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Towards sustainable waste management in Myanmar - key results from the project 'Capacity building on waste management in the Bago Region'

Photo: MJT Agricultural Machinery Co.ltd

Photo: Kyaw Min Sah

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Abstract
This report presents key results from the project 'Capacity building on waste management in the Bago Region'. It synthesizes primary and secondary data on various aspects of waste management in the Bago Township, including a study of the formal and informal waste management systems and their key actors, and a study of microplastic pollution of the Bago River. Building on Action Research it further presents four pilot cases promoting sustainable waste management practices and behavioural change through a cleanup of a river side waste dump, waste management at the local market, new waste management systems and composting at selected monasteries.

Keywords: Waste management, Formal and informal waste sectors, Macroplastic pollution, Myanmar
Emneord: Avfallshåndtering, Formell og uformell sektor, Macroplast forurensning, Myanmar

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Preface

This report presents a comprehensive summary of the key results from the project 'Capacity building on waste management in the Bago Region' (*in short*: 'Bago Waste project'). The project period was 2020-2023, and it has been part of the Myanmar-Norway Environmental Programme's second phase. The project was funded by the Royal Norwegian Embassy in Myanmar with support from the Norwegian Development Programme to Combat Marine Litter and Microplastics.

It was the Bago Township Development Committee (TDC) who expressed in 2018 an urgent need to improve the waste management situation in the township. They had limited capacity to formulate effective waste management plans and resource limitations to support waste management. The Bago Waste project started in January 2020. It built on the Integrated Water Resource Management (IWRM) phase I project (2015-2018), led by NIVA, which had already worked closely with local authorities in the Bago Township. At the time of project formulation and initial implementation, Myanmar was in a state of rapid economic development, while also suffering from environmental consequences in terms of increased pollution and unsustainable resource management.

The primary objective of the project has been to build capacity to tackle waste management issues in the Bago Region and Bago Township. This involved a focus on waste from domestic and small-scale industrial sources to reduce the influx of plastic pollution into the Bago River and followed a knowledge-based approach that involved research, awareness raising activities, and some infrastructural support.

The report summarises the project's approach, activities, and impacts. It provides insights into the governance of the waste management sector in Bago Township, examines the scale of the waste management issues, investigates the formal and informal waste sector, assesses macroplastic pollution of the Bago River and reflects on the project interventions (pilot cases) that were possible to implement both before and after the coup, that were key to the project approach.

The Covid-19 pandemic prevented project travel to Myanmar from March 2020 onwards, and in February 2021, a military coup took place with terrible consequences for the people of Myanmar. The latter event also had an impact on the Myanmar-Norway Environmental programme, with the Bago Waste project All activities in projects involving collaboration with governmental bodies were frozen. The Bago Waste project henceforth ended collaboration with governmental actors. The project's pre-existing local partners outside the public sphere, including the law firm Justice for All and the private company MJT Agricultural Machinery, allowed this project to continue at a lower activity level over a three-year period.

This report would not have been possible without the support of several people and institutions. The Royal Norwegian Embassy in Yangon provided the funds needed to undertake the project. Dr. Saw Nyo Win (former Bago Region minister MONRFEC) and Dr. Aung Khin (former Bago TDC chair), as well as a number of employees at various departments and committees provided support and institutional guidance till February 2021. Ye Htun Aung (MJT) contributed with important information to the report. We also thank the monasteries and its residents who were proactive and engaged throughout work on waste management issues.

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Oslo, Norway, 20.12.2023.

Summary

This report presents the key results from the project 'Capacity building on waste management in the Bago Region' (2020-2023). The project explored various aspects of waste management in Bago Township using an Action Research and a participatory approach. The report builds on key concepts related to waste management, while also providing a snapshot of macroplastic litter in the Bago River. It unpacks and discusses concepts and practice with a rich and unique dataset from the Bago Region in Myanmar. The report provides insights for policy recommendations, it addresses behavioural change, and applied measures. These are informed by the experience of project implementation, research, and the setting up of four pilot cases that targeted sustainable waste management practices on the ground in Myanmar over a period of challenging and violent socio-political change.

The report includes four chapters. Chapter one presents the project background, objectives, and partners. Chapter two provides a detailed overview of the waste management system in the Bago Region (within a Myanmar governance context) by examining its key actors, their characteristics, and interactions. The primary data collected in the project is presented and analysed in relation to theoretical literature on the formal and informal waste sectors. The analysis documents the roles of various actors, with their diverse interdependencies, and complex social and institutional dynamics.

Chapter three presents a study on macroplastic pollution in the Bago River. This monitoring work was carried out using a structured template for a visual observation-based method over a six-month period in 2023 to characterise the loads, typologies, and spatiotemporal variabilities of macroplastic pollution in the Bago River. The goal of this study was to relate the impact of mismanaged waste to the amount of plastic litter present in the riverine environment. Urban centres, such as Bago City, play a key role as a source of pollution to the river. The study identified the dominant types of litter in the river; and provides knowledge on the influence of seasonality on riverine macroplastic loads in this region.

Chapter four details the project's activities and experiences in promoting sustainable waste management practices and behavioural change through four pilot cases: (i) Cleanup of a river side waste dump, (ii) waste management at the Phyazay market case, both of which were implemented till February 2021, and afterwards (iii) implementation of responsible waste management at selected monasteries, and (iv) decentralisation of waste management by means of composting at a monastery. All pilots were motivated by an applied approach that draws on existing knowledge and literature – as described in the introductory sections in chapters two and four – implemented considering local socio-cultural and political settings. For example, the pilot cases have also been implemented in monasteries, which are important institutions in Myanmar that hold authority for theoretical ideas and norms to be locally translated, valued, and anchored in cultural and daily practices. The approach in the pilots was to draw on concepts related to community participation, best practices, awareness raising and site rehabilitation within a wider waste management context, with the intent to practically promote and illustrate the transformative potential of such initiatives.

Overall, this report concludes by highlighting the complexity, but also importance and potential for waste management systems to improve through targeted measures, collaborative research, and inclusive approaches. Unfortunately, the situation after the coup has severely limited international and domestic co-operation between actors, as well as resources. Nevertheless, it is hoped that this report, through its extensive documentation and analysis, will be useful and informative to readers, and to the people of the Bago Region and Myanmar.

List of Abbreviations

3R	Reduce, reuse, recycle
DAO	Development Affairs Organization[1]
DASW	Development Affairs and Social Welfare
CDC	City Development Committee
DOA	Department of Agriculture
CSO	Civil Society Organization
DRD	Department of Rural Development
DWIR	Directorate of Water Resources and Improvement of River Systems
ECD	Environmental Conservation Department
ED	Education Department
EO	Executive officer
EPI	Environmental Performance Index
FD	Forest Department
FDG	Focus group discussion
EU	European Union
EU WFD	European Union Water Framework Directive on Common Water Policy
IBM	Integrated Behavioural Model
ISWM	Integrated Solid Waste Management
IWRM	Integrated Water Resource management
IWUMD	Irrigation and Water Utilization Management Department
MONREC	Ministry of Natural Resources and Environmental Conservation
MONRFEC	Ministry of Natural Resources, Forestry and Environmental Conservation
MOU	Memorandum of Understanding
NGO	Non-governmental organisation
NIVA	Norwegian Institute for Water Research
NLD	National League for Democracy
NORAD	Norwegian Agency for Development Cooperation
NWMSMP	National Waste Management Strategy and Master Plan
PET	Polyethylene terephthalate
PPP	Public-private partnership
PRO	Producer responsibility organisation
PVC	Polyvinyl chloride
RBMP	River Basin Management Plan
SAC	State Administration Council
SDG	Sustainable Development Goal
SME	Small and Medium Enterprises
TDC	Township Development Committee
TTM	Transtheoretical Model
UNDP	United Nations Development Programme
UN-HABITAT	United Nations Human Settlements Programme
YCDC	Yangon City Development Committee
WASH	Water, Sanitation, and Hygiene

[1] The Development Affairs Organization (DAO) is a ministry on Region and State level, and a department on township level (Arnold et al 2015). In the report we refer to agency as the "Municipal Department", in line with the practices of the project's local partners.

