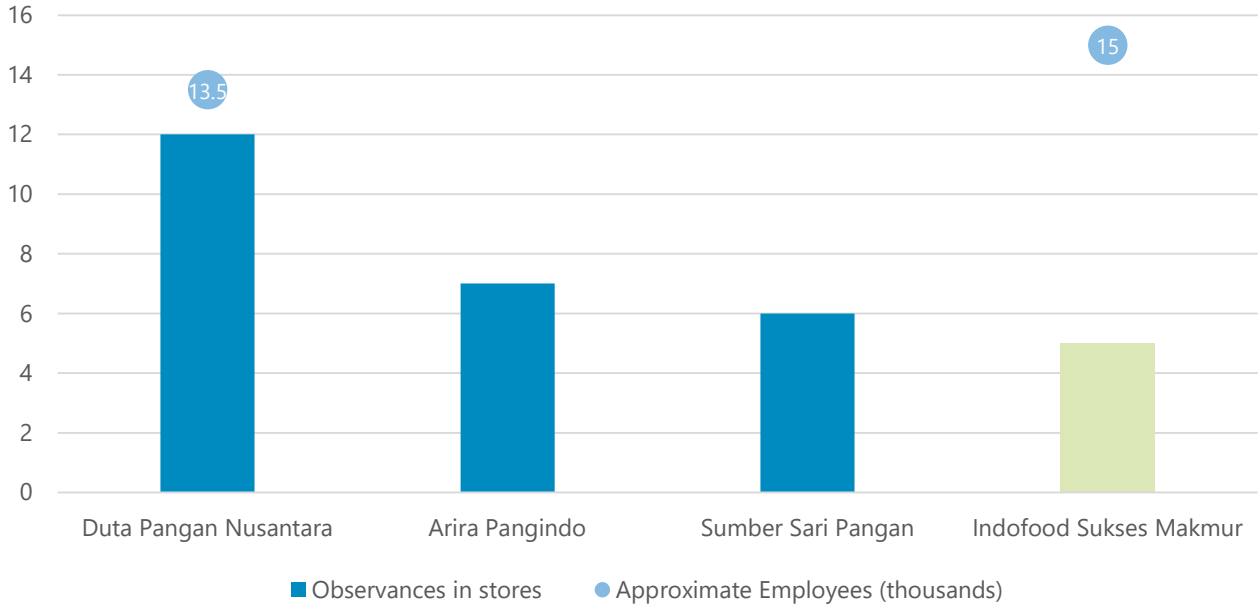
Figure 7: Observances of candy parent companies in stores (columns) and approximate number of employees in thousands (points), where available from public sources; multinational companies and conglomerates are shown in green.



**Note: number of employees for Perfetti Van Melle Indonesia is for Perfetti Van Melle overall.*

[4] Mayora Group. https://www.mayora.com/en/about-us/mayora-at-a-glance
[5] Forbes. "Anthony Salim & Family." https://www.forbes.com/profile/anthoni-salim/

Figure 8: Observances of chip parent companies in stores (columns) and approximate number of employees in thousands (points), where available from public sources; multinational companies and conglomerates are shown in green.



FMCG products found in Ataúro are primarily owned by regional parent companies, with beverages being the most local to the area (Table 1). Most of the products surveyed come from Indonesia, with some production of beverages and candy local to Timor-Leste (Figure 8 and Figure 9).

Table 1: Approximate distances between Ataúro and parent company headquarters.

	Length Store to Parent Company (km)		
	Minimum	*Maximum*	*Average*
Beverages	95	10,210	1,684
Candy	1,461	2,236	2,055
Chips	1,461	2,236	1,787

**Note: Distances were projected using an Azimuthal Equidistant projection. Values have been rounded to the nearest km.*

Figure 8: Parent company locations for fast-moving consumer good brands surveyed in Ataúro.

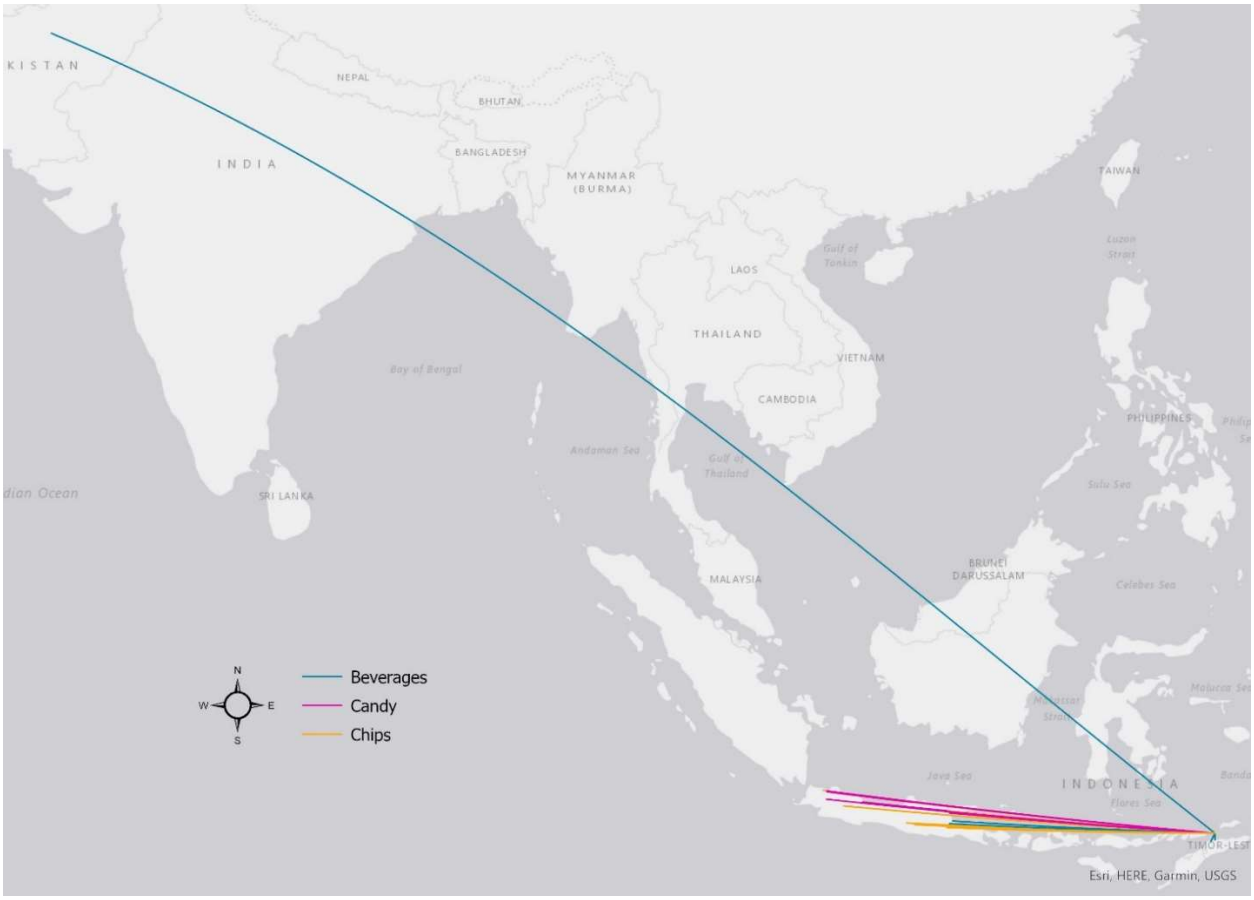
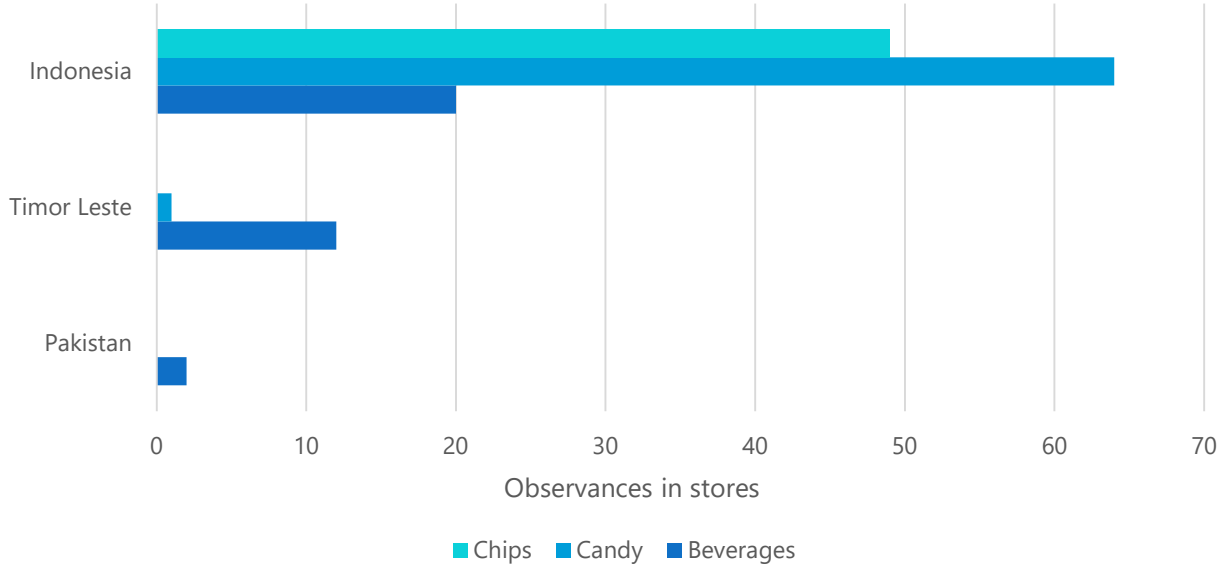


Figure 9: Parent company countries for fast-moving consumer goods brands surveyed in Ataúro.



Liquiçá

In total, ten stores were surveyed in Liquiçá, where 225 convenience products packaged in single-use plastic were recorded, including 88 beverages, 75 candies, and 62 chips. These included 28 unique beverage brands, 25 unique candy brands, and 24 unique chip brands.

Popular brands were determined by their presence in more than 50% of the stores surveyed. Popular brands across, in order of the frequency of observances, the three categories are listed below, with parent companies included in parentheses after the brand name.

- Beverage brands: **Country Choice** (*Sinar Sosro*), **Aquase** (*Erindo Mandiri*), **Floridina** (*Mitra Alam Segar*), **Fresca** (*Consorcio Austim Beverages*), **Indomilk** (*IndoLakto*), **Vera** (*Milrex Rego Uni*)
- Candy brands: **Kiss** (*Mayora Indah*), **Hot Hot Pop** (*Bronson Prima Industri*), **MintZ** (*Ultra Prima Abadi*), **Relaxa** (*Agel Langgeng*), **Kopiko** (*Mayora Indah*), **Lazery Milk** (*Union Foods*), **Mentos** (*Perfetti Van Melle Indonesia*)
- Chip brands: **Kusuka** (*Arira Pangindo*), **Jitu Snack** (*Sumber Sari Pangan*)

From all recorded beverage brands, the 28 brands were mapped to 22 beverage parent companies. The 25 candy brands were mapped to 13 parent companies, and the 24 chip brands were mapped to 14 parent companies. Observances of parent companies present more than five times in the 10 surveyed stores are charted by category below, along with the approximate number of employees in thousands as a proxy for company size (Figures 10, 11, and 12). An approximate number of employees was obtained from publicly available online sources such as the company website or LinkedIn page and is unlisted where not available.

Some parent companies (highlighted green) are owned by larger conglomerates or multinational companies. For beverages, Sinar Sosro is owned by the holding company Rekso, which owns several large companies in Indonesia including McDonald's Indonesia.[6] IndoLakto is part of Indofood, owned by the large conglomerate the Salim Group.[7] For candy companies, Mayora Indah is part of the Mayora Group, a multinational FMCG company based in Indonesia.[8] Perfetti Van Melle Indonesia is owned by Perfetti Van Melle, an Italian-Dutch multinational confectionary company.[9] Ultra Prima Abadi is owned by the Orang Tua Group, an international consumer goods company based in Indonesia.[10] For chips, Indofood Sukses Makmur, like IndoLakto, is owned by the Salim Group.[11]

[6] Rekso. https://www.reksointernational.com/aboutus/
[7] LinkedIn. https://www.linkedin.com/company/pt-indolakto/?originalSubdomain=ca
[8] Mayora Group. https://www.mayora.com/en/about-us/mayora-at-a-glance
[9] Perfetti Van Melle. https://www.perfettivanmelle.com/services/faqs/
[10] OT. https://www.ot.id/company
[11] Forbes. "Anthony Salim & Family." https://www.forbes.com/profile/anthoni-salim/

Figure 11: Observances of beverage parent companies in stores (columns) and approximate number of employees in thousands (points), where available from public sources; multinational companies and conglomerates are shown in green.

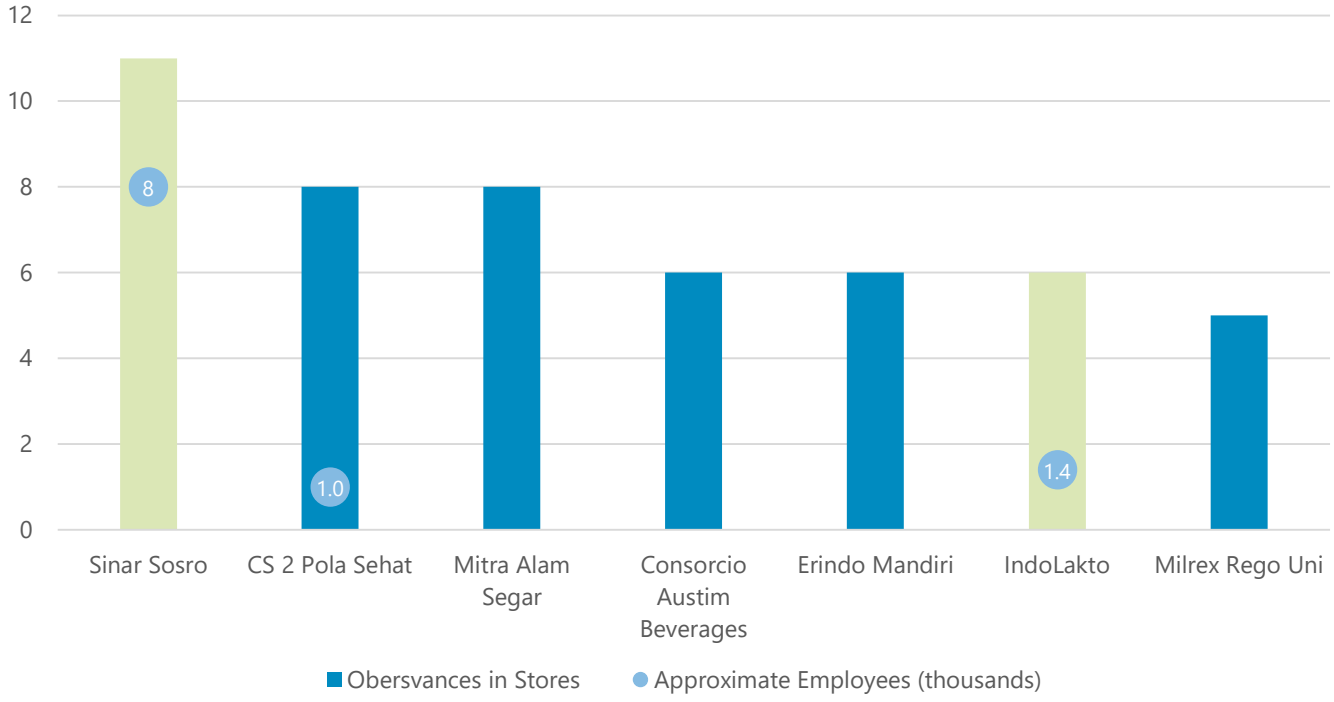


Figure 12: Observances of candy companies in stores (columns) and approximate number of employees in thousands (points), where available from public sources; multinational companies and conglomerates are shown in green.

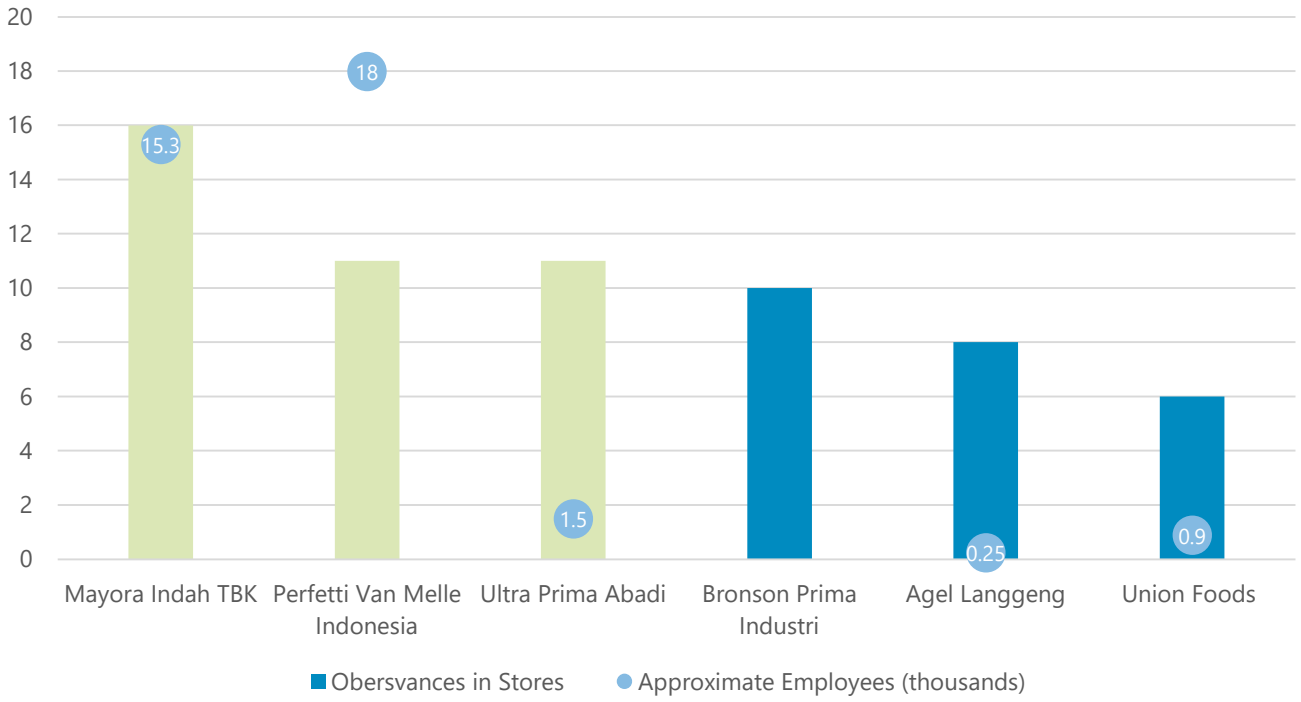


Figure 13: Observances of chips parent companies stores (columns) and approximate number of employees in thousands (points), where available from public sources; multinational companies and conglomerates are shown in green.

Like Ataúro Island, Liquiçá's FMCG products are largely originating from regional parent companies (Table 2), although there are a few additional countries represented in the parent company headquarters, including Australia, Malaysia, Cyprus, and China (Figure 14 and Figure 15).

Table 2: Approximate distances between Liquiçá and parent company headquarters.

	Length Store to Parent Company (km)		
	Minimum	*Maximum*	*Average*
Beverages	12	13,462	2,259
Candy	1,457	9,479	2,096
Chips	1,457	3,805	1,962

**Note: Distances were projected using an Azimuthal Equidistant projection. Values have been rounded to the nearest km.*

Figure 14: Parent company locations for fast-moving consumer good brands surveyed in Liquiçá.

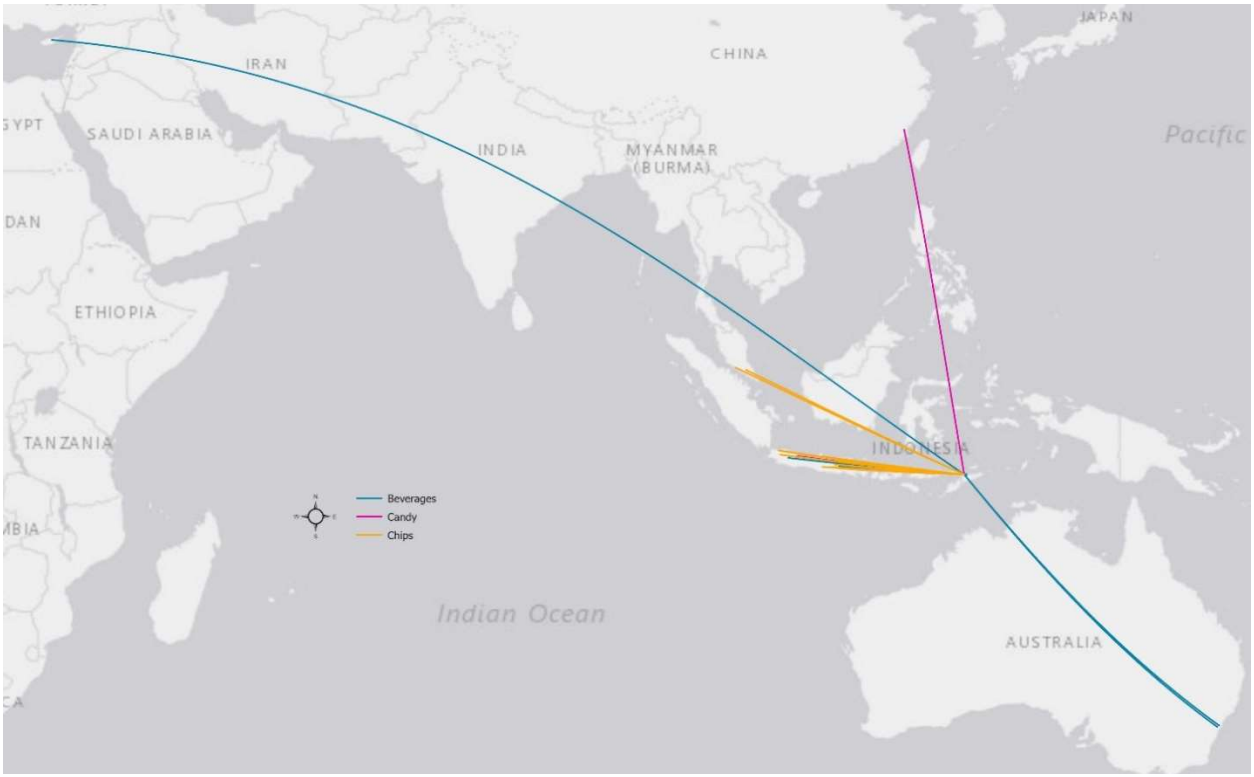
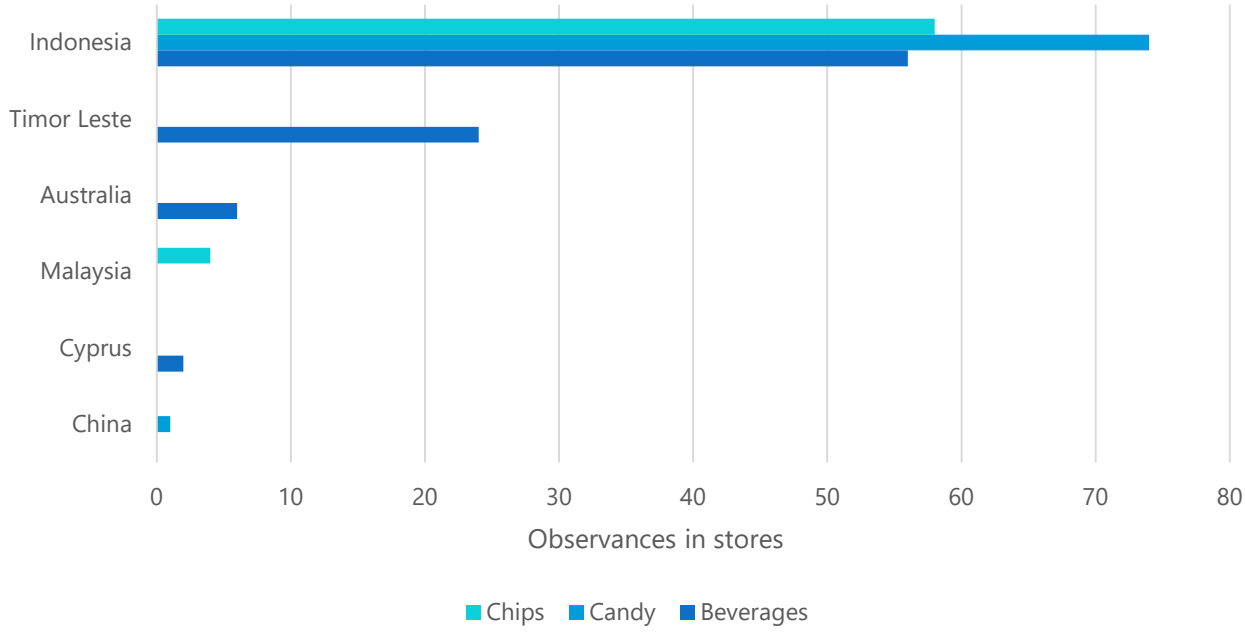


Figure 15: Parent company countries for fast-moving consumer goods brands surveyed in Liquiçá.



Dili

In total, 20 stores were surveyed in Dili, where 714 convenience products packaged in single-use plastic were recorded, including 250 beverages, 211 candies, and 253 chips. These included 71 unique beverage brands, 46 unique candy brands, and 82 unique chip brands. Popular brands were determined by their presence in more than 50% of the stores surveyed. Popular brands across, in order of the frequency of observances, the three categories are listed below, with parent companies included in parentheses after the brand name.

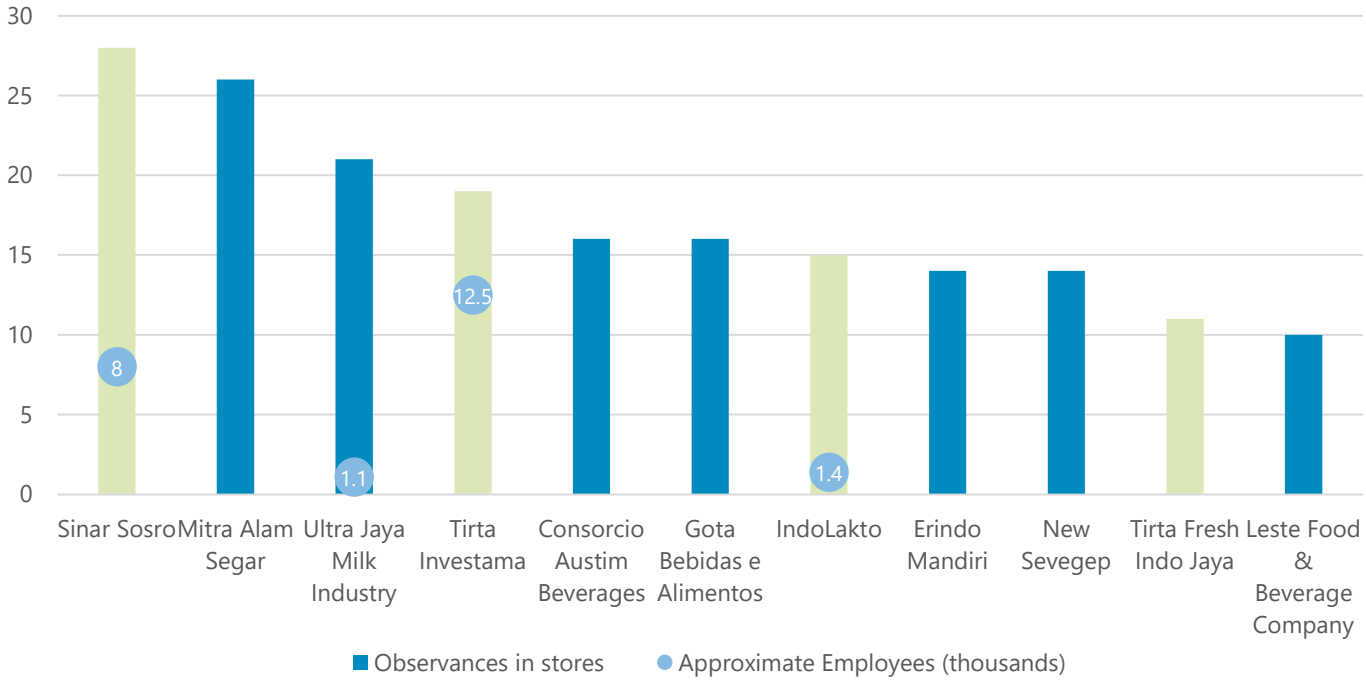
- Beverage brands: **Aqua** (*Tirta Investama*), **Country Choice** (*Sinar Sosro*), **Gota** (*Gota Bebidas e Alimentos*), **Fresca** (*Consorcio Austim Beverages*), **Indomilk** (*IndoLakto*), **Aquase** (*Erindo Mandiri*), **Le Minerale** (*Tirta Fresh Indo Jaya*), **Floridina** (*Mitra Alam Segar*), **Leste** (*Leste Food & Beverage*)
- Candy brands: **Lazery Milk** (*Union Foods),* Pendekar Biru, Yupi, **Hot Hot Pop** (*Bronson Prima Industri*), **Relaxa** (*Agel Langgeng*), Happydent, **Kiss** (*Mayora Indah*), **Kopiko** (*Mayora Indah*), **Mentos** (*Perfetti Van Melle Indonesia*), **Tamarin** (*Mayora Indah*)
- Chip brands: **Kusuka** (*Arira Pangindo*), **Chitato** (*Indofood Sukses Makmur*), **Qtela** (*Indofood Sukses Makmur*), **Taro Net** (*Putra Taro Paloma*), **Tos Tos** (*Dua Kelinci*)

From all recorded beverage brands, the 71 brands were mapped to 48 beverage parent companies. The 46 candy brands were mapped to 25 parent companies, and the 82 chip brands were mapped to 31 parent companies. Observances of parent companies present more than 10 times in the 20 surveyed stores are charted by category below, along with approximate employees in thousands as a proxy for company size (Figure 16, 17, and 18). Approximate number of employees was obtained from public online sources such as the company website or LinkedIn page and is unlisted where not available.

Some parent companies (highlighted green) are owned by large conglomerates or multinational companies. For beverages, Sinar Sosro is owned by the holding company Rekso, which owns several large companies in Indonesia including McDonald's Indonesia.[12] Tirta Investama is owned by Danone, a large global player in both the dairy and bottled water spaces, with its headquarters in Paris, France.[13] IndoLakto is part of Indofood, owned by the Salim Group.[14] Tirta Fresh Indo Jaya is part of the Mayora Group, a multinational FCG company based in Indonesia.[15] The most prevalent candy parent company, Mayora Indah, is also part of the Mayora Group. Perfetti Van Melle Indonesia is owned by Perfetti Van Melle, an Italian-Dutch multinational confectionary company.[16] Ultra Prima Abadi is owned by the Orang Tua Group, an international consumer goods company based in Indonesia.[17] For chips, Indofood Sukses Makmur, like IndoLakto, is owned by the Salim Group. Universal Robina Corp, owned by the conglomerate JG Summit Holdings, is one of the largest consumer goods companies in the Philippines.[18]

[12] Rekso. https://www.reksointernational.com/aboutus/
[13] Danone. "Facts and Figures." https://www.danone.com/about-danone/at-a-glance/danone-data.html
[14] LinkedIn. https://www.linkedin.com/company/pt-indolakto/?originalSubdomain=ca
[15] Mayora Group. https://www.mayora.com/en/about-us/mayora-at-a-glance
[16] Perfetti Van Melle. https://www.perfettivanmelle.com/services/faqs/
[17] OT. https://www.ot.id/company
[18] Universal Robina. https://www.urc.com.ph/

Figure 16: Observances of beverage parent companies stores (columns) and approximate number of employees in thousands (points), where available from public sources; multinational companies and conglomerates are shown in green.



**Note: For the approximate employees for Tirta Investama, employees are all Danone Aqua employees in Jakarta, Indonesia.*

Figure 17: Observances of candy parent companies stores (columns) and approximate number of employees in thousands (points), where available from public sources; multinational companies and conglomerates are shown in green.

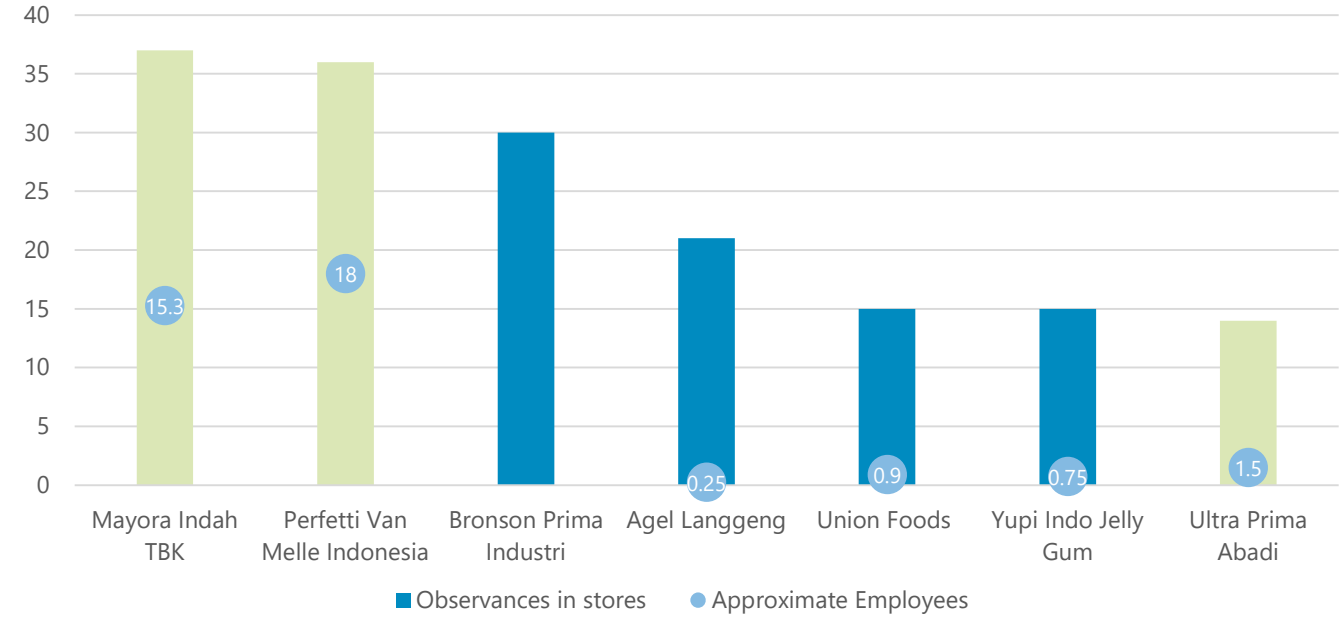
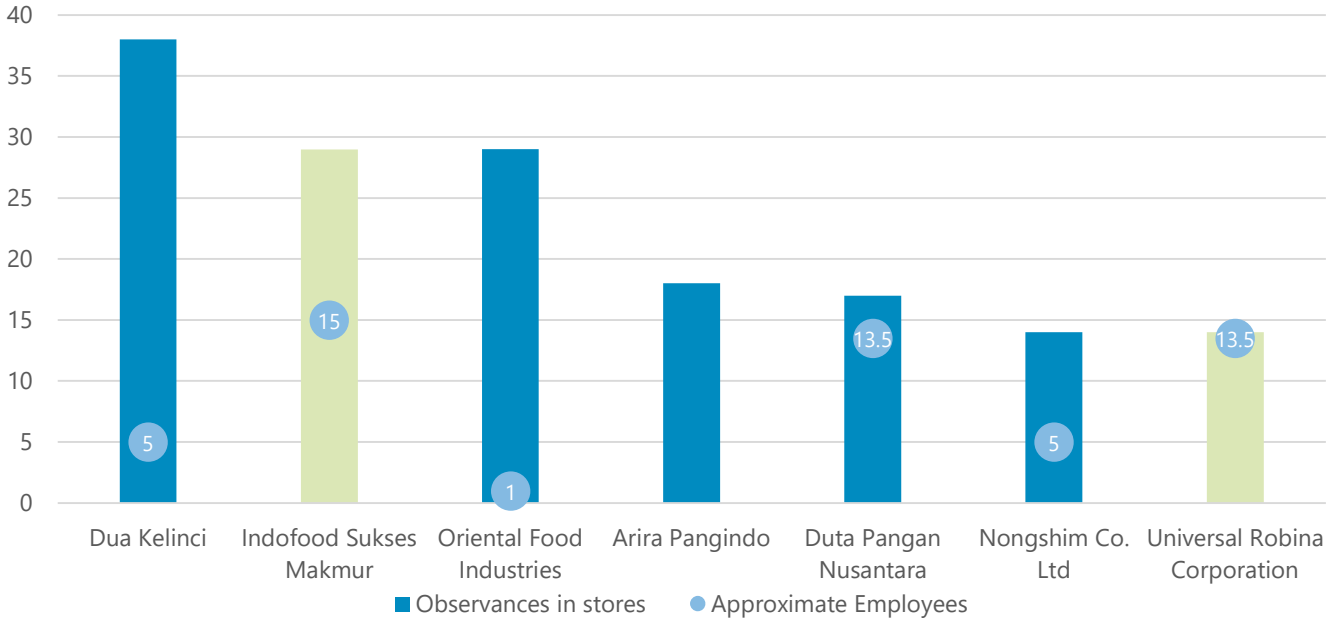


Figure 18: Observances of chips parent companies stores (columns) and approximate number of employees in thousands (points), where available from public sources; multinational companies and conglomerates are shown in green.



In addition to having a greater quantity of brands and parent companies for FMCGs compared to Ataúro Island and Liquiçá, the products found in Dili are also, on average, coming from further away (Table 3). Parent companies found in Dili are headquartered in 13 different countries (Figure 19 and Figure 20).

Table 3: Approximate distances between Dili and parent company headquarters.

	Length Store to Parent Company (km)		
	Minimum	*Maximum*	*Average*
Beverages	26	19,718	3,516
Candy	1,477	9,489	2,220
Chips	1,482	13,152	3,382

**Note: Distances were projected using an Azimuthal Equidistant projection. Values have been rounded to the nearest km.*

Figure 19: Parent company locations for fast-moving consumer good brands surveyed in Dili.

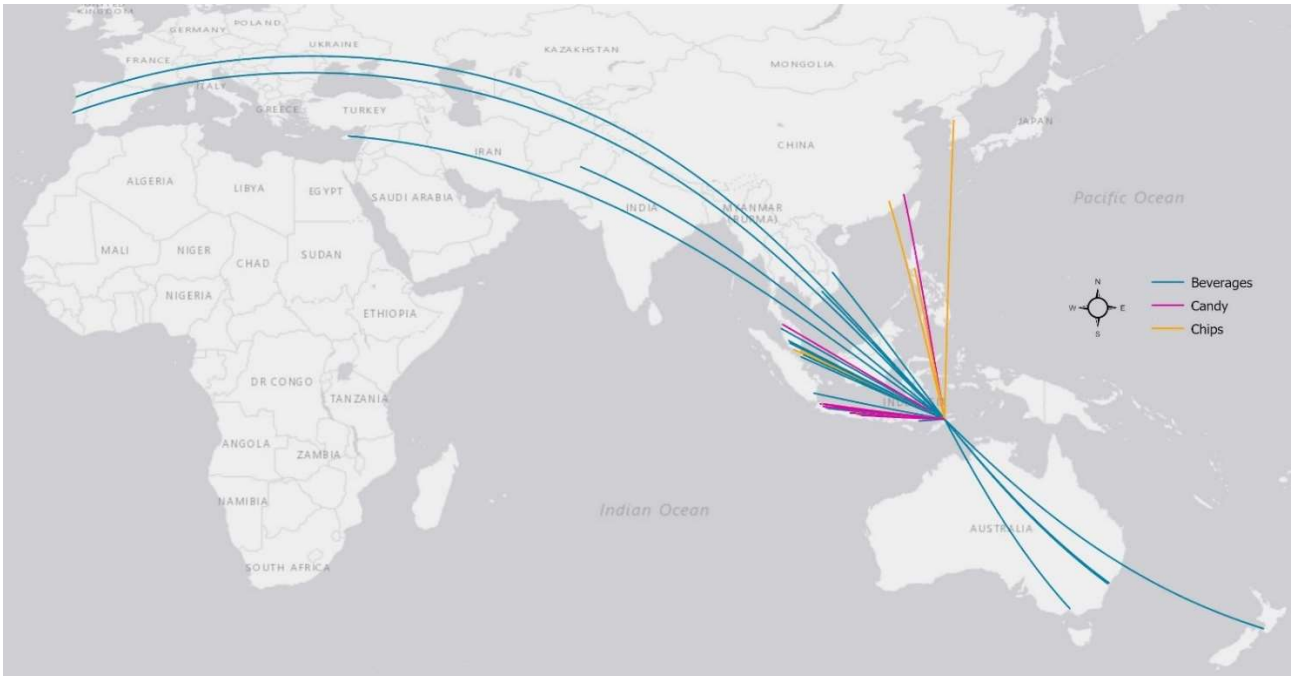
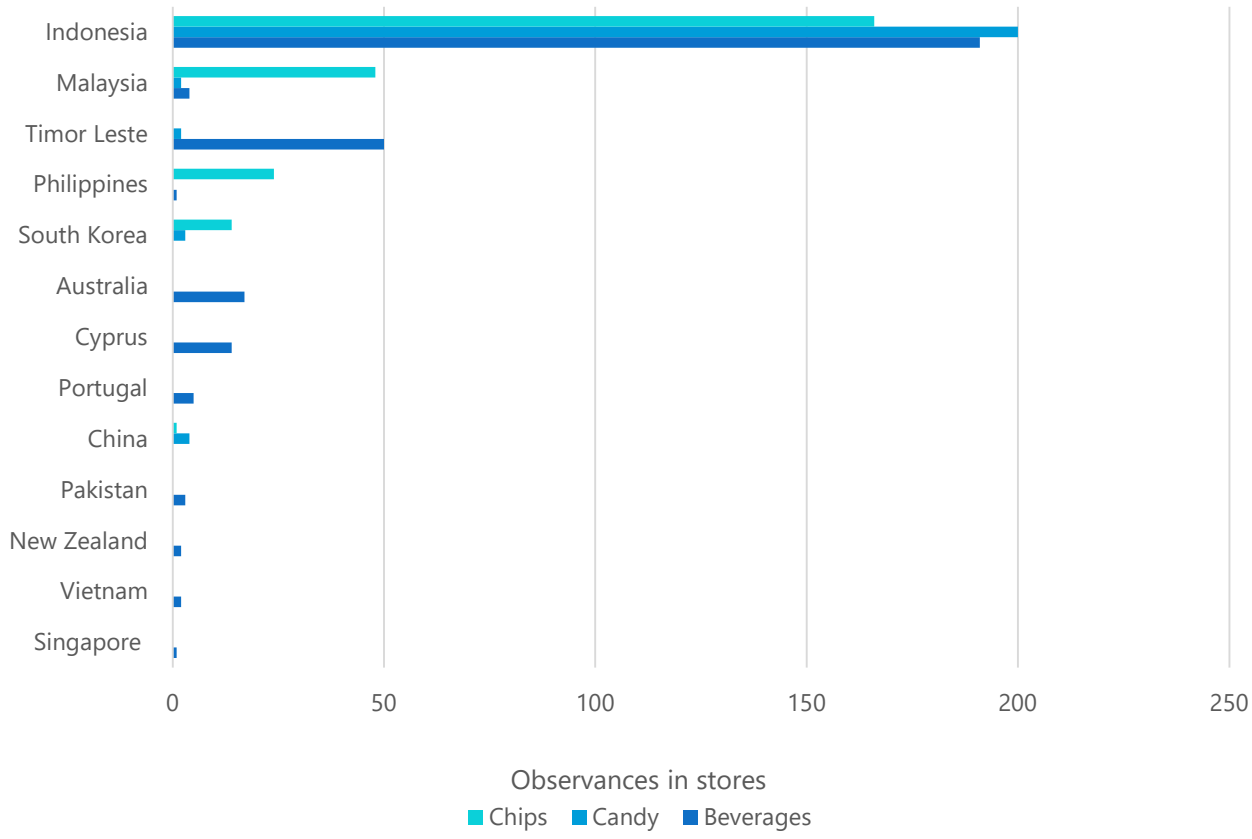


Figure 20: Parent company countries for fast-moving consumer goods brands surveyed in Dili.



Findings

While EPR is conceptually established under Decree Law 37/2020, no implementation or enforcement of EPR has yet been attempted in Timor-Leste. Given Timor-Leste's compact size, implementing an EPR program may not be a huge cost and could generate additional investment and jobs, in addition to reducing plastic pollution.

Recent pushes to expand EPR in developing countries in Southeast Asia include preliminary policies in early phases of implementation in Indonesia, Vietnam, and the Philippines, all countries exporting to Timor-Leste. The regional trend toward EPR may mean less industry resistance to an EPR program in Timor-Leste. One of the key challenges in EPR implementation across these countries is governmental capacity for oversight – piloting EPR as a voluntary program, such as is currently underway in Sri Lanka,[19] may allow time for enlisting industry to develop appropriate targets, developing the domestic recycling industry, and increasing monitoring and administrative capacity. This could establish the groundwork for a successful, mandatory EPR program in the long term.

In existing EPR policy in Southeast Asia, medium, small, and micro enterprises (MSMEs) have often been excluded from EPR obligations due to concerns about staff capacity. However, as demonstrated by the number of employees as a proxy for business size, there are many large corporations importing products to Timor-Leste. Across all communities and categories, there are large multinational corporations importing FMCG products. Multinational corporations are often quick to adopt EPR schemes, and minimally providing more guidance around voluntary EPR standards may be an effective starting place to collaborate with industry and support the recycling industry in Timor-Leste, while building up the administrative capacity to oversee and implement full-scale mandatory EPR program in the future.

Additionally, the FMCG surveys identified several beverage brands producing locally in Timor-Leste, from seven different parent companies. These include the following companies:

- Compania Aquafu
- Compania Ira-Mor
- Consorcio Austim Beverages
- Frizy Segar Nikmat
- Gota Bebidas e Alimentos
- Leste Food & Beverage Company
- Milrex Rego Uni.

These local production facilities mean deposit return schemes (DRS; where a fee is levied on bottles at the point of purchase and returned to the consumers when the bottle is turned in to be refilled) are within the technical capacity of the existing corporations in Timor-Leste. While the existing 30% import tax on empty, single-use plastic packaging,[20] such as plastic bottle preforms that are used to locally produce bottled water, was intended to push local producers away from SUP and towards reuse, little change in product packaging has occurred since this law was enacted in 2020. Further incentivizing reuse, such as by subsidizing infrastructure for DRS collection points, may derisk these programs for local producers. Collaboratively working with industry to incentivize refill would be a significant move towards limiting plastic pollution.

[19] USAID. "Municipal Waste Recycling Program Extended Producer Responsibility: Lessons Learned from Sri Lanka." https://pdf.usaid.gov/pdf_docs/PA00XV7B.pdf

[20] "Import of Bags, Packaging and Other Plastic objects." *Timor-Leste Trade Information Portal.* https://timor-lestetradeportal.org/en-gb/search-measure/view/1332

Community

To understand current attitudes and perceptions of plastic waste, semi-structured interviews were conducted with 109 key stakeholders. Among those interviewed, 15 were national or municipal government officials or village leaders, five were from waste management or recycling operations, and four were from non-profit organizations. Local businesses, including 83 stores and restaurants, were interviewed by the team during product and packaging surveys (Table 4).

Table 4: Summary of Stakeholder Interview List

Stakeholder Group	Number of Interviews
National government official	4
Municipal government official	3
Village leader	8
Policy consultant	1
Development agency	1
Non-profit organization	4
Cottage-industry recycling	3
Waste management or recycling operator	2
Grocery or convenience store	40
Restaurant or food vendor	43

One of the main concerns frequently repeated by the interviewees was inconsistent and inadequate levels of awareness among the community around appropriate ways to manage waste. Interviewees expressed that there are still high levels of littering, negatively impacting local environments. In Dili, concerns centered around improved socialization of new practices associated with the new collection point bins, including putting waste in bins at the assigned times in the evening and ensuring waste is placed in the bins and not adjacent to them. Some stakeholders, especially from non-profit organizations, discussed awareness-raising as a tool to promote reduction in addition to management.

> **"It's a small country, and we all know the government is trying to manage waste, but the community doesn't have awareness of the impact of waste on their lives and on the environment. There are also impacts on fishing and tourism. Some people will still throw waste in the river. Seas full of plastic won't attract tourists."** – Non-profit organization

> **"We need to think about changing the community mindset to dispose of waste in the dumpsters and respect the times when they are supposed to use them."** – Waste management of recycling operator

> **"[In Dili] they are supposed to charge a penalty for putting waste next to bins instead of in the bins but this is not enforced."** – National government official

> **"Behavior change education is the main thing we need to work more on. We need to change people's mindsets to understand the impacts of plastic so they will contribute to reduction."** – Non-profit organization

Interviewees also noted ways current efforts at awareness raising fall short, including inadequate dedication of resources, irregular frequency, and outdated methods of outreach. Clear and consistent storytelling leveraging media platforms may more effectively reach the community. Interviewees also highlighted the importance of targeted messaging to encourage youth to champion environmental stewardship.

> **"Awareness raising is not effective right now because it depends on volunteers, and the campaigns are not frequent enough."** – Non-profit organization

> **"We want to have monthly awareness-raising campaigns, but there are budget limitations."** – National government official

> **"We need to make sure that our messages are clear. Changing people's minds is challenging."** – National government official

> **"The awareness of the seriousness of issues like plastic pollution doesn't trickle down everywhere. Pamphlets and posters don't work, because the literacy level is low. We need storytelling to make a significant impact on behavior change."** – Public sector consultant

> **"It's hard to get people to show up to meetings. We may need to focus on using media to raise awareness."** – Municipal government official

> **"The lack of awareness contributes to littering. We teach the kids in Green Schools[21] not to litter and encourage them to teach their parents. Shaming their elders works. We want the students to be the champions."** – National government official

Among the stores and restaurants interviewed, opinions were varied if plastic pollution is a problem for their communities. In Ataúro, about 57% of the 23 businesses interviewed felt it was an issue, and a few stakeholders additionally referenced the challenges with waste from other areas washing up on the beaches in Ataúro. In Liquiçá, about 60% of the 20 businesses expressed concern about plastic pollution. Other stakeholders in Liquiçá felt like waste was already adequately managed through burning. Some stakeholders mentioned that plastic is useful, because it makes it easier to start these fires. In Dili, over 80% of businesses interviewed felt plastic pollution was a problem. This finding points to several possible explanations: firstly, plastic waste may be more visible in Dili because of the higher waste generation associated with a higher population, but also, it could be that awareness raising around plastic waste has saturated more of the population in the capital than in other communities in Timor-Leste.

> **"[Plastic pollution] feels like a big problem. When sea waves come, they wash all the waste up on the beach, right at the front of our business."** – Grocery or convenience store (Ataúro)

[21] "Green School Initiative Helps Keep Timor-Leste Clean, One Bottle at a Time." *United States Agency for International Development*. https://www.usaid.gov/timor-leste/news/green-school-initiative-helps-keep-timor-leste-clean-one-bottle-time

> **"Our area is not really impacted by plastic pollution, because there is very little plastic. Plastic is only used when people come to buy things."** – Restaurant or food vendor (Liquiçá)

> **"There is no plastic pollution because the community is aware of how to manage their own plastic."** – Restaurant or food vendor (Liquiçá)

> **"No, plastic isn't a problem here. Our shop is just average, it's not too big. Therefore, all the plastic we have, we gather, and then we burn it in a far-away place, far away from where the community lives."** – Grocery or convenience store (Liquiçá)

> **"We think plastic is good and we use it to start the fire."**– Restaurant or food vendor (Ataúro)

> **"We need to put effort on using less plastic, cause using plastic causes plastic pollution, and it impacts the environment."** – Grocery or convenience store (Dili)

For businesses that did feel plastic pollution was a problem in their area, two key areas of concern emerged during the interviews. The first was human health – stakeholders repeatedly expressed concerns about respiratory distress from inhaling smoke from burning plastics. Others mentioned concerns about disease-spreading flies and mosquitos breeding in mismanaged waste, like litter. Again, the frequency at which businesses expressed those concerns differed across geographic areas. In Ataúro, about 48% of business expressed concerns about plastic related to human health, compared to only 35% in Liquiçá and over 70% in Dili.

> **"When we burn waste carelessly, the smoke impacts community health."** – Grocery or convenience store (Ataúro)

> **"When we litter, that cause many flies, and when we burn the plastic waste carelessly, the smoke can cause people to cough and get sick."**– Restaurant or food vendor (Dili)

Less frequently than human health but still with some frequency, business owners mentioned concerns about negative environmental impacts of plastic, from detrimental impacts on marine life, to negative effects on soil quality, to the added risk of flooding from drains clogged with plastics. Notably, the rate at which businesses mentioned environmental impacts of plastic was similar across all three communities – around 39% in Ataúro, 30% in Liquiçá, and 35% in Dili. This suggests that focusing first on the human health consequences of plastic pollution in awareness campaigns may resonate more than environmental concerns with business stakeholders, and that further awareness raising around marine plastic pollution is necessary.

> **"The impact of plastic pollution is that, when it is raining, all the plastic will be flushed into the sea and can affect the sea animals."** – Restaurant or food vendor (Ataúro)

> **"Waste thrown carelessly can cause the soil production to be not good."** – Grocery or convenience store (Ataúro)

> **"When we litter or throw away the plastic, when we don't put it in its place, then when the rain comes, it causes a problem. It will clog the drains, and water can't flow so it will cause floods."** – Restaurant or food vendor (Dili)

Generally, stakeholders expressed differing opinions on whether environmental protection was an important topic to community members. Some felt that environmental protection was not a high-ranking

concern compared to day-to-day economic challenges, and stakeholders referenced that many Timorese leaders have never seen the pristine reefs around the island. This perception that Timorese people are not aware of their own resources is contrasted with significant efforts at engaging youth by the Land and Maritime Boundary Office (LMBO), including the Future Youth Ambassadors of the Blue Economy program, which engages young professionals working in marine biology and the dive industry,[22] and the recent launch of the "My Sea, My Timor" illustrated children's book, which is being distributed to schools throughout the country.[23] Especially given the unique biodiversity and marine ecosystems in Timor-Leste, raising awareness of plastic pollution's impacts on marine ecosystems is especially important.

> **"The feelings of environmental protection are not there. It's not important to people. People are used to throwing waste wherever they want… We need frequent campaigns and regular education to change mindsets."** – Non-profit organization

> **"The Timorese want to protect ocean resources, and respect and appreciate the ocean. But we need more methods to help them achieve ocean protection."** – Public sector consultant

Additionally, several village leaders and businesses in Ataúro, Liquiçá, and Dili referenced the possibility of establishing 'tara bandu' for waste. A widely held understanding of tara bandu, a traditional Timorese custom, is that it is a communal agreement that promotes peace and reconciliation by defining social norms and outlining behaviors and practices community members want to enforce. Sufficient engagement of the community in establishing agreement around this social contract is a key mark of legitimacy for tara bandu.[24] Tara bandu laws were outlawed during Indonesian occupation, but there have been recent efforts to use tara bandu to protect natural and ocean resources, including forests,[25] mangroves and reefs,[26] and fisheries.[27] Tara bandu related to waste could leverage a native natural resources management model that complements the already decentralized waste management practice in Timor-Leste, where authority and responsibility to manage waste exists at the local level. The Ministry of Agriculture and Fisheries, which is responsible for coastal zone management, may be able to facilitate some of the local-level conversations needed around plastic waste and ocean conservation to encourage village leadership to explore tara bandu for waste. However, this may be more challenging in urban areas like Dili with mixed cultural identities. At minimum, the strength and importance of local leadership highlights the need to gain buy in for national policies and create support for implementation at the community level.

> **"There is no policy from the [national] government yet. But we have tara bandu, our local law, to prevent the community from littering or throwing the waste on the side of the road or into the river."** – Village leader (Liquiçá)

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[22] "Timor-Leste Celebrates World Ocean Day 2024." June 10, 2024. https://timor-leste.gov.tl/?p=37812&lang=en&n=1
[23] "Prime Minister Xanana Gusmão Launches Blue Economy Photo Book in New York." September 25, 2024. https://timor-leste.gov.tl/?p=39714&lang=en&n=1
[24] Belun and The Asia Foundation. "Tara Bandu: Its Role and Use in Community Conflict Prevention in Timor-Leste." June 2013. https://belun.tl/wp-content/uploads/2013/08/Tara-Bandu-PB-English.pdf
[25] Pawanka Fund. "Tara Bandu, a Tradition of Sustainability." October 2018. https://pawankafund.org/blog-news/tara-bandu-a-tradition-of-sustainability/
[26] Bhattacharya, Bikash Kumar. "Timor-Leste: Maubere tribes revive customary law to protect the ocean." October 26, 2018. *Mongabay*. https://news.mongabay.com/2018/10/timor-leste-maubere-tribes-revive-customary-law-to-protect-the-ocean/
[27] "Ilimano Communities Declare Tara Bandu in Lian-lidu's Marine Area." *Blue Ventures*. August 13, 2024. https://blueventures.org/ilimano-communities-declare-tara-bandu-in-lian-lidus-marine-area/

> **"If the community is littering, we need to have local law or tara bandu related to waste."** – Grocery or convenience store (Ataúro)

> **"Every municipality is responsible for controlling waste and educating people. We need to activate city-level officials to educate and penalize people who are not disposing of waste correctly."** – National government official

> **"People at the community level like the village chief heads need to have the authority to implement these policies and penalize people who don't comply."** – Non-profit organization

Interviewees also spoke to the need for broader collaboration across stakeholder groups, especially within the government. Stakeholders expressed a desire for more cooperation between agencies on awareness campaigns and coordination across different departments working on waste but highlighted that a structure to enable this collaboration would need to be developed. Multiple government agencies are working on awareness, enforcement, or infrastructure related to plastic pollution or waste management, including LMBO in the Prime Minister's office, the Ministry of Tourism and Environment, and the Ministry of Public Works. One of the outcomes of a recent CAP in Melaka, Malayasia, was the city's proposal to establish a City Taskforce to integrate stakeholder groups and collaborate on awareness campaigns.[28] As a UNESCO world heritage site, Melaka has increasing tourism rates, and the city has focused on co-developing awareness campaigns with their waste management system.[29]

> **"We're working on understanding existing resources and trying to break down silos across development agencies and ministries."** – Public sector consultant

> **"Policies for waste management are already in place, but we lack implementation. There are overlapping policies from different ministries."** – Waste management or recycling operator

Timor-Leste has several innovative policies on plastic pollution, though interviewees expressed concerns related to implementation of these policies. Firstly, an import tax of 30% is levied on empty, single-use plastic packaging,[30] such as plastic bottle preforms that are used to locally produce bottled water. Interviewees noted that this import tax is directed toward the general fund and suggested that a specific allocation towards waste management may be appropriate. Timor-Leste also enacted a ban through Decree Law 37/2020 on single-use plastic products considered "not environmentally friendly."[31] Government officials interviewed stated that there are 13 proposed materials in the SUP ban, but 11 of the materials are still being negotiated with companies and distributors to ensure there are available and affordable alternatives. Enforcement of the SUP ban falls under the purview of the Department of Pollution Control within the Ministry of Tourism and Environment.

The two materials already enforced under the SUP ban are single-use plastic bags and foam take-out containers. For bags, while some store owners detailed consumer complaints about the cost of reusable

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[28] Urban Ocean. "Project Opportunities to Accelerate Clean, Healthy Cities and Seas: City Opportunity Booklet." https://resilientcitiesnetwork.org/wp-content/uploads/2022/10/Opportunity-Booklet_FINAL_220525.pdf

[29] Circularity Informatics Lab. Circularity Assessment Protocol: Melaka, Malaysia. https://cdn.prod.website-files.com/6155e0c2fe4ef5f637f9f979/64c96a8c9b6548d50734d6fb_Melaka-Report-2021-08-31-reduced.pdf

[30] "Import of Bags, Packaging and Other Plastic objects." *Timor-Leste Trade Information Portal.* https://timor-lestetradeportal.org/en-gb/search-measure/view/1332

[31] "Timor-Leste Statement at the Second Session of the Intergovernmental Negotiating Committee to develop an international legally binding instrument on plastic pollution, including in the marine environment." https://resolutions.unep.org/resolutions/uploads/timorleste_2.pdf

bags, other stakeholders noted that requiring people to pay for reusable bags is a positive to encourage reuse. Store owners also mentioned traditional alternatives to plastic, such as woven baskets from palm leaves. Interviewees had mixed opinions on the enforcement level of the bag ban; the government is working at a customs level and educating distributors to prevent the importation of plastic bags, but there is still illegal importation.[32] Stakeholders noted that the land border on the west side of the island is a particular challenge to control. There also seems to be a difference in implementation of the SUP bag ban depending on the size of the store; multiple stakeholders referenced better enforcement and higher adoption among large supermarkets compared to local markets, where repackaging of bulk goods into smaller bags is common. This unequal implementation of a SUP bag ban, excluding local marketplaces, is similar to what was seen in a CAP study in Santiago, Chile.[33]

> **"In our restaurant we never use the plastic, we only use reusable bags and use traditional basket made from palm leaf when buying goods."** – Restaurant or food vendor (Ataúro)

> **"Many community members are still using plastic, because in many markets, they still provide plastic. The difficulty for the community is they don't want to buy the reusable bags and other alternatives because the price is not as cheap as plastic."**– Restaurant or food vendor (Ataúro)

> **"The SUP ban policy has been received very well at the national level. People see the impact of plastic on the beach."** – National government official

> **"There is no enforcement on the SUP ban. Plastic is still used everywhere in the markets."** – Waste management or recycling operator

> **"We are also raising awareness around the single-use plastics ban. In the big supermarkets, people use reusable bags, but you will still see plastics in the small markets… The local markets are still using plastic because they are repackaging bulk goods into individual packages."** – National government official

For take-out foam containers, restaurants reported switching from plastic to paper where possible, though some food products like soup remain a challenge. Vendors also referenced traditional alternatives like using coconut leaves to serve food, as well as using only reusable food-ware for in-house dining.

> **"The government came to the restaurant and banned the black plastic and Styrofoam containers."** – Restaurant or food vendor (Dili)

> **"We don't see a reduction in marine debris from the SUP ban… We don't see foam-to-go containers anymore, but we do still see pre-packaged foam goods, like noodle cups."** – Non-profit organization

In general, the discrepancies between policies on paper in Timor-Leste and the implantation of these policies was a theme that emerged repeatedly through the interviews. Stakeholders felt there were still significant needs around socialization and awareness raising for policies; inspections and monitoring; and

[32] Belarmino de Sa, Jose. "Plastic bags continue to dot Dili despite ban." *Tatoli*. January 23, 2024. https://en.tatoli.tl/2024/01/23/plastic-bags-continue-to-dot-dili-despite-ban/13/#:~:text=In%20march%202020%2C%20the%20Government,other%20plastics%20in%20Timor%2DLeste.

[33] Circularity Informatics Lab. Circularity Assessment Protocol: Santiago, Chile. February 1, 2023. https://cdn.prod.website-files.com/6155e0c2fe4ef5f637f9f979/64c96a8c9b6548d50734d708_Santiago%20CAP%20Report_Final_English.pdf

enforcement and penalties. In this context, interviewees also felt that furthering EPR In Timor-Leste, currently suggested in concept under Decree Law 37/2020,[34] would require creating a new central implementing institution to work across Ministries.

> **"Management itself is the biggest challenge. We have good programs on paper, but we still have to work on how to control and monitor waste."** – National government official

Waste separation at source was widely agreed upon as a key to unlocking better waste management practices in Timor-Leste. Many interviewees felt this was a necessary future direction, and one interviewee referenced Indonesian waste banks as a potential model. In Indonesia, over 25,000 waste banks provide decentralized recycling and educational centers for community members to drop off their waste and sort out recyclables.[35] Again, awareness and education were frequently mentioned as missing links, but some stakeholders suggested that infrastructure to enable source segregation would need to come in advance of behavior change campaigns. More immediate plans mentioned by government officials and waste management operators suggest having some post-collection sorting, likely to extract organics, at the landfill.

> **"If we had unlimited funding, we would like to work at a community level to educate about separating waste. We would also need to invest in proper infrastructure after the community is segregating their waste."**– National government official

> **"People need to see the improved facilities. Behavior change is linked to that."** – National government official

> **"Our current waste management contract doesn't include segregation, but the plan is to include it in the future. We will collect mixed waste and then sort it at the Tibar landfill. We are looking into options for how to do this segregation."** – Municipal government official

Aligning economic incentives to support source-separated collection remains a challenge. Some stakeholders held that economic benefit to community members would be required to promote waste segregation – people expect to be compensated for raw material for recycled goods. Some stakeholders suggested government collaboration with private companies to fund the collection of source-separated waste. While multiple government officials interviewed suggested public-private partnerships for collection, private recyclers mentioned that it is currently challenging to work with government to set up collection hubs. Other stakeholders mentioned the lack of data on recyclable waste volumes may be preventing further investment in recycling infrastructure. Low volumes of waste in a small country like Timor-Leste make the economies of scale for recycling a significant challenge.

> **"We need separation at a collection level. We need separation into organic, inorganic, and hazardous waste. But the challenge is collection… The challenge is who would be responsible for collecting different waste streams. Some companies want to collect recyclables, but the economy of scale is a challenge."** – National government official

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[34] States that "after the usage and completion of its rotation cycle, the commercial company operator must accept the return of the plastic object and becomes responsible for the subsequent waste management"; "Plastic Pollution Prevention in Timor-Leste: Gap Analysis of Current Legislation, Policies, and Plans." *Pacific Regional Environment Programme*. May 2023. https://library.sprep.org/sites/default/files/2023-05/plastic-pollution-laws-legislation-timor-leste.pdf

[35] Saraswati, Aviaska Wienda. "Waste Bank A Solution to Pollution." *Greeneration Foundation*. July 25, 2023. https://greeneration.org/en/publication/green-info/waste-bank/

> **"People want to be paid for dropping off their waste. People see it as a raw material for a product."** – Waste management or recycling operator

> **"Some companies want to invest in recycling, but they are unsure about the volumes of waste."** – Waste management or recycling operator

In addition to waste separation, stakeholders widely agreed that more effort needs to be directed towards supporting recycling in Timor-Leste. For both large-scale and cottage-industry recyclers, establishing end-markets for their products was reiterated as a key challenge. Recyclers felt that the eco-friendly nature of their products was a selling point, but there was still a need to spotlight recycled products and garnish more support for the industry. Negotiating or subsidizing more favorable shipping rates for the export of recycled products, establishing marketplaces for recyclers to sell their goods, and emphasizing eco-friendly products in procurement guidelines were suggested solutions. For example, recycled pavers from a local recycling company called Caltech are currently being used in a renovation project for Cristo Rei park.[36] The Land and Maritime Boundary Office is also piloting a program for collecting recyclables in their offices, a program that could be expanded to other ministries as well as government-run entities like schools. Ocean-bound plastic credits were also mentioned as a potential funding mechanism for recycling, but some stakeholders felt the cost of registering to produce ocean-bound plastic credits was prohibitive for small recyclers in Timor-Leste.

> **"The end market is the biggest obstacle – where to sell the product…. We would like to see more use of the recycled products we are creating. This is our biggest focus area. We are also looking at trying to export the product in the future."** – Waste management or recycling operator

> **"We need a government facilitated space to sell recycled products."** – Cottage-industry recycler

In addition to recycling, composting was repeatedly mentioned by interviewees as a potential solution to some of the waste management challenges. While not a direct solution to plastic pollution, community composting could work easily with decentralized structures for solid waste management in Timor-Leste to reduce overall waste volumes, and some stakeholders mentioned that there is already community knowledge of composting landscaping waste. Low cost, low technology options could be as simple as static piles with passive aeration[37], or advanced decentralized methods like black fly soldier (BSF) composting, a process that is being quickly adopted in other tropical areas like Indonesia. BSF shortens improves turnover times and produces fly larvae which can be used as a protein source for fisheries, poultry or livestock.[38] While biodegradable plastics are exempted from the SUP ban, most biodegradable plastics available on the market are only compostable in the carefully controlled heat and moisture environments of an industrial composting plant. Biodegradable plastics are not currently widespread in Timor-Leste and should not be emphasized as a solution unless investment in industrial composting infrastructure proceeds this push. Some stakeholders felt locally made compostables, like palm leaf products, may be better to displace SUPs in some contexts. As part of the plan to add waste segregation

[36] Circular-R. *Caltech*. https://www.caltechgrp.com/circul-r/
[37] "Approaches to Composting." United States Environmental Protection Agency. https://www.epa.gov/sustainable-management-food/approaches-composting
[38] Wulandari, Fitri. "Indonesia pins hopes on a common fly to reduce food waste, carbon emissions." *GovInsider.* January 3, 2024. https://govinsider.asia/intl-en/article/indonesia-pins-hopes-on-a-common-fly-to-reduce-food-waste-carbon-emissions

of collected mixed waste at the landfill, interviewees mentioned a future effort to add composting at Tibar. Green waste separated after collection may be highly contaminated with plastics, and this may be a concern in identifying appropriate uses for this compost material.

> **"Some communities are already doing composting from food and organic waste. We need more education around this because it could reduce the waste going into the bins."** – Non-profit organization

> **"Many Timorese communities rely on agriculture, so we could use the compost as soil fertilizer. We could even sell the compost."** – Non-profit organization

> **"We want to have compost windrows to process green waste. We plan to give compost to farmers. We will mix the landscaping green waste with food waste."** – Waste management or recycling operator

For both recycling and composting, there was a sentiment from several stakeholders that their community lacked the expertise to implement these programs without guidance. Stakeholders suggested training for community members around both recycling and composting as a way to increase local capacity.

> **"The big obstacle is that we don't have any experts to look into this. I could have a plan to recycle the non-organic waste or compost the organic waste. But just myself, I can't. I need smart people in this area, such as an advisor to help me make the plan so that it goes well."** – Municipal government official (Liquiçá)

> **"We don't have the experience to reuse the plastic waste in a good way."** – Restaurant or food vendor (Dili)

Discussion of waste reduction efforts, like refill and reuse programs, was less frequent compared with conversation on waste management and recycling. Much of the conversation around reuse and refill that did occur focused on water; while many households purchase large refillable jugs for consumption at home, both water bottles and single-serve water cups are very common for on-the-go consumption and at parties and events. Stakeholders felt that a holistic approach to reducing plastic waste would require a focus on expanding access to clean drinking water, with appropriate quality control measures to ensure health and safety for consumers. A low investment option would be to increase availability of large refillable jugs already used in households in public buildings such as government offices to clean drinking water and encourage "bring your own container" habits.

> **"We need more drinking water taps and convincing people that they are safe. Right now, there is no clean water."** – Public sector consultant

> **"I think refill and reuse would need a lot of education. Reuse could start in offices. It would be good to have returnable, refillable water bottles, but there needs to be quality control. The health side needs to be involved because there is a human health and safety concern."** – Non-profit organization

Similarly requiring a holistic solution, stakeholders cited economic concerns as a driving force behind purchases of small packets and sachets of products and inhibiting consumers from bulk purchases, which are often more affordable per unit and result in less waste. Refill schemes in Timor-Leste could be modelled from programs like Algramo in Chile, which seeks to eliminate both plastic pollution and the

poverty tax through offering refill at consistent prices regardless of quantity.[39] Micro-refilling for home care products is permitted in the Philippines, and advocates are pushing for expanded use in personal care and cosmetics as a way to displace the sachet economy.[40] Stakeholders were generally skeptical about the success of refill but referenced that large institutions like schools or offices may be appropriate testing grounds. While some stakeholders felt economies of scale and necessary transport for reuse would be challenging outside of Dili, one stakeholder mentioned that reuse was already happening in rural areas where plastic is more valuable. This existing behavior could perhaps be leveraged into adoption of other refill or reuse schemes.

> **"Everything is imported, and people can't afford bulk purchases. People are buying small packets of shampoo and coffee. Transport to refill centers might be difficult. They may work in Dili, but they probably wouldn't be sustainable in other areas."** – Public sector consultant

> **"In small villages and high up on the mountains, plastic is valuable. People keep reusing it until it breaks."** – Non-profit organization

Finally, stakeholders pointed to tourism as both a challenge and an opportunity. With the impending expansion of tourism in Timor-Leste, improving waste management practices now is critical to establish a pathway to cope with increased waste volumes associated with tourism in the future. Municipal officials in Liquiçá discussed the need to install more waste bins to manage the waste generation in tourist areas. Stakeholders generally felt that the lack of adequate waste management was currently stunting growth in tourism. Tourism was also pointed to as a potential lever for promoting more environmentally friendly practices; most tourists visiting Timor-Leste are there to enjoy the natural resources of the island such as the reefs and mountains and may be willing to put their dollars behind environmental protection.

> **"As we expand the economy and industries in Timor-Leste, we know there will be more waste, so it's very important to focus on this now. We need to control the waste before the economic growth."** – Public sector consultant

> **"[Ataúro] is a tourist place – we can manage our own plastic but it is always difficult because all the waste is brought and washed to our island. Additionally, a lot of people always come to this place and creates a lot of plastic waste."** – Non-profit organization

> **"There is a relationship between poor waste management and limited tourism."** – National government official

> **"Tourists who come here are mountain climbers and divers. Most tourism here is nature tourism, so hotels that commit to environmental best practices could get more business… Outside of marine operators, I haven't seen commitments for eco-friendly practices among the tourism industry."** – Public sector consultant

[39] Moller Dominguez, José Manuel. "Algramo-Catalyzing Reusable Packaging." *MIT Solve*. https://solve.mit.edu/challenges/elevateprize/solutions/33585#:~:text=The%20primary%20reason%20Algramo%20came,on%20a%20per%20unit%20basis.

[40] Jambeck, J.R., et al. "The Circularity Assessment Protocol in Cities to Reduce Plastic Pollution." Community Science. January 30, 2024. https://onlinelibrary.wiley.com/doi/full/10.1029/2023CSJ000042

A program to certify eco-friendly businesses, for example, could be developed, or increasingly common tourist taxes or eco-fees[41] could be levied on visitors. For example, in Dominica where a recent CAP was conducted, eco-friendly travel is a key part of their eco-tourism strategy.[42] Existing resources like the Pacific Asia Travel Association's *Plastic Free Toolkit for Tour Operators*[43] could be translated into the Timor-Leste context and local language to provide guidance to industry as eco-tourism expands.

[41] Leahy, Kate. "What is tourist tax and will you have to pay it in Europe this summer?" *National Geographic*. July 7, 2024. https://www.nationalgeographic.com/travel/article/what-is-tourist-tax

[42] Commonwealth of Dominica. "Eco-friendly travel is at the heart of Dominica's Eco-Tourism Sector." November 22, 2023. https://www.cbiu.gov.dm/news/dominica/dominicas-eco-tourism-sector/

[43] Pacific Asia Travel Association. *Plastic Free Toolkit for Tour Operators: Your Guide to Reducing Single Use Plastic.* 2020. https://www.switch-asia.eu/site/assets/files/3971/4_3a__pata_plastic_free_toolkit_for_tour_operators-1.pdf

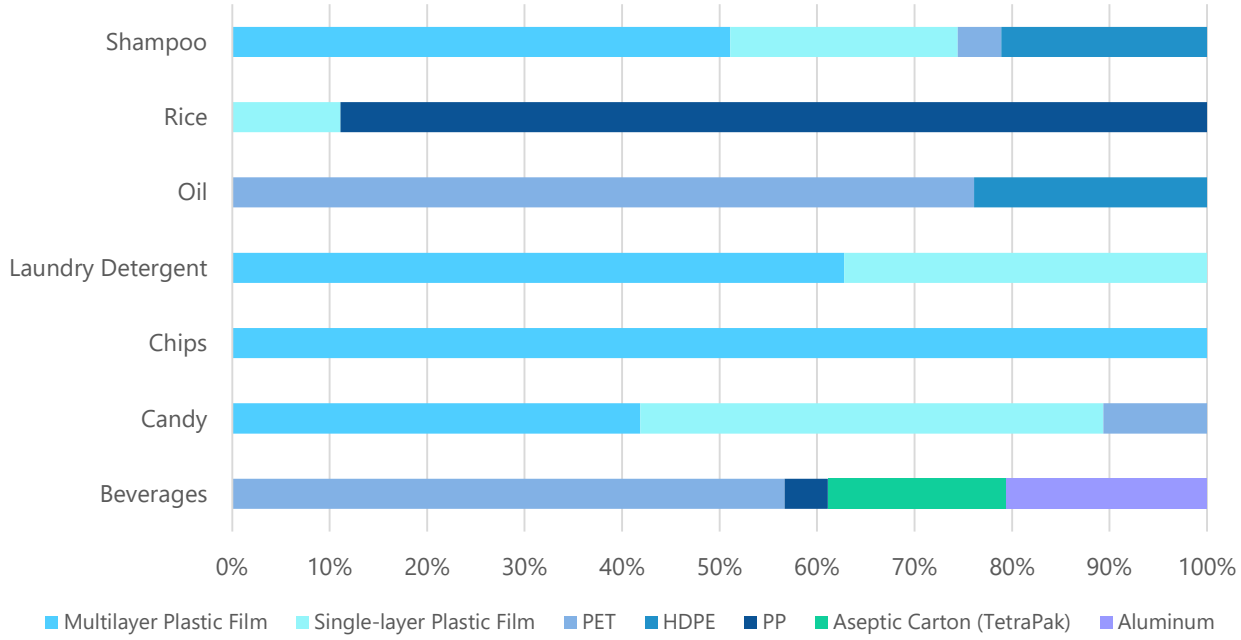
Product Design

In each store surveyed – 10 in Ataúro Island, 10 in Liquiçá, and 20 in Dili – the team conducted visual surveys of packaging type for the three FMCG products (beverages, candy, and chips) and for a set of household and staple products (shampoo, rice, oil, and laundry detergent). Percentages of each material type were visually estimated for each product in stores where they were present. The range of product sizes was also recorded, in grams for solid products (candy, chips, and rice) and in milliliters for liquids (shampoo, laundry detergent, oil, and beverages).

In addition to surveying convenience and grocery stores, the team surveyed restaurants and food vendors in each community. Like the stores, 10 restaurants were surveyed in Ataúro Island, 10 in Liquiçá, and 20 in Dili. Through visual assessments and discussions with restaurant owners, the team assessed the material type for to-go food items like containers, cups, utensils, and straws, present. Note that many restaurants did not provide single use food-ware, so material types are displayed in absolute quantities.

Ataúro

Figure 21: Packaging materials for a selection of convenience and staple products in Ataúro stores.



Multilayer plastic film was a common packaging type for shampoo, laundry detergent, chips, and candy in Ataúro Island. Multilayer film can be particularly problematic, as it is lightweight and easily escapes the waste system, but its multi-material structure makes recycling economically and technically challenging. Polypropylene (PP) was the most common packaging material for rice, and polyethylene terephthalate (PET) was the most common packaging material for both oil and beverage (Figure 21). PP is technically recyclable, but PET has stronger international recycling markets. Over 20% of beverages were packaged in

aluminum; popular beverage brands in Ataúro packaged only in aluminum included Coca Cola and Sprite (Coca Cola Bottling Indonesia).

Chips and candy came in the smallest sizes, while rice and oil were offered in larger quantities. Notably, other household staples like shampoo and laundry detergent were offered in small quantities, typically in multilayer or single-layer film (Figure 21). Refill or bulk purchasing programs may enable both waste reduction and more cost-effective purchasing for households.

Figure 22: Average product minimum and maximum sizes for a selection of convenience and staple products in Ataúro stores.

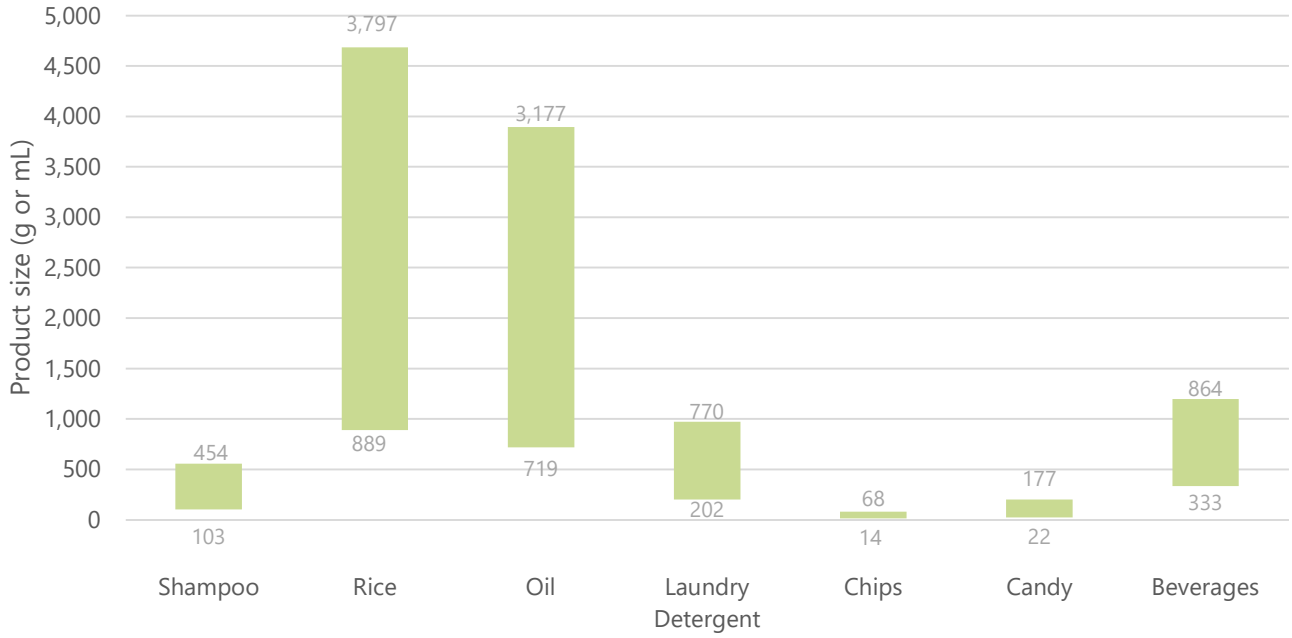
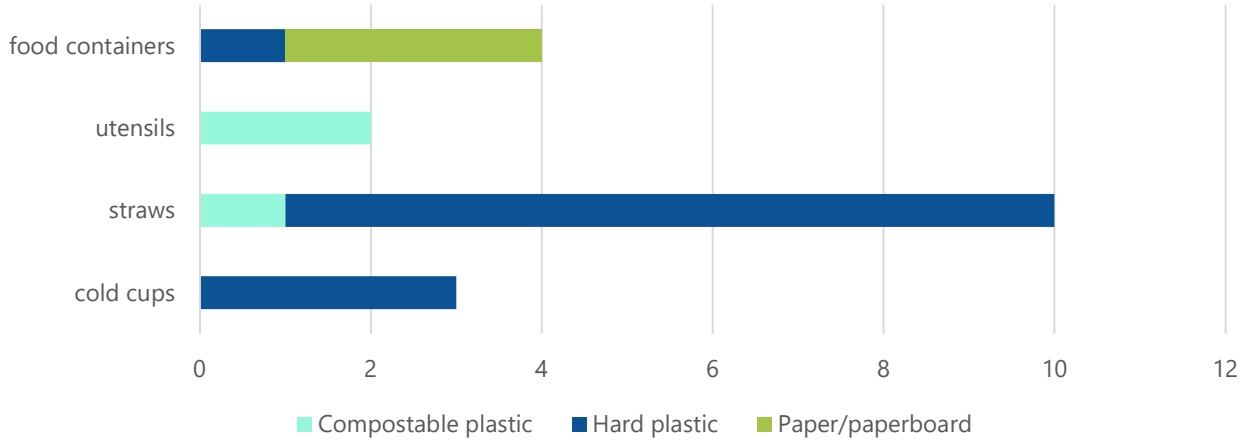


Figure 23: Material type for single-use food packaging surveyed in ten Ataúro restaurants.



For material surveys in restaurants, most single use food-ware was hard plastic (Figure 22). Food containers were often paper; while single-use paper displaces plastic and is less likely to fragment

compared to foam containers, which are banned in Timor-Leste, paper-to-go containers and cups are often lined with plastic or chemicals like Perfluoroalkoxy alkanes (PFAs) to make them water- and oil-resistant, and these additives can be dangerous to human health. Most notable, however, is that many restaurants on Ataúro island were not offering takeout, and instead were using ceramic or glass to serve customers through in-house dining. Straws are an exception where restaurants are using single use food-ware to in-house dining; one compostable plastic straw, and two instances of compostable plastic utensils, were surveyed in Ataúro.

Liquiçá

Staple and convenience products surveyed in Liquiçá had a similar composition to those surveyed in Ataúro. Multilayer plastic film, which is difficult to recycle, was a common packaging type for shampoo, laundry detergent, chips, and candy. PP was the most common packaging material for rice, and PET was the most common packaging material for both oil and beverage (Figure 24). PET has strong international recycling markets. Aseptic cartons were also a significant packaging material for beverages in Liquiçá; like multilayer plastic film, the multimaterial structure of aseptic cartons makes recycling more challenging. Over 20% of beverages were packaged in aluminum; popular beverage brands in Liquiçá packaged only in aluminum included Dellos (Dellos International Co) and Sprite (Coca Cola Bottling Indonesia).

Unlike Ataúro, rice was offered in very large bulk quantities in stores in Liquiçá. Laundry detergent was also offered in larger sizes compared to Ataúro. Bulk purchasing is often more economical on a per unit basis, and additionally provides a degree of waste reduction compared to smaller packaging sizes. Other products were similar, with chips and candy in the smallest sizes (Figure 25).

Figure 24: Packaging materials for a selection of convenience and staple products in Liquiçá stores.

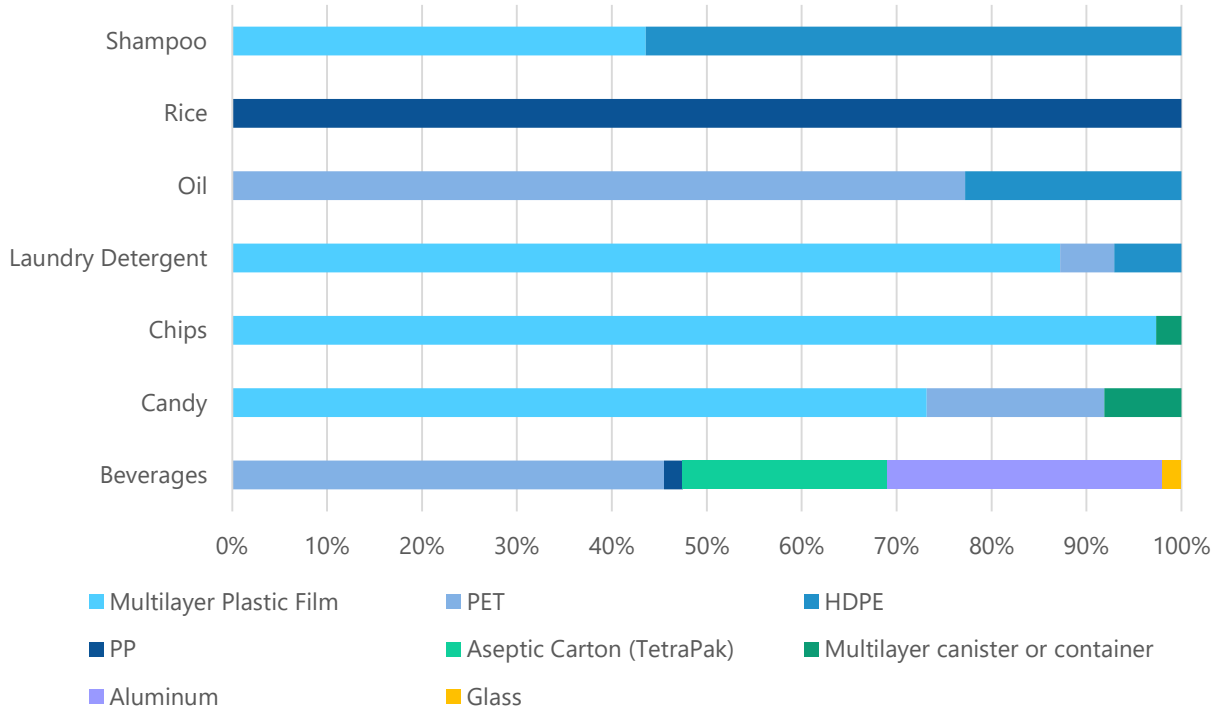
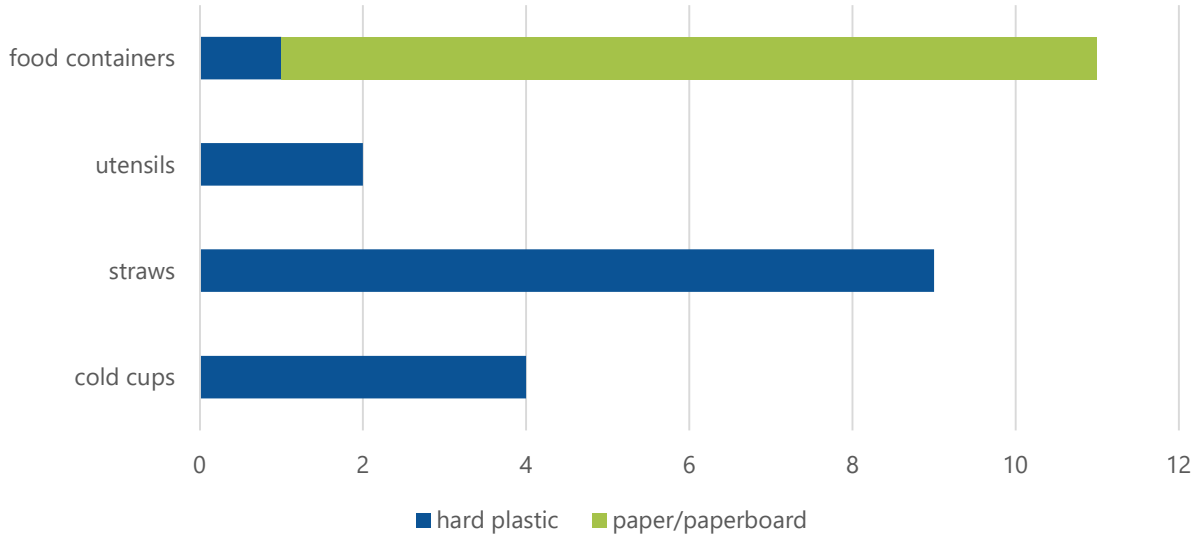


Figure 25: Average product minimum and maximum sizes for a selection of convenience and staple products in Liquiçá stores.

For material surveys in restaurants, most single-use food-ware was hard plastic, except for food containers which were most commonly made of paperboard (Figure 26). In contrast with Ataúro, most restaurants were offering takeout food options in single-use containers. Takeaway drinks were less common. No compostable plastics were observed in the to-go food-ware in Liquiçá, but three of the paperboard food containers were labeled as biodegradable.

Figure 26: Material type for single-use food packaging surveyed in ten Liquiçá restaurants.



**Note: One restaurant offered both hard plastic and paperboard food containers, putting the total count at 11 food containers.*

Dili

In Dili, packaging composition of staple and convenience products had slightly more variety compared to the same products surveyed in Ataúro and Liquiçá. Multilayer plastic film, which is difficult to recycle, was a common packaging type for shampoo, laundry detergent, chips, and candy, though more shampoo was packaged in high density polyethylene (HDPE) compared to in the other two communities. PP was the most common packaging material for rice (Figure 27). A small fraction of rice was also packaged in single-layer plastic film, which is reflective of the rice repackaging currently occurring in Dili supermarkets. This repackaging again reflects the need for smaller purchasing sizes demanded by consumers economic considerations; "bring your own container" refill centers could provide this type of flexible purchasing quantity while reducing waste.

Repackaging is common for goods like sugar, rice, cooking oil, fried foods (banana, casava, chips, cookies), beans, fruits (apple, grapes, oranges) and salted fish. All stores surveyed in Dili, Ataúro, and Liquiçá were repackaging at least one product.

Figure 27: Packaging materials for a selection of convenience and staple products in Dili stores.

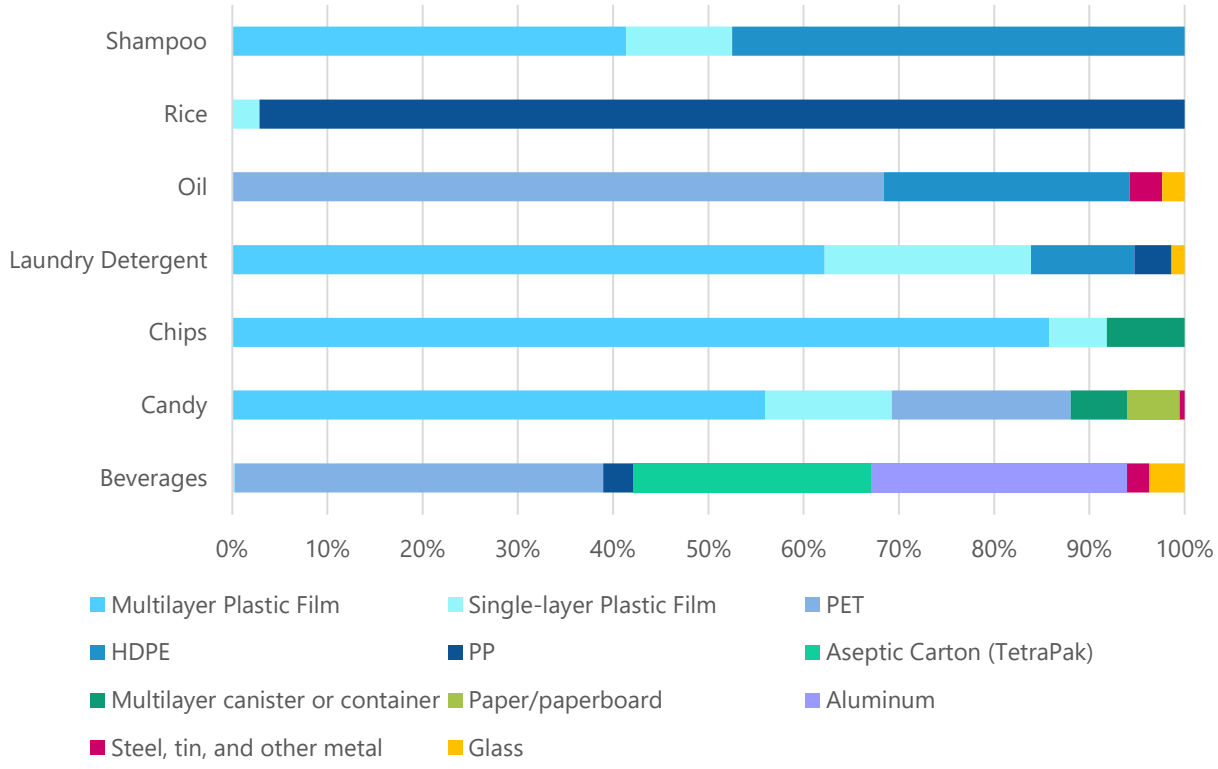
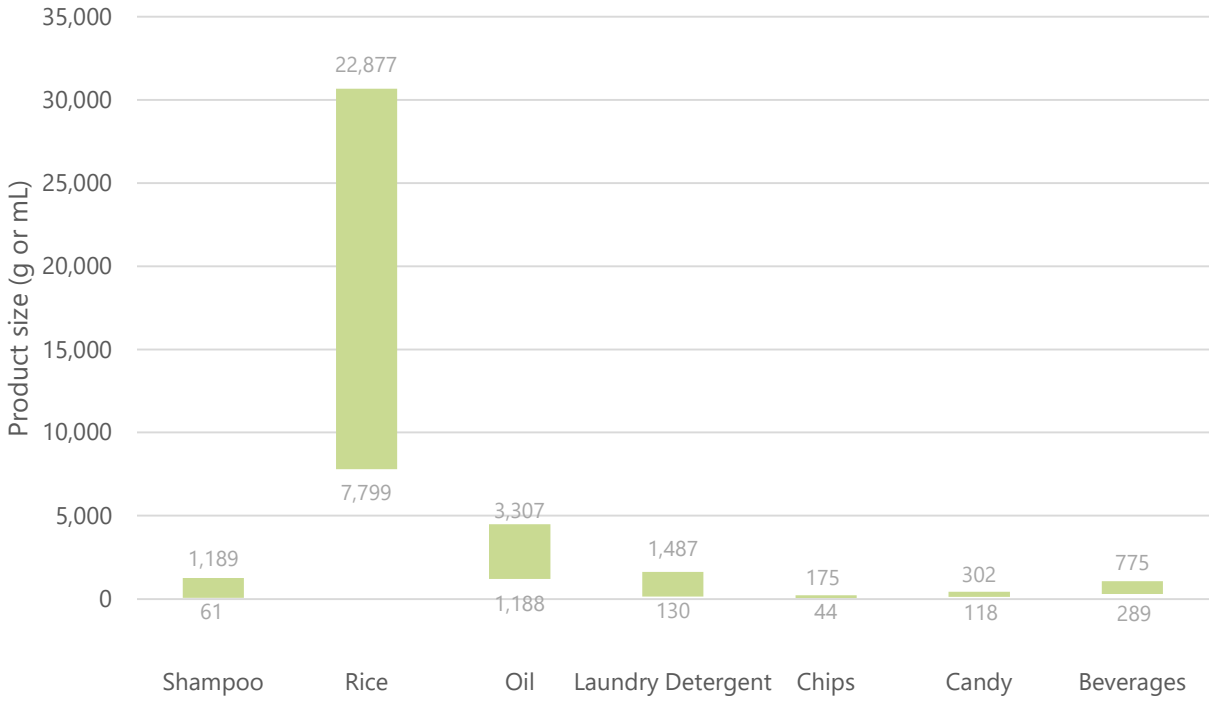


Figure 28: Bulk rice and repackaged rice in smaller sizes available in a supermarket in Dili.

PET was the most common packaging material for both oil and beverages. Aseptic cartons and aluminum also comprise significant fractions of the beverage packaging in Dili (Figure 27). Popular beverage brands packaged only in aluminum included Dellos (Dellos International Co), Sagiko (Chia Khim Lee Food Industries), Coca Cola (Coca Cola Bottling Indonesia), and Bear Brand (Nestle Indonesia). Both PET and aluminum have strong international recycling markets, and aluminum is currently collected for export in Dili. Like multilayer plastic film, aseptic cartons are economically and technically challenging to recycle due to their multi-material structure. A small fraction of beverages in Dili were packaged in glass. You-C1000 (Djojonegoro C-1000) is a popular beverage packaged only in glass.

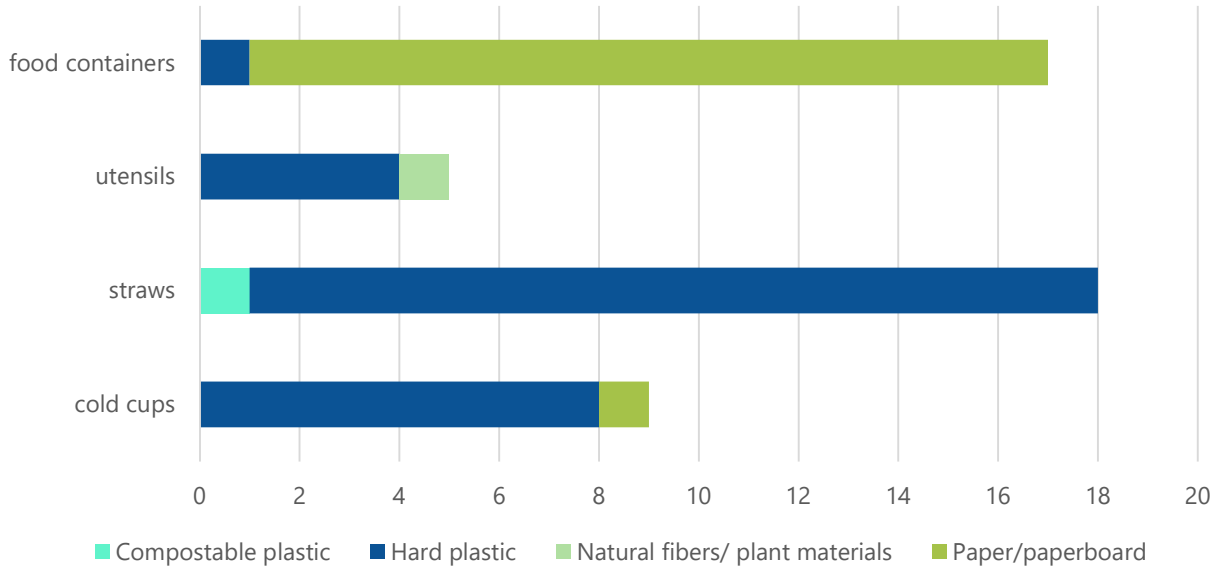
Like Liquiçá, larger quantities of rice and laundry detergent were available in Dili compared to Ataúro. Shampoo, however, was offered in quantities nearly four times larger than the average largest size on supermarket shelves in Liquiçá. Bulk purchasing is often more economical on a per unit basis, and additionally provides a degree of waste reduction compared to smaller packaging sizes (Figure 29).

Figure 29: Average product minimum and maximum sizes for a selection of convenience and staple products in Dili stores.



For material surveys in restaurants, most single-use food-ware was hard plastic, except for food containers which were most commonly made of paperboard (Figure 30). In contrast with Ataúro, most restaurants were offering takeout food options in single-use containers. Takeaway drinks were less common. One compostable plastic straw was recorded, and additionally four of the paper food containers were labelled as compostable.

Figure 30: Material type for single-use food packaging surveyed in twenty Dili restaurants.



Findings

Across all three communities, the most common packaging type is multilayer film, especially prevalent for shampoo, laundry detergent, chips, and candy. Because multilayer film contains multiple material types, it is costly and technologically difficult to recycle. Globally, few multilayer film recycling systems exist at scale. Aseptic cartons are also a common beverage packaging material. Similarly to multilayer plastic film, aseptic cartons are multi-material and therefore developing economically viable recycling streams is often challenging. Multilayer plastic packaging, including both multilayer plastic film and aseptic cartons like TetraPaks are unlikely to find viable external recycling markets. However, both are currently accepted by Caltech for recycling into plastic board (see **End of Cycle** chapter).

However, there are common packaging types that are recyclable – notably PET, HDPE, and aluminum which are all high-value recyclables collected and exported in other island markets. Glass is also currently accepted at Caltech., but because of the added weight, it is unlikely to support a profitable export market. Glass bottles, however, could be washed and refilled locally if a DRS system was implemented.

Regarding product size, Ataúro tended to have smaller product sizes which may in turn result in the generation of more packaging waste. All stores surveyed in Dili, Ataúro, and Liquiçá were repackaging at least one product. Refill with "bring your own" packaging or bulk buying options may facilitate waste reduction in this context. Notably, Liquiçá had similar product sizes to Dili except for shampoo. More than 40% of shampoo offered in Liquiçá was also packaged in multilayer plastic film. This again could be a logical target for refill or bulk buying, or even cottage industries eliminating the need for plastic packaging, such as shampoo bars. Supporting cottage industries by subsidizing initial equipment investment may derisk these ventures for small businesses.

Many restaurants and food vendors across all three communities are using hard plastic and paperboard in single-use food-ware. Yet, many are also not offering takeaway food and instead offering in-house dining with reusable dishware like ceramic or glass. Further solidifying this behavior through policy or incentives may encourage this existing waste reducing practice. One area where almost all restaurants are using plastic food-ware for both takeout and in house dining is straws – a straw on-request policy may eliminate some of this waste, without increasing cost to businesses.

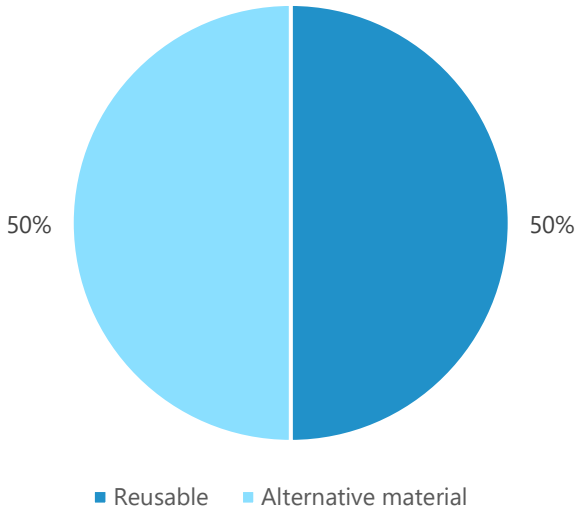
Use

To understand how products are typically used and any available reuse systems in Timor-Leste, household and personal care items were surveyed in stores in Ataúro, Liquiçá, and Dili. Alternatives to plastic packaging were noted, along with the use type (reusable, alternative, compostable material), the cost per unit, and the cost per unit of a comparable SUP product.

Ataúro

In Ataúro Island, three out of the 10 stores (30%) surveyed had some kind of alternative. Most commonly, these were reusable products or alternative materials like paper (Figure 31). Alternatives included cups, plates, and utensils; only six unique products were observed across all stores.

Figure 31: Types of alternatives found in stores; Table 4: and cost difference compared to similar products packaged in single-use plastic.



Alternative Type	Cost Difference for Alternative
Reusable	2x
Alternative material	2x

Both reusable products (such as metal utensils and glass cups) and alternative material products (such as paper plates) were approximately twice as costly as their SUP comparable products (Table 4).

Of 13 stores interviewed in Ataúro about alternatives to plastic in their shops, 8 stores (about 62%) reported selling reusable bags, costing around $0.50. An additional 4 stores (about 31%) where store owners said they repurposed boxes in which they received goods to give to customers who were purchasing in large quantities. Boxes were consistently named as one of the main types of waste generated in stores by interviewees. This existing form of reuse – among others mentioned like using boxes as chicken coops and plastic bottles as floats for seaweed aquaculture – highlights that one-for-one swaps of single-use bags for reusable bags, which cost more for customers, may not be the only route to limit plastic consumption. For those stores that did not carry reusable bags, the price difference versus single-use plastic was most often cited as the reason. Encouraging existing forms of reuse as important and valid forms of complying with the single-use plastic ban may encourage further expansion of these practices.

> **"We haven't used plastic alternatives because the community likes using plastic the most, because it is cheaper. They don't really buy the reusable bags."** – Grocery or convenience store (Ataúro)

> **"We don't recycle our waste, but the waste such as empty boxes, we reuse or give to people who buy chickens to use as chicken coops. For the plastic water bottle, we reuse it as a float to tie seaweed. The plastic jar, we reuse for storing corn and other food."** – Grocery or convenience store (Ataúro)

Additionally, as mentioned in the Product Design chapter, reusable food-ware for in-house dining is another widespread form of reuse currently occurring in Ataúro. Only about 40% of restaurants report using single-use takeout food containers, and only about 30% report offering takeout cups. Traditional ways of serving food like using coconut leaves may also provide a route to reduce plastic waste. For both in-house and takeout food, single-use plastic straws remain common due to the lack of alternatives.

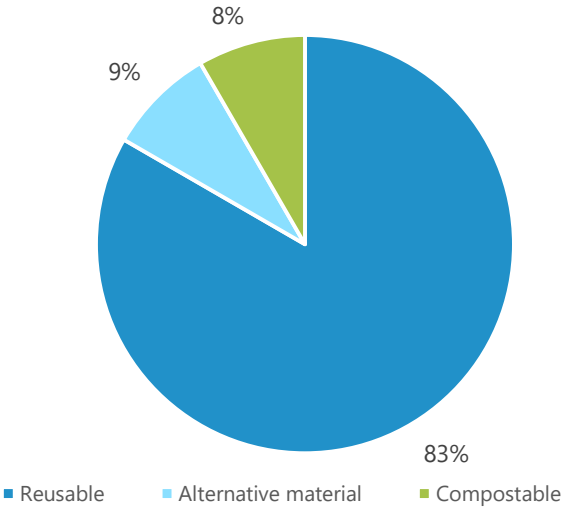
> **"In our restaurant, there is no such thing as using plastic, because those who come and eat here never bring the food home or take it away... I only offer ceramic plates and cups to serve the food."** – Restaurant or food vendor (Ataúro)

> **"In our place, we use the straws to drink the coconut water and for this, there is no other alternative."** – Restaurant or food vendor (Ataúro)

Liquiçá

Five out of the 10 stores surveyed in Liquiçá had some kind of alternative. In total, 12 unique alternative products were identified, most of which were reusable products (Figure 32). Common alternatives included cups, plates, straws, and utensils. All available alternatives cost approximately twice as much as similar products packaged in single-use plastic (Table 5).

Figure 32: Types of alternatives found in stores; Table 5: and cost difference compared to similar products packaged in single-use plastic.



Alternative Type	Cost Difference for Alternative
Reusable	2.1x
Alternative material	2x
Compostable	2x

Of 9 stores interviewed in Liquiçá, 5 stores (about 56%) reported selling reusable bags when asked about alternatives to plastic in their shops. Five stores (about 56%) also said they repurposed boxes in which they received goods to give to customers who were purchasing in large quantities. Boxes were consistently named as one of the main types of waste generated in stores. Again, the cost-saving associated with existing forms of reuse like using boxes, compared to reusable bags, was mentioned as a benefit for stakeholders.

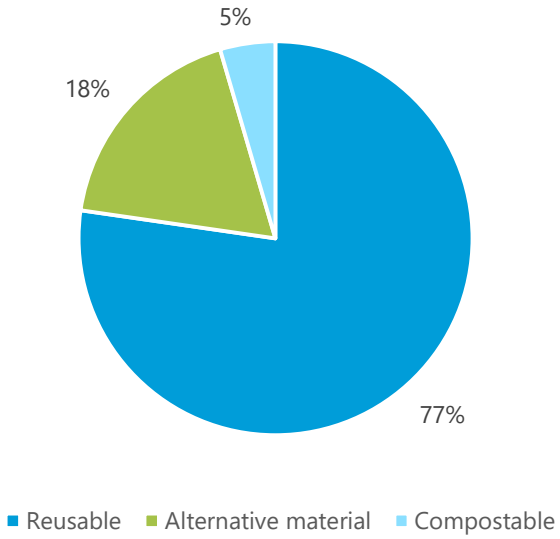
> **"The customers are happy when we offer boxes because they don't need to buy the reusable bags to put the goods."** – Grocery or convenience store (Liquiçá)

As mentioned in Product Design, takeout food is more widespread in Liquiçá compared to Atuaro. 100% of restaurants report using single-use takeout food containers (though they were often paper). Still, takeout beverages are less common, with about 40% of restaurants offering these.

Dili

Eight out of the 20 stores surveyed in Dili offered some form of alternative to single-use plastic. In total, 22 unique alternative products were identified; common alternatives included bowls, cups, food wrap, plates, and utensils, most of which were reusable (Figure 33). Compostable and alternative material (like paper) alternatives were the most affordable compared to single-use plastic products. Reusable products, such as aluminum cups, cost on average 3.6x more compared to single-use plastic (Table 6).

Figure 33: Types of alternatives found in stores; Table 6: and cost difference compared to similar products packaged in single-use plastic.



Alternative Type	Cost Difference for Alternative
Compostable	2x
Reusable	3.6x
Alternative material	1.8x

Of 18 stores interviewed in Dili, 100% reported selling reusable bags when asked about alternatives to plastic in their shops, highlighting the unequal enforcement of the SUP bag ban in different communities in Timor-Leste. The issue of unequal enforcement between large supermarkets and small stores within Dili

was also reflected. Stores reported bag prices ranging from $0.35 to $1, depending on bag size. Ten stores (about 56%) also said they repurposed boxes in which they received goods to give to customers who were purchasing in large quantities. Boxes were once again named as one of the main types of waste generated in stores; a recent study from the Japan International Cooperation Agency (JICA) estimated that paper and cardboard comprised over 63% of the waste generated in shops and markets.[44] In Dili, store owners interviewed expressed that their customers have adapted to bringing their own reusable bags over time (Figure 34). Still, the preference for free bags persists.

> **"Some people are using the reusable bags and some people are still using plastic. The big shops have started using reusable bags, and many small shops are still using plastic."** – Grocery or convenience store (Dili)
>
> **"Many community members, when they come to buy goods, they always bring their own reusable bag. Because [the single-use bag ban] has been happening for a long time, so people just follow it."** – Grocery or convenience store (Dili)
>
> **"In our shop we offer alternatives such as reusable bags, but many people say they don't want to buy it – they want it for free"."** – Grocery or convenience store (Dili)

Like Liquiçá, more restaurants in Dili – 85% of those surveyed – are offering takeout in single-use containers, though they are often made of paper. 45% of restaurants report using single-use takeout cups, most often hard plastic.

Figure 34: Example of reusable bags available in Dili.

[44] Nippon Koei Co. and Japan International Cooperation Agency. "Data Collection Survey on Solid Waste Management in Dili Municipality for Reducing Marine Plastic Waste in Timor-Leste," October 2024.

Findings

Alternatives to single-use plastic are not widely available in any of the three communities. However, in both Ataúro and Liquiçá, where products are available, reusable products cost about twice as much as SUP. Therefore, there is an economic advantage to using reusable products, and it does not take many uses to recover the initial investment. While the cost for reusable products is higher in Dili, it is still less than four times the cost of SUP, which still requires relatively few uses to recover the initial investment.

The ban on single-use bags seems to be more widely implemented in Dili than Liquiçá and Ataúro. Boxes from packaged goods are a significant source of waste for most businesses and may be repurposed to carry groceries in lieu of reusable bags. Ataúro has less takeout food offerings in single-use containers and cups compared to the other locations. Incentivizing and encouraging in-house dining could help limit future increases in waste generation.

Collection

Ataúro

Ataúro Island has limited collection systems; most residents manage their own waste through burying or burning. Of 23 local business interviewed on Ataúro Island, 43% reported burning as their primary method of managing their waste. Plastic was mentioned by several interviewees as a helpful source of fuel to start the fires. Village leaders noted that there is a waste collection truck that will collect waste from households, but there does not currently seem to be any further management practices such as a sanitary landfill or exporting waste off the island (See **End of Cycle** chapter).

> **"The waste that we generate, we throw it into the big bins and burn it."**– Restaurant or food vendor (Ataúro)
>
> **"My community doesn't have any knowledge on plastic waste. They don't know yet that plastic can contaminate the soil. They still dig a hole and bury the waste."**– Village leader (Ataúro)

Liquiçá

In Liquiçá, there is a municipal truck collecting waste weekly and transporting it to the Tibar landfill, which is owned by Dili municipality. Municipal government officials interviewed in Liquiçá report that community members bring their waste to a waste collection point, where it is picked up daily and transported to the landfill. There is no cost for waste collection to the community, and many commercial businesses also utilize the public waste bins for disposal. Some large shops are transporting their own waste to Tibar landfill, but this seems to be a voluntary practice rather than enforced policy. While interviewees felt access to waste collection was almost universal within the city, reaching more rural areas outside of the city center remains a challenge. Smaller, more flexible forms of transportation like waste motorbikes may be needed to reach these areas. Despite the existing collection system, 40% of the 20 businesses in Liquiçá reported burning as their primary waste management tool, indicating that compliance with the waste collection system needs to be further increased.

> **"They bring their waste to the public bin and then the car will pick it up. For some of the big shops and restaurants, they decided to transport their own waste to the dump site."**– Municipal government official (Liquiçá)
>
> **"In my area, for the family that lives near the main road, it is easy for them because they can put their waste at the front of their house and the vehicle provided by the government will come, pick up the waste, and transport it to Tibar landfill. But not everyone can access the vehicle. Many in my community live in rural areas that are difficult to access by vehicle, so they either burn or bury their waste." –** Village leader (Liquiçá)

Dili

Dili is in the process of expanding and modernizing their collection system. In transitioning from concrete structures to dumpsters that can be automatically lifted and emptied by waste trucks, the city plans to expand to over 1,000 collection points throughout the capital, up from the current quantity of around 500. Collection points were identified through a study with the Asian Development Bank (ADB) based on the quantity of waste. Interviewees estimated that initial investment in improving the waste management system has a price tag of about $3 million on collection equipment – including bins, compacting collection trucks, and motorbikes to reach households on narrow and steep roads – and about $10 million on remediating the landfill, with a planned operational cost of about $1 million annually. Collection is contracted to a private company that is a partnership between China Harbor and a Timorese business called Pax, and waste collection fees charged to the municipality are around $17/ton for collection and transport to Tibar landfill.

Currently in Dili, mixed waste is collected in large dumpsters (Figure 35). Interviewees reported wanting to push for waste segregation, but the recently rolled-out infrastructure does not support segregated waste collection (see **Community**).

Figure 35: Dumpsters at collection point in Dili

Full adoption of the collection bin system will require further awareness raising. One village leader noted that, currently, smaller waste vehicles are picking up directly from households, and residents are only using collection points for large quantities of waste. Residents are supposed to put waste in collection points between 6 pm – 6 am due to road traffic, but interviewees felt that this was not a widely followed practice. Government officials also mentioned residents placing bulk waste like construction and demolition debris in collection point, damaging the dumpsters. Simultaneously, trucks are supposed to

collect waste from all points daily, but some interviewees reported that the waste collection frequency was inconsistent and that some waste bins overflowed. One interviewee recommended GPS monitoring of trucks to track collection routes and efficiencies. Socialization of appropriate usage of the new system – considering both logistical requirements as well as convenience and reliability for residents – will be needed.

> **"Normally we bring it to the waste collection point at the main road if we have lots of waste. If we only have a little waste, we will gather it in the sacks and waiting for the waste car to come and collect it."**– Village leader (Dili)

> **"The community always puts the waste into the big black plastic bags or into the rice sacks, and then they hang it at the front of the house so the waste car can pick it up. But if the car did not come then the community will still throw it to the farm field." –** Village leader (Dili)

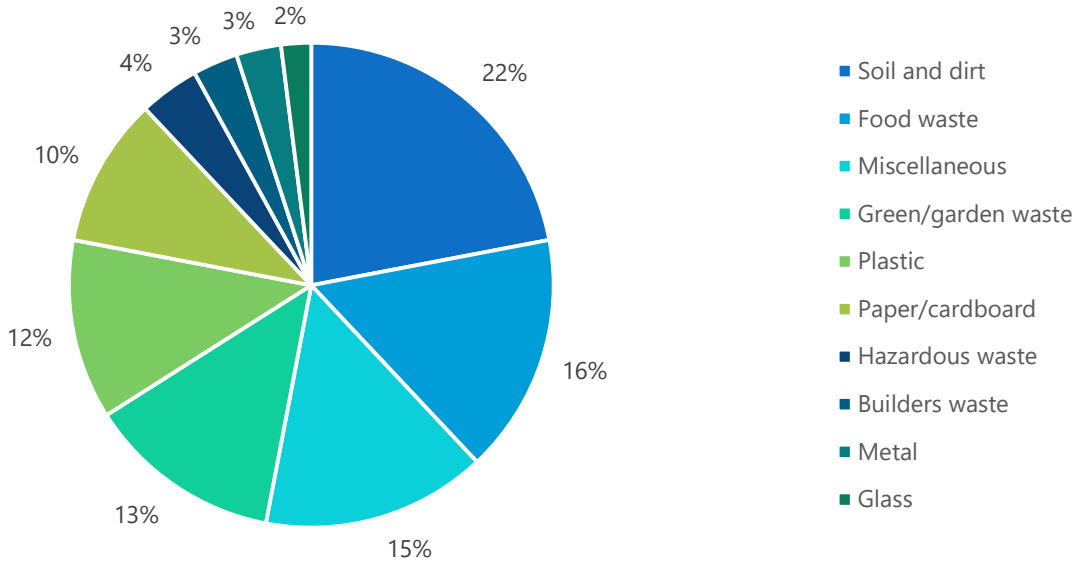
Like Liquiçá, smaller vehicles will be needed in the waste collection fleet to access hard-to-reach areas, which is a planned part of the current investment. Working with communities to allocate space for the collection bins was also noted as a particular challenge in peri-urban areas.

> **"At this moment, in our community we burned all the waste as the waste bin has been full and started to rot. The waste vehicle can't enter and collect the waste because of the narrow road and the car is big. Some community members who have a car will transport their own waste [to Tibar] once it is enough."**– Village leader (Dili)

Little to no data on waste composition exists in Ataúro and Liquiçá; improved localization waste generation and waste characterization data could support improved waste management capacity in these communities. In Dili, a recent waste generation and composition study by JICA in Dili estimates that daily per capita waste generation ranges from 0.66 kg/person in low-income areas to 0.75 kg/person in high income areas, with an overall average of 0.71 kg/person. Total waste generation in Dili is currently estimated at about 303 tons/day, with a projected increase to 635 tons/day in 2050. Organic waste, including soil and dirt, food waste, and green waste, was the largest fraction of household waste observed in Dili (Figure 36). Plastics comprised about 12% of the household waste stream, with an estimated recyclable plastic fraction of 8%. Notably, plastics were a larger fraction of the waste stream in many commercial sources – 15.5% in shops and markets, 24.6% in institutions, 15.3% in clinics, and 18.9% in hotels.[45] This speaks to the need for separated household and commercial collection systems.

[45] Nippon Koei Co. and Japan International Cooperation Agency. "Data Collection Survey on Solid Waste Management in Dili Municipality for Reducing Marine Plastic Waste in Timor-Leste," October 2024.

Figure 36: Household waste composition in Dili; source: JICA



In addition to the household collection points, public waste bins exist throughout the city along parks and oceanfront areas. There is also a recent awareness campaign launched in Dili called the Blue Fish campaign, with fish-shaped bins to collect recyclables (Figure 37). Several government officials interviewed highlighted this as a successful community awareness campaign and mentioned a desire to expand the area to other coastal areas and tourist sites (note that this is a new effort and interviewees could not verify if materials added to the bins were actually recycled). Ensuring residents are not disillusioned by false promises of recycling will be critical to the success of this campaign.

Figure 37: Public trash cans and recycling collection points in Dili.

Similarly to Ataúro and Liquiçá, there is not a clear separate waste collection system for commercial businesses in Dili. Some small and medium enterprises are using public waste bins for waste collection. About 35% of the 40 stores and restaurants interviewed in Dili reported that they were transporting their own waste to the Tibar landfill. Burning waste seems to be less common within Dili, perhaps because of the existing collection efforts. Only 5% of the 40 businesses interviewed in Dili reported burning as their primary waste management method. The team did observe some dry and wet waste sorting at private businesses, but contamination existed in the bins (Figure 38).

Figure 38: Wet and dry waste bins at a private business in Dili.

Private haulers also exist in Dili, ranging from very small neighborhood collectors working with households to large operations contracted with private business. Caltech offers waste collection as a paid service to businesses as well as recycling. They also have a drop-off site for recyclables, where it is no-cost to bring material (Figure 39). They accept all plastics except Polyvinyl chloride (PVC), including PET bottles, as well as paper and cardboard; glass; metals; and e-waste.[46] Caltech also works with their employees to offer community hubs at employee residences, where neighbors can bring recyclable waste.

[46] Caltech Environmental Division. https://www.caltechgrp.com/environmental/#Waste

Figure 39: Drop-off site for recyclables at Caltech.

Waste pickers are also supporting recycling in Timor-Leste. Most informal collectors are working at the Tibar landfill, collecting plastics, metals, and aluminum; HDPE plastics are sold to Caltech, while metal and aluminum recyclables are aggregated for export. One interviewee estimated that there are about 65 informal workers currently collecting recyclables from Tibar. Once the landfill remediation efforts are completed and a waste separation facility is added to Tibar, there is a plan to integrate informal workers into the waste separation efforts at this site.

> **"I'm collecting plastic, metal, and aluminum. Mainly HDPE plastic for Caltech. For 1 kilo of plastic, I am paid about 10 cents. Metal is about 18 cents per kilo, and aluminum is about $1 a kilo. There is a Chinese company buying the [metal and aluminum] recyclables." –** Waste picker

Currently, unless contracting with a private hauler, residents (and businesses using public waste bins) are not directly paying the cost of collection, despite the legal framework to charge for waste collection being established under the Decree Law for Solid Waste Management: Number 2/2017.[47] A previous proposal to bill for waste collection through electricity bills was met with resistance from the electricity company. Requiring private businesses to contract a private hauler may limit the volume of collection facilitated through the public system. Developing a model to finance waste collection could start with charging commercial entities for waste hauling or requiring them to contract private haulers, which may also encourage reduced waste generation. In a recent CAP project in Can Tho, Vietnam, one of the outcomes

[47] Nippon Koei Co. and Japan International Cooperation Agency. "Data Collection Survey on Solid Waste Management in Dili Municipality for Reducing Marine Plastic Waste in Timor-Leste," October 2024.

was the city's proposal to develop an equitable waste fee.[48] Adequate controls for illegal dumping must also be addressed as collection fees come online.

> **"The government needs to separate household and commercial waste for collection. Commercial waste collection needs to be separated and done by private haulers." –** National government official

> **"There is a provision in the law about a waste tax being included in the electricity bill. But we are still having challenges will that system and figuring out how to allocate the tax to the municipality." –** Municipal government official

However, other interviewees mentioned that existing funding allocated to municipalities through the national government is adequate to address waste management concerns. The JICA study identified that expenditures for both solid waste management (SWM) and cleanups were significantly below budgeted amounts in Dili in 2023. Around $600,000 out of a budget of nearly $900,000 was spent on solid waste management.[49]

> **"The government has an adequate budget at the municipal level for collection and transport. Municipalities put in an annual request to the national government for waste management funding." –** National government official

Another method of collection currently leveraged across all three communities is cleanups. Village officials in both Ataúro and Liquiçá report weekly cleanups hosted every Friday. In Dili, a cleanup crew of around 300 people work to clean the main roads as well as occasionally parks and beaches. Although still under the budgeted amount, Dili actually spent more on cleanups in 2023 than SWM, with a price tag of over $750,000.[38] Non-profit organizations concerned with protecting ocean resources are also conducting cleanups along beaches and coastlines.

> **"Our group always does cleanup activities. There is always high participation from communities and youth. We always work with the youth environmental activists." –** Non-profit organization

[48] Urban Ocean. "Project Opportunities to Accelerate Clean, Healthy Cities and Seas: City Opportunity Booklet." https://resilientcitiesnetwork.org/wp-content/uploads/2022/10/Opportunity-Booklet_FINAL_220525.pdf

[49] Nippon Koei Co. and Japan International Cooperation Agency. "Data Collection Survey on Solid Waste Management in Dili Municipality for Reducing Marine Plastic Waste in Timor-Leste," October 2024.

End of Cycle

On Ataúro Island and in other small and rural communities throughout Timor-Leste, most residents are managing their own waste through burying or burning. Of 23 local business interviewed on Ataúro Island, 43% reported burning as their primary method of managing their waste.

> **"The easiest way to minimize waste is to burn it, so that is what they do in rural areas and small communities." –** Non-profit organization
>
> **"In village areas, people are burning their waste. But it's only a small quantity of waste, so there is minimal impact. It's mostly organic waste, but it's burned instead of composted." –** Non-profit organization

One large dumpsite known as Tibar, in operation since the 1970s, exists outside of Dili. Both Liquiçá and Dili bring their waste here. Currently, the dumpsite is undergoing remediation to install a geomembrane lining, gas capture, and leachate treatment system as an engineered landfill (Figure 40).

Like the unpaid collection system, there are no tipping fees for depositing waste at the dumpsite, even for the other small municipalities outside of Dili are also bringing waste to the landfill or private commercial businesses. The landfill is owned by Dili municipality and operated through a contract with a private company, China Harbor and Pax. Tibar does not accept construction and demolition waste or hazardous waste.

Interestingly, only around 185 tons/day of waste per day reaches the Tibar landfill, in contrast with the estimated 330 tons/day of waste generation in Dili.[50] After remediation, the landfill will have an estimated 10 years of capacity. Interviewees reported further plans to construct several additional engineered landfills in other parts of Timor-Leste. Interviewees also informed the team that the long-term plan is for the Dili landfill to have a waste processing facility, which would use a screening processing to separate out wet waste for composting. This type of processing is likely to generate a highly contaminated fraction of organic waste, which will not produce a clean, usable compost. Separation at source is an important first step for implementing a composting system in Dili; more decentralized, small-scale composting could also enable waste reduction before transport to the landfill (see **Community**).

[50] Nippon Koei Co. and Japan International Cooperation Agency. "Data Collection Survey on Solid Waste Management in Dili Municipality for Reducing Marine Plastic Waste in Timor-Leste," October 2024.

Figure 40: Dili dumpsite (left), which is currently undergoing remediation to build an engineered landfill (right).

Plastic recycling, while limited, exists on different scales in Dili. Some cottage industry recycling, including jewelry making and basket weaving, has incorporated elements of traditional Timorese craftsmanship with prevalent, free materials like plastic bottles or grocery bags to create products (Figure 41). While these small-scale efforts are unlikely to facilitate waste processing on a large scale, these efforts could be leveraged as effective and impactful awareness raising tools for both the local population and tourists to Timor-Leste.

Figure 41: Cottage industry recycling in Timor-Leste, making baskets from bottles (left) and earrings from plastic grocery bags (right)

On a larger scale, Caltech is a recycling company outside of Dili that is estimated to recycle just under one ton of waste per day.[51] Caltech produces pavers made from HDPE plastic and glass, as well as plastic board from mixed plastics (Figure 42).[52] The recycled pavers were recently used in a large public works project, but interviewees generally pointed out that finding end-markets for locally produced recycled products is the biggest challenge to expanding recycling in Timor-Leste (see **Community**).

Figure 42: Recycled pavers (left) and "plastic board" (right) produced by Caltech.

[51] Nippon Koei Co. and Japan International Cooperation Agency. "Data Collection Survey on Solid Waste Management in Dili Municipality for Reducing Marine Plastic Waste in Timor-Leste," October 2024.
[52] Caltech Circul-R. https://www.caltechgrp.com/circul-r/

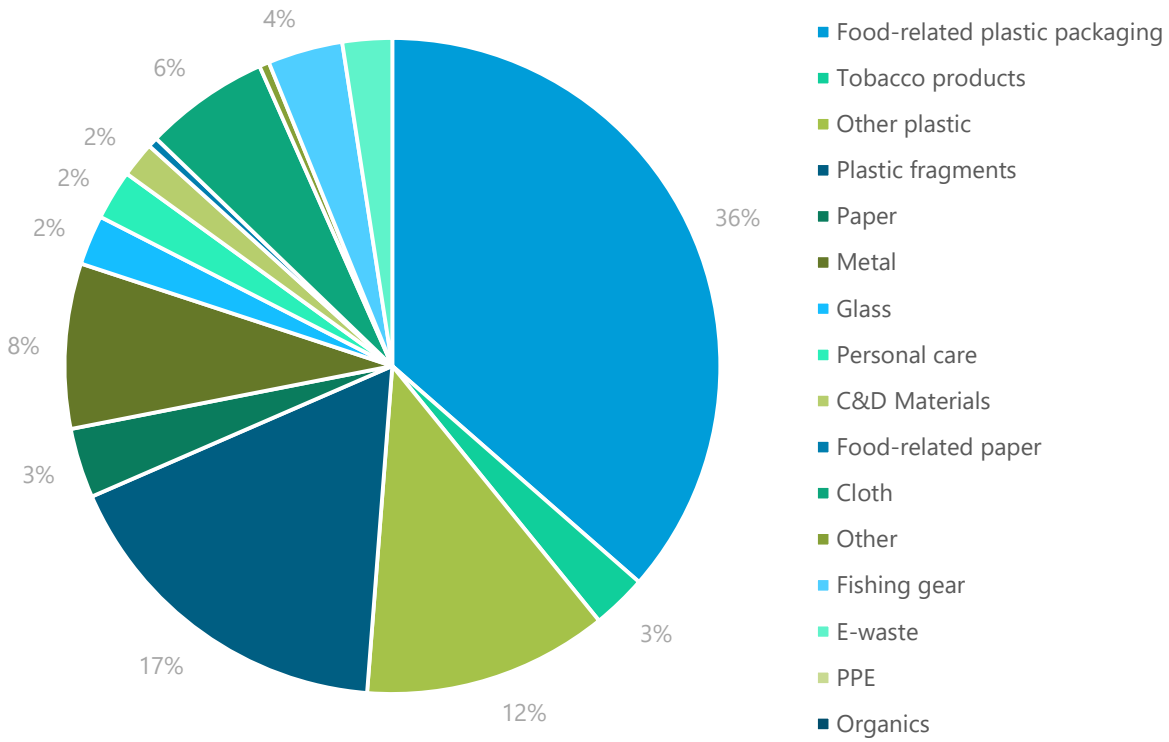
Leakage

To assess litter composition and densities across Timor-Leste, randomized litter surveys were conducted in Ataúro, Liquiçá, and Dili. Summaries for each location and general trends are included below. Transect locations were selected using a stratified random sampling method, in which transects were randomly selected in ten square kilometers which were distributed across three groups of population count (upper, middle, lower) based on LandScan ambient population data. Litter items were recorded using the open-source Marine Debris Tracker app. A full list of items available in the app and their associated material categories as well as a map of sample sites and their surveyed litter densities can be found in the Appendix.

Ataúro Island

In total, 406 items were logged in 9 transects (each 100m^2) characterizing 3 different square kilometer areas across three groups of population count. The lower population group included sites with ambient population counts ranging from 0 – 2 people; the middle population group ranged from 2 -58 people; and the high population group ranged from 58 – 803 people.

Figure 43: Litter characterization in Ataúro Island.



Food-related plastic packaging was the largest proportion of litter (36%), followed by plastic fragments (17%), and other plastic (12%). Overall, 62.3% of litter items logged were primarily plastic (Figure 43). Composition of litter follows similar patterns across all three population tertiles, though there is a notable increase in the proportion of plastic fragments in low population count areas. This may suggest that litter stays longer in these areas and is beginning to degrade (Figure 44).

Figure 44: Proportion of most common plastic items in low (inner), mid (middle), and high (outer) population count areas in Ataúro Island.

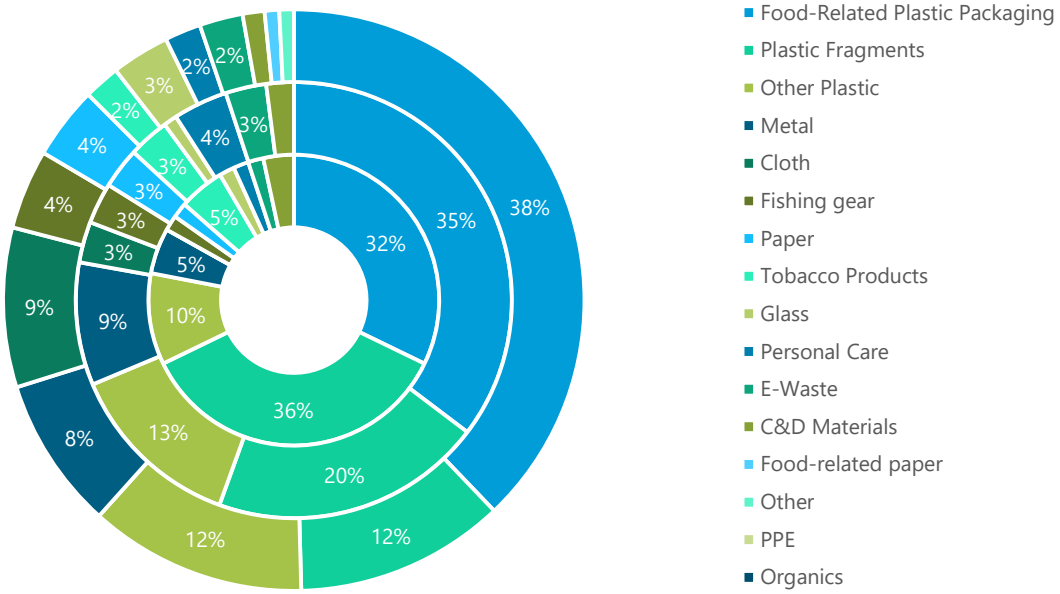
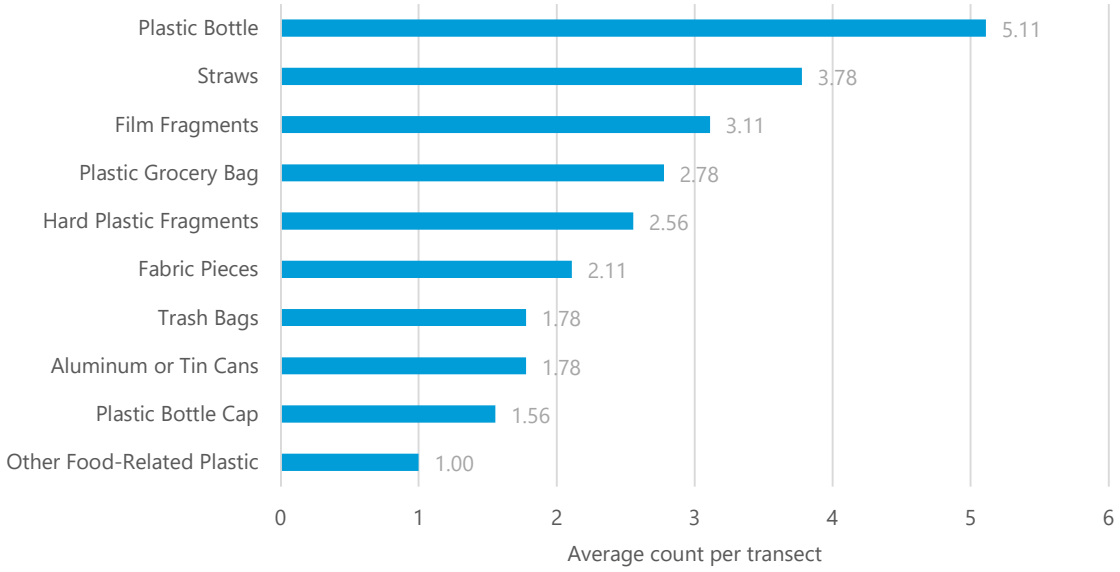


Figure 45: Top ten litter items in Ataúro Island.



Overall, plastic bottles were the most prevalent litter item observed in the transects in Ataúro Island (Figure 45). Addressing accessible clean drinking water on the island or collaborating with local water bottling companies to offer refill programs, may facilitate waste reduction related to bottles. Straws and grocery bags were also prevalent in the litter; both products are, in theory, addressed by Timor-Leste's SUP ban, but restaurants mentioned in interviews that no viable alternatives for straws exist. Interestingly, straws were the most frequent litter item in the upper population tertile site in Ataúro (Table 7). A "straws only on request" policy may limit prevalence of this litter item. Aluminum and tin cans were in the top five litter items in both the middle and lower population sites; in Dili, aluminum cans are collected and exported for recycling. Establishing a viable recycling pathway for cans, perhaps through partnering with businesses like hotels to aggregate cans in one location and moving to Dili when a sufficient quantity is obtained, may discourage littering of these items.

Table 7: Top litter items for each area of population count in Ataúro Island.

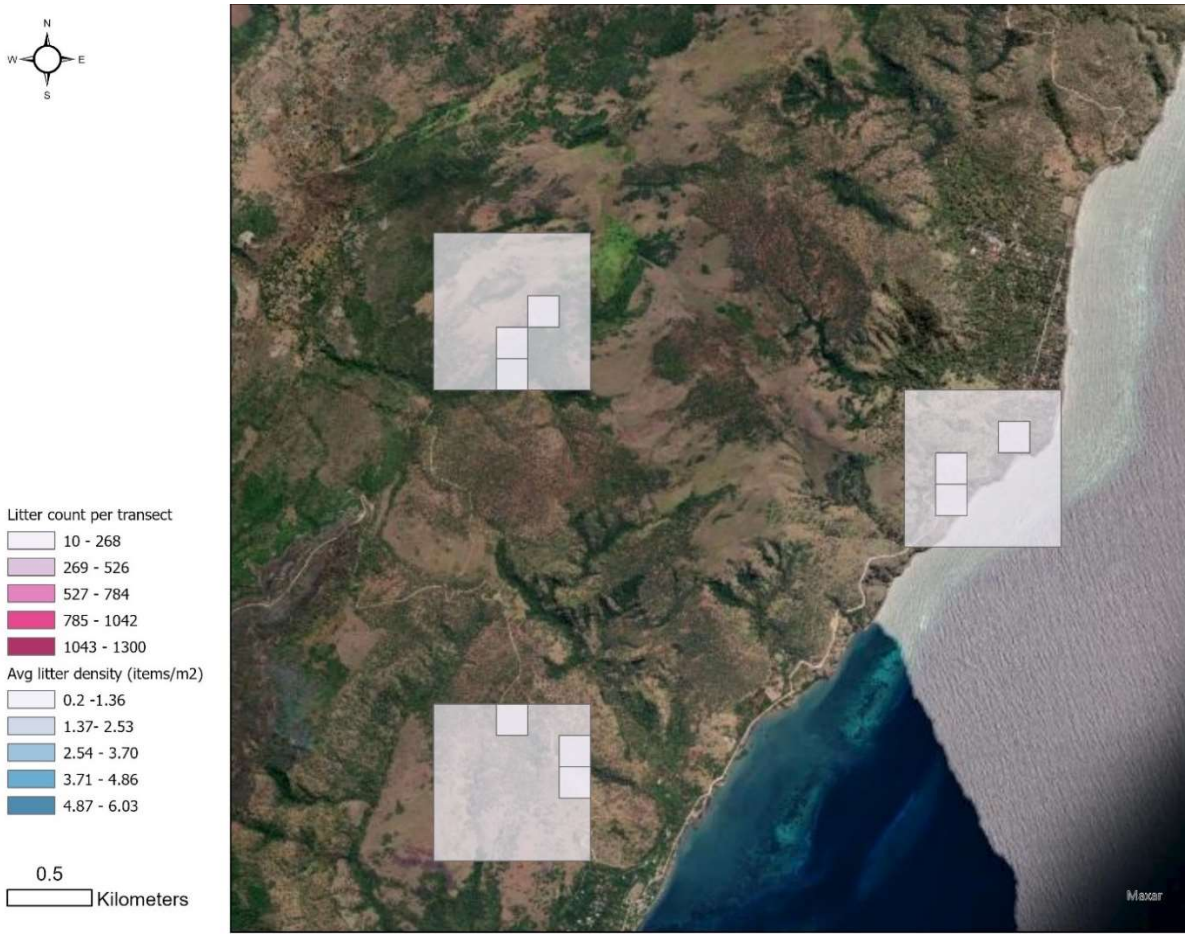
Population Tertile	**Upper (58 – 803 persons/km^2**	**Middle (2 – 58 persons/km^2)**	**Lower (0 – 2 persons/km^2) (58 – 803 persons/km^2)**
Top Five Litter Items	1) Straws	1) Hard plastic fragments	1) Film fragments
	2) Plastic bottles	2) Other food-related plastic	2) Plastic bottles
	3) Fabric pieces	3) Plastic bottle	3) Mini alcohol bottles
	4) Plastic grocery bags	4) Plastic grocery bag	4) Aluminum or tin cans
	5) Trash bags	5) Aluminum or tin cans	5) Hard plastic fragments

Average litter density surveyed in the transects varied with ambient population count, increasing in areas with more people. However, overall litter densities were relatively low in Ataúro Island – at 0.45 items/m2 – compared to both Liquiçá and Dili (Table 8; Figure 46). This highlights the importance of intervening to prevent plastic pollution and improve waste management in Ataúro Island before further development of the tourism industry.

Table 8: Litter density for each area of population count in Ataúro Island.

Population Tertile	**Transect count**	**Range litter items per transect (items/100 m^2)**	**Average litter density per site (items/m^2)**
Upper (58 – 203 persons/km^2)	3	80 — 87	0.88
Middle (2 – 58 persons/km^2)	3	26 — 42	0.33
Lower (0 – 2 persons/km^2)	3	10 — 36	0.20

Figure 46: Average litter densities on Ataúro Island.



Note that the legend for Figure 44 utilizes the same scale to demonstrate litter densities in Ataúro Island, Liquiçá, and Dili. Therefore, all transect locations and sites are shown in the lightest colors as they depict low litter densities relative to those found in Liquiçá and Dili.

Liquiçá

In total, 2,411 items were logged in 9 transects (each 100m^2) characterizing 3 different square kilometer areas across three groups of population count. The lower population group included sites with ambient population counts ranging from 7 – 621 people; the middle population group ranged from 622 – 987 people; and the high population group ranged from 988 – 5,953 people.

Food-related plastic packaging was the largest proportion of litter (36%), followed by tobacco fragments (29%), and plastic fragments (11%). Overall, 74.0% of litter items logged were primarily plastic (Figure 45). Composition of litter follows similar patterns across all three population tertiles, but both the middle and high population tertiles have a higher proportion of food-related plastic compared to the low population areas. The low population area also has a very high proportion of tobacco products, which may point to a need for a targeted campaign against cigarette butt litter (Figure 47).

Figure 47: Litter characterization in Liquiçá.

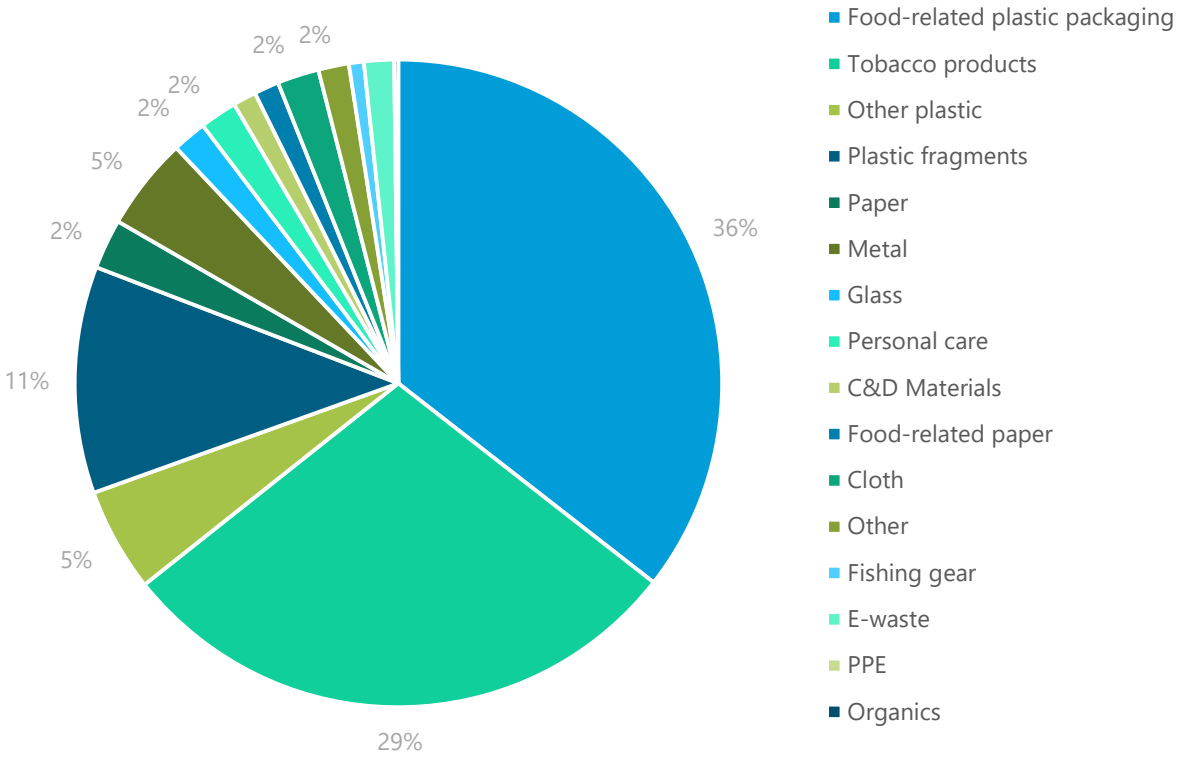
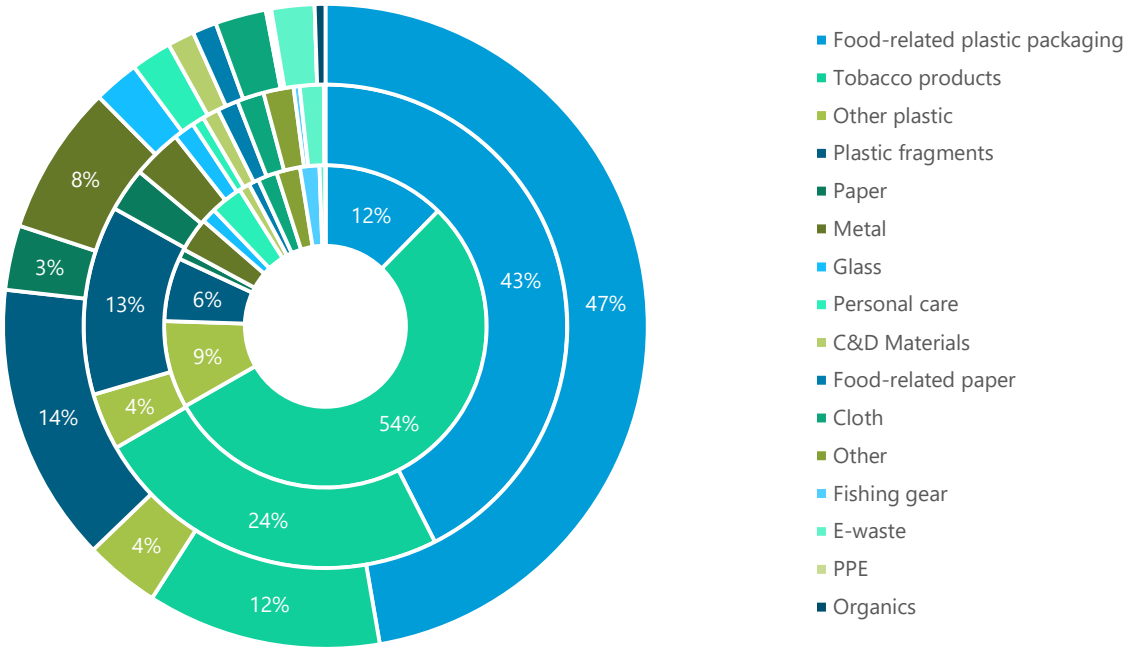


Figure 48: Proportion of most common plastic items in low (inner), mid (middle), and high (outer) population count areas in Liquiçá.



Overall, cigarettes were the most prevalent litter item observed in the transects in Liquiçá (Figure 49). Awareness campaigns could target this issue and educate the public on negative environmental consequences of cigarette butt litter. Like Ataúro Island, plastic bottles were also a common litter item. Addressing accessible clean drinking water or collaborating with local water bottling companies to offer refill programs may facilitate waste reduction related to bottles. Unlike in Ataúro, aluminum cans were not in the top ten litter items, suggesting they are captured for recycling and export. Aseptic cartons, another common form of beverage packaging in Liquiçá, are not as easy to recycle and were found in the top ten litter items. Grocery bags and straws were also prevalent in the litter. Grocery bags were notably the most prevalent litter item in the upper population tertile (Table 9). More complete socialization and implementation of the SUP bag ban in Liquiçá may be needed.

Figure 49: Top ten litter items in Liquiçá.

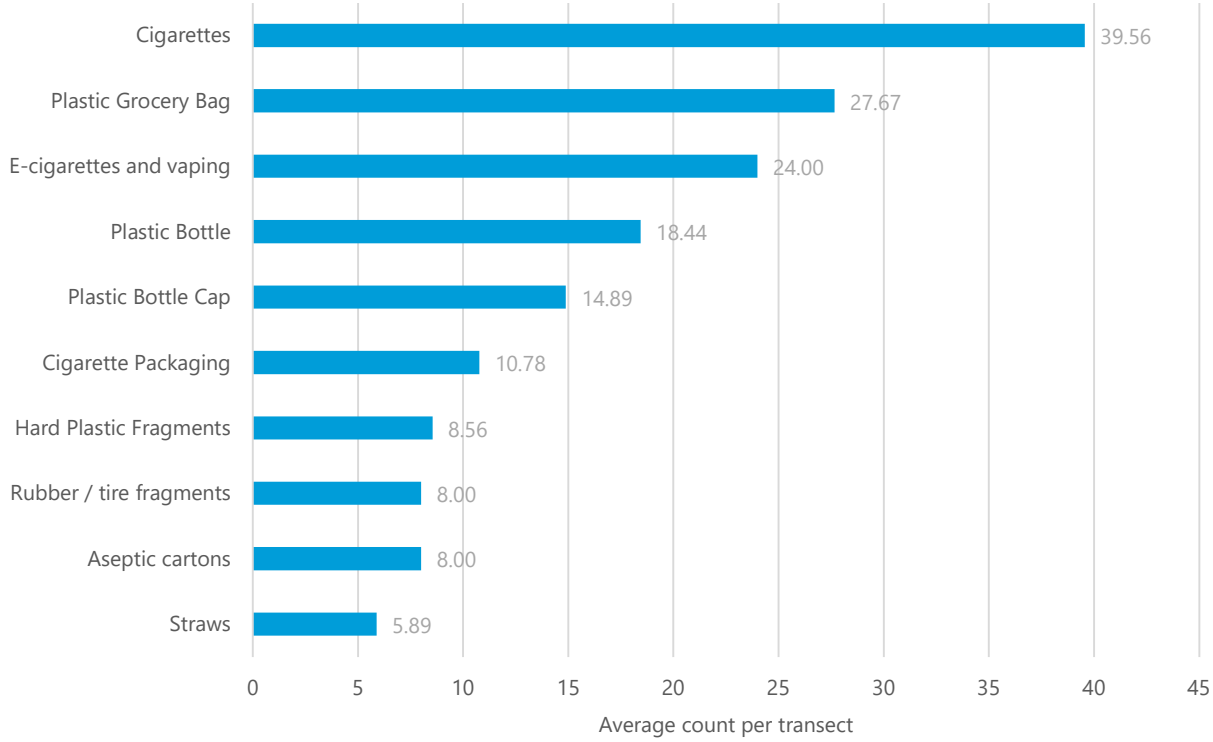


Table 9: Top litter items for each area of population count in Liquiçá.

Population Tertile	**Upper (988 – 5,953 persons/km²)**	**Middle (622 – 987 persons/km²)**	**Lower (7 – 621 persons/km²)**
Top Five Litter Items	1) Plastic grocery bag	1) E-cigarettes and vaping	1) Cigarettes
	2) Plastic bottle cap	2) Cigarettes	2) Plastic bottle
	3) Cigarette packaging	3) Cigarette packaging	3) Plastic grocery bag
	4) Cigarettes	4) Trash bags	4) Plastic bottle cap
	5) Plastic bottle	5) Plastic bottle	5) Aseptic cartons

Overall, the average litter density in Liquiçá was 2.68 items/m^2 (Table 10; Figure 50). The average litter density surveyed in the transects was similar in upper and low population areas and peaked in middle population areas. This pattern has been observed in other CAP cities, where lower population areas generate less waste and upper population areas have more developed waste management infrastructure. Middle population areas can be the perfect storm of high waste generation and limited infrastructure.

Table 10: Litter density for each area of population count in Liquiçá.

Population Tertile	Transect count	Range litter items per transect (items/100 m^2)	Average litter density per site (items/m^2)
Upper (988 – 5,953 persons/km^2)	3	207 — 286	2.47
Middle (622 – 987 persons/km^2)	3	158 — 503	3.32
Lower (7 – 621 persons/km^2)	3	130 — 322	2.25

Figure 50: Average litter densities in Liquiçá.

Dili

In total, 9,615 items were logged in 18 transects (each 100m^2) characterizing 6 different square kilometer areas across three groups of population count. The lower population group included sites with ambient population counts ranging from 16 – 625 people; the middle population group ranged from 626 – 3,343 people; and the high population group ranged from 3,344 – 30,520 people.

Food-related plastic packaging was the largest proportion of litter (36%), followed by tobacco products (29%), and other plastic (10%). Overall, 78.0% of litter items logged were primarily plastic (Figure 51). Composition of litter follows similar patterns across all three population tertiles, although – notably different than Liquiçá – food-related plastic packaging was a larger proportion of the litter in low population areas. Tobacco products were more significant fractions of the litter in both mid and high population areas (Figure 52).

Figure 51: Litter characterization in Dili.

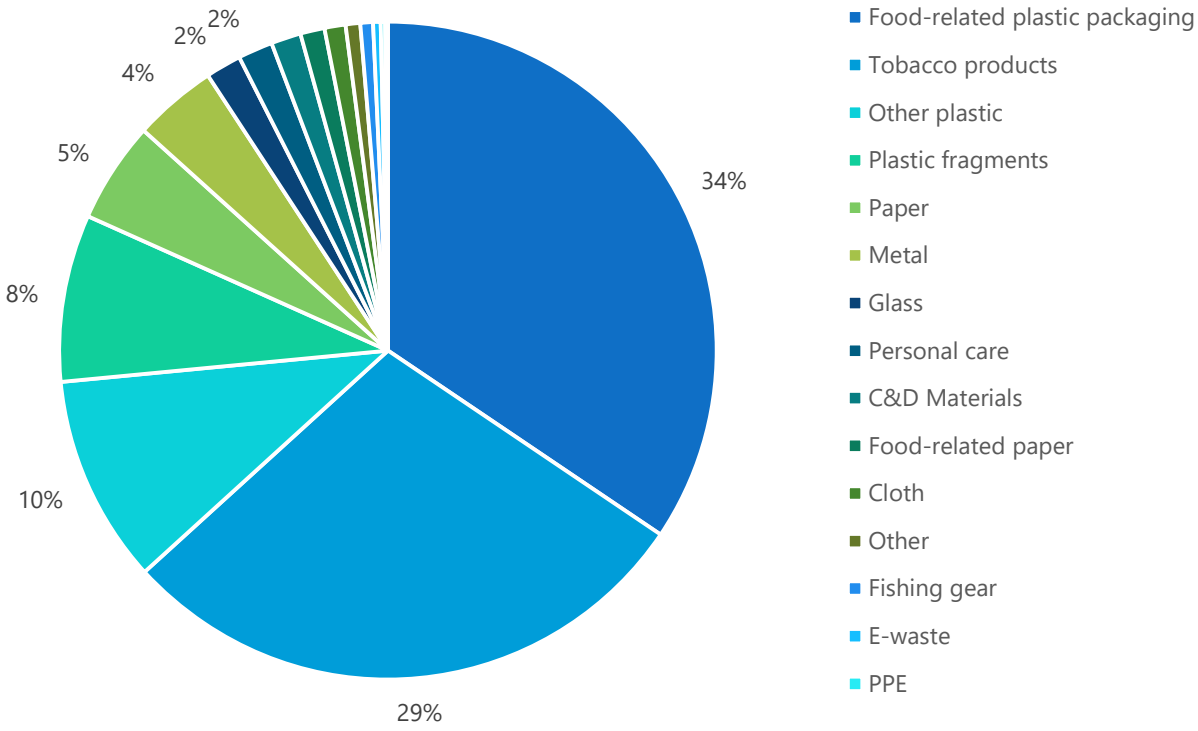


Figure 52: Proportion of most common plastic items in low (inner), mid (middle), and high (outer) population count areas in Dili.

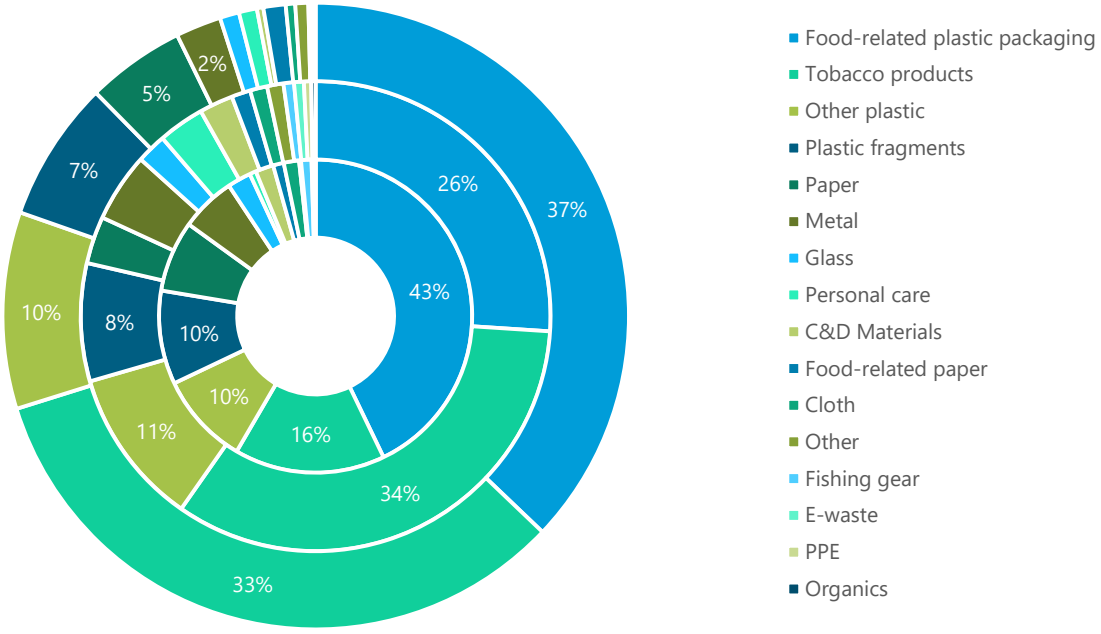
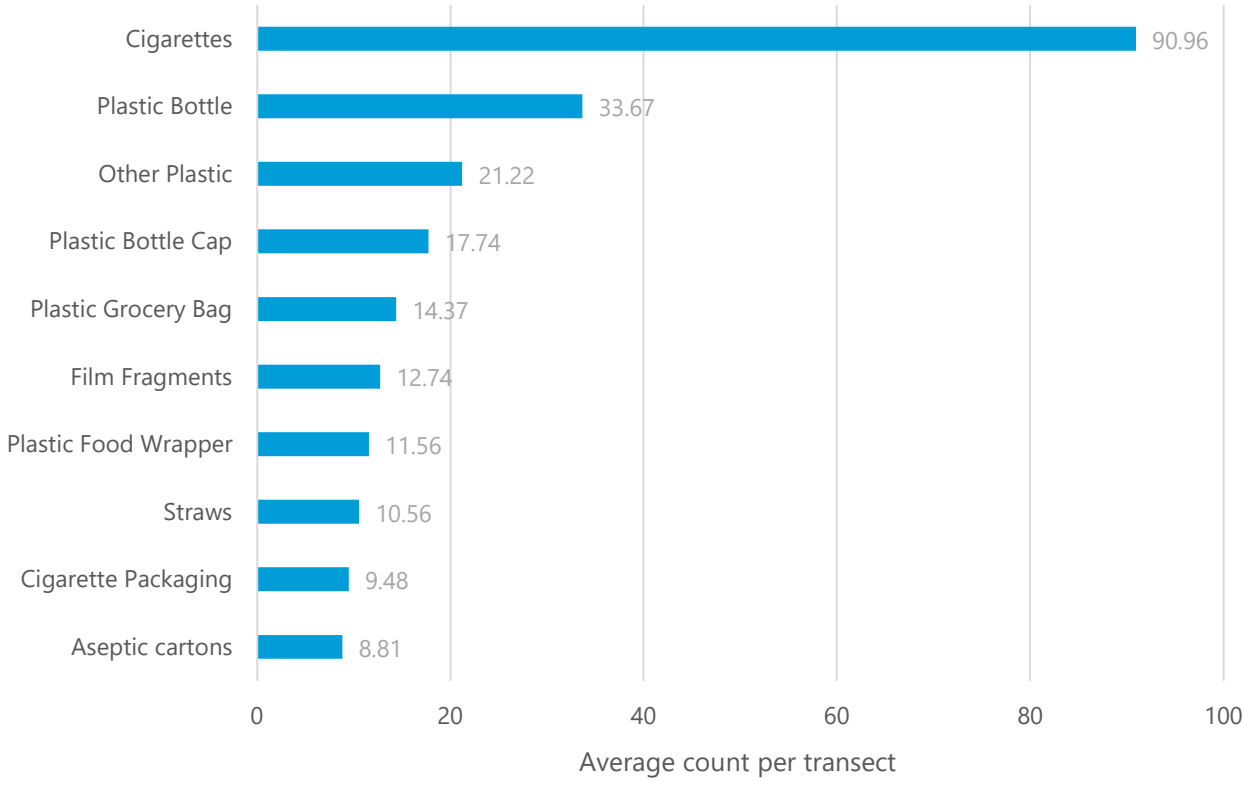


Figure 53: Top ten litter items in Dili.



Overall, cigarettes were the most prevalent litter item observed in the transects in Dili (Figure 53). Awareness campaigns could target this issue and educate the public on negative environmental consequences of cigarette butt litter. Again, aluminum cans which are collected for recycling export are not in the top 10 litter items but plastic bottles the second most frequently found item and aseptic cartons were in the top 10 litter items. Plastic bottles were in fact the top litter item in both the upper and lower population tertiles (Table 11). Addressing accessible clean drinking water or collaborating with local water bottling companies to offer refill programs may facilitate waste reduction related to beverages. Despite the prevalence of reusable bags in supermarkets in Dili, plastic grocery bags were still a common litter item, which may be reflective of their continued usage in local markets.

Table 11: Top litter items for each area of population count in Dili.

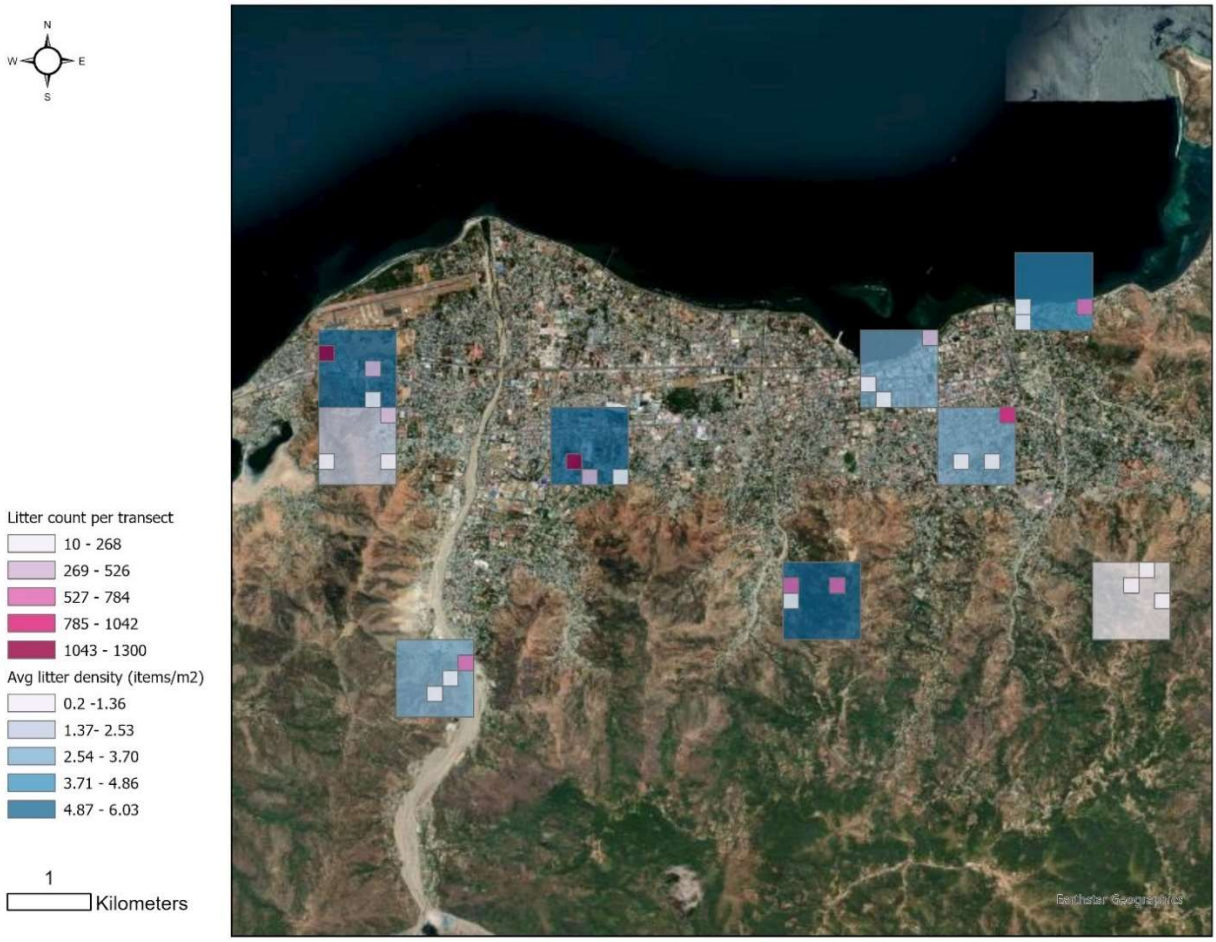
Population Tertile	**Upper (3,344 – 30,520 persons/km^2)**	**Middle (626 – 3,343 persons/km^2)**	**Lower (16 – 625 persons/km^2)**
Top Five Litter Items	1) Plastic bottle	1) Cigarettes	1) Plastic bottle
	2) Other plastic	2) Other plastic	2) Cigarettes
	3) Plastic bottle cap	3) Plastic bottle	3) Plastic food wrapper
	4) Plastic grocery bag	4) Plastic bottle cap	4) Plastic bottle cap
	5) Film fragments	5) Film fragments	5) Plastic grocery bag

Overall, the average litter density in Dili was 3.56 items/m^2 (Table 12; Figure 54). Average litter density surveyed in the transects was similar in both upper and middle population areas and was slightly lower in less populus areas.

Table 12: Litter density for each area of population count in Dili.

Population Tertile	**Transect count**	**Range litter items per transect (items/100 m^2)**	**Average litter density per site (items/m^2)**
Upper (3,344 – 30,520 persons/km^2)	9	66 — 1,141	3.94
Middle (626 – 3,343 persons/km^2)	9	161 — 1,300	3.99
Lower (16 – 625 persons/km^2)	9	10 — 737	2.74

Figure 54: Average litter densities in Dili.



Comparison

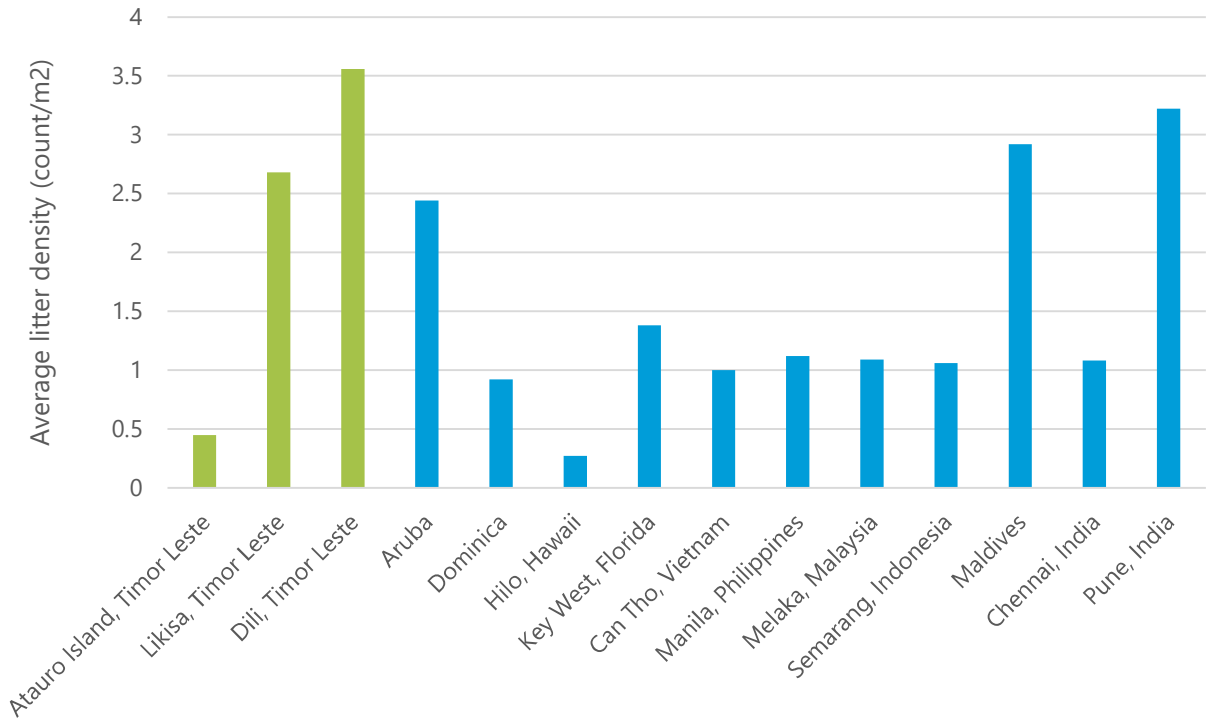
Average litter densities were highest in Dili, followed by Liquiçá, with Ataúro Island having the lowest average litter densities (Table 13).

Table 13: Average litter densities in each location.

Location	Transect count	Range litter items per transect (items/100 m^2)	Average litter density per site (items/m^2)
Ataúro	9	10 — 87	0.45
Liquiçá	9	130 — 503	2.68
Dili	27	10 — 1,300	3.56

Compared to other CAP cities, the average litter density in both Liquiçá and Dili is relatively high, similar to locations like Pune, India, which has a population of nearly 7 million, and the Maldives, which has around 2 million tourists per year (Figure 55). The higher litter densities already observed in the absence of high populations of residents or tourists highlight that the waste management systems are already not fully capturing existing waste.

Figure 55: Average litter densities (items/m2) in Timor-Leste compared to other CAP communities in islands and in South and Southeast Asia.



Across all communities, site characteristics also impacted the transect litter densities. Transect descriptors in the following graphs reflect self-reported descriptions of the surrounding area, collected by the team during litter surveys.

Commercial areas had the highest litter densities in Liquiçá, while mixed use areas had the highest litter densities in Dili. Residential areas had the highest litter densities in Ataúro, likely because of the low population in other parts of the island (Figure 56). High litter levels in both commercial and mixed-use areas in Liquiçá and Dili reiterate the need for separate commercial collection systems that place more responsibility for their waste onto businesses. Notably, residential areas had high litter densities in Dili as well, speaking to the need to improve waste collection infrastructure. In both Dili and Liquiçá, urban areas had higher litter densities compared to rural and peri-urban areas (Figure 57).

Figure 56: Average litter count per transect based on land use.

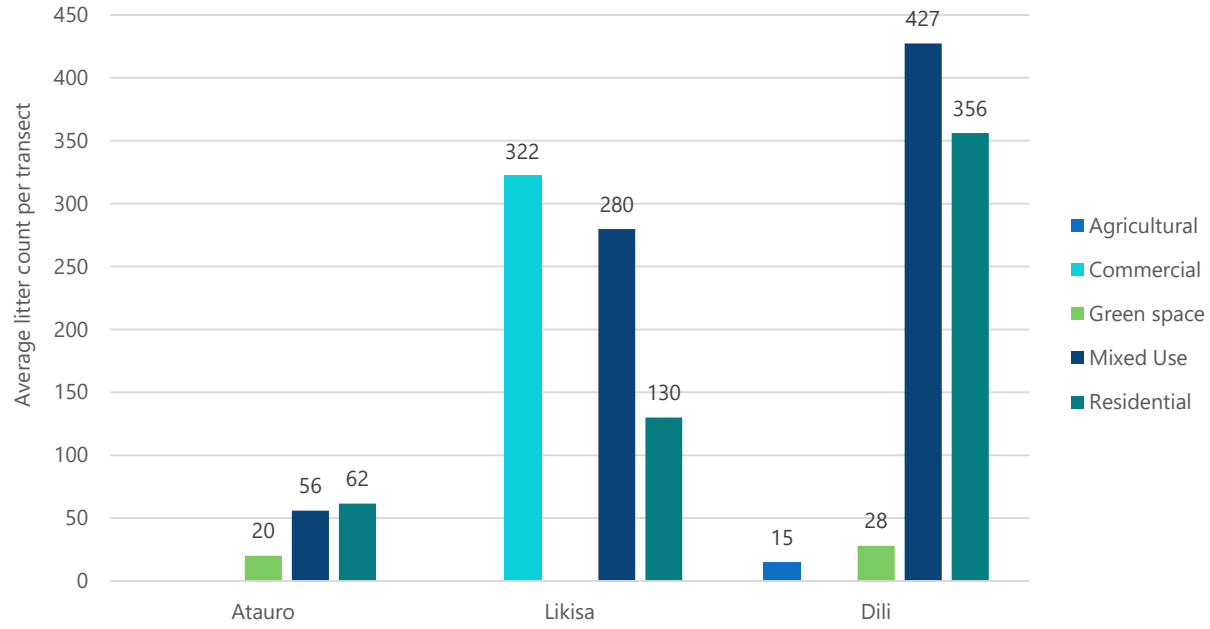
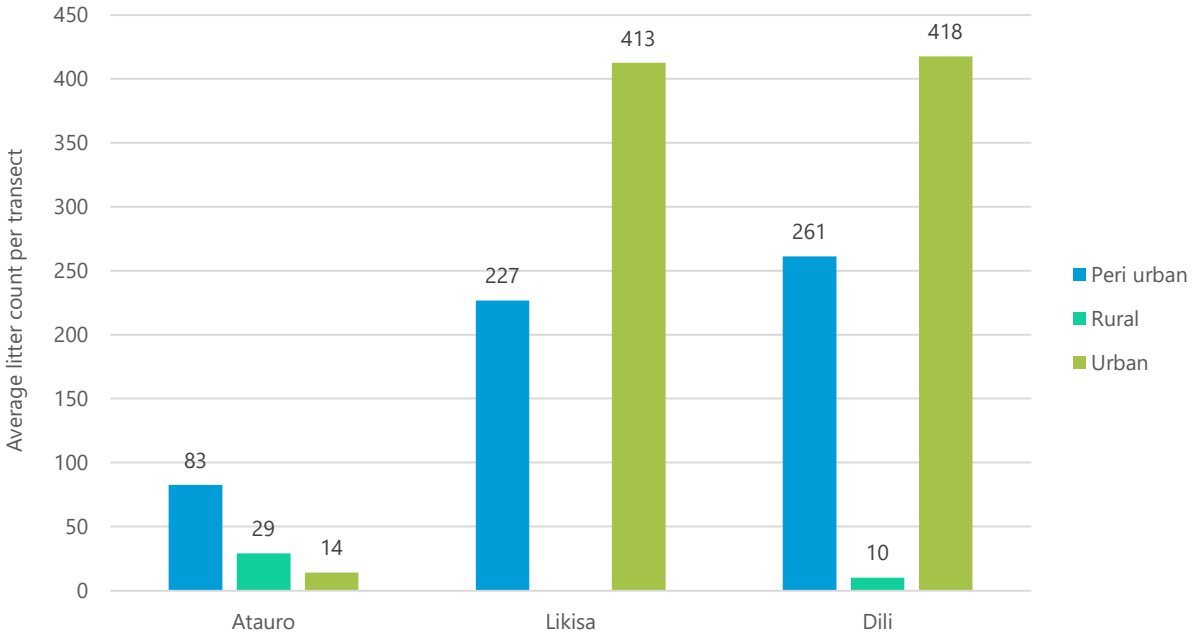
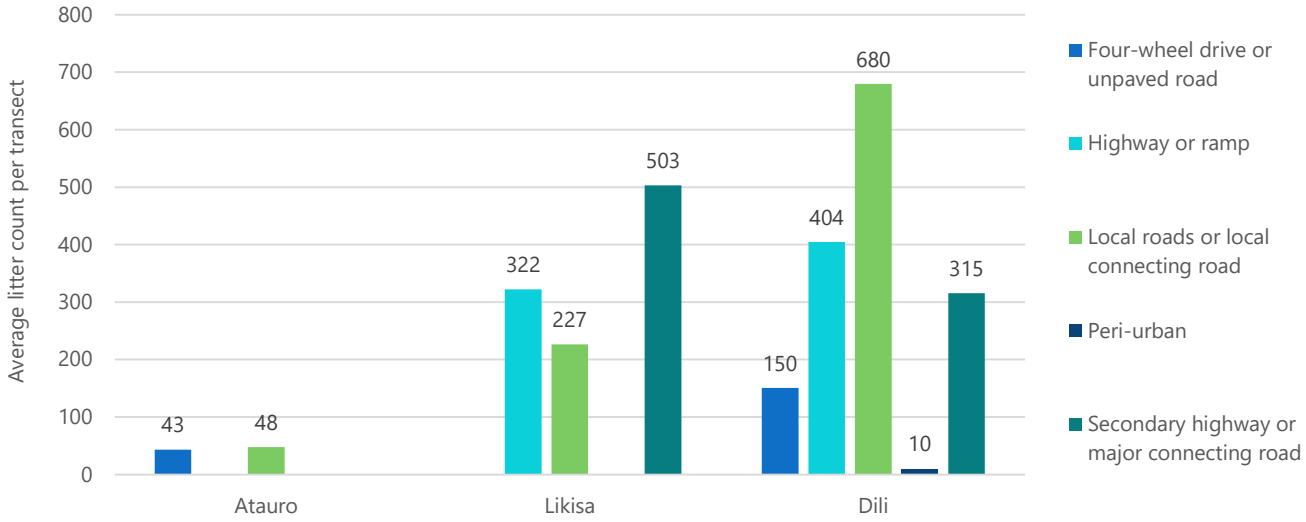


Figure 57: Average litter count per transect versus urban areas.



Road type also influenced litter densities; local roads had the highest litter densities in Dili, while secondary highways had the highest densities in Liquiçá (Figure 58). Targeted cleanup efforts or signage may need to be directed to different environments in different communities in Timor-Leste.

Figure 58: Average litter count per transect by road type.



Cleanups are already happening across the three communities, which may help to remove plastics already leaked into the environment and raise awareness for participating community members (see **Collection** chapter). However, addressing upstream interventions including reduction, improving waste management, and raising awareness will be critical to prevent the continued flow of plastic waste into the environment.

Opportunities

CIL found the following opportunities to expand and enhance circularity in Timor-Leste based on the findings of this report. These opportunities are categorized based on the seven spokes of the CAP model. Stakeholder engagement with the partners of this project should take place to further expand, refine and prioritize these opportunities based on local context, impact, feasibility, and cost. It is important to note that the opportunities listed below are individualized based on the findings, but solutions cannot happen in a vacuum and are most impactful when strategically combined within a holistic system framework.

Input

- As most plastics are imported, control measures could be implemented at ports of entry. The Department of Pollution Control under the Ministry of Environment and Tourism is already working with the Customs Authority to limit the import of plastic bags, which could be expanded to other unnecessary and single-use plastic (SUP) products under the SUP ban.
- In the short-term, explore specific EPR implementation details in Timor-Leste, including obligated producers and importers, regulated products and packaging, collection targets, and government capacity to implement. This could be supported by development partners and leverage regional learnings.
- Given Timor-Leste's compact size, implementing an EPR program may not be a huge cost and could generate additional investment and jobs, in addition to reducing plastic pollution.
- EPR could be piloted as a voluntary program, while enlisting industry to develop appropriate targets for various products, developing the domestic recycling industry, and increasing monitoring and administrative capacity. This will establish the groundwork for successful, mandatory EPR in the long term.
- Multinational corporations are often quick to adopt EPR schemes, and minimally providing more guidance around voluntary EPR standards may be an effective starting place to collaborate with industry and support the recycling industry in Timor-Leste, while building up the administrative capacity to oversee and implement full-scale mandatory EPR program in the future.
- Another option to implement the polluter pays principle could be a tax on plastic imports, directed towards a central fund held by a transparent, accountable organization to manage collection, sorting, and end-of-life.
- Local production capacity for beverages means DRS are within the technical capacity of the existing corporations in Timor-Leste. In addition to the existing import tax on plastic preforms, further incentives such as subsidized collection infrastructure could encourage local beverage companies to consider refill.

Community

- In the short term, consistent, adequately funded campaigns through media platforms are needed to further awareness around plastic pollution in Timor-Leste's sensitive ecosystem and promote behavior change around waste management. Awareness raising efforts should be expanded to communities outside of Dili and should include regular surveys to monitor effectiveness.
- Targeted messaging should encourage youth to champion environmental stewardship. The LMBO Future Youth Ambassadors and the "My Sea, My Timor" programs are great steps in this direction that could be expanded.
- Storytelling focused first on the human health consequences of plastic pollution may resonate with stakeholders' existing concerns. Protecting marine life, preserving soil health, and preventing flooding are relevant environmental messages. Expanding awareness around the impacts of plastic pollution on ocean health should be a target to protect Timor-Leste's unique ecosystems.
- With several policies related to SUP already developed, improved implementation could result in waste reduction. The SUP bag ban, for example, is unequally implemented – the policy is not thoroughly enforced in local marketplaces and in communities outside of the capital.
- In the medium-term, the government could strengthen the SUP regulation by finalizing the list of banned items and socializing the alternatives. Involving local leadership in the implementation of these national policies, such as by developing toolkits for policy socialization, could help promote widespread enforcement.
- A collaborative taskforce on plastic could break down silos within government ministries and enable more cooperation between agencies on awareness campaigns and coordination across different departments working on waste, environment, and health, such as LMBO, the Ministry of Tourism and Environment, the Ministry of Public Works, and village leadership.
- Tara bandu (a traditional Timorese communal agreement) related to plastic pollution could promote a native natural resources management model and encourage more local leadership engagement on waste management. The Ministry of Agriculture and Fisheries could facilitate local-level conversations needed around plastic waste and ocean conservation to encourage village leadership to establish tara bandu for waste, especially in areas outside Dili.
- Capacity building at the local level, including training for waste segregation and composting, could support local authorities to better manage waste in their communities. Existing training materials available from partners like the World Bank, USAID,[53] UNEP, and the International Solid Waste Association could be translated and adapted to the local context.
- A specific allocation of the single-use plastics import tax towards waste management may be an opportunity to raise funds for waste management infrastructure.
- Source separation of waste would facilitate both recycling and composting.
- Suggested tools to support recycling in Timor-Leste include offsetting shipping costs for the export of recyclable material, establishing marketplaces for recyclers to sell their goods, and emphasizing eco-friendly products in procurement guidelines.
- Locally made compostables, like palm leaf products, should be specified as viable alternatives in messaging and socialization around the SUP bans.
- There is an opportunity to leverage existing reuse behavior, like reusing bottles for food storage, to expand reuse schemes in rural areas where plastic is more valuable.

[53] USAID. "USAID Clean Cities, Blue Ocean: Virtual Event and Training Hub." https://gateway.on24.com/wcc/eh/3570340/usaid-clean-cities-blue-ocean-engagement-hub

- Providing access to clean drinking water through refill stations in public areas like government offices, schools, and other institutions could support both waste reduction and human health.
- Refill schemes in Timor-Leste could be modelled from programs which seek to eliminate both plastic pollution and the poverty tax by offering refill at consistent prices regardless of quantity.
- While currently in a nascent stage, the ecotourism sector has enormous potential and a strong interest in improved circularity. Tourism could be a catalyst for more environmentally friendly business practices, which could be supported by a voluntary eco-friendly business certification program. Existing resources like the Pacific Asia Travel Association's *Plastic Free Toolkit for Tour Operators* could be translated to provide guidance to industry as eco-tourism expands.
- A tourist tax or eco-fee could help subsidize additional waste management capacity needed to address tourism.

Product Design

- The legal framework to improve product design already exists, as does an environmental tax that could level the playing field between single-use plastics and their alternatives. There are 13 proposed materials in the SUP ban, but 11 of the materials are still being negotiated with companies. Moving forward the SUP ban could prevent import of problematic plastics.
- Multilayer plastic packaging, including both multilayer plastic film and aseptic cartons like TetraPaks are unlikely to find viable external recycling markets. However, they are currently accepted by Caltech for recycling. Similarly, because of its heavy weight, exporting glass for recycling is likely not viable, but glass is also currently accepted at Caltech.
- There is an opportunity to recycle some common packaging types – notably PET, HDPE, and aluminum which are all high-value recyclables collected and exported in other island markets.
- Aluminum is a common packaging type for beverages and collected to export as a recyclable. The existing SUP ban could be used to promote aluminum packaging for imported beverages.
- Refill or bulk purchasing programs may enable both waste reduction and more cost-effective purchasing for households. Incentivizing refill with "bring your own" containers can allow for flexible purchasing quantities. Creating enabling economic conditions to support households buying in bulk, such as bulk buying cooperatives, may also reduce packaging waste.
- Because shampoo is available in small multilayer packaging in both Ataúro and Liquiçá, shampoo may be a logical target for refill, bulk buying, or even cottage industries that eliminate the need for plastic packaging, such as shampoo bars. Supporting cottage industries by subsidizing initial equipment investment may derisk these ventures for small businesses.
- With some restaurants still using reusable foodware for in-house dining, there is an opportunity to encourage this existing waste-reducing practice through policy or incentives, such as mandating reuse for in-house dining or working with food establishments on an eco-certification program.
- Almost all restaurants are using plastic straws ware for both takeout and in-house dining – a straw on-request policy may eliminate some of this waste, without increasing cost to businesses.

Use

- There are already alternatives to some single-use plastics available, but they are small in number. Programs like sustainable buying cooperatives, eco-friendly product guides, or collaboration with existing distributors could enable more availability of alternatives to SUP.
- With reusable items in Ataúro and Liquiçá costing around two times more than single-use items, reuse is economically favorable – it does not take many uses to recover an initial investment.
- Boxes – a common store waste product due to packaged imports – were offered in lieu of reusable bags in some stores. Boxes were also reused as chicken coops, while plastic bottles were reused as floats for seaweed aquaculture. Encouraging existing forms of reuse as important and valid forms of complying with the SUP ban may encourage further expansion of these practices.
- The SUP bag ban is unequally implemented – the policy is not thoroughly enforced in local marketplaces and in communities outside of the capital. Continued socialization and enforcement, integrating village leadership, is needed to reach communities outside Dili.
- Incentivizing in-house dining could help limit future increases in waste generation.
- Some compostable plastics were seen marketed as alternatives to SUP in stores. These should not be promoted without investment in industrial composting facilities in Timor-Leste.

Collection

- Source separation at the collection stage would facilitate cleaner waste streams that would enable both composting and recycling.
- While municipal budgets currently allow for no-cost collection, a sustainable collection model will rely on consistent financing. This transition could start with charging commercial entities or requiring them to contract private haulers, which may also encourage reduced waste generation. Adequate controls for illegal dumping must be addressed as charges begin.
- Separation of commercial waste from the public waste management system could be coupled with incentives like free recycling drop off points or organic waste collection to incentivize large commercial waste producers to segregate their waste.
- Since there is a waste collection truck and system in Liquiçá, there is an opportunity to encourage or incentivize its use instead of previous practices of open burning. Improved compliance with the existing collection system is good short-term goal in the community.
- Given the likely future increases in tourism in Ataúro, collection systems like a transfer station need to be established.
- Investment in smaller, more flexible forms of transportation like waste motorbikes is needed to collect waste in narrow streets, alleyways, or outside of cities.
- In the cities of Ataúro and Liquiçá, improved localization waste generation and waste characterization data could guide investment to support improved waste management capacity.
- Dili has been underspending on waste management, so there is an opportunity to expand and improve on current collection efforts within the existing budget.
- Government support for collection hubs through public-private partnerships with recyclers could support the recycling industry in Timor-Leste. It is unrealistic to expect a nascent recycling industry to fund collection of recyclables at scale without government subsidy.

- Collection programs in institutions like schools and offices are cost effective and could increase awareness of recycling.
- As SWM systems develop in Timor-Leste, there is an opportunity to structure contracts with waste management operators to bring private waste companies into partnership and align incentives on reduction, such as contracts based on the quantity of households rather than weight.
- Cleanups are already occurring in communities across Timor-Leste and could be further encouraged as public awareness tools.

End of Cycle

- There is an opportunity to reduce open burning by capturing and managing waste generated outside of Dili, such as through a transfer station system. Transfer station locations should be optimized for convenience and community ease-of-use while protecting environmentally sensitive areas. Creating a solid waste management system is especially important on Ataúro Island if the island is central to future eco-tourism increases.
- Remediating the Tibar landfill and operating it as a sanitary landfill is a positive step, though more sanitary landfill capacity may need to be generated in the future and in other geographies.
- Decentralized, small-scale composting could enable waste reduction before transport to the landfill, saving landfill space while creating a useable end product for Timorese agriculture.
- While small-scale cottage industry recycling efforts (such as crafted jewelry and baskets) are unlikely to facilitate waste processing at a large scale, these efforts could be leveraged as effective and impactful awareness-raising tools for both the local population and tourists to Timor-Leste.
- Some processing of recycled plastics – like collaborating with private recyclers to subsidize the purchase of equipment for extruding recycled plastic string – may provide local craftsmen the raw materials to make eco-friendly, recycled while decreasing manual processing of waste,
- There is an opportunity to explore or incentivize end-markets for locally recycled materials. Suggested tools to support recycling in Timor-Leste include offsetting shipping costs for the export of recyclable material, establishing marketplaces for recyclers to sell their products, and using government procurement to support recyclers.
- The Tibar landfill, the only sanitary landfill in Timor-Leste, does not accept hazardous or construction and demolition (C&D) waste. These waste streams often contain plastic or chemical additives that can have negative environmental impacts. Establishing end points for hazardous waste (such as storage for export) and C&D waste (such as a C&D landfill) is a important medium-term goal, important both for environmental protection and preserving landfill space in Tibar.
- Establishing tipping fees at the landfill could align economic incentives towards waste reduction, as long as measures are in place to prevent illegal dumping.

Leakage

- Plastic bottles were a common litter item in all three cities. Expanding access to clean drinking water on the islands or collaborating with local water bottling companies to offer refill programs – even using already widespread refillable jugs – may facilitate waste and litter reduction related to bottles.
- Since bottles are so prevalent in the litter, there is an opportunity to collect and recycle plastic bottles, which are often made of high value PET. Subsidized costs could support export.
- Aluminum cans were in the top 10 litter items in Ataúro, but not in Liquiçá or Dili where they are being collected for export. Establishing a viable recycling pathway for cans, perhaps through partnering with businesses like hotels to aggregate cans in one location and moving to Dili when a sufficient quantity is obtained, may discourage littering of these items.
- Plastic grocery bags are still prevalent in litter, re-emphasizing the need for further enforcement of the SUP bag ban and promotion of reusable bags or other alternatives like boxes in local markets and areas outside of the capital.
- Cigarettes were prevalent in the litter in transects in Dili and Liquiçá. Awareness campaigns could educate the public on the negative environmental consequences of cigarette butt litter.
- Because litter density differed by varying types of land-use and roads in each city, targeted infrastructure, cleanup efforts, or signage could be directed to different environments in different communities in Timor-Leste. Community leaders mentioned that cleanup efforts are already occurring; in Liquiçá, they could be directed towards connecting highways, while in Dili more cleanup is needed along local roads.
- High litter densities in Ataúro highlight the importance of intervening to prevent plastic pollution and improve waste management in Ataúro Island before further development of the tourism industry.

Glossary

ADB: Asian Development Bank

BSF: Black soldier fly

CAP: Circularity Assessment Protocol

CIL: Circularity Informatics Lab

DRS: deposit return schemes

EPR: Extended Producer Responsibility

EPS: Expanded polystyrene

FMCG: Fast moving consumer goods

HDPE: high density polyethylene

JICA: Japan International Cooperation Agency

KOICA: Korea International Cooperation Agency

LBMO: Land and Maritime Boundary Office

MSA: Ministry of State Administration

MSME: Medium, small, and micro enterprises

MSW: municipal solid waste

PET: polyethylene terephthalate

PFAs: perfluoroalkoxy alkanes

PP: polypropylene

PVC: Polyvinyl chloride

SUP: single-use plastic

SWM: solid waste management

UGA: University of Georgia

USAID: United States Agency for International Development

Appendix

Table A1: Full List of Debris Tracker Litter Items and Associated Material Categories

Material	Items
C&D Materials	Aggregate & Brick Bolts, Nails, and Screws Building Materials Lumber Other C&D
Cloth	Clothing Towels or rags Fabric Pieces Other Cloth
E-Waste	Batteries E-Waste Fragments Wire Other E-Waste
Fishing Gear	Buoys and Floats Fishing Line Other Fishing Gear Plastic Net or Net Pieces Plastic Rope
Glass	Glass Bottle Glass or Ceramic Fragments Other Glass
Metal	Aluminum Foil Aluminum or Tin Cans Foil to-go container

	Metal Bottle Caps or Tabs Metal Fragments Other Metal
Organic Waste	Food Waste Other Organic Waste
Other	Other Popsicle or lollipop Stick
Other Plastic Products	Bulk Bags Flip Flops or shoes Plastic String, Tape, or Packing Straps Rubber Bands Trash bag Tires Balloons Plastic toys or balls Car Parts Hard plastic jugs or containers Other Plastic
Food-Related Paper	Paper cups Paper food box or container Paper plates or bowls Compostable paper cups Paper food wrapper Compostable food box or container Napkins Other Food-Related paper

Paper	Office paper and newspaper Tags, tickets, and receipts Corrugated Cardboard Paper fragments Other Paper
Personal Care Products	Blister Pack or other pill packaging Cotton Buds Ear plugs Personal Care Product Sachet or packet Toothbrushes Toothpaste or Other Product Tube Flossers Feminine products Needles and syringes Other Personal Care Product
Food-related plastic	Foam cups Plastic cups Compostable plastic cups Cup Lids Plastic Bottle Aseptic cartons Mini alcohol bottles Plastic Bottle Cap Plastic Food Wrapper Condiment packet or container Plastic Grocery Bag Sandwich or snack bags Plastic Utensils

	Straws Foam to-go container or clamshell Plastic to-go container or clamshell Compostable plastic container or clamshell Other Food-Related Plastic
Plastic Fragments	Film Fragments Foam Fragments Hard Plastic Fragments Rubber/ tire fragments Other Fragments
PPE	Disinfectant Wipes Disposable Gloves Face Masks Other PPE
Tobacco Products	Cigarette Packaging Cigarettes Tobacco Sachets or packets E-cigarettes and vaping Plastic cigar/cigarillo tips Lighters Cannabis-related waste Other Tobacco Product