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White Paper

Solid Waste Management Markets in Rural Cambodia

Assessing the solid waste value chain, from generation and sorting to transportation, disposal, and resource recovery in rural Kampong Chhnang, Pursat, and Siem Reap provinces.

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Waste pickers sort through trash at an unmanaged dumpsite in Kampong Chhnang Province. Credit: Claire Meyer

Executive Summary

Approximately 75 percent of Cambodia's 17 million residents reside in rural areas, where residential waste collection services are largely absent.[1] Nationally, four percent of waste is estimated to be recycled.[2] As a result, rural households, businesses, and communities often defer to unsafe and unsustainable means for waste disposal, including burning, burying and open dumping. To collect waste, protect human health and keep trash out of the natural environment, it is critical that solid waste management (SWM) expands in rural areas to meet growing and urgent needs.

This white paper examines the current state of SWM in rural Cambodia, with a specific focus on three Cambodian provinces: Kampong Chhnang, Pursat, and Siem Reap. The research team conducted a market assessment through literature review, primary data collection with stakeholders, and an experimental demand generation test. Findings highlight each stage of the waste management process, from waste generation to collection, transportation, disposal, and processing/recycling from the perspectives of local community residents, the private sector, and representatives of the public sector.

Waste Generation: Cambodia has experienced a significant increase in solid waste generation, with an average annual growth rate of 6.42 percent between 2008 and 2020.[3] Projections suggest this trend will persist, with an anticipated rise in daily solid waste generation growing to 1.16 kilograms per person per day by 2030 and 2.13 kilograms per day by 2050.[4] The widespread proliferation of single-use plastics (SUP) in Cambodia is a key driver of the increased volume of non-organic waste in need of disposal.[5] [6] Moreover the increased generation of industrial and medical waste compounds the risk to environmental and human health.

Public education and incentivization campaigns, including taxes on SUP containers and bags, offer potential to reduce the waste generated in rural Cambodia. Extended producer responsibility (EPR) programs that require or motivate sustainable packaging or container buy-back programs may also be effective in reducing the volume of SUP products distributed throughout the country.

Waste Collection: Solid waste collection services are predominantly concentrated in urban areas, leaving rural regions underserved. Presently, waste collection services extend to roughly 40 percent of households in Cambodia, encompassing 28 cities and 162 districts, with a majority of services overseen by private companies.[7] However, outside of cities, district level waste collection services only extend to approximately 18 percent of households.[8] The informal sector, composed of waste collectors who pick up trash from households and surrounding streets – often referred to as "et jay" – plays a major role in collection of recyclable waste in rural areas.

To expand formalized collection services, it will be critical to motivate households to pay for services. Service providers will need to establish trust through reliable service provision, transparent pricing structures and efficient payment collection. Service optimization, including efficient waste collection routes, vehicles, and collection methods will be necessary to reduce costs and improve business viability. To reach remote areas, service providers may need to employ decentralized waste collection

[1] World Bank, World Development Indicators.(2023). Rural population (percent of total population) [Data file]. Retrieved from https://databank.worldbank.org/source/health-nutrition-and-population-statistics# World Bank, 2023. World Bank Development Indicators - Rural population

[2] Pheakdey DV, Quan NV, Khanh TD, Xuan TD. "Challenges and Priorities of Municipal Solid Waste Management in Cambodia." International Journal of Environmental Research and Public Health 19, no. 14 (2022): 8458. doi: 10.3390/ijerph19148458. PMID: 35886307; PMCID: PMC9322170.

[3] Pheakdey (n2) 3.

[4] NCSD/MoE First Biennial Update Report of the Kingdom of Cambodia to the United Nations Framework Convention on Climate Change. 2020. Retrieved from https://unfccc.int/documents/232019

[5] Quicksand. (2015). Cambodia's Plastic Bag Ecosystem and Usage. Retrieved from https://www.switch-asia.eu/site/assets/files/1244/plastic_bag_ecosystem_and_usage_research_summary.pdf

[6] Mathew, M. (2023). Plastic control key for Cambodia to create circular economy. Khmer Times. Retrieved from https://www.khmertimeskh.com/501306321/plastic-control-key-for-cambodia-to-create-circular-economy/

[7] Dek Vimeanreaksmey. Current Situation of Solid Waste Management in Cambo dia. 2022. https://www.iges.or.jp/sites/default/files/inline-files/14_P1. percent20MoE percent2C percent20Cambodia.pdf

[8] Dek (n5) 4.

systems. In order to improve the efficiency, sustainability, and safety of waste collection, it will also be critical to further engage the informal sector.

Landfills and Dumpsites: The critical distinction between landfills and dumpsites is that landfills are engineered and require active management, while dumpsites are often informal and are either unmanaged or managed on an ad hoc basis. While engineered landfill sites are increasing in prevalence across Cambodia, few are receiving waste from rural areas and dumpsites remain the prevalent site for waste disposal. Significant investment is needed to establish and operate properly managed landfill facilities that incorporate pollution control measures and integrated resource recovery systems that minimize environmental risks and associated costs. These landfills will require clear mandates for support from public and private institutions, publicly allocated budgets, guidance and regulations for operators, and technical expertise to ensure sustained, effective use. Emphasizing waste diversion will also be important. Through the promotion of recycling, composting, and waste-to-energy approaches, the volume of waste deposited in landfills and dumpsites can be significantly reduced. The development of comprehensive waste management policies and procedures backed with robust enforcement mechanisms, will be required to standardize waste disposal practices and discourage illegal dumping.

Processing and Recycling: While formal waste collection is limited in rural Cambodia, some areas do have active recycling sectors, dominated by informal waste collectors, small to medium-sized junk shops, and private sector processors. This industry currently provides an outlet for only the most valuable recyclables, including metals and some plastics, primarily PET plastic bottles. Low value plastics like HDPE are sporadically collected, while LDPE, polystyrene, and other items are relegated to dumpsites and household burning, burying, or dumping. In order to incentivize collection of these materials, it will be critical to engage small-medium waste collection enterprises in rural communities and significantly expand the amount of waste they process. Other options include extending the reach of urban-based recyclable processing into rural areas. If waste collection services are extended to rural areas, recycling can be improved through integration of waste sorting and landfill management. Collaborative efforts with technology providers and research institutions are also necessary to identify cost-effective and eco-friendly solutions. Encouraging domestic recycling industries through incentives, supportive infrastructure, and improved market access for recycled materials is essential. Extended producer responsibility (EPR) programs, which hold manufacturers accountable for the entire lifecycle of their products, also offer an opportunity to fund the development of recycling infrastructure and service offerings.

Institutional Arrangements and Frameworks: In Cambodia, a wide range of policy guidance encouraging safe and sustainable solid waste management currently exists. However, resource limitations, uncertainty about the rules, and a lack of technical knowhow among the public sector at the regional level results in inconsistent adherence to policies While linkages exist between the public sector and private SWM operators in rural areas, support and oversight are often limited. Capacity building programs offer the potential to enhance the skills and knowledge of the public sector to engage SWM market actors and build a sustainable market ecosystem. Refinement and enforcement of local SWM policies and use of public awareness campaigns, could promote community level SWM behavior change. It is also important to invest in research, data management, and continuous program monitoring to support informed decision-making. Infrastructure development in underserved areas, the exploration of diverse financial mechanisms, policy harmonization, and the introduction of incentives for recycling and resource recovery are all fundamental steps toward advancing solid waste management and environmental sustainability in Cambodia.

This white paper underscores the importance of embracing comprehensive approaches to address Cambodia's rural SWM challenges and capitalize on the opportunities they present. Implementing the recommendations beginning on page 45 can pave the way for a cleaner, healthier, and more economically sustainable future for the country.

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Acronyms

ADB	Asia Development Bank
ASEAN	Association of Southeast Asian Nations
C&D	Construction and Demolition
CCWC	Commune Committee of Women and Children
CE	The Circular Economy
CRDT	Cambodian Rural Development Team
DCWC	District Committee of Women and Children
DoE	Department of Environment
DoEF	Department of Economy and Finance
EPR	Extended Producer Responsibility
EU	European Union
FCDO	Foreign Commonwealth and Development Office
FACT	Fisheries Action Coalition Team
GGGI	Global Green Growth Institute
GIZ	The Deutsche Gesellschaft für Internationale Zusammenarbeit
HCE	Health Care Establishments
HCW	Health Care Waste
ISD	Improving Public Service Delivery For Citizens In Cambodia
JICA	Japanese International Cooperation Agency
MoE	Ministry of Environment
MPWT	Ministry of Public Works and Transport
MoH	Ministry of Health
MSW	Municipal Solid Waste
NGO	Non-governmental Organization
PPE	Personal Protective Equipment
PET	Polyethylene Terephthalate
PPP	Public Private Partnership
3Rs	Reduce, Reuse, Recycle
RDF	Refuse Derived Fuel
SDC	Swiss Agency for Development and Cooperation
SDG	Sustainable Development Goal
SME	Small- and Medium-sized Enterprises
SUP	Single-Use-Plastic
SW	Solid Waste
SWM	Solid Waste Management
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
USAID	United States Agency for International Development
WtE	Waste to Energy
WRP	Whitten & Roy Partnership

Background

A private waste collection company collects waste from a market in Kratie Province.
Credit: Tyler Kozole

Background

The absence of waste collection and safe disposal in rural areas has a direct impact on public health, environmental wellbeing, and the economic prosperity of rural Cambodian communities. Proximity to untreated solid waste and unsafe disposal practices expose communities to the risk of disease and injury. **Spread of mosquito-borne diseases like malaria, dengue, and chikungunya, all of which are endemic in rural Cambodia, have been linked to solid waste prevalence.[9]** Injuries related to burns, cuts, and infections due to interaction with solid waste are also commonly reported in rural Cambodia. In addition to impacting the quality of life of rural families, these health burdens are a drain on household and community productivity and income. [10] [11]

The common practice of burning waste, especially plastics, can emit hazardous and carcinogenic compounds such as dioxin, furans, and mercury, exposing households to lifelong health risks. **Smoke inhalation can also contribute to respiratory infections, which are the leading killer of children under five years old globally.[12] The burning of waste and emissions from unmanaged dumpsites generate carbon dioxide, methane and nitrous oxide, all potent greenhouse gasses that are accelerating the pace of global climate change.[13]**

Poor waste management practices, especially in tourist destinations, can deter visitors and prevent expansion of the tourism sector.[14] Before the pandemic, tourism represented nearly 20 percent of Cambodia's GDP and remains key to Cambodia's economy and potential for economic growth.[15]

[9] Khan, A., Bisanzio, D., Mutuku, F. et al. Spatiotemporal overlapping of dengue, chikungunya, and malaria infections in children in Kenya. BMC Infect Dis 23, 183 (2023).

[10] World Bank. 2023. Cambodia Overview. Retrieved from https://www.worldbank.org/en/country/cambodia/overview

[11] Ministry of Environment. 2023. Official Website. Retrieved from https://www.moe.gov.kh/en

[12] Circular Economy Strategy and Action Plan, Cambodia. (2022). Prepared by the Department of Green Economy (DGE) of the Secretariat General for Sustainable Development (GSSD) of the National Council for Sustainable Development (NCSD), in collaboration with policy experts from UNDP and SIDA. Retrieved from https://www.undp.org/cambodia/publications/circular-economy-ce-strategy-and-action-plan?gad_source=1&gclid=Cj0KCQiAjMKqBhCgARIsAPDgWlzTo_jBImNjOEm02s5aGXoPiNl0NgiaMYdb9M_ai9CfPvshzJI9624aApwqEALw_wcB

[13] Circular Economy Strategy and Action Plan (n11) 12.

[14] United Nations Environment Programme. (2021). Rethinking Single-Use Plastic Products in Travel & Tourism. Retrieved from https://wedocs.unep.org/bitstream/handle/20.500.11822/36324/RSUP.pdf

[15] Worlddata.info. (2021). Tourism in Cambodia. Retrieved from https://www.worlddata.info/asia/cambodia/tourism.php

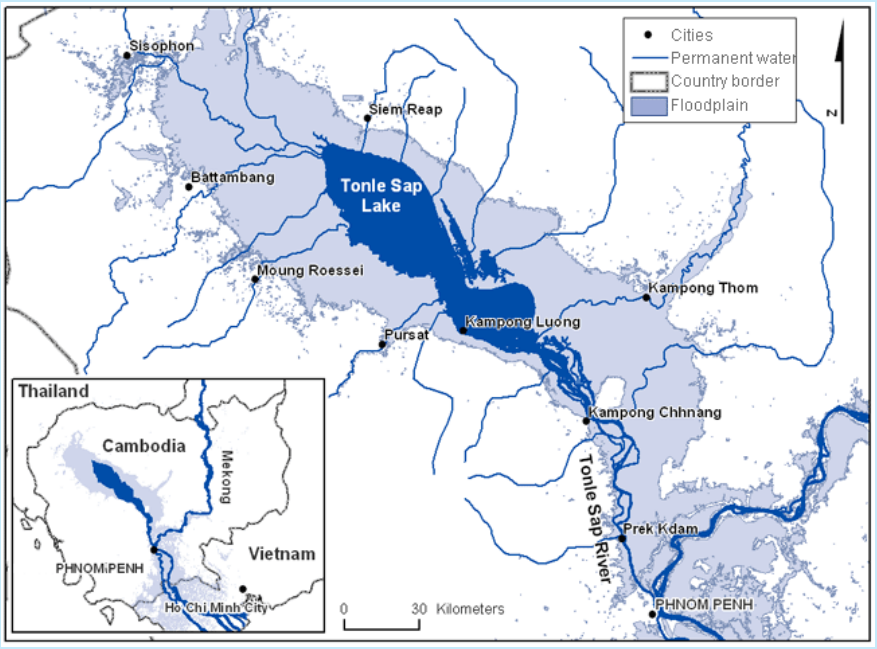
Sub-national administrations have recognized waste and solid waste management as a key priority to encourage tourism, acknowledging its significant impact on the enhancement of aesthetics, public order, and environmental quality.[16]

86 percent of Cambodia's territory, including 75 percent of the national population, are in the highly flood-prone Mekong River Basin. Waste is carried by floods into water bodies connected to the Mekong and have the potential to be carried all the way to the ocean.[17] [18] Asian rivers may release up to 86 percent of the global annual plastic input into the oceans. [19] [20] [21]

The Mekong River has the 10th largest water discharge in the world and is one of the highest plastic mass load inputs into the ocean.[22] **It is estimated that 221,700 tonnes of plastic entered the Tonle Sap Basin, which discharges into the Mekong River, from 2000 to 2020.** [23]

As 75 percent of Cambodia's population is based in rural areas, in order to reduce the burden of solid waste on health, the environment, and the economy, it will be critical to expand solid waste management systems outside of cities into Cambodia's rural communities. [24]

Figure 1: Tonle Sap and Lower Mekong Basin. Source: Mekong River Commission, 2006.



[16] The Phnom Penh Post. (2023). Waste management set as 'priority' for tourism industry, environment. Retrieved from https://www.phnompenhpost.com/national/waste-management-set-priority-tourism-industry-environment

[17] The Mekong River Commission. (2019). State of the Basin Report 2018. Vientiane, Lao PDR. Retrieved from https://www.mrcmekong.org/assets/Publications/SOBR-v8_Final-for-web.pdf

[18] Axelrod, N. (2016). The Role of the Mekong River in the Economy. WWF. Retrieved from https://wwfasia.awsassets.panda.org/downloads/key_findings_mekong_river_in_the_economy.pdf

[19] Jambeck, J.R., et al. (2015). Plastic waste inputs from land into the ocean. Science, 347, 768-771. Retrieved from https://jambeck.engr.uga.edu/landplasticinput

[20] Lebreton, L., van der Zwet, J., Damsteeg, JW. et al. River plastic emissions to the world's oceans. Nat Commun 8, 15611 (2017). https://doi.org/10.1038/ncomms15611

[21] Schmidt, Christian & Krauth, Tobias & Wagner, Stephan. (2017). Export of Plastic Debris by Rivers into the Sea. Environmental Science & Technology. 51. 10.1021/acs.est.7b02368. Retrieved from https://gwern.net/doc/economics/2017-schmidt-2.pdf

[22] Haberstroh, C. J., et al. (2021). Environ. Res. Lett., 16, 095009. DOI: 10.1088/1748-9326/ac2198. Retrieved from https://iopscience.iop.org/article/10.1088/1748-9326/ac2198

[23] Finnegan, A.M.D., & Gouramanis, C. (2021). Projected plastic waste loss scenarios between 2000 and 2030 into the largest freshwater-lake system in Southeast. Retrieved from https://www.nature.com/articles/s41598-021-83064-9

[24] World Bank (n1) 1.

Research Objectives and Methodology

Et jay, Ms. Nov Saroeun, collects recyclable waste from households in Kampong Luong, Pursat province.
Credit: Simon Toffanello

Research Objectives and Methodology

This paper examines SWM practices in three rural Cambodian provinces: Kampong Chhnang, Pursat, and Siem Reap. Its primary objective is to identify pressing issues within the SWM sector, pinpoint strategic improvements, and identify possible interventions. **Key research objectives look at:**

1. **Demand for rural SWM services, including market trends, household inclinations, incentives and obstacles related to access and utilization of services.**
2. **The rural SWM value chain, including collection, disposal, recycling, and resource recovery.**
3. **Public sector roles, policies, regulatory frameworks, and initiatives for rural SWM.**
4. **Possible opportunities for improvement and market facilitation within the sector.**

A mixed-method approach, integrating qualitative and quantitative research techniques, was used to evaluate the SWM market within the three target provinces situated in the Tonle Sap region of Cambodia.

Figure 2: Map of Research Locations

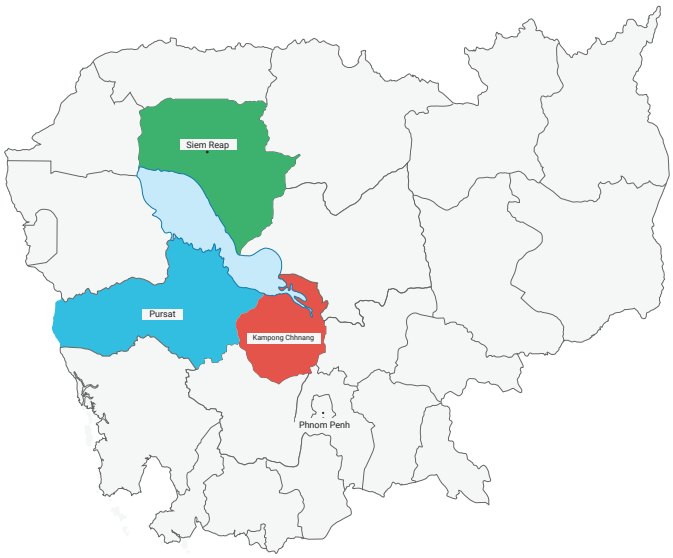
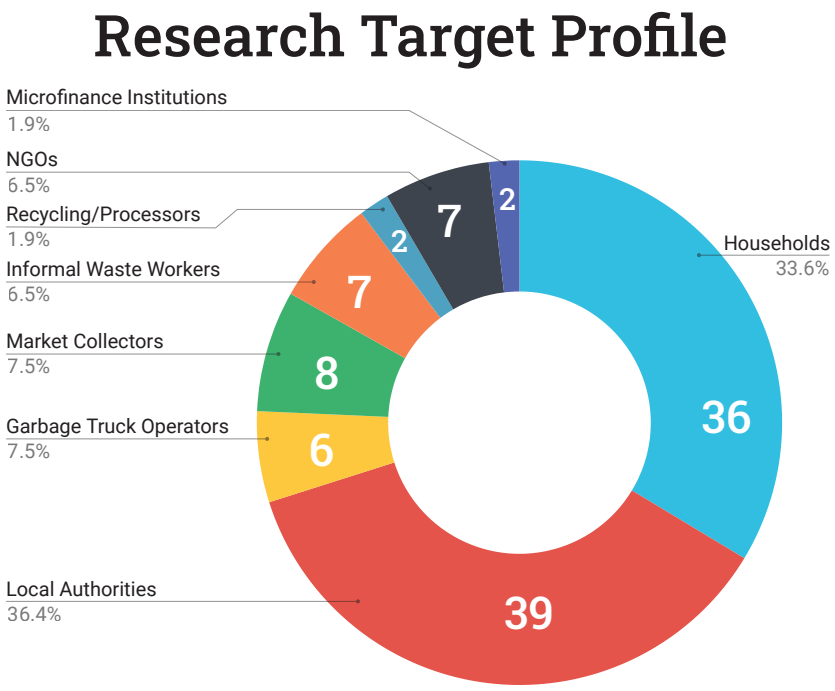


Figure 3: Research Target Profile



Data collection occurred in each of these provinces during a 12-day period in May and June 2023. The research encompassed interviews conducted with a diverse range of stakeholders, including households, supply chain participants, local government officials, development partners, non-governmental organizations (NGOs), educational institutions, and healthcare facilities. The data and information for these provinces were gathered using four primary data collection methods:

1. Key Informant Interviews:
Interviews with sector experts, government agencies and development partners with firsthand knowledge and experience in the Cambodian SWM sector.

a. In-depth Interviews. 60 minute interviews discussing behaviors, needs, challenges, and aspirations related to SWM.
b. Rapid Interviews. 20 minute interviews to validate insights and gather general feedback.

2. Focus Group Discussions:
Discussions to test ideas and foster consensus. An observational approach captured real-world behaviors and practices to ensure data mirrored actual actions rather than verbal claims.

3. Stakeholder Workshops:
Workshops to share results and validate findings as well as foster collaboration and engagement among SWM stakeholders.

4. Market Demand Testing:
Assessing customer willingness to purchase solidwaste collection services through real-world simulation of sales presentations to 274 rural households in three Tonle Sap-adjacent districts of Kampong Chhnang and Pursat province.

Market Trends

Plastic pollution along the Tonle Sap Lake in Pursat Province.
Caption: Simon Toffanello

Market Trends

The SWM landscape in Cambodia is rapidly evolving. As the nation confronts increasing waste generation, including industrial and hazardous waste, there is a growing demand for sustainable waste management solutions. International support from organizations and NGOs is playing a pivotal role in advancing waste management practices, while a notable shift toward decentralized waste management at the local level reflects a commitment to improving infrastructure and services. The following market trends are evident in rural Cambodia:

Increasing Waste Generation:

Cambodia has witnessed a significant increase in solid waste generation, with an average annual growth rate of over six percent between 2008 and 2020.[25] Already exceeding the global average per capita (0.78kg vs 0.74kg per day in 2020,[26] respectively), projections suggest this trend will persist, with an anticipated rise in daily solid waste generation to 1.16 kilograms per person per day by 2030 and 2.13 kilograms per day by 2050.[27] This increase is associated with population expansion (annual growth rate of 1.4 percent from 2008 to 2019 and urbanization (7.8 percent growth rate from 2008 to 2019).[28] As waste generation escalates, there is a corresponding increase in industrial and hazardous waste.

Increased Focus on Sustainable Waste Management Solutions:

Cambodia has recently made significant strides in advancing innovative solid waste management through the adoption of sustainable strategies and action plans. The Circular Economy (CE) Strategy and Action Plan, established in 2021, aims to guide the nation toward a circular economic model, aligning with global goals for economic prosperity, social inclusivity, and environmental sustainability. The National Waste Management Strategy (2018-

[25] Pheakdey (n2) 3.

[26] ibid 3.

[27] Development (NCSD)/Ministry of Environment (MoE). (2020). First Biennial Update Report of the Kingdom of Cambodia to the United Nations Framework Convention on Climate Change. Retrieved from https://unfccc.int/documents/232019

[28] National Institute of Statistics - Ministry of Planning. (2019). General Population Census of the Kingdom of Cambodia 2019: National Report on Final Census Results. Retrieved from https://nis.gov.kh/nis/Census2019/Final percent20General percent20Population percent20Census percent202019-English.pdf

2035) emphasizes the adoption of sustainable technologies, while the National Environment Strategy and Action Plan (2016-2023) outlines key policy tools and financing options aimed at promoting sustainable natural resource management and environmental protection. Moreover, Cambodia has shown its commitment to biodiversity conservation and sustainable waste management by endorsing the Bangkok Declaration on Combating Marine Debris in 2019.

Rise in International Support and Funding:

Global funding is trending towards pro-environment initiatives, including efficient waste management. Large funds of US$60 million and $180 million have recently been programmed by the World Bank and ADB, respectively, for waste management service and infrastructure development, improvements in revenue collection systems, and environmental sustainability in Cambodia.[29] [30] Bilateral funders including the United States Agency for International Development (USAID), the European Union (EU), GIZ, the Japanese International Cooperation Agency (JICA) are also currently supporting programs in Cambodia that are exclusively or partially dedicated to waste management, particularly plastics, often focusing on critical and protected ecosystems. Other bilateral donors active in Cambodia, including the UK Foreign Commonwealth and Development Office (FCDO) and the Swiss Agency for Development and Cooperation (SDC), have supported plastics and waste management initiatives throughout their international portfolios. UN agencies including the United Nations Development Programme (UNDP) and Environment Programme (UNEP) are actively funding and implementing plastics and solid waste management initiatives.

Several NGOs, social enterprises, and corporations including Chip Mong EcoCycle, Composted, Cambodian Rural Development Team (CRDT), Everwave, Fisheries Action Coalition Team (FACT), Fauna & Flora International, iDE, GEI Mekong, Global Green Growth Institute, GRET, River Ocean Cleanup, TONTOTON and others are actively involved in promoting sustainable waste management implementation and research initiatives. These combined efforts demonstrate growing sector attention to addressing waste management issues. Private funders, foundations and corporate-social-responsibility divisions of companies are also engaged in solid waste initiatives within Cambodia and the Asia Pacific region more broadly.

Geese pick through plastic waste to eat in Pursat Province. Caption: Simon Toffanello

[29] Asia Development Bank (ADB). (2021). $180 Million ADB Loan to Improve Urban Services in Cambodia. News Release. Retrieved from https://www.adb.org/news/180-million-adb-loan-improve-urban-services-cambodia

[30] The World Bank. (2020). Cambodia: Solid Waste and Plastic Management Improvement Project (P170976): Project Information Document (PID). Retrieved from https://documents1.worldbank.org/curated/en/722141586260533194/pdf/Concept-Project-Information-Document-PID-Cambodia-Solid-Waste-and-Plastic-Management-Improvement-Project-P170976.pdf

Solid Waste Management Value Chain

Waste collectors in Kratie Province.
Credit: Tyler Kozole

Solid Waste Management Value Chain

The rural solid waste management value chain in Cambodia includes waste generation, collection, transport, disposal, and recycling. The public, private, and informal sectors actively participate in the value chain. While each component of the value chain shows deficiencies in terms of safety, efficiency, and scale, rural waste collection and disposal services are particularly underdeveloped. Informal waste pickers and small-medium enterprises (SMEs) provide relatively consistent rural collection for valuable recyclables, including aluminum, scrap metal and, to a lesser but still significant extent, PET plastic bottles and cardboard. Conversely, formal waste collection services for non-recyclables rarely reach rural communities. When such services do exist, they often serve a small number of households, businesses, and public institutions closest to district towns. Waste disposal is primarily handled on-site by those who generate the waste through burning, open dumping or burying. The waste that is collected by collection services from district centers is often transported to unmanaged or informal dumpsites and regularly burned to minimize accumulation. While some landfills have recently been constructed that could be accessed by rural communities, they are largely unused.

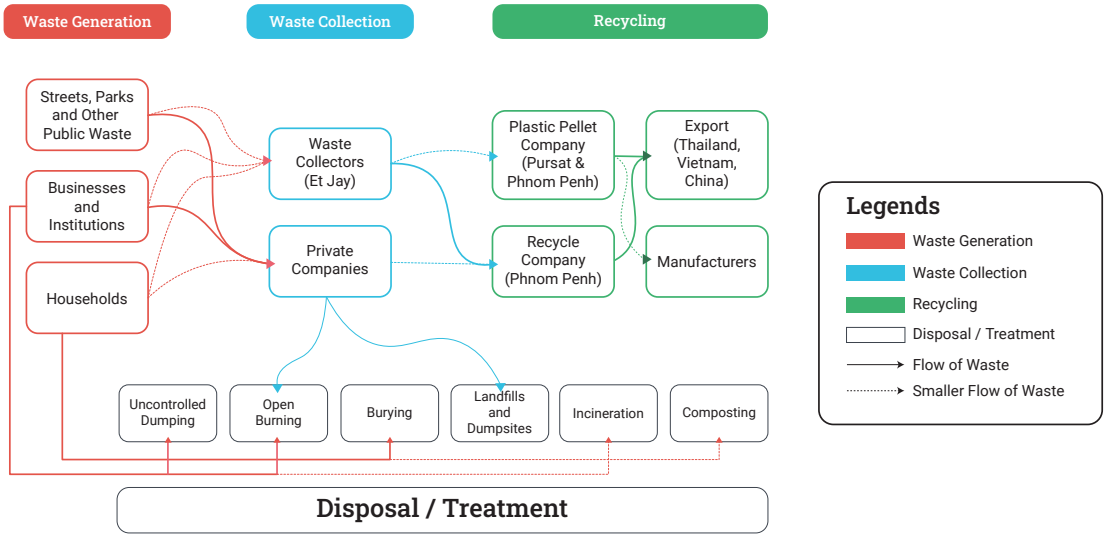


Figure 4: Solid Waste Value Chain Map

Waste Generation and Separation

The evolving socio-economic dynamics in rural Cambodia, catalyzed by economic expansion and urbanization, have significantly affected the types and volume of waste generated. This shift in consumer behavior has led to an increased variety of waste, primarily attributed to SUPs, packaging, and food waste. **Food waste constitutes the largest share, ranging from an estimated 54-80 percent in the examined provinces, followed by plastics at 3-15 percent, and other miscellaneous items at 0-15 percent.**[31] It is important to note that some of these figures are likely outdated, particularly from Siem Reap, where the most recent data available is from 2011. Considering the rapid development and shift in consumption patterns of rural Cambodia, there is a growing need for updated data on waste composition.

Key Actors & Challenges

Households:

Waste generation in rural households is influenced by family size, economic status, and consumer behavior. Household waste accounts for approximately 55 percent of generated waste in Cambodia.[32] Larger families and higher-income households tend to produce more waste. Consumer preference for single-use items, such as plastic bags and bottles, and a lack of awareness about waste reduction practices also drive the volume of waste. While some valuable recyclables, such as aluminum cans and PET plastic beverage bottles, are separated and sold to local waste collectors known as "et jays," systematic waste separation for efficient SWM remains limited. Rural communities do not yet express high levels of awareness regarding the environmental and economic benefits of waste separation and it is rare to observe use of differentiated waste bins for separate types of waste at private or institutional levels.

Waste separation practices are limited in rural Cambodia, posing challenges to the efficiency of recycling and waste collection efforts. Waste separation helps reduce the amount of waste that ends up in landfills, which in turn reduces greenhouse gas emissions and the risk of ground water contamination. From an economic perspective, waste separation can help reduce the costs associated with waste disposal and can create new job opportunities in the recycling industry.

Table 1: Waste Composition Breakdown (percent)

Province	Food Waste	Paper	Plastic	Metals	Textile	Glass	Wood/ Dry Matter	Other*
Kampong Chhnang	80	2	3	8	1	1	-	-
Pursat	50-65	2-4	10-15	2-6	2-4	4-6	1-2	10-15
Siem Reap	54	6	11	1	3	3	11	11

**Other waste items: ceramic, brick, inert materials, stone, etc.*
Table Data Source: Pheakdey (n2) 4.

[31] Pheakdey (n2) 4.

[32] IGES Centre Collaborating with UNEP on Environmental Technologies (CCET) of Institute for Global Environmental Strategies (IGES). (2020). State of Waste Management in Phnom Penh, Cambodia (Version 2, 2020). Retrieved from www.iges.or.jp / www.ccet.jp.

Travelers and Mobile Vendors:

Travelers often openly discard single-use items such as plastic wrappers and containers from snacks and beverages, contributing to the waste buildup along roadways, rest areas, and other public spaces. Mobile vendors, particularly those selling food and drinks, also generate significant waste in public spaces, especially during events, market days, or other gatherings. These businesses typically rely on single-use items such as aluminum cans, plastic bags, cups, bottles, and straws. While awareness of open waste littering is likely a barrier to improved waste management amongst travelers and mobile vendors, there is also a general lack of containers in public spaces where they can appropriately dispose of waste.

Businesses:

Local businesses, comprising markets, restaurants, food stalls, hotels, guesthouses, and shops, generate approximately 44 percent of the total waste generated.[33] Within markets, waste includes organic food waste and non-food packaging waste, such as plastic bags, styrofoam, plastic wrappers, cardboard boxes, and textiles. Notably, markets and public areas inadvertently become unofficial dumping sites for local residents and accumulation of waste often surpasses the market's waste storage and collection capacity.

Restaurants, food stalls, retail shops, and hotels generate comparable waste streams, including organic materials, plastics, aluminum cans, and potentially hazardous waste such as cleaning agents and chemicals.

Schools:

In Cambodian schools, the waste generated primarily consists of plastic waste (26 percent), grass/yard trimmings (24 percent), paper (23 percent), kitchen waste (nine percent) and textiles (one percent).[34] [35] Cumulatively, these materials amount to an estimated 91,426 tonnes of waste annually across Kampong Chhnang, Pursat, and Siem Reap, accounting for less than one percent of the total waste generated. [36] [37] There is a general lack of comprehensive waste separation in schools Though some schools have implemented initiatives for separating plastics and aluminum cans, other significant waste materials such as paper, organic materials, and textiles, remain overlooked.

Plastic waste scattered along the roadside in Boribo District, Kampong Chhnang Province. Credit: Tyler Kozole

[33] IGES (n29) 9.

[34] Department of Education Management Information System. (2019). Public Education Statistics & Indicators. Retrieved from https://data.opendevelopmentcambodia.net/en/library_record/public-education-statistics-and-indicators-2018-2019/resource/c6cd0699-4a73-4166-bd5d-ca694e64b961

[35] Japan International Cooperation Agency (JICA). (2005). The Study on Solid Waste Management in the Municipality of Phnom Penh in the Kingdom of Cambodia. Retrieved from: https://openjicareport.jica.go.jp/pdf/11784451_01.pdf

[36] Department of Education Management Information System (n31) 2.

[37] JICA (n32) 1-3.

A school in Kampong Chhnang province collects plastic bottles to sell to an et jay. Credit: Vann Theaven

Healthcare Facilities:

Waste from healthcare facilities is divided into two main categories: general waste and health care waste (HCW). General waste includes non-toxic and non-hazardous solid or semi-solid waste from health care establishments (HCEs) that is not contaminated with medical waste, such as food waste, paper, plastics, textiles, metals, glass, and garden waste. HCW, generated at healthcare facilities, laboratories, and clinics, consists of potentially infectious materials like human or animal tissue, blood, body fluids, drugs, swabs, vials, dressings, bandages, syringes, needles, and sharp instruments.[38] The Cambodian Ministry of Health (MOH) reports that approximately 80 percent of waste generated in healthcare facilities is general waste, while the remaining 20 percent is HCW and consists of materials containing harmful microorganisms that can lead to infections and outbreaks, along with other hazardous substances posing risks to human and animal health, causing toxicity, and contributing to environmental pollution. In rural healthcare settings, there is an estimated generation of 0.62 kg of general waste and 0.11 kg of HCW per bed per day. Infectious and pathological waste accounts for 15 percent, sharps for one percent, and chemical and pharmaceutical waste for three percent.[39]

Rural healthcare facilities lack formalized systems and equipment for segregating HCW (ex: using color -coded bags, sharps containers, or differentiated waste bins). According to the MOH, while basic segregation exists in MOH-supported hospitals, the procedures are not standardized and lack regular training.[40] Preventive measures to minimize waste generation, such as source reduction and inventory control are not regularly practiced by healthcare facilities in Cambodia.

Agriculture:

Agricultural waste in Cambodia includes crop residues (rice husks, rice straw, stems, and other plant parts), agricultural plastics (mulch, irrigation systems,packaging), and hazardous materials (pesticides, insecticides, chemicals). Despite agriculture contributing about 22 percent of GDP and involving 57 percent of households in production, there is limited available data on the waste generated from these activities. [41] [42] According to the International Journal of Environmental

[38] Ministry of Health. (2011). Technical Guidelines on Healthcare Waste Management. Retrieved from https://niph.org.kh/niph/uploads/library/pdf/GL012_HCW_Guideline_Eng.pdf

[39] Ministry of Health, Cambodia, for the Asian Development Bank. (2016). Cambodia: Greater Mekong Subregion Health Security Project (Additional Financing). Publisher/Source. Retrieved from: https://www.adb.org/projects/documents/gms-health-security-project-cam-oct-2016-iee.

[40] Ministry of Health (n35) 36.

[41] The World Bank. (2022). World Development Indicators. Agriculture, forestry, and fishing, value added (percent of GDP) - Cambodia. Retrieved from https://data.worldbank.org/indicator/NV.AGR.TOTL.ZS?locations=KH

[42] National Institute of Statistics, Ministry of Planning. (2020). Cambodia Agriculture Survey 2020 Final Report. Retrieved from https://www.nis.gov.kh/nis/Agriculture/CAS2020/CAS2020_Final_Report_EN.pdf

and Rural Development, annually, Cambodia generates over 12 million tonnes of by-products of rice (8.6 million tonnes), corn (2.9 million tonnes), and cassava (0.9 million tonnes). However, only 55 percent of rice straw, utilized for cattle feed, mushroom feedstock, and mulch-based vegetable production, is collected, while the remaining 45 percent is burned or left to degrade. Similar practices are observed for cassava, with approximately 25 percent of cassava stems being utilized for seedlings, while the remaining 75 percent is burned. [43]

Approximately 515,450 tonnes of agricultural plastic waste is generated annually in Cambodia, constituting up to 12 percent of the total waste generated in the country.[44] The widespread use of plastic mulch, driplines, and plastic nets contributes significantly to this total. A substantial amount of plastic waste, especially plastic mulch, is often left in fields. This practice leads to the release of microplastics into the soil, subsequently entering rivers and groundwater. Moreover, due to the absence of waste management infrastructure in rural areas, a majority of farmers resort to burning (95 percent) or burying (3.3 percent) their plastic waste.[45] The high price of plastic alternatives (such as biodegradable plastic) hinders reduction of agricultural plastic waste. [46]

Collection and Transportation

Although organized waste collection systems have been successful in urban and some peri-urban regions of Cambodia, waste collection in rural areas is limited and shows regional disparities (see Table 2). According to the Ministry of Environment, waste collection services cover around 40 percent of households in Cambodia, extending to 28 cities and 162 districts.[47] However, outside of cities, district level waste collection services only extend to approximately 18 percent of households.[48] In the research sites, the coverage rates in the provincial towns were found to be approximately 19 percent in Krong Kampong Chhnang, 21 percent in Krong Pursat, and 39 percent in Krong Siem Reap. At the district level, the coverage rates were notably lower, standing at about three percent in both Boribor (Kampong Chhnang) and Krakor (Pursat). These figures underscore the challenges and disparities in waste collection services, particularly in more rural and remote areas.

Key Actors & Challenges

Waste Collectors ("Et Jay"):

Waste collectors, commonly referred to as "et jay," primarily gather and sell recyclable materials, focusing on plastics, metals such as aluminum cans and copper wire, and cardboard. They collect from households, businesses, and landfills/dumpsites. These collectors often build a degree of trust and familiarity within their communities and some waste generators (including schools, businesses, and households) express a degree of loyalty to individual et jays. Et jays are often informal workers, however they usually sell their products to larger,

[43] Dyna Theng et al. Production and Utilization of Crop Residues in Cambodia: Rice Straw, Corn Stalk, and Cassava Stem. 2021. Retrieved from https://iserd.net/ijerd122/12-2-17.pdf

[44] Rianawati, E., Azizi, A., Larasati, M., Dewanto, R. H. (2023). A Study of Horticulture Plastic Products: Environmental Impact in Cambodia. Resilience Development Initiative (RDI).

[45] Dyna Theng et al (n38) 8.

[46] ibid 8.

[47] Dek (n5) 4.

[48] Dek (n5) 4.

more formalized et jays who have assets like waste compactors (balers) and trucks. These larger et jays often aggregate at commune or district levels and transport waste to other provinces, often near urban centers like Phnom Penh or Battambang, to sell to recycling facilities.

Et jays make slim profit margins due to the relatively low price for waste sold in addition to a wide range of variable, unpredictable costs. Et jays are often faced with poor road quality, making travel to remote locations untenable at times (especially during the monsoon season) and usually a time-consuming process that can risk damaging their vehicles. Lack of storage locations for waste that they have collected is also a constraint for many smaller et jays, resulting in the need for them to take frequent trips to sell their products. Et jays often face income instability due to fluctuating material prices and competition. Due to their lack of storage capacity and often the immediate need for income, smaller et jays have little bargaining power to negotiate selling prices with buyers.

Et jays are often exposed to hazardous materials including chemicals, pathogens (through organic waste) and sharp objects. They seldom wear personal protective equipment (PPE), and sometimes children are engaged in this process alongside parents or other family members.

Private Waste Collection Companies:

Privately owned garbage truck services often serve urban and peri-urban areas but rarely serve rural communities. Service provision often revolves around district market locations, as the collection companies frequently get permission to collect waste from district administrators in connection to these markets. Broader service provision to peri-urban and rural locations may at times be required by the government as a stipulation in their contract. Service providers report that district market areas and nearby homes and businesses are more profitable than more distant surrounding areas, noting that the revenue from serving such locations enables them to cover some costs of venturing farther away from these population centers.

Compressed recyclable waste at a junk shop in Kampong Chhnang Province. Credit: Claire Meyer

Waste collection services providers manage relatively low profit margins with high costs associated with staff compensation and vehicle operations and maintenance. Short contract durations, some of which can be as little as a year, disincentivize service providers from making long-term investments in the durability or quality of their assets.

Service providers themselves are often expected to collect service fee payments from households and businesses. Many express challenges collecting regular and complete amounts. Waste truck operators often have no way of knowing which households have paid for services, at times opting to simply collect all household waste within a given area (or not). Service provision routes are not always planned for efficiency, and the variety of unwieldy waste containers (or simply loose waste) they are required to empty prevents efficient loading during stops. Households have expressed a lack of trust in the reliability of waste collection service providers to regularly collect waste, which manifests in a lack of willingness to pay.

As waste is loaded onto trucks, waste truck employees are often sorting valuable recyclables, which they later sell as a group to boost their income. This separation process is tedious and time consuming, often reducing the collection speed and efficiency of waste trucks. Waste that is not separated for sale to collectors is often dumped at open dump-sites, which are sometimes far from the areas where waste is collected. At times, service providers are known to dump informally to reduce the burden of transporting waste long distances.

Collection service employees, usually young men, aged between 14-25, face significant safeguarding risks through heavy lifting, proximity to heavy machinery, and daily direct exposure to large quantities of untreated and hazardous waste. Employees at times report working daily shifts of 12-14 hours, much of which is in the dark. These challenging working conditions lead to high staff turnover rates.

Collection service providers report limited engagement with local authorities beyond the initial contracting process. They lack performance benchmarks and rarely report back to contracting authorities.

Market Opportunity for Household Waste Collection

The total addressable market for waste collection in Kampong Chhnang, Pursat, and Siem Reap, as detailed in Table 2, signifies the overall number of households without access to formal waste collection services, highlighting a considerable market opportunity for improving solid waste management practices. It should also be noted that households already reached by services are not necessarily receiving reliable or quality service delivery, and are not necessarily paying the full amount requested of them by local authorities and service providers.

Table 2: Total Households, Collection Coverage and Total Addressable Market by District.

Province	District	Total Households[49]	Coverage Rate (percentage of households paying for a service)*	Total Addressable Market (Households)**
Kampong Chhnang	Krong Kampong Chhnang	9,398	19 percent	7,613
	Boribor	13,628	3 percent	13,220
Pursat	Krong Pursat	14,094	21 percent	20,509
	Krakor	23,468	3 percent	22,764
Siem Reap	Krong Siem Reap	56,107	39 percent	34,225

**Coverage rate calculated as the total number of households currently paying for and receiving collection services (as reported by district-level waste collectors) divided by the total number of households in the district.*

***Addressable market calculated as the total number of households minus the number of households currently accessing collection services.*

A commonly reported perception among local authorities, service providers, and SWM implementers from the NGO community is that households in rural areas are unwilling to pay for waste collection services. In partnership with sales consultancy Whitten and Roy Partnership (WRP), iDE used a lean demand generation rapid trial (sales trial), to assess consumer willingness to pay for a rural solid waste management/collection service.

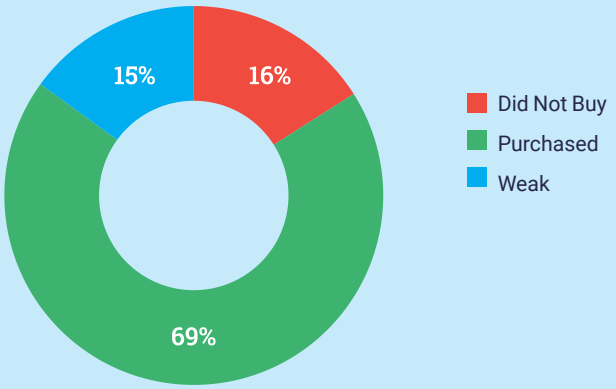
In this method, a professional sales agent conducted sales presentations for a hypothetical, twice-weekly solid waste collection service in three rural communes in the east Tonle Sap Lake area: two in Kampong Chhnang province (Chhnok Tru, Boribor District and Kampong Hau, Kampong Laeang Disrict) and one in Pursat (Kbal Trach, Krakor District). Some 274 households were visited with sales presentations, distributed roughly equally per commune. Households were offered the option to pay KHR 10,000 (USD 2.50) for a one-month subscription or KHR 50,000 (USD 12.50) for a six month subscription.

Customer willingness to pay was based on individuals' responses in this simulated sales experience, which they perceived as a true sales experience until after the purchasing decision was made. After households made a purchasing decision, the sales agent informed them that this was a trial for the purpose of assessing local demand for services. Data was recorded on securing their informed consent. Only households which affirmed willingness to buy, with cash in hand, were determined to be "buying" households.

The research team found that 69 percent of the 274 households which received a sales presentation were willing to pay USD 2.50 (10,000 KHR) per month. An additional 15 percent claimed they were willing to purchase, but did not present cash at the time of the sale (considered "weak commitment" in Figure 6 below).

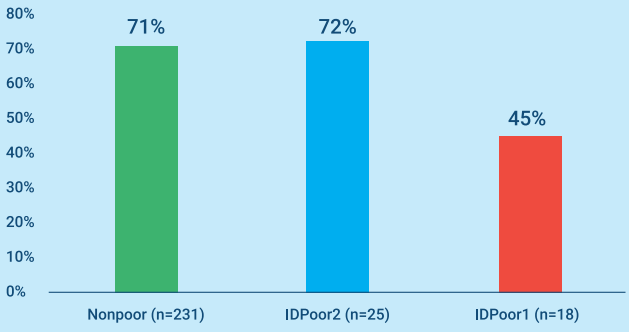
[49] National Institute of Statistics (n23) 156, 184, 185, 190.

Figure 5: Percentage of Household Purchasing Decisions for SWM Collection Service (n=274)



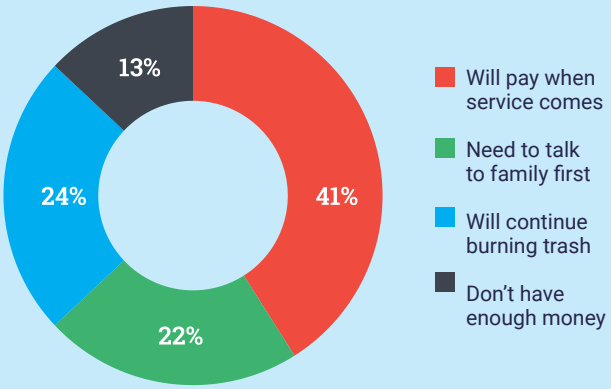
Of all IDPoor 2 households engaged (n=25), 72 percent agreed to purchase compared with 71 percent of all non-poor households (n=231).[50] Of IDPoor1 households engaged (n=18), 45 percent agreed to purchase. While these results do not represent a statistically representative subset of IDPoor households, this initial finding suggests that cost may only be a purchasing barrier for the very lowest income households.

Figure 6: Percentage of Household Purchasing Decisions Among IDPoor and Non-Poor Households (n=274)



Of the 85 household representatives who responded that they were not interested in purchasing at that time, the largest proportion, 41 percent, reported that their main reason for not purchasing was that they would pay when the service actually arrived. Only 13 percent reported that KHR 10,000 per month was too expensive for this service. However, considering the difference in purchasing behaviors between the most impoverished households and the proportionately more wealthy households, cost of service provision must still be considered an important barrier to community-wide service adoption.

Figure 7: Reason for Purchasing Objections Among Non-Purchasing Households (n=85)



Nearly all households who made decisions to purchase (97 percent) opted for the one-month subscription rather than the six month plan. This indicates a low level of trust in service provision and an indication that quality of service provision will determine continued payments from households. This point is further corroborated by the large number of households which, as mentioned above, expressed interest in paying if and when services actually arrive. As such, a limitation of this research is that these figures do not account for customer willingness to pay consistently over time.

[50] The IDPoor system is the Cambodian government's national poverty registration system, implemented and managed by the Ministry of Planning. IDPoor 1 households are considered to be the most impoverished, followed by the proportionally less-impoverished IDPoor 2. Non-poor households are considered by the government to not be living in poverty.

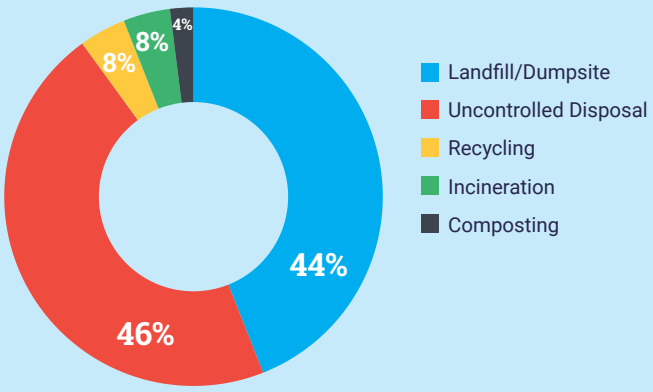
Willingness to Pay for Waste Collection Services

In general, this research indicates a latent level of demand for household-level waste collection services in the surveyed rural areas. Further testing will be needed to indicate whether or not this finding applies to other rural areas. It is important to note that these households were approached by an experienced sales agent using a professional sales approach. This reinforces the notion that there is opportunity for behavior change through a value-driven, household-focused approach rather than through a more traditional, education-focused, community-based approach.

Disposal Methods & Challenges

Waste disposal in Cambodia mainly involves uncontrolled dumping, landfills/dumpsites, and incineration. **Uncontrolled dumping, the most common practice, includes burning, burying, and discarding trash, and accounts for approximately 46 percent of the total waste generated in Cambodia.**[51] Burning waste is often done informally and the practice is distinct from incineration, which implies complete destruction of waste through sustained and controlled heat at extremely high temperatures. Burning alone constitutes 50 percent of uncollected waste, which presents risks to both the environment and health. [52] **Landfills and open dumpsites account for approximately 44 percent of waste disposal, but their implementation across provinces faces operational challenges.** Incineration makes up a modest four percent of waste disposal and encounters difficulties in both small and large-scale implementation.

Figure 8: Percentage of Waste Disposal Types [53]



Landfills/Dumpsites:

Cambodia's MSW management heavily depends on landfills and open dumpsites, constituting 44 percent of waste disposal.[54] The vast majority of these are understood to be open dumpsites, which are essentially unmanaged waste storage locations where waste is deposited, sometimes with excavated trenches for storage and perimeter barriers such as fences. Dumpsites are sometimes privately owned by waste collectors, publicly owned by municipalities, or informally established without a specific private or public designation for waste disposal. Informal waste collectors are often able to freely access these sites to extract valuable recyclables. Waste collection service operators and informal collectors note that they will at times burn these sites to reduce volume, making it easier to access and identify new, unsorted waste that could contain valuables, respectively.

Engineered landfills, conversely, are high-investment facilities with environmental controls and management processes, including regular compacting, soil cover, leachate treatment, gas management systems, hazardous waste storage, and material recovery facilities. Nationally-collected data often groups the two types of sites. According to the Ministry of Environment, the country hosts 213

[51] Pheakdey (n2) 11.
[52] Godlove, C., & Pak, K. (2020). Scoping Study Report on Municipal Solid Waste Management in Kep Province.
[53] Pheakdey (n2) 11.
[54] Pheakdey (n2) 10.

Pursat Landfill
Credit: Asian Development Bank

landfills and dumpsites, with 142 state-owned and 70 private sites, collectively receiving over 10,000 tonnes of MSW daily[55] .

The current market assessment identified one engineered landfill in both Kampong Chhnang and Pursat and none in Siem Reap. Both of these two landfills were designed and constructed with ADB funding. Seven dumpsites were identified in Kampong Chhnang, 10 in Pursat, and 11 in Siem Reap. These dumpsites range in size, degree of management, and type of ownership. At least nine engineered landfills have been constructed across Cambodia, seven with ADB funding (Battambang, Kampong Chhnang, Kampong Thom, Kampot, Kep, Kratie, and Pursat) and two with national government funding (Phnom Penh and Sihanoukville). Three additional ADB-funded landfills are currently under construction in Banteay Meanchey, Kampong Cham, and Steung Treng. Interviews with local authorities and implementers indicate that challenges over institutional roles and responsibilities, including budgeting, are barriers to the sustained and efficient use of these engineered landfills. Operation and maintenance (O&M) strategies for landfills are individually determined by either the Provincial Department of Environment or the district administration, leading to a divergence in concepts, designs and approaches nationally.

Uncontrolled Dumping:

In rural areas where formal waste collection services are lacking, households and businesses often resort to uncontrolled disposal methods such as burying waste, dumping in open areas, and disposing of waste in water bodies. On average, households engage in uncontrolled dumping about every two days,[56] contributing to approximately 46 percent of MSW in Cambodia.[57] This prevalent practice leads to soil and water contamination. In water body-adjacent communities, waste is frequently disposed of in the water, while non-flooded communities tend to rely more on waste burning.

[55] Neth Pheaktra. Interview on Solid Waste Management in Cambodia. Khmer Times, 2022. Retrieved from https://www.khmertimeskh.com/501141817/5000-tonnes-of-daily-waste-not-dumped-in-landfills/

[56] Edward Creaser, Jeremy Smith, Andrew Thomson PhD. (2018). Perspectives of Solid Waste Management in Rural Cambodia. Research School of Engineering, The Australian National University. Retrieved from https://jhe.ewb.org.au/index.php/jhe/article/view/125

[57] Pheakdey (n2) 11.

Uncontrolled dumping of waste has polluted the environment around the homes of those living near the Tonle Sap Lake. Credit: Tyler Kozole

Burning:

Burning waste out in the open is common practice in rural Cambodia, with households engaging in this activity approximately every three days, on average. [58] Open burning accounts for more than 50 percent of the waste not collected by formal service providers.[59] Burning occurs at households and businesses, often on their own properties or in nearby public areas. Burning waste is hazardous and releases harmful pollutants into the air, including particulate matter, volatile organic compounds, and carcinogenic substances, such as dioxins, contributing to environmental and health risks.

Schools and healthcare facilities often burn their waste. Some schools have allocated specific waste pits for burning generated trash on their premises. At the district and commune levels, the Ministry of Environment has introduced waste stoves to burn waste, currently used by two healthcare centers in the research area. However, broader implementation of these waste stoves encountered challenges, including issues with waste transportation, insufficient human resources, and a lack of financial support, leading to an unsuccessful implementation.

Incineration:

Incineration accounts for approximately four percent of waste disposal.[60] Incineration is a high-temperature waste treatment process, reaching temperatures between 900 and 1000 °C, breaking down waste into chemical components through oxidation while generating both heat and energy. It can reduce waste mass by 80-85 percent and volume by 95-96 percent.[61] Cambodia currently lacks large-scale incineration for MSW management, with the exception of Chip Mong's Ecocycle co-processing facility, which is converting waste into heat energy for cement production (see Waste to Energy Section below). Small-scale incinerators have been introduced to address waste challenges in urban and some rural communities. By 2021, at least 54 such incinerators operated in the country, each with a capacity between one and eight tonnes per hour. [62] In our research area, Pursat had

[58] Creaser (n42) 22.

[59] Pheakdey (n2) 14.

[60] Pheakdey (n2) 11.

[61] Pooja G. Nidoni. Incineration Process For Solid Waste Management And Effective Utilization Of By Products. 2017. Retrieved from https://www.irjet.net/archives/V4/i12/IRJET-V4I1270.pdf

[62] Royal Government of Cambodia (RGC). Urban Solid Waste Management Policy 2020-2030. 2021. Retrieved from https://data.opendevelopmentcambodia.net/laws_record/urban-solid-waste-management-policy-2020-2030/resource/7e20235a-9a2d-4183-beca-4e185bd19bf8 (In Khmer)

two incinerators, Siem Reap had four, while Kampong Chhnang did not have any. These incinerators were primarily located in health centers and were primarily used for treating hazardous waste. Challenges include resource constraints for setup and operational costs for small-scale incinerators, while large-scale incinerators require significant investments and technical expertise, which are often lacking in rural areas. Both types of incinerators raise environmental concerns related to emissions of greenhouse gasses.

Recycling, Waste to Energy and Composting

Recycling, waste to energy initiatives, and composting present a growing but still underdeveloped opportunity for reuse and value extraction of waste in rural Cambodia. **Collection of select recyclable materials, namely metals and PET plastic are relatively common in rural areas, as noted above. However, high capital investment requirements for machinery and infrastructure have impeded the development of a domestic recycling industry that includes end-stage processing, including plastic pelletization and metals melting.** Waste-to-energy initiatives face similar capital investment barriers. Composting, despite requiring few resources, remains uncommon.

Recycling:

Recycling is the process of collecting, sorting, processing, and converting discarded waste materials into raw materials for the production of new products. While in Cambodia, the revenue recovered from recyclables has increased from $25.6 million in 2010 to $56.3 million in 2021, recycling still only constitutes four percent of the country's waste disposal.[63]

Rural areas heavily depend on informal collectors who collect from local businesses and households and sell recyclables to larger collectors who then transport recyclables either to Phnom Penh's recycling facilities or export raw materials to neighboring countries such as Thailand and Vietnam. Most recyclables are processed to some degree in-country (compacted and/or shredded), however final processing including plastic pelletizing and metal melting is primarily done in neighboring Thailand or Vietnam.[64] This heavy reliance on informal collection is due to the lack of established infrastructure and limited public awareness about recycling in rural regions. Additionally, the absence of household-level

Compressed recyclable waste at a junk shop in Kampong Chhnang Province. Credit: Claire Meyer

[63] Pheakdey (n2) 13.

[64] SEA circular. (2020). Country Profile Cambodia. Retrieved from https://www.sea-circular.org/wp-content/uploads/2020/05/SEA-circular-Country-Profile_CAMBODIA.pdf

Waste pickers sort waste at a dumpsite in Kratie Province. Credit: Tyler Kozole

waste separation reduces the efficiency of rural recycling initiatives and compromises the quality of the recycled materials they generate.

With Thailand and Vietnam set to close their borders to recyclable plastic waste by 2025, Cambodia faces the challenge of identifying new export markets or establishing a domestic plastic recycling system. [65] [66] This would involve developing facilities like bottle-to-bottle recycling plants specifically designed for PET bottles, ensuring the country can adapt to changing regional dynamics and contribute to environmental sustainability.

Plastic Pelletizing:

Plastic pelletizing processes convert scrap plastic into reusable materials. These facilities are uncommon in Cambodia, especially in rural areas. The high capital costs of industrial equipment, the large volume of plastic intake necessary for profit, and variability of the quality of received plastic impede business viability. [67] [68] Market actors interviewed during the research indicated that fluctuations in the price, type, and quality of plastic, both in domestic and international markets, contribute to uncertainty and are a barrier to investment. Limited access to industrial inputs, including water, energy, and wastewater treatment, prevent the development of operational, sustainable, and safe recyclable processing. For example, a plastic pelletizing facility interviewed in Pursat, designed to handle around 500 tonnes of plastic waste annually, remains non-operational due to water access issues. As a result, a considerable amount of Cambodia's plastic is exported to neighboring countries.

Waste-to-Energy (WtE):

Waste-to-energy (WtE) converts non-recyclable waste into usable energy, such as electricity, heat, or fuel through incineration. In Kampot province, Chip Mong Eco-Cycle co-processes waste, including garment and footwear waste, rubber, plastic, oil, paint, pesticides, and agrochemical waste, among others, to create energy for cement production. The facility has the capacity to process up to 30 tonnes of waste per hour.[69] The KH09 Waste-to-Energy initiative, implemented by the Global Green Growth Institute (GGGI), conducted a pre-feasibility study in 2019 with the goal of establishing a centralized Refuse-Derived Fuel (RDF) facility in Phnom Penh to reduce coal usage in the city's cement manufacturing sector. Other projects, such as GEI Mekong's pyrolysis solutions in Phnom Penh and a Siem Reap municipal waste project, are exploring the feasibility of implementing waste-to-energy solutions.

While waste-to-energy technology has the potential to significantly reduce the amount of landfill waste, high initial investment and operational expenses have prevented the proliferation of such industrial -scale facilities in Cambodia. Lack of public waste segregation also presents a barrier for these initiatives, as wet, organic waste is not an effective fuel for energy conversion.

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[65] Igini, M. (2023). Thailand Announces Ban on Plastic Waste Imports by 2025. EARTH.ORG. Retrieved from https://earth.org/thailand-ban-plastic-imports/#

[66] Nguyen, D. (2019). Vietnam to end plastic scrap imports from 2025. VnExpress International. Retrieved from https://e.vnexpress.net/news/business/economy/vietnam-to-end-plastic-scrap-imports-from-2025-3900351.html

[67] United Nations Environment Programme. (2022). Marine Litter in Cambodia: A Situation Analysis and Recommendations for Planning and Action. Retrieved from https://wedocs.unep.org/bitstream/handle/20.500.11822/41423/marine_litter_cambodia.pdf?sequence=3&isAllowed=y

[68] Quicksand (n5) 6. 52, 54.

[69] Weerasinghe, J., & Chip Ming Ecocycle. (2023). Co-Processing of Hazardous Waste in Cement Kiln. Retrieved from https://uncrd.un.org/sites/uncrd.un.org//files/11th3r_ps-5-ppt-3.pdf

Composting:

Composting, defined as a controlled, aerobic (oxygen-required) process that converts organic materials into a nutrient-rich soil amendment or mulch through natural decomposition, provides an opportunity for waste reduction and resource recovery. Organic waste accounts for over 50 percent of the total waste generated in Cambodia; however, only about 2 percent of total waste is composted. [70] Some informal composting occurs in rural farming communities. At present, only a few small-scale composting facilities are operational in Cambodia. These facilities typically employ an onsite composting method, involving the creation of an aerated pile containing food waste, yard trimmings, and animal products. Limited awareness of benefits and techniques and absence of suitable infrastructure, such as bins and designated areas, hampers composting adoption within households and communities.

A large-scale composting facility exists in Battambang, linked to the landfill and resource recovery center. An additional composting facility is nearly complete in Siem Reap, operated by Ecofarm, an agricultural cooperative in the area, with support from GRET and the Improving Service Delivery for Citizens in Cambodia (ISD) project, which is co-funded by GIZ and the Swiss Agency for Development and Cooperation (SDC). This plant is to be operated by Ecofarm under a public-private partnership contract with Sotr Nikom district. The facility will sort valuable organic waste and convert it into high-quality fertilizer using vermicomposting.

[70] Pheakdey (n2) 14.

Role of Women and Children in Solid Waste Value Chain

Market waste collector ("phasi") in front of their waste truck in Krakor District, Pursat.
Credit: Tyler Kozole

Role of Women and Children in Solid Waste Value Chain

Role of Women

In Asia, more than 95 percent of individuals engaged in recovering specific types of plastics for recycling are informal workers, with women comprising the majority of this workforce in certain countries in the region.[71] In Phnom Penh alone, there are at least 2,000 informal waste workers, predominantly women, who participate in daily garbage collection, concentrating on gathering recyclables from dumpsites, landfills, and streets. [72]

In rural areas, women also play an active and valuable role in informal waste collection from communities and dumpsites. They often work in hazardous and unsanitary environments, lacking proper protection and safety measures. Due to their informal working status, these women are often excluded from social services, legal protection, and other benefits associated with formal employment. This exclusion exacerbates the health and environmental risks they face.[73] Women working in the SWM sector generally earn disproportionately less compared to men, which is further compounded by the low value assigned to plastic and other recycled waste. [74]

Globally and within Cambodia, there is a lack of descriptive, quantitative data on women in waste management.[75] Much of the information available is qualitative, which while valuable, does not characterize the full scale of involvement and challenges faced by women waste collectors.

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[71] The Phnom Penh Post. (2022). Uplift the forgotten women behind Asia's plastic waste recycling systems. Retrieved from https://www.phnompenhpost.com/opinion/uplift-forgotten-women-behind-asias-plastic-waste-recycling-systems

[72] Eitel, K. (2019). Waste Pickers - A Brief History of Cambodia's Plastic Crisis. Southeast Asia Globe. Retrieved from https://southeastasiaglobe.com/home-7/

[73] Ibid 17.

[74] USAID. Women's Economic Empowerment and Equality (WE3) Technical Assistance. (2019). Municipal Waste Management and Recycling WE3 Gender Analysis Report. Retrieved from https://pdf.usaid.gov/pdf_docs/PA00TQSH.pdf

[75] USAID (n72) 16.

Involvement of Children

Within families engaged in informal waste collection, it is common for children to be in some way engaged in the work. Financial desperation and lack of options for childcare drive the participation of children in SWM, both in rural and urban contexts.[76] In Anlong Pi dumpsite in Siem Reap, around 300 informal waste pickers, including over 100 children, depend on collecting recyclable materials for their livelihoods. These children endure extended work hours, often laboring up to 10 hours a day in environments that pose significant health risks.[77] [78] Children are exposed to injuries from broken glass, sharp objects, and contaminated materials, which not only impact their immediate health, but also lead to long-term health complications if left untreated.[79] The involvement of children in SWM, as with other types of child labor, prevents children from attending school and limits their potential to break cycles of generational poverty.

At the household level, children are also disproportionately vulnerable to the impacts of poor waste management. The common practice of burning waste, especially plastics, exposes children to serious health risks. Smoke inhalation can also contribute to respiratory infections, which are the leading killer of children under five globally.[80]

Woman and child at a dumpsite in Kratie Province. Credit: Tyler Kozole

[76] Sartori, S. (2016). Tourism and waste management: the sustainability challenge. SWITCH-Asia Network Facility. [Online]. Retreived from https://www.switch-asia.eu/backup-content/tourism-and-waste-management-the-sustainability-challenge/

[77] Board, J. (2018): With Cambodia 'drowning in a wave' of waste, plastic could be banned at Angkor Wat. Channel News Asia, 30.06.2018. [Online, last accessed: 15.03.2020]

[78] Sartori, S. (n69).

[79] Verma, R., Vinoda, K.S., Papireddy, M., & Gowda, A.N.S. (2016). Toxic Pollutants from Plastic Waste - A Review. Procedia Environmental Sciences, 35, 701-708. https://doi.org/10.1016/j.proenv.2016.07.069.

[80] Circular Economy Strategy and Action Plan (n11) 12.

Institutional Arrangements and Frameworks

Waste bins from GIZ-funded 3RproMar project in Kratie Province.
Credit: Tyler Kozole

Institutional Arrangements and Frameworks

The Cambodian national and subnational institutional arrangements, mandates, and frameworks for SWM determine the levels and nature of technical support, funding, private sector engagement, and regulations affecting the sector. While mandates and policies have typically revolved around urban and provincial town contexts, they provide a framework for expanding solid waste management service delivery to rural spaces.

Policy and Regulatory Framework

In Cambodia the public institutional landscape for SWM is composed of laws, subdecrees, and guidelines. These policy documents include a range of themes including designation of mandates and authority, setting incentives and requirements to reduce waste generation, and providing guidelines, standards and regulations for pollution control and SWM implementation and monitoring. These policy documents are national in scope and include rural and urban areas in their mandates. The table below presents key national policy documents associated with solid waste management.

Table 3: Solid Waste Policies 1996-2021

Policy	Date	Summary
Law on Environmental Protection and Natural Resource Management	1996	• Designates the MoE as the primary authority for developing policies, regulations, and coordinating waste management and pollution control efforts. • Mandates environmental impact assessments for projects before government approval, supports sustainable resource use, fosters public engagement in environmental protection, and bans environmentally harmful activities.
Sub-Decree No. 36	1999	• Regulates SWM with a focus on technical expertise and safety. Aims to protect public health, preserve environmental quality, and conserve biodiversity. • MoE tasked with creating guidelines for the proper disposal, collection, transportation, storage, and recycling of waste; responsible for establishing guidelines related to the management of hazardous waste. • Provincial and city authorities responsible for developing waste management plans for their respective regions, covering short-term, medium-term, and long-term strategies.
Environmental Guidelines on Solid Waste Management in Kingdom of Cambodia	2006	• Provides guidelines for establishing SWM plans for authorities and private sector actors • Provides instructions on landfill operation and closure • Provides composting methodologies • Addresses the management of hazardous medical waste • Guides public education on SWM
Sub-Decree on water pollution control, No. 27 ANRK.BK	2009	• Establishes regulatory measures for water pollution control to prevent and minimize water pollution in public water areas • Provisions on waste and hazardous discharge • Guidelines on monitoring pollution sources including sampling, analysis, responsibility and corrective action of effluent discharge
Sub-Decree No. 113	2015	• Improves the management of garbage and solid waste in urban areas with a focus on efficiency, transparency, and accountability to ensure urban aesthetics, public health, and environmental protection. • Strengthens the responsibilities of various entities involved in waste management, entrusting waste management functions to municipal, city, and district administrations, including waste collection, final disposal, clean-up of recreation areas, the dissemination of public awareness, and enforcement. (see Table 4 below for breakdown of responsibilities).
Sub-Decree No. 16	2016	Prevents illegal disposal of electronic and electrical equipment waste (e-waste).
Sub-Decree No. 168	2017	• Promotes thev reduction of the import, production, distribution, and use of plastic bags in order to enhance public health, environment, and landscaping. • Includes provisions to manage and reduce single-use plastic (SUP), reduce and manage plastic imports, and address micro-plastic pollution.
Sub-Decree No. 124	2018	Offers tax incentives to small and medium-sized enterprises (SMEs) operating in priority sectors, including waste processing for the tourism sector.
Urban Solid Waste Management Policy 2020-2030	2021	• Provides medium and long-term strategies and outlines the further formulation of legal frameworks for sound waste management including plastic. • Mandates the local government to take measures for sound waste management • Calls on the private sector to invest in waste management including landfill operations.

Administrative Framework

Institutional mandates and responsibilities at the national level primarily concern the Ministry of Environment and Ministry of Interior and include development of national level SWM policies and guidelines. The Ministry of Public Works and Transport plays a more narrow role in SWM focused on landfill identification and management. Through Sub-Decree No. 113, which mandates decentralization of waste management functions to municipal, city and district administrations, subnational entities hold a significant degree of authority and agency over rural SWM implementation and service delivery.

Between various levels and ministries of government, some SWM mandates can at times overlap and create coordination challenges that limit the efficiency of implementation. For example, activities related to landfill and dumpsite identification and management to serve both rural and urban areas are shared between the national, provincial, commune, district, and commune level as well as between Ministries and Departments of Environment, Interior, and Public Works and Transport. Solid waste management planning is similarly spread between a wide range of public actors at the subnational level. Notably, provincial town halls and district administrations have similar responsibilities for SWM within provincial towns and districts, respectively. However, interviews indicated that provincial town halls have access to SWM budget for services whereas districts are generally required to secure private investment for such services. Below is a high level summary of mandated and assumed responsibilities, based on literature review and interviews with public sector stakeholders:

Dumpsite in Kratie Province. Credit: Tyler Kozole

Table 4: Solid Waste Management Responsibilities by Government Level

Level	Authority	Responsibilities
National	Ministry of Environment	• Develop guidelines for waste disposal, collection, transportation, storage, and recycling • Formulate guidelines for hazardous SWM
	Ministry of Interior	• Support and cooperate with MoE on capacity building for sub-national administrations on the implementation and promotion of solid waste management • Monitor and evaluate SWM implementation in urban or "downtown" areas
	Ministry of Public Works and Transport	• Provide necessary equipment (i.e. tractors and excavators) • Collaborate with stakeholders like ADB to regulate suitable landfill locations, oversee construction and design, and ensuring environmental standards are met
Provincial	Department of Economics and Finance	• Participate in selecting waste provider via bidding process • Issue licenses to selected waste service provider
	Department of Environment	• Support with identification of landfill/dumpsite locations and provide oversight. • Organize environmental cleanup activities • Prepare bi-annual and annual reports on waste management progress
	Provincial Town Hall	• Responsible for SWM in the provincial town • Manages the bidding process for garbage trucks and market waste collection • Provide guidance and educational programs on waste separation, recycling, and environmental hygiene • Develop management plans and yearly action and budget plans for waste management. • Establish and manage cleaning, collection, and transportation services of solid waste • Support identification of landfill/dumpsite locations and provide oversight • Manage SWM budget, including subsidies for garbage trucks, public street cleaning services, and trash bins on public streets
District	District Administration	• Responsible for SWM in districts (outside of provincial town) • Manages the bidding process for garbage trucks and market waste collection • Provide guidance and educational programs on waste separation, recycling, and environmental hygiene • Develop management plans and yearly action and budget plans for waste management. • Establish and manage cleaning, collection, and transportation services of solid waste • Support identification of landfill/dumpsite locations and provide oversight • Initiate procurement and installation of district or commune-level incinerators
	District Committees of Women and Children (DCWC)	• Educate CCWCs on SWM practices • Educate villages on SWM practices through public forums
Commune	Commune Council	• Oversee some community SWM activities (e.g., waste bin distribution, road cleanups) • Hold monthly meetings with village chiefs on SWM issues • Ensure clean markets & address community waste concerns • Allocate land for and oversee use of dumpsites
	Commune Committees for Women and Children (CCWC)	• Advise Commune Council on women and children's local-level concerns • Conduct educational sessions with the community, including on waste segregation and disposal
Village	Village Chief	• Conduct door-to-door waste management education • Organize community meetings for NGO staff to share SWM information • Support commune office's SWM activities (e.g., road cleaning) • Provide waste situation reports to the commune office

Supplier Licensing, Bidding Processes and Contract Management

The processes of supplier licensing, bidding, and contract management for waste management services in rural Cambodia involves several departments. **The Department of Economy and Finance (DoEF) is responsible for managing market contract procedures and investment at the provincial, district, and commune levels. The provincial town hall handles bidding processes for garbage trucks in the provincial town and the district administration handles bidding processes for garbage trucks at both the district and commune levels. The Department of Environment ensures environmental compliance related to waste disposal and landfills across the provincial, district, and commune levels.**

Waste Collection:

Rural authorities are involved with two primary waste collection services: (1) garbage trucks collecting waste from various sources and (2) market collection services focusing on cleaning, security, and waste gathering from local markets and surrounding businesses. Businesses with contracts to conduct market collection will sometimes also collect waste from households nearby market or en route to dumpsites, either at the request of local government or upon their own initiative to collect service fees. Prospective service providers are required to submit a technical and financial bid to either the DoEF for market contracting or to the district administration for residential waste truck services.

Garbage Trucks:

The process for awarding garbage truck services lacks uniform transparency across locations. In some instances, service providers submit a technical and financial plan, which is reviewed and may either be approved as submitted or undergo negotiations to include additional information or investment. The approval of submitted bids is dependent on negotiations with local authorities and whether or not there are other competitive bids. In other instances, local authorities may request additional investments for landfill or dump site development, necessitating equipment such as tractors, bulldozers, and excavators. The duration of contracts is apparently determined through negotiations between local authorities and service providers. Interviews with service providers revealed highly variable garbage truck service contract durations from three to 10 years.

Market Collection:

Contracts for services that govern the collection and management of market stalls in rural Cambodia, known as "phasi." These contracts require service providers to recoup their investment through collection of daily fees from each shop in the commune/district market, ranging from 500 to 1000 KHR, along with an additional fee for garbage disposal. Companies managing markets are responsible for ensuring the security of goods and maintaining a clean market space for every shop. Waste disposal is either subcontracted with a garbage truck service or handled by the phasi. The Provincial Department of Economy and Finance (PDEF) directly supervises this process, setting the rates for fee collection and overseeing technical bidding.

Market collection contracts are generally for either short or long terms. Short-term contracts involve an annual bidding and re-application process. Long-term market contracts require that the phasi contributes investments in the renovation or construction of markets. In this scenario, PDEF grants service providers contracts that can extend over 20 years, depending on negotiations between the service provider and local authorities. The length of contracts is tied to the level of investment provided, with longer contracts being contingent on higher levels of investment. These contracts encompass responsibilities for market collection and the obligation to maintain a clean market space for every shop.

The implementation of bidding procedures and determination of licensing durations for residential and market waste collection vary by district and province. This variety, in addition to short-term contracts requiring annual reapplications, presents planning challenges for service providers, especially if they wish to operate in more than one district. Lack of standardization discourages investment and also creates challenges for efficient and effective monitoring and provision of solid waste services in rural areas.

Obtaining licenses for both garbage truck service providers and market collection incurs varying costs, ranging from from $5,000 to $12,000 annually in the research areas. The specific parameters determining these costs may include the geographical expanse the service provider intends to cover or the scale of the market they aim to serve. Larger service areas or markets may incur higher licensing fees due to increased operational scope and potential economic opportunities.

Disposal:
Disposal requirements are often included within waste collection contracts. The private sector service provider is sometimes responsible for all the costs related to dumpsites including the land (renting or buying), construction and maintenance. This is more frequent in provincial towns, where service providers are required to have existing access to approved waste disposal land and invest in the construction, maintenance, and ongoing costs of the landfill/dumpsite. However, at the district and commune level, there are some instances where the district administration or communice council will provide free land for dumpsites to the private sector service provider. In these cases, the service provider is still often required to manage the site, including additional construction and maintenance costs, with limited oversight from the government.

Recycling:
Recycling facilities in Cambodia are typically privately owned companies that are often not included in the scope or mandates of public solid waste management frameworks. Throughout the research process, specific licensing requirements for private recycling facilities were not identified.

Financing

SWM systems in rural Cambodia are primarily driven by small-scale private sector investment and occasionally supported through a blend of public and private funding sources. Donor organizations and multilateral finance institutions like the ADB and World Bank have contributed and committed significant amounts of financing for large-scale infrastructure like landfills.

Public Financing:
Municipalities and local authorities are responsible for SWM budget allocation. However, these funds are often inadequate to develop comprehensive SWM infrastructure and services. To support these efforts, the Ministry of Environment contributes annually to provincial town halls, providing KHR 100-200 million ($25,000 to $50,000) for SWM, which contributes to essential resources such as garbage trucks and trash bins. MoE is also currently providing waste trucks to district administrations in some areas, which are then loaned or given to service providers who own government contracts for market or residental waste management. It is not apparent that any public assistance or subsidies, beyond the provision of some capital equipment including trucks, are extended to support the private sector. The viability gap between the cost of providing rural SWM services for entire communities and the amount of revenue available from household services fees (and other cost-recovery mechanisms) is generally not well understood by local authorities. This knowledge gap prevents effectively determining local government's ability to plan for and allocate budget to financially support rural, private sector-driven waste collection services.

Private Financing:
Due to limited public financing for SWM in Cambodia, private sector investments play a significant role in the financing landscape. Companies or entrepreneurs are often the primary sources of investment in rural waste collection services, market construction and renovation, recycling and resource recovery facilities, and landfill operations. Waste collection service providers recoup their investment primarily through service fees paid by households and businesses. Collectors of recyclables earn their revenue through the sale of these materials within the recycling value chain.

Donor/Multilateral Funding:
International organizations and NGOs occasionally provide financial support for SWM projects in Cambodia, aiming to enhance infrastructure, raise public awareness, and build the capacity of local authorities and communities. For example, the World Bank, Asian Development Bank, GIZ, and the Japan International Cooperation Agency have invested in public SWM infrastructure, systems, and policy development projects in Cambodia since 2021.

Waste pickers sort waste at a dumpsite in Kratie Province Credit: Tyler Kozole

Public Sector Motivations and Constraints

Motivations

Public Health and Environmental Protection:
Inadequate SWM practices can lead to the spread of diseases, environmental degradation, and pollution of essential water sources, necessitating proactive measures to mitigate these substantial risks.

Tourism:
Acknowledging tourism as a key contributor to economic growth, job creation, and revenue generation, the government aims to ensure a clean, welcoming environment to attract and retain tourists.

Climate Change Mitigation:
Solid waste management plays a pivotal role in climate change mitigation efforts. The decomposition of organic waste in landfills produces methane, a potent greenhouse gas. The implementation of waste management strategies like composting can divert organic waste from landfills, effectively reducing methane emissions. Moreover, waste-to-energy processes offer an opportunity to generate energy from non-recyclable waste, contributing to the transition towards a low-carbon economy.

National and International Commitments:
Cambodia has made commitments to international agreements and national policies focusing on sustainable development and environmental conservation. The country actively participates in the Paris Agreement to combat climate change, endorses the ASEAN Framework of Action on Marine Debris, and has enacted the National Waste Management Strategy. Furthermore, Cambodia aligns with the Bangkok Declaration, emphasizing biodiversity conservation and resource management. The National Environment Strategy and Action Plan (2016-2023) further underscores Cambodia's dedication to environmental integration and sustainable practices.

Constraints

Limited Financial Resources:
There is limited funding available for critical SWM aspects such as waste management infrastructure development, procurement of necessary equipment, and recruitment of skilled personnel.

Lack of Clear Mandates:
Some lack of clarity and overlap of roles and responsibilities, especially at the subnational level, creates uncertainty and reduces the efficiency and effectiveness of SWM planning and implementation.

Limited Technical Capacity and Enforcement:
Shortage of technical experience and acumen, particularly at the subnational level, prevents effective execution of responsibilities. Limited regulatory oversight of private sector service providers and household waste disposal makes it difficult to ensure service provider and resident compliance with recommended and safe waste management practices.

Inequitable Resource Distribution:
Urban centers, rather than rural areas, have primarily received attention and funding from public, private and external donor sources, driving disparity between urban and rural SWM provision and access.

Logistical Challenges:
Issues like poor road infrastructure, remote locations, and widely dispersed populations make regular waste collection services costly and inefficient using the currently employed approaches.

Waste picker collects waste from a floating waste barrier in Krakor District, Pursat Province. Credit: Vann Theaven

Conclusions and Recommendations

Waste collection truck in Kratie Province.
Credit: Tyler Kozole

Conclusions and Recommendations

In order to ensure a cleaner, safer, more productive future for rural Cambodians, improvements are necessary at each component of the SWM value chain. Institutional arrangements and frameworks need to be strengthened while prioritizing safeguarding for all stakeholders.

Waste Generation and Separation:

Cambodia is facing an escalating challenge in waste generation due to urbanization, industrial growth, and changing consumer behaviors. The wide spread proliferation of SUPs has significantly increased the quantity of non-organic waste requiring disposal. It is important to raise awareness regarding responsible waste management practices, including waste reduction and waste separation at the source while highlighting the adverse consequences of waste pollution. Incentive-based programs that reward households to reduce and separate waste could significantly improve compliance. Partnerships with industries and manufacturers, in addition to extended producer responsibility (EPR) regulation, will reduce the volume of waste generated by consumer goods. Strategies may involve minimizing packaging and promoting reusable product designs.

Waste Collection:

Waste collection services are primarily concentrated in urban areas, leaving rural areas underserved. In rural areas with collection services, the coverage is generally limited to district markets and a small number of nearby households. There is a latent demand for waste collection in rural areas and it is essential to expand collection services to meet this need. Rural service expansion requires reliably collecting household payments, which in

turn requires ensuring reliable service provision, transparent pricing, and efficient payment collection systems. Enhancing service efficiency through optimizing waste collection routes, vehicles, and methods, is crucial to reduce costs and enhance business viability. Implementers should develop and test decentralized waste collection models to reach the most remote areas. To avoid further marginalizing informal workers in the solid waste management value chain, it will be critical to recognize, include and support these entrepreneurs to operate more efficiently, safely, and profitably. SWM efforts should prioritize formalization and professionalization of the sector.

Landfills and Dumpsites:

Rural household waste disposal practices largely involve burning, burying, or openly dumping waste in unmanaged dumpsites that lack environmental and human health safeguards. Significant investment is crucial to construct and operate additional sustainable landfill facilities with stringent pollution controls and integrated resource recovery systems to minimize environmental risks and costs. While constructed landfills are increasing in prevalence in Cambodia, few are fully operational. Many are not receiving waste from rural areas nor are connected to formal waste collection systems. These facilities need to be linked to waste collection systems, including incentivizing service providers to engage and reliably dump there. Strong public ownership over the functioning of these facilities is critical, which will require clear operational responsibilities, budget allocation, and technical expertise. Prioritizing waste diversion through recycling, composting, and energy recovery can significantly reduce waste deposited in landfills and dumpsites. Establishing comprehensive waste management policies with robust enforcement mechanisms is essential to standardize disposal practices and deter illegal dumping.

Agricultural Waste:

In rural Cambodia, agricultural by-products, namely crop residues and plastics, play a significant role in waste generation. Sustainable use of crop residues, such as rice husks and straw, for purposes like cattle feed or mushroom cultivation, could minimize waste and add economic value to these types of agricultural by-products.

Cambodia also generates approximately 515,450 tonnes of agricultural plastic waste each year, constituting up to 12 percent of the total waste generation throughout the country. [81] Farmers face high prices for alternative products and practices, indicating the need for low-cost, sustainable alternatives to plastic mulch and other plastic inputs. Familiarization and incentivization of farmers to adopt such products will be necessary to increase use. Facilitating proper disposal of agricultural waste, through market incentives, collection services or more sustainable practices will also be imperative.

Processing and Recycling:

While the recycling industry in Cambodia has grown in the last decade, only four percent of Cambodia's waste is recycled, and the majority is exported to Thailand and Vietnam. The impending closure of borders in both Thailand and Vietnam for recyclable plastic waste by 2025 poses an urgent need. [82] [83] Cambodia must identify new export markets or establish a more robust domestic plastic recycling system.

Investments in sustainable processing technologies and recycling industries are vital. Collaboration with technology providers and research institutions can identify cost-effective and environmentally friendly solutions. Encouraging domestic recycling industries through providing incentives to households and businesses to sort and collect plastic waste, investing

[81] Rianawati (n44) 7.

[82] Igini, M. (2023). Thailand Announces Ban on Plastic Waste Imports by 2025. EARTH.ORG. Retrieved from https://earth.org/thailand-ban-plastic-imports/#

[83] Nguyen, D. (2019). Vietnam to end plastic scrap imports from 2025. VnExpress International. Retrieved from https://e.vnexpress.net/news/business/economy/vietnam-to-end-plastic-scrap-imports-from-2025-3900351.html

or offsetting costs of recycling infrastructure, and facilitating market access for recycled materials will strengthen the recycling ecosystem. The introduction of EPR programs holds manufacturers accountable for product life cycles, and through tarrifs assessed by these frameworks, could be used to fund recycling infrastructure development. To avoid further marginalizing informal waste collectors, it will be critical to facilitate inclusive formalization of the sector through training, capacity-building, and providing employment through the establishment of sorting centers and recycling facilities.

Institutional Arrangements and Frameworks:

A wide range of policy guidance currently exists in Cambodia encouraging safe and sustainable solid waste management. However, the implementation and enforcement of these policies, particularly in rural areas, has lagged due to a general focus on urban contexts, resource constraints, unclear and overlapping mandates, lack of standardization of contracting processes, and limited technical expertise at the subnational level. It will be necessary to build the public sector's capacity to provide rural SWM services and effectively collaborate with service providers. Standard, transparent, and market-friendly methods and processes for service provider bidding and performance monitoring can incentivize private investment to deliver high quality SWM services in rural areas. Local application of refined and enforced SWM policies, together with public awareness campaigns, can encourage behavioral changes in SWM at the community level. Investing in generating and sharing information and data on best practices will allow innovation to spread throughout rural Cambodia and accelerate SWM coverage rates. Improving infrastructure in underserved areas, exploring financial mechanisms to increase viability and affordability of service provision, aligning policies and mandates, and introducing incentives for recycling and resource recovery are other key steps the public sector can take toward advancing solid waste management in rural Cambodia.

Safeguarding:

Solid waste management workers, both in the formal and informal sectors, face dangerous working conditions. Waste collectors (often young men aged 14-25) frequently work 12-14 hours per day and face safeguarding risks through heavy lifting, use of heavy machinery, direct exposure to large quantities of untreated and hazardous waste, and little or no use of personal protective equipment. Development and enforcement of safeguarding strategies for worker protection in the SWM sector are needed to ensure worker safety.

Women play a significant role in waste collection and recycling, particularly in informal waste collection. Children, driven by economic necessity, often participate in waste collection and sorting as well, both in local communities and dumpsites.

To mitigate the risks faced by women and children engaged in informal waste collection, it will be important to increasingly formalize and regulate the SWM sector. This will require developing more robust solid waste management systems that are monitored for quality and safety while offering adults valuable employment options. It will be critical to engage and advocate for informal and formal workers to ensure safety and dignity. Families engaged in waste management will need to be incentivized to avoid child labor and have viable opportunities for childcare and wellbeing. Household -level behavior change and access to reliable waste collection services will reduce the risk that children face daily due to unsafe SWM practices. Policy changes to protect children from hazardous waste management practices and ensure safer working conditions is also vital.

Geese pick through plastic waste to eat in Pursat Province.
Caption: Simon Toffanello

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