1 Introduction

As many developing countries in Southeast Asia, Myanmar is struggling to manage the environmental effects accompanying rapid industrialisation, urbanisation, economic growth, and increased or changed patterns of consumption. Myanmar has also been facing significant challenges related to waste management. It is estimated that in many townships, one to two-thirds of waste remains uncollected (Dickella Gamaralalage 2020: 225). Similarly, waste in urban agglomerations is frequently dumped in public areas such as streets and waterbodies, burned, or disposed without proper treatment. On the Environmental Performance Index – which includes three indicators on waste management: controlled solid waste, recycling rates, and ocean plastic pollution – Myanmar ranked as low as 167 among the 180 analysed countries in 2022 (EPI 2022). Of the total waste generated in Myanmar, the urban areas are the main sources, with the cities Yangon, Mandalay, and Naypyidaw responsible for more than half of all generated waste (MONREC, 2018). This demonstrates the importance of urbanisation in waste handling issues. The municipal solid waste, defined as non-gaseous and non-liquid waste, comes from daily residential and commercial use, where households (60%), markets (15%), and commercial use (10%) are most important. The municipal solid waste in Myanmar comprises mostly of organic materials (77%), but plastic (13%) and paper (7%) are also significant sources (MONREC, 2018).

The local and regional environmental footprints from solid waste pollution are large, caused by the lack of effective waste treatment, infrastructure, handling, policy, and management plans. Rapid economical and societal development in combination with a diverse and changing climate are putting enormous pressure on Myanmar's solid waste infrastructure, and there is a pressing need to build capacity on waste management from both domestic and industrial sources. Accumulated waste, hereunder especially plastic waste, has further effects beyond the place of its origin, and its leakage into the environment and waters degrades rivers and seas. The importance of proper waste management is addressed in the Sustainable Development Goals, primarily in SDG 11 on Sustainable Cities and Communities, SDG 12 on Responsible Consumption and Production, and SDG 14 on Life below Water (SDG 2015). SDG Target 11.6 calls for a reduced environmental impact of cities, by paying special attention to air quality and municipal and other waste management. Further, Target 12.4 calls for achieving the environmentally sound management of chemicals and all wastes throughout their life cycle, followed by Target 12.5 on substantially reducing waste generation through prevention, reduction, recycling, and reuse. Addressing wider water impact from waste is specifically spelled out in Target 14.1 on preventing and significantly reducing marine pollution of all kinds, from land-based activities, including marine debris and nutrient pollution (SDG 2015). This showcases how waste must be treated as a crosscutting issue and integrated into other policy domains. For the SDG framework to become effective, waste needs to be addressed holistically and considering the local realities.

Considering the shortcomings of waste management in Myanmar it is becoming even more urgent to implement preventive and active measures and to reduce waste generation. This report presents the results from the project *Capacity building for waste management in the Bago Region* ongoing during 2020 – 2023. In the Bago Region, the project has focused on the Bago Township and Bago City (Figure 1), being a major contributor to waste flow and pollution in the area. The Bago River receives large quantities of waste as it flows through Bago City and acts as a main transport route of the waste from the city and other settlements and into the sea south of Yangon. This makes the local waste management in Bago City a regional, and even global, issue, as it contributes to marine pollution and environmental degradation. The project aimed to build capacity in Myanmar for the overarching objective of improved management of waste pollution from domestic and small-scale industrial sources to reduce the negative effects from waste pollution on the environment. To contribute to this long-term objective, two studies and four pilot cases on waste management were undertaken. The project engaged in extensive research for mapping and understanding the local situation including a study on monitoring of macroplastics in the Bago River, and a study to map and analyse the waste management practices including its actors and their relationships. Informants to this study have included authorities

at both Bago Township and Bago Region levels, the private waste collection company MJT who was contracted by authorities for household waste collection, and actors from the informal sectors, such as scrap dealers and waste pickers. Both qualitative and quantitative data have been collected using triangulation of methods and sources to facilitate validation and verification of information. This study has provided information about the variety of actors and their diverse interdependencies that are involved in waste handling practices which are crucial to consider when planning any policy interventions. The study on macroplastics analysed the loads of plastic waste being transported by the Bago River, and the potential role of the Bago City as source of pollution to the river.

In parallel to the focus on documenting waste management situation, the project aimed to promote sustainable waste management practices. These pilot cases were implemented as participatory action research, where the involved partners and stakeholders were central for identifying the pilot studies and to develop targeted and locally appropriate activities and investments for improved waste management. The four pilot cases aimed to address different sites and aspects of waste management in Bago City and included:

(i) clean-up of a riverside
(ii) waste management practices in a city market
(iii) responsible waste management in selected monasteries
(iv) decentralised waste management by means of composting

The report presents a comprehensive synopsis of the key results from the project 'Capacity building for waste management in the Bago Region'. Chapter 1 proceeds with a description of the project approach, and the project local partners in Bago. Chapter 2 follows with presenting the results from interviews undertaken in 2020 with public and, during 2020- 2023, with private actors, and from surveys and key-informant interviews with scrap dealers and waste pickers in 2022 and in 2023. Chapter 3 introduces a pilot study on the incidence of macroplastic pollution in the Bago River. Chapter 4 presents the empirical work from the implementation of the four selected pilot cases and reflects on the achievements gained. Finally, chapter 5 presents concluding remarks addressing the project approach and reflecting on the significant waste management challenges in Myanmar and the importance of understanding current waste management practices for working towards a more sustainable waste management.

1.1 Project background, and the project extended partnership

Sustainable waste management is a complex challenge that involves many different actors and governance levels that need to work in tandem to achieve a change of practices – ranging from individual behavioural change and awareness to infrastructural provision, recycling capacity, and better co-ordination among governmental institutions and non-governmental actors. In Myanmar, this has been a challenge due to the relative isolation of the country internationally following long periods of military rule, in addition to limited economic resources and priority setting around waste management. It was only in 2017 that waste collection was given priority within the local government, acknowledging the insufficient waste collection levels in Bago Township (Informal communication with Bago government officials, 2017 – 2019)[2]. This discussion resulted in the establishment of a public-private partnership in 2019 with the MJT waste collection company, who received responsibility for collection and processing services of household waste. Prior to that, waste management services by local authorities were piecemeal and lacked an overarching co-ordinated strategy, as well as experience and capacities.

[2] Apart from the publications listed in the Reference list at the end, the report largely builds on information from informal communication (direct, e-mails and calls), field observation and interviews. Such sources are anonymized and available by the authors and will be thereafter indicated in the brackets.

Prior to the formal project initiation in 2020, project targets were identified as part of discussions during visits with public actors in Bago Township in 2018 and 2019. This was possible due to the long-term engagement by NIVA in Bago since 2015 as part of the Integrated Water Resource Management Institutional building and training projects I and II in Myanmar[3]. Knowledge about the situation and actors in Bago Township, challenges, and needs were the basis for a project that received funding from the Norwegian embassy in Yangon during 2020- 2023. For the Bago waste project, the identified important actors have been included: The waste management company MJT, the Bago Township Development Committee (TDC), political representatives (i.e., the then-MP for Bago Township), civil society actors (such as the NGO 'Clean Bago movement'), and different government departments and ministries (ranging from water resources, river transport, revenue department etc.). Each of these had one or several roles relevant to waste management activities in the Bago Township. For instance, permission to operate along the heavily polluted Bago River involved several departments in the Bago Region, such as the Union level regional offices of the Irrigation and Water Utilization Management Department (IWUMD), Directorate of Water resources and Improvement of River Systems (DWIR), the Region Minister of MONFREC, the Development Affairs Organization (DOA) (also referred to as the Municipal department), and the Bago Township Development Committee. Jurisdictional overlap and lack of co-ordination between different departments was identified as a key barrier to effective waste management, which the work in the sites chosen for the first two pilot cases sought to address.

During late 2019 and the first half year of 2020, before the Covid-19 pandemic, physical meetings between NIVA and representatives from the Bago sub-basin Development Committee[4] including local authorities that were also important for the Bago waste project were undertaken to discuss the project. Physical meetings with the waste collection company MJT to discuss the project also took place in this period. Regular contact during March-June 2020 on virtual platforms followed with core local actors for the development of workplans for the project; notably, Kyaw Min San (former MONRFEC Minister and Parliament member, now leading the law firm Justice for All[5], Ye Htun Aung (the manager of the waste collection company in the Bago Township), and with the Bago Region Forest Department[6]. In May 2020, it was agreed to include Justice for All, represented by Kyaw Min San, and the MJT waste collection company, represented by Ye Htun Aung, as local partners in the project. The arrangement is referred to as an extended partnership. These local partners ensured, in parallel with the development of the project workplan, communication flow with the then-MONFREC minister Dr. Saw Nyo Win and other core local authorities such as the Bago Township Development Committee. The situation described laid the ground for a Memorandum of Understanding (MOU) that was signed between the Bago Region government and NIVA in August 2020, with the project description being an annex to the MOU.

An advisory board established in 2020 – including the aforementioned actors from the government, private sector, and civil society – represented an important platform for the project participatory management approach. By involving diverse actors, the project brought together viewpoints and concerns, ensured that activities were adapted to the local context, and anchored the project approach within the local development plans. The advisory board – with a group of members headed by the then-Bago Region MONRFEC minister (Dr. Saw Nyo Win)[7] – was confirmed in a virtual meeting on Zoom on October 22nd, 2020, 2020. This meeting brought together all relevant stakeholders, including representatives from the Forest department (FD), the Environmental Conservation department (ECD), the Directorate of Water resources and (DWIR), the Irrigation and Water Utilization Management Department

[3] The Integrated Water Resources Management Institution building and training project (2015-2018, and 2019-2023) was coordinated by NIVA and funded by the Norwegian embassy in Yangon (https://mnenvironment.com/integrated-water-resources-managament/)

[4] Information about the IWRM project and the establishment of the Bago River Sub-basin Management is included in, Nesheim et al. (2018).

[5] The law firm "Justice for All" is officially registered in Myanmar as a legal right company.

[6] The Forest Department (MONREC) Union level office in Bago was a central collaborating partner for the IWRM project (2015-2018 and 2019- 2021).

[7] Imprisoned from February 2021 – 2023 following the military coup.

(IWUMD, Region ministry (MONFREC), the Development Affairs Organization (DOA, also referred to as the Municipal department), the Bago Township development committee, the waste collection company MJT, and civil society representatives. An important objective of this meeting was to present and discuss workplans for the following six months. The meeting was steered by Kyaw Min San (Justice for All), and a Bago Forest Department employee provided translation. It was then agreed with the advisory board to first develop two pilot sites for clean-up and awareness activities. One was the Phyazay market, an intermediate sized public market (Figure 4.7), and the second was a dump site along the Bago River in the neighbourhood of the Kyaw Khat Wine monastery (Figure 4.5) (see sub-sections in 4.2). Activities related to these two pilots were implemented in collaboration with local authorities during the period August 2020-January 31st, 2021. In connection with the pilot site neighbouring the Kyaw Khat Wine monastery, contacts with deputy monks were established. As part of the interaction with this monastery, the project partners gained knowledge and an understanding of the need for pilots to promote sustainable waste management systems at monasteries in Myanmar.

Buddhist monasteries – which represent, in Myanmar, autonomous independent systems with internal institutions and decision-making processes – were, in 2021, identified as opportunities for two pilot cases, and in total six monasteries were enrolled as cases. The first monasteries were approached in June 2021 by the local project partners to discuss their possible engagement. The participatory approach for the project then no longer involved the advisory board that was dissolved following the coup. For the monastery pilots, monastery specific working groups were established for feedback and anchoring of plans (see 4.2.2). Activities in these pilots during 2021-2023 included awareness raising activities, clean-up activities, and provision of infrastructure. The extended project partnership included NIVA and the local project partners, and the staff employed at the local project partners Justice for All and the MJT waste collection company. The partnership prepared preliminary work plans that were discussed with deputies at the different monasteries. All activities undertaken in Myanmar were undertaken by the local project partners. During the project period the extended project partnership communicated on various occasions and platforms, for most parts weekly and, during intense periods, several times a week.

Figure 1.1. Photo (left) shows actors during a waste collection event organized in 2018 (Source, Kyaw Min San); Right photo, from a meeting discussing project plans, including local authorities, MJT, and NIVA at the Forest Department in Bago Township in 2020 (Source: Hans N. Adam).

The local partner Kyaw Min San and the law firm Justice for All

Kyaw Min San, who leads the independent law firm Justice for All (https://www.justiceforall-lawfirm.com/), was included as a local partner in an extended project partnership arrangement. Mr. San has, since the beginning, been a senior advisor to the Bago waste project but the relationship between NIVA and Mr. San in fact started as part of the Integrated Water Management Institution building and training project (https://mnenvironment.com/integrated-water-resources-managament/) (short IWRM

project); namely, in 2015. As part of the IWRM project, Mr. San was in 2016- 2017 the chair for the Bago Sub-basin Management Committee established by this project, and during 2017-2019, NIVA were in regular contact with Mr San who was then a Bago Parliament member (as part of the IWRM project's objective to implement the river basin management approach, in line with the Myanmar National Water Framework Directive). This background was fundamental for his involvement in the Bago Waste project.

As part of the Bago Waste project, Kyaw Min San was, in 2020, responsible for the direct engagement with local and regional authorities in Bago, as well as for interviews with public actors. In 2021 -2023, he has, together with the other local partners (including also the below mentioned people employed by Justice for All), been active in enabling the project participatory approach with the work groups established for each pilot case and contributed with local awareness raising and various co-ordination activities. Also important to mention is his contribution to strategic project advice, in particular to ensure that safety procedures were followed considering the developing political situation in Myanmar and Bago, as well as during the Covid 19 pandemic. Mr. San is a co-author of this report.

The law firm Justice for All also represented a local means for employing assistants working for the project, where two deserve a particular mention.

Mrs May Thazin Phoo has worked as a research assistant for the project since 2021. She conducted data collection and surveys and aided in planning and organising awareness-raising activities, preparing materials, and supporting the analysis of data and information gathered, in co-ordination with a small team of research assistants that reported to her. Before her involvement in the Bago waste project, May Phoo was associated with the IWRM project (during 2017-2020); first as a master's student supported by this project, and then as a staff at the Watershed Management Division at MONREC, who were a partner to the IWRM project. Mrs Phoo is a co-author of this report.

Mr. Aung Myo Htut is a civil society representative who was employed by Justice for All to contribute to Bago waste project activities. He has been a key person for developing the three videos developed by the project for awareness raising purposes. Mr. Aung Myo Htut was also involved in the IWRM project, as an elected secretary of the Bago Sub-basin Reference Group being established by this project in 2017 (this reference group was dissolved in 2021).

The local partner Ye Htun Aung and the MJT Agricultural Machinery Co.ltd.

Mr Ye Htun Aung is the manager at the private company MJT Agricultural Machinery in Bago Township and was included as a co-operation partner in an extended project partnership arrangement. NIVA first interacted with Ye Htun Aung during a visit to Bago Township in 2019, in a meeting with waste management actors attended by municipal and private actors. The intention of the meeting was to gain a better understanding of the waste management situation in Bago Township with the objective to develop and inform a project description with NIVA and funders (Royal Norwegian Embassy in Yangon and NORAD). MJT Agricultural Machinery, hereafter in the report referred to as "MJT" or as the "waste collection company", was contracted by the Bago Township Development Committee in a private public partnership agreement for 30 years, to be responsible for collection of municipal waste and manage the Sin Phyu Kwin (White Elephant) landfill. Recognising the crucial role of MJT in promoting sustainable waste management practices in the township and understanding the need for the access and development of infrastructure, as well as cleanup activities, NIVA continued to have regular contact with Mr. Aung. Mr. has been instrumental for the project's initial set up, and in particular in the pilot cases (Chapter 4. He enabled access to infrastructure at MJT, and to networks. Mr. Ye Htun Aung participated in the project's internal coordination meetings at inception and initial phases, assisting with the co-ordination of infrastructure and awareness raising and clean-up activities. At MJT, Mr. Aung also enabled the contribution of other employees to the project. Here, we in particular mention Nyi Nyi Min Htet, who was important for the "composing pilot", by means of his expertise in composting techniques.

1.2 The Bago Township and project geographical focus

The Bago Region, located in southern central part of Myanmar, is one of 14 administrative Regions and States in Myanmar (Figure 1.2). The region is divided into districts and townships, among them being the Bago District and the Bago Township. The Bago Township is the basic administrative unit of Myanmar's local government and was the key geographical of the Bago Waste project. The Bago River flows from the Pegu Yoma mountain range in the North, running South through meandering sections of over 331 km before it reaches the Yangon River near Yangon. At Yangon, it flows into the sea at the Gulf of Martaban of the Andean Sea. The Bago River flows through Bago City, which is a key source of marine pollution, as it carries discarded waste and litter from the towns and settlements that it runs through. The Bago City is located about 60 km from the country's largest city and former capital Yangon, as well as from the coast. The drainage systems of the Bago River Basin are in poor condition and a major cause of flooding almost every year, in particular in urban areas during the monsoon period.

In the upper part of the basin, there is less human impact and land use is dominated by forestry, while agriculture dominates the lower part of the Sub-basin. The forested areas consist of scrubland and deciduous and evergreen forests that have been reduced in recent decades due to deforestation (Haruyama 2013; personal communication by the author with the Forest Department, 2015). Overall, in the sub-basin, grassland is the most dominant land use type, contributing to more than 32 % of the total area, whereas open land is about 28 %. The other land use types in the basin are agriculture and forest. The majority of the population are farmers: approximately 50% have farms of around 10 acres, some of around 30 acres, and just a few with more than 100 acres (Personal communication with the Agriculture Department in Bago based on numbers from the Bago District[8], presented in Eriksen et al. 2017). In 2015, referring to numbers from the Bago District, 73.8 % of the population was rural and 26.2 % was urban. The industrial sector is a driver of economic development in the region, but the scale of activities remains relatively low though with some increase the recent decade mainly due to the relatively short distance from Yangon. There are smaller factories and workshops dispersed throughout the township, and an industrial zone located in the southern part of Bago City.

The Bago waste project has focused within the Bago Region on the Bago Township and Bago City, which is a major contributor to waste flow and pollution in the area. Bago City is the administrative and economic centre of the region. According to the 2014 Myanmar census report, 491,434 people live in the Bago Township (Government of Myanmar and UNFPA, 2016). The township hosts a number of schools and a university, several hospitals, and around 200 monasteries. Small-scale farming remains the primary occupation in the township (Nesheim et al., 2022).

[8] The total population in the Bago District which covers an area of 2,909.2 km², was 1,770,785 in 2014 (Department of Population, Ministry of Immigration and Population, 2015).

Figure 1.2. The map to the left shows the location of the Bago City in Myanmar (mapsofindia.com); the map to the right shows the Bago Township area (Google Maps, 2018)

The Governance of regions and states in Myanmar follows the 2008 constitution, involving a centralised and a decentralised system. As identified as part of tasks in the IWRM project (Tun et al., 2016), in Bago 32 departments of 19 Union level ministries have offices in Bago Township, where some of these departments have mandates relevant for waste clean-up and management, including the Environmental Conservation Department (ECD), the Education Department, the Department of Rural Development (DRD), the Forestry Department (FD), the Irrigation and the Water Utilization Management Department (IWUMD), and the Directorate of Water and Resources and Improvement of River Systems (DWIR). The decentralised governance system refers to the Bago Region government that comprises legislative, executive, and judicial branches. The Bago Region government is directly responsible for waste governance in Bago Region by means of the Region Chief Minister (appointed by the Union president), the Bago Minister of Natural Resources, Forest and Environmental Conservation (MONFREC), and of Development Affairs and Social Welfare (DASW). Each Minister leads several associated departments, and the minister of MONRREC and DASW leads the Region and the township level Development Affairs Organization, referred in this report as the Municipal department[1]. The Municipal Department, including its "cleaning unit", was prior to 2019 responsible for both waste collection in urban centres of the city and for management of the Bago Township landfill. The budget for implementing public policies is financed by means of transfers from the Union level and taxes collected in the Township.

Committees in Myanmar play an important role in coordinating work between departments and typically include representatives from several departments and governance levels. In Bago, the Township Development Committee (Bago TDC) was established in 2017 with two elected civil society representatives and has the formal responsibility for overseeing the management of waste collection, water, sewage, and urban road maintenance, and urban electricity in Bago City. The Bago TDC is directly accountable to the Region government and to the MONRFEC Minister.

In February 2021, a military coup unseated the democratically elected government led by the National League for Democracy (NLD). Subsequently, a military regime was established, which governs the country through the 'State Administrative Council' (SAC). The coup and the subsequent military SAC regime have had a serious impact on the general governance functioning in the country, due to its termination of civil

servants across multiple government bodies, and as several officials quit their jobs in government departments and agencies. The rule to involve elected members in the TDC was abolished, and currently no body of elected representatives exists at the township level.

Until the coup, the Bago TDC was responsible for ensuring the financing, planning, and delivery of urban services related to waste management. In 2019, the Bago TDC contracted waste collection from households in Bago City areas to the private waste collection company MJT. Local actors report that since the coup in February 2021, the level of engagement of the TDC has been less (Information the local project partners, 2021 - 2023).

Regarding households in rural areas within the township where waste is not collected, waste is compiled and then incinerated. Typically, food waste is given to domestic animals. Some waste is also just discarded on land or into the Bago River (field observations 2015-2019).

The waste collected is disposed of at the open dump landfill site the *Sin Phyu Kwin* (white elephant field)[9]. The landfill was established around 2017 and covers an area of approximately 12 acres. It is managed by MJT according to the contract with the local authorities. MJT estimated in 2021 that the company collected roughly 140 tonnes per week, mostly from household waste, equalling 480 tonnes a month and 44,000 tonnes a year (Interview MJT, December 2021). Due to collection of waste also from other urban areas in the township, the waste collection company informed in an interview in November 2023 that more waste is collected. Waste statistics from Bago show that organic waste dominates the waste composition and accounts on average for 65% of collected waste. This is in line with the average for organic waste in low-income countries in 2012, which was reported as 64 %, but has shown a decreasing trend due to the changing consumer patterns (Kaza et al., 2018).

Source segregation of waste at the collection points or in other parts of the Bago Region in general is not practiced. Recently, however, some developments were observed. At the Myoma market (800 shops) and the Kone Sane Zay Market (484 shops), segregated organic waste, fruit and vegetable waste, and plastic waste are collected by the collection company. Organic waste is collected twice daily: in the morning and in the evening. This amounts to almost 3 tonnes of organic waste daily (Informal communication with MJT, December 2023). Different types and relative amounts of waste collected by the MJT in 2021 and 2022 is presented in Figure 1.3. The figure shows that biodegradable and household waste amounts to 70%.

[9] The Sin Phyu Kwin landfill is the main landfill in the Township and there is also another landfill in the Bago township in the Phayargyi ward administered by the ward administration.

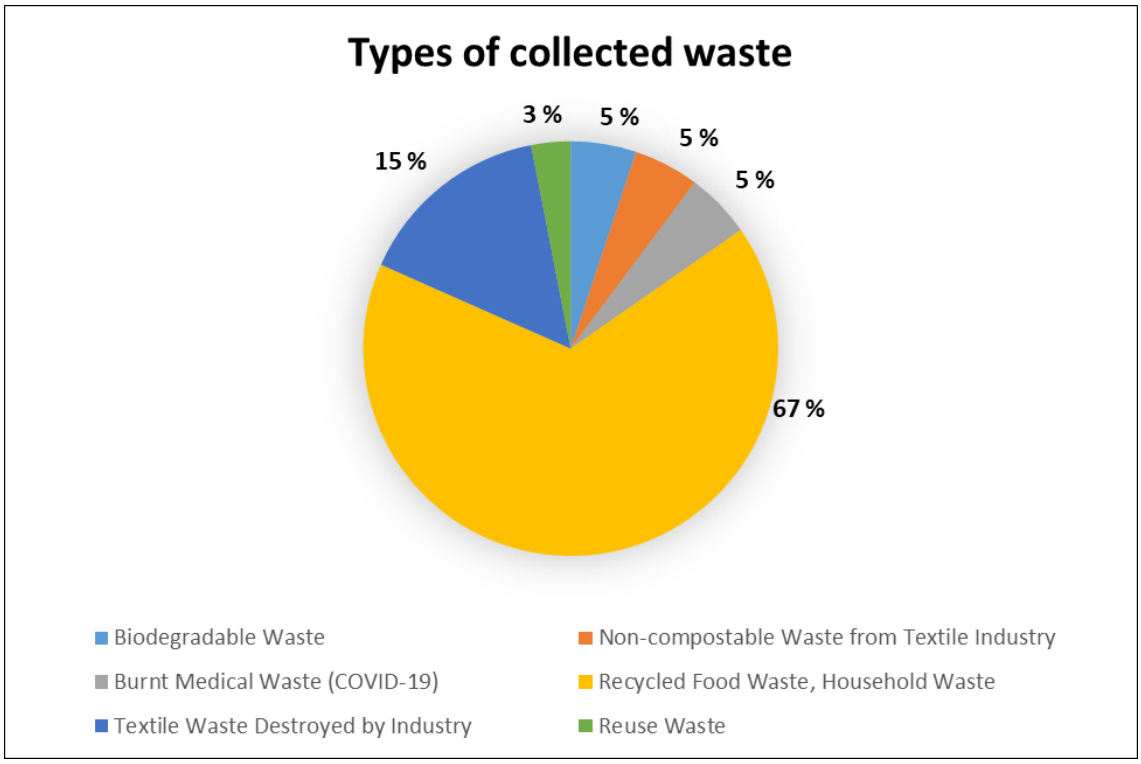

Figure 1.3 Waste collected types and relative amounts, data from 2021 and 2022 (MJT, 2022).

Figure 1.4 The Sin Phyu Kwin landfill in Bago Township in 2022 (Source, upper left and right, lower right, May Phoo in 2022, lower right Ye Htun Aung in 2022).

2 A study on the formal and informal waste sectors in Bago Township

2.1 Introduction and background for studying the formal and informal waste sectors

This chapter provides a holistic overview of the waste management system in the Bago Region by looking at the involved actors, their characteristics, and interactions. The primary data collected in the project is presented and discussed within the context of the relevant literature on the formal and informal waste sectors.

Data and information on the formal waste sector actors are based on the interviews undertaken as part of the project in 2020 with (i) the Bago Township municipal department, (ii) the Bago Township Development Committee, and (ii) the waste collection company. Mapping of the informal sector builds on surveys and key-informant interviews with scrap dealers and waste pickers undertaken in 2022 and in 2023. Results presented in this chapter are based on a total of 115 interviews including primary and follow-up interviews. The interviews have been anonymised and quotations in text refer to interview partners with their assigned ID. An overview of the interviews is presented in Table 2.2.

The analysis illustrates that waste management in Bago involves a variety of actors, with diverse interdependencies and complex social and institutional dynamics. Understanding key waste actors and their roles is crucial to plan any policy interventions. It is important to understand the actor landscape before learning about some project activities in the next chapters, where some actors have been actively involved.

The chapter is divided into five main sections. This section 2.1 introduces the purpose and presents the background for studying the formal and informal waste sectors. Section 2.2 provides an overview of the waste management actors. Following this, in section 2.3, we investigate two groups of actors – waste pickers and scrap dealers – in an in-depth analysis and further analyse their roles in waste management in Bago. We see the two groups as providing crucial links between the waste value chains. Despite their importance, there is very little literature and data concerning both groups in Myanmar in general, and in the Bago Region, and we try to address this gap. In section 2.4, we address some important cross-cutting issues, including gender roles, health and safety, and waste related stigmas and discrimination. We conclude in section 2.5 with both a theoretical and practical discussion on how to build upon both systems to ensure more integrated and sustainable waste management. There, we discuss the hierarchies versus networks, issues of formalisation, socio-economic and environmental outcomes, and sharing responsibilities.

Background for studying the formal and informal waste sectors.

Although the dichotomy between the formal and informal waste sector might seem clear, the realities are far more complex. In the waste handling and management sector, the formal sector refers to “official and legal operations” that “can be public and/or private enterprises with responsibility for waste collection and management” (Tong et al., 2021). It is therefore common that the formal sector is not restricted to public actors but that the public actors also rely on other stakeholders, both smaller and larger private companies, or individuals.

In many countries, an informal waste economy thrives alongside the formal sector and, sometimes, these informal activities dominate collection and handling of recyclable waste. The informal waste economy can broadly be defined to comprise "all forms of unregistered employment", referring to "individuals, private micro-businesses working in secondary material collection and recovery services, their activities are neither organized nor recognized by the authorities in charge of formal waste management" (Tong et al., 2021). The informal waste economy also comprises entrepreneurial individuals and small- and medium-sized enterprises earning an income from collecting and selling or buying and reselling waste, operating within the waste value chain and often highly skilled in their occupations (Chandran et al., 2018; Chen, 2012; Doron & Jeffrey, 2018; ESCAP, 2019; Gajera & Bhan, 2018; Gill, 2009; Gunsilius, 2010; Harriss-White, 2020). While informal actors in the waste value chain can be highly heterogenous in terms of income, the group has in common that the work takes place outside the regulatory framework of the state or is insufficiently covered by formal arrangements (De Soto, 1989; Feige, 1990; ILO, 2018). The operational practices of the informal sector differ across and within countries (see for example, (Steuer et al., 2017) for China; (Hande, 2019) for India; (Fidelis et al., 2020) for Brazil; and (Gall et al., 2020) for Kenya). At the same time, it is increasingly being acknowledged that the dichotomy of the informal and formal sectors is fluid (Gutiérrez-Galicia et al., 2021; Harriss-White, 2020).

It is difficult to find reliable data on the global scale of informal recycling activities. Estimates of the number of people who depend on waste picking to support their livelihoods vary greatly, between 15-20 million people worldwide (Morais et al., 2022) to even up to 2% of the population of Asia alone (Wilson et al., 2006), which would mean 80-90 million just on that continent. Globally, it is estimated that waste pickers recover up to 58% of recycled post-consumer plastic waste (Lau et al., 2020).

In many cities, informal waste pickers provide the only form of household waste collection, contributing to cleaner communities, improved public health, circular waste management systems (Barford & Ahmad, 2021; van Niekerk & Weghmann, 2019; Velis, 2017), municipal savings (Harrisberg, 2019; Kaza et al., 2018), and reduced climate emissions (WIEGO, 2019), while workers in the informal waste sector bear the adverse socio-economic costs of mismanaged plastic waste (Velis, 2017). This is amplified by limited access to social protection and government insurance schemes, below minimum wage earnings (Gill, 2009), hazardous working conditions (Ferronato & Torretta, 2019), exploitation, harassment (WIEGO, 2018), and stigmatisation (Harriss-White, 2020), as well as limited recognition and largely exclusionary policies and strategies aimed at reducing plastic pollution (Cass Talbott, 2022).

It is worth noting that the informal sector largely relies on the unregistered workforce of the waste pickers, but the workforce becomes more organised, institutionalised, and more "formal" in the subsequent parts of the value chain. We observe that some "informal" scrap dealers can be registered units that have (at least some) officially employed workforce and deduct some taxes, while other scrap dealers may run recycling enterprises linked to the formal waste recycling industry higher up in the value chain. In general, we observe that the formal system is handling all types of waste, while the informal system focuses on valuable types of waste, including metal, glass, plastic, paper, and other recyclables.

Although the distinctions are sometimes blurred, the formal and informal waste systems coexist and complement each other. In the coming paragraphs, we will present how the formal and informal waste systems operate in the Bago region. In the informal system, we identify and define two important actor categories: waste pickers and scrap dealers. First, in section 2.3.1, we introduce the category of waste pickers defined as a person or group informally engaged in collection and recovery of recycled waste. There are many terms in the literature describing individuals collecting waste, including waste pickers, scavengers, reclaimers, waste collectors, and recyclers. We use the term waste picker as this was the official English term adopted at the First World Conference of Waste Pickers in Bogota (WIEGO, 2023). Waste pickers are sometimes organised into bigger groups, networks, and associations. The second actor category that we use are the scrap dealers analysed in section 2.3.2. The term scrap dealer (also referred

to in literature as intermediaries, middlemen, and recycling shops) has been developed to describe a specific role in the waste value chain referring to people who buy materials from waste pickers and further sell them to the industry and other end users (Nzeadibe, 2019). Scrap dealers are responsible for sorting and cleaning of the materials, aggregating them in larger volumes, and assuring compliance with industry standards. They should be seen as an important link between the waste pickers and the recycling facilities (Kumar et al., 2018; Tong et al., 2021).

2.2 Waste management and actors in the Bago area

Diverse actors play an important role in sustainable waste management and their particular constellations are case-specific. This section follows the waste value chains in the Bago area and identifies key actors in the different parts of the value chain.

Waste collection in Myanmar occurs in urban areas and it is the responsibility of local authorities. Following the Bago Region Municipal Law (2017) it is the township and city development committees (TDCs/CDCs) that have the overall mandate for waste management. In Bago Township, before 2019, waste collection was undertaken by the cleaning unit of the municipal department, when the Bago TDC partly outsourced waste collection to the company MJT as part of a public-private partnership. Between 2019 and 2021, the municipal public collection and collection by the company coexisted but, after the 2021 military coup, the public service has stopped. Interview information received in 2021 indicates that after the military coup, the State Administration Council (SAC) regime had a serious impact on the general governance functioning in the country due to its termination of civil servants across multiple government bodies. For this reason, and because public actors have already been introduced in chapter 1, they will not be part of the following analysis (this chapter). Regarding households in rural areas where waste is not collected, waste is compiled and then incinerated. Typically, food waste is given to domestic animals. Some waste is also just discarded on land or into the Bago River (field observations 2015-2019). Occasionally civil society actors may organize waste clean-up events.

Waste in Bago follows different value chains depending on the type and quality of the waste, which determine its value. While some waste can be managed on site (burned, discarded, composted, or dumped in landfill), valuable and recyclable waste (metal, textiles, electronics, plastics, cans, PET) are often processed. Some of it is processed and upcycled in Bago, while most valuable waste is transported in bulk to larger reselling and recycling centres in Yangon and Mandalay or exported to Thailand or China for further processing in factories (Interviews with local actors in the Bago Region, 2021).

Following the waste value chain, five types of key actors in waste management in the Bago Region were identified. We start with actors with a formal mandate for waste management and continue with the industries where waste is produced. Waste pickers, scrap dealers, and the end users/production companies are identified as important categories of actors managing waste.

Actor	Interviews
Municipal department	4
Township development committee	4
Private waste collecting company MJT	15
Industries	28
Scrap dealers	26
Waste pickers	38/42[10]

Table 2.1 – Overview of interviews

The waste collection company MJT

The waste collection company MJT (hereafter referred to as the waste collection company, or just, MJT) was contracted by the Bago TDC to collect household waste in the Bago Township in three urban areas for a period of 30 years, including the right to collect waste from other institutions and enterprises. The contract states that MJT must pay 150 lakhs (150 million MMK) every third month (50 million MMK per month) to the Municipal department for the waste collection rights. MJT operates and manages the open dump landfill site the *Sin Phyu Kwin* (white elephant field), covering 12 acres in the Bago City.

In 2021, MJT had four three-wheeled trucks (*thonebane*) and 15 large open-bed trucks (*naut-pwint*). Household waste collection covers 32,000 households and occurs twice a week by announcing the pick-up with a Waste Tax Collector app and on Facebook[12]. Households, depending on size, pay between 1500 – 4500 MMK (0.7 – 1.4 USD) for waste collection and the price is set by the TDC (data from November 2023). The waste collection company also collects waste from 34 large-scale industries and, less frequently, from an additional 19 industries who can request collection of waste by phone call. The industry and restaurants typically pay between 60,000 to 150,000 MMK (28-71 USD) per month, depending on the waste volume. There are about 200 monasteries in the Bago Township, of which three have a weekly waste collection arrangement, while the rest has a more flexible, call-on-demand service. It has been estimated that MJT collects roughly 140 tonnes per week, mostly from household waste equalling 480 tonnes a month and 44,000 tonnes a year (Interview with MJT, 2021). Within the landfill area, the waste collection company also produces compost for sale. The daily production of compost was 7500 kg in November 2023, sold in bags of 30 and 50 kg to two companies – one in Yangon and one in Mandalay (Interview MJT, November 15$^{th.}$ 2023)[11].

The waste collection company sometimes relies on the work of waste pickers to fulfil its operations. This happens in narrow city streets where the company trucks cannot enter, and some waste pickers help with transporting the waste to the company truck. However, the relationship between the company and the waste pickers can be characterised as being complex. The entrance to the landfill was closed in 2019, and since then the company has entered special arrangements with the waste pickers. For a period, after paying some entrance fees, waste pickers were allowed to sort dumped waste to recover recyclable materials that they sold to the company's recycling unit on site. A fee of 40,000 MMK was charged for 14 days waste picking in a month, being perceived as high by the waste pickers. It is estimated that around 150 waste pickers entered this arrangement with the company. Recently, the company decided to offer

[10] The number of interviews conducted was 38, but some were group interviews where the respondents were answering the questions together, so the total number of interviewees was 42.

[11] The system involves mixing vegetable, fruit, fish waste with wood powder, and branches by excavator to prepare a pile of organic waste. A microbial inoculant solution (Maple EM solution) is poured onto this pile by MJT staff, after mixing, the pile is covered for 30 – 40 days, and the compost is ready.

quasi-employment to selected waste pickers (about 40 waste pickers in November 2023). This illustrates that the more "formal" waste sector is still complemented by informal services.

Figure 2.1 The photos (left) show the MJT waste collection area and company trucks; (right) MJT collection staff at work (Source, Ye Htun Aung, 2020).

Waste pickers

Key informant interviews estimated that there are between 200-300 waste pickers across Bago City (Interview, Bago Township, November 2021). They collect waste from streets, households, and directly from restaurants, markets, and coffee shops, as well as from the landfills, often using manual pushcarts (*lat-toon-hle*). Waste pickers collect and sort waste from different sources: landfills, dumpsites, households, or waste from shops at markets. The waste pickers in Bago primarily come from two areas: the Mya Thida village and from the Zaing North ward. Mya Thida consists of 25-30 households and was established around the year 2000 because of employment opportunities at the nearby rubber plantation. In 2017, the Sin Phyu Kwin (White Elephant field) landfill was opened nearby, creating opportunities for village members and some newcomers to work as waste pickers at on that site. Key informant interviews estimated that that in spring 2023 around 100-150 waste pickers visited the landfill. The second community at Zaing North ward is in Bago City centre by the railway station and includes around 100 informal dwellings.

Two groups of waste pickers from the White Elephant landfill and from the Bago City rarely meet as they collect in different areas. Hence, there is little information sharing between these two groups. Previously, there could be some conflict between the groups when they were both collecting at the landfill. Each waste picker community consists of smaller groups of people, often tied by family relations, who collaborate on practical tasks such as pushing heavy pushcarts or leasing three-wheel motorbikes. Information, for example about particularly valuable waste, is usually only shared within these smaller groups.

The number of waste pickers in Bago increased after the COVID-19 pandemic and the coup. Before that, they were mainly present at the landfill and dump sites, while now waste pickers with push carts can frequently be seen in the city. Sometimes, also people outside the waste picker communities described above collect waste for sale, including children. Many waste pickers use three-wheelers, while some use leased motorbikes. They work alone or in small groups, often with family members.


Figure 2.2. Left, a picture of waste pickers employed by MJT attending a morning meeting to organize the day (Source, May Phoo, 2022); Right, Interview with a waste picker working at the landfill (Research assistant employed at Justice for All, 2023)

Scrap dealers

Scrap dealers in Bago city are typically non-specialised and buy various types of recyclables. The majority are small family-run businesses, and they receive recyclables from households in the neighbourhood and further resell to larger scrap dealers. Small scrap dealers are a direct continuation of the informal waste value chain. They often serve as intermediaries between the waste pickers and bigger scrap dealers. Our field research indicates that there are approximately 25-30 bigger scrap dealers in Bago: mostly intermediate (with 5-10 employees) and 5-10 large scale scrap dealers (with more than 10 employees). What is common for bigger scrap shop owners is that they have high educational status, where the majority have completed high school or tertiary education. They are a very diverse age group (our respondents range from 25 to 71 years old). They also represent a more "formal" waste management system because they have licences for their enterprises. Bigger scrap dealers typically also have storage facilities, trucks for transport (owned or rented when needed), and three-wheel motorbikes that they rent to trusted waste pickers. Some have waste processing equipment. Although partly formalised, they still rely on the informal waste sector and, apart from the regular employees, they enter informal work arrangements with selected waste pickers. Similar to waste pickers, the number of scrap dealers in Bago has increased rapidly in the last decade, from around 20 to 200 (Interview 2023).


Figure 2.3 Left, picture of a scrap dealer sorting glass; right, a scrap dealer using a pressing machine (Source, May Phoo, 2022).

Industries - producers and buyer of waste

Small-scale enterprises such as restaurants and snack bars are in general responsible for handling their own waste. Only a minority of the industries appear to receive waste collection services. Before 2019, the industries could call either MJT, or the Municipal Department Cleaning Section upon the need for waste

collection, while after the coup, this type of service provision from the public authorities has been suspended (personal communication with the waste collection company, 2021, 2022, and 2023). Some industries has signed contracts with MJT for regular waste collection. Some industries do not have permanent contracts but call MJT and pay for each collection (Interviews with MJT, 2021 and 2023). Larger industries store their waste and transport it directly to the landfill and pay MJT based on truck loads (Interviews, 2022). If the waste is valuable, industries enter both formal and informal agreements and sell their waste to scrap shops, production companies, or MJT. Examples of waste sold directly by the industry to the industry include organic waste sold for fish feed or textile leftovers sold to pillow and mattress businesses. Some industries sell their plastic and cardboard waste to scrap dealers or MJT.

Diverse industries depend on sorted recyclables as a resource for their own production. Industries buying recyclables can be small local enterprises in Bago, but also larger industries located in Yangon and Mandalay, or even international enterprises from Thailand and China. Plastics, cans, and PET bottles are often traded to Yangon and Mandalay. Metals (especially iron) are attractive materials for export and are traded via Yangon and Mandalay.

Industries sourcing recyclables typically buy one type of material, requiring a certain quantity and level of quality. As mentioned earlier, companies buying waste can have agreements with companies producing waste. However, according to our interviews, many production companies purchase waste from scrap dealers. Companies buying waste collaborate with scrap dealers to assure sufficient resource quantities. Recyclables are bought at market prices that are prone to significant fluctuation. Resource prices increased in the last years due to increasing fuel prices and changes in currency rates. Prices are also affected by quantity and product quality. Contaminated recyclables, for example, are cheaper as they imply added treatment costs for the production company.

2.3 Analysing the informal waste system

This section provides an in-depth analysis of waste pickers and scrap dealers – which represent two under-researched actor categories – and investigates their work practices and interactions. Section 2.3.1 introduces categories of waste pickers, discusses their relationships[12] with the other actors, and reflects on challenges specific to the group. Section 2.3.2 follows the same structure, focussing instead on scrap dealers. Finally, section 2.3.3 discusses important practices related to waste weighing, valuation, and price negotiation and the role of digital technologies.

2.3.1. The waste picker and scrap dealer informants to the study

The waste picker informants

Interviews with 42 waste pickers working in the landfill or in the city show that waste picking is common among both males and females. They are mainly adults but are sometimes also children. Our youngest interview partner was just 8 years old, while the oldest waste picker interviewed was 78. At the landfill, our snowball sampling method resulted in more female interview partners (11 female waste pickers and 7 male waste pickers), while this trend was reversed in the city (17 male waste pickers and 4 female waste pickers). Also, in the city, female waste pickers worked collectively (with their husbands, female friends, or schoolchildren). It was sometimes said that children work in waste picking during school holidays (id-38

[12] A detailed study of actors' relationships and social capital in the Bago waste management has been recently published in (Nesheim et al., forthcoming)

says “in summer, schools are closed and there are many children collecting waste to get pocket money”), but this also depends on the family situation.

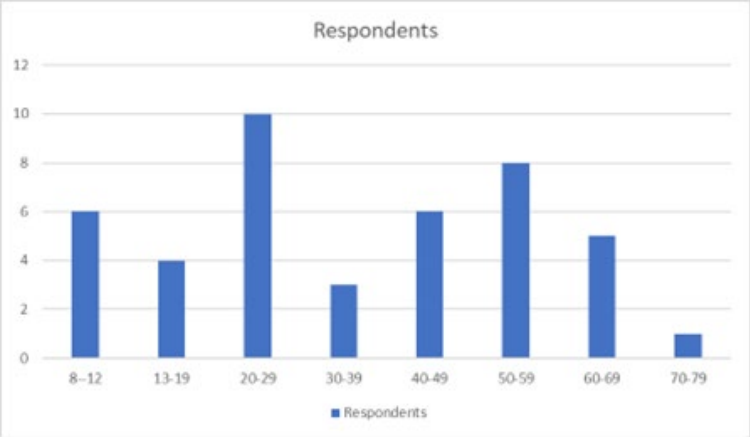

Figure 2.4 Interviewed waste pickers by age

During the interviews, it was observed that the waste picker community is diverse in terms of both experience and skills. Some experienced waste pickers seem to have professionalised the work by gaining access to information about where and when to collect and where and when to sell waste to maximise profit. They are also skilled in sorting and valuation of waste and may enter into agreements with scrap dealers to receive extra services, which will be discussed later. Such waste pickers often explained in the interviews that they favour waste picking compared to other alternative occupations, as it gives more freedom compared to wage work in agriculture or industry (id-2 “no need to care about boss, get high income”, so she is “happy to do that job”). Table 2.1 below briefly summarises the main differences between “regular” and more professional, experienced, and successful waste pickers. More vulnerable waste pickers need to sell their recyclables quicker and closer, often for lower prices. For them, waste picking is often their only source of livelihood as they don’t have any alternative income sources. One respondent lost his father during COVID-19 and had no choice but to collect and sell waste to survive. The same can be said for children trying to support their family’s livelihood. This is a livelihood strategy that is open for everyone, irrespective of the age, gender, and skills, and can be started and stopped at any moment, adjusting to the person’s needs, capacities, health, and life situation.

Regular or vulnerable waste pickers	Skilled, experienced, and “professional” waste pickers
Low income (<5 USD/day)	Higher income (id-35 claims 30 USD/day/maximum)
Bamboo baskets/ penang bags, pushcarts	Access to pushcarts/ three-wheel bikes/motorbikes
Sell to the closest scrap dealers	Find trusted scrap dealers, enter informal contracts
Income from waste selling only	Income from waste selling and additional benefits from their scrap dealer, quasi-like employment with advanced payments, access to transport, information, support for health and police emergencies

Table 2.1 - Differences between regular and more experienced waste pickers

Informants from the waste picker community also mentioned several challenges that they face daily in their work. Regarding practical challenges, many waste pickers struggle with waste transportation. They

sew penang bags and use them at the landfill. Bamboo baskets are also used for carrying waste. For transportation to the scrap dealers, pushcarts are used, but not all waste pickers have access to them. Sometimes they can be shared or hired in the village. Very few waste pickers have a driver's license and few own vehicles such as three-wheel motorbikes. Another challenge is associated with working in the rainy season, when prices are lower, working conditions are harder, and waste gets more contaminated. Especially in recent years, the difficult economic situation has resulted in more people collecting waste. This results in greater competition among waste pickers. Another challenge is the unpredictability of their situation. For example, before the public-private-partnership in Bago waste management, the landfill was open to everyone willing to collect recyclables. After the waste collection company took over, landfill access was restricted. Such rules and regulations are created without dialogue and on very short notice, largely affecting the livelihood of many concerned waste pickers.

The scrap dealer informants

Interviews with 26 scrap dealers indicate that this group is more male dominated compared to the waste pickers and there is a smaller age range. Women in scrap shops often work by supporting their male relatives who own and operate the business.

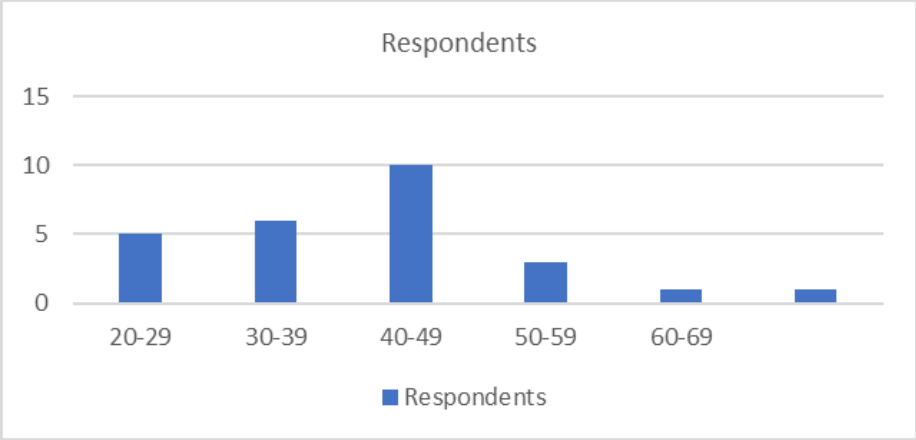

Figure 2.5 – Interviewed scrap dealers by age.

The scrap dealer profession requires investments, networks, and skills. Most of the scrap dealers interviewed (22) had a formal license from local authorities, while 4 operated without a license. It needs to be noted that ten informants selected for broader interviews represented medium and large scrap dealers and they all possessed a license. Possessing a license does not necessary mean that the scrap dealer can be placed within the formal waste management system. On the contrary, scrap dealers aggregate waste collected by waste pickers and those with formal licences rely on an unregistered workforce, so this distinction remains fluid.

Based on their age and occupational experience, the informants represented a diversified group. Some had only a year of experience working as scrap dealers, while the majority had been in the business longer, even more than 40 years. All interviewed scrap dealers worked full-time in their businesses, very often with their family members. Several also had high educational status, where the majority having completed high school or higher education. Some scrap dealers offered employment for several workers: the biggest scrap shop employed up to 40 people including seasonal workers and helpers. Half of the scrap dealers owned waste processing equipment.

Typically, the scrap dealers operate in a dense network of relationships both upstream (relationship with sellers of waste) and downstream (relationships with buyers of waste). The scrap dealers interviewed had

different types of informal or more formal relationships with sellers of waste, i.e., waste pickers or enterprises. Most bilateral relationships are with the waste pickers and other scrap dealers but relationships with households and industries are also common. Less commonly reported were relationships with other sellers of waste, e.g., the waste collection company, waste from the governmental offices, and the agricultural sector.

Several significant daily challenges were identified by the interviewed scrap dealers. Many respondents face infrastructural problems, often related to storage. Larger storage areas facilitate greater flexibility for the scrap dealers to make selling decisions. This also relates to transportation. As transportation costs are high, scrap dealers try to optimise but they can face significant limitations. Many mentioned that the lack of an industrial zone for waste in Bago, which exists in some other cities in Myanmar, is a challenge for their work. Id-1 suggests "to have a specific place for all waste shops, define zone like in Yangon, in doing so they could handle all the market condition and save transportation charges". Similarly, id-5 said, "he would like to have a specific place for the industrial zone, for waste buying and selling business". Selling and buying waste and organising joint transportation is difficult because of the distances involved. It was also mentioned that many scrap dealers struggle to make investments in technologies and machines. Id-1 and Id-2 claim it "would be better to have a pressing machine, investments for technology and machines, government support, it could reduce the space for transportation and save charges".

Other challenges are related to waste quantity and quality. First, waste supply is unstable and is subject to seasonal variations. Id-9 explains that "the abundance of the waste varies according to the season, dry season is more plentiful than in the rainy season". Additionally, COVID-19 lockdowns, electricity disruptions, and the effects of the coup also influence waste supply. Another challenge is the waste quality as scrap dealers need to assure certain standards for their customers. Finally, many scrap dealers complain about high price fluctuations. Id-7 mentions that "the price fluctuations are so high that the recycling shops are having trouble with price negotiation between waste pickers and dealers". Bigger scrap dealers are more resilient and can wait to sell their waste, but also face limitations related to storage and facilities. Additionally, scrap dealers often have high operational costs (including paying their employees and waste pickers, where they also offer advanced payments) but they often face payment delays from their contractors. Id-4 mentioned that he "had to wait for cash [from the buyer] for a month". They are also exposed to thefts and accused of stealing by the police. Id-1 says, "he could not know buying valuable waste (copper, iron), from owner or maybe from the thief (...) police always comes to the shops and is looking for stolen things".

Daily challenges for scrap dealers	
Infrastructure	Storage problems
	Transportation access and optimization
	Lack of an industrial zone
	Investments for technologies and machines
Waste	Unstable waste supply
	Waste quality
Financial	Big price fluctuations
	Payment delays
	Thefts

Table 2.2 – Daily Challenges for Scrap Dealers

2.3.2. Practices in trade of recyclables

Interviews with actors from the informal sector often discussed important practices in their daily work, where loyalty is highly valued. Unfair practices can happen, for example waste pickers can put stones inside cans to make them heavier and scrap dealers may cheat in weighing and valuation. Therefore, though waste pickers and scrap dealers are free to choose with whom they collaborate, strong and long-lasting mutual relationships built on trust seem to be the preference of most actors.

Below we present different practices of trade, including mechanisms for mutual benefits, waste weighing, valuation and price negotiations, and use of digital technologies.

Mechanisms for mutual benefit as advance payments, transport, social security

Trade relationships between scrap dealers and waste pickers comprise several different exchanges that function as mechanisms for mutual benefits and to regulate trade. The degree to which the scrap dealer perceives the trade relations with the waste picker to be predictable varies. Some waste pickers are perceived as unpredictable, meaning that leased motorbikes can be stolen or that a waste picker fails to deliver recyclables as agreed. The scrap dealer will buy recyclables from anyone; however, supplying information, disseminating skills, and providing vehicles requires establishment of trust.

Advance payment and gifts: Many scrap dealers offer advance payment for recyclables to the waste pickers. Some large scrap dealers additionally give gifts to valued waste pickers during festivals and aid and social support in case of emergencies. Id-4 mentioned that “she had a good relationship with her scrap dealer, he is kind to all waste pickers and provides support (money), gifts in festivals”.

Provision of vehicles for transport: Many medium and large scrap dealers lend three-wheel motor bikes to their best waste pickers. Many of our scrap dealer informants confirmed that they have three-wheel motorbikes for lease (Id 1,2, 4, 7, 8 and 10). Such arrangements help scrap dealers to receive more recyclables more quickly, but it can also be seen as an investment in their trusted waste pickers.

Exchange of Information and skills: Scrap dealers and waste pickers exchange information and skills about access to and volumes of waste, security, or prices. Waste pickers often learn from scrap dealers about waste valuation, quality, sorting, and composition. Such skills help waste pickers to earn more and scrap dealers to assure good quality recyclables. Id-7 stated that "the initial scrap dealer teaches them to identify different types of waste to collect". Id-6 mentioned that he has “good relationship with managers from industries who inform him about the updated market situation (...) and share the estimation of high/low price in the coming days”.

Social support in case of emergencies: Waste picker informants explained that some scrap dealers would provide support in case of emergencies, such as arrests or punishment by the police for not having a driver’s license. Some scrap dealers support their most trusted waste pickers in health emergencies, such as by paying for doctor’s visits and medicine in case of health problems. Id-18 said he has “like family relationships” with his scrap dealer, who is giving “assistance for health problems, understand his difficulties”.

Waste valuation and price bargaining

The relationships between scrap dealers and waste pickers are not always good. Mechanisms of mutual benefit presented above are typical for long lasting relationships between successful scrap dealers and waste pickers. Still, there are lots of opportunistic behaviours, some scrap dealers and waste pickers try to maximize short-term benefits, and there can also be unfair trade practices.

Waste pickers and scrap dealers: scrap dealers try to secure a reliable supply of high-quality waste by guaranteeing waste pickers fair prices. Scrap dealer with id-6 mentioned that waste pickers "prefer his shop because of the right purchasing price, weight and assess the valuable waste with fair/good price (i.e., no haggling for the valuable items, no mixing the valuable with cheaper waste)." Similarly, id-7 stated that "his shop guarantees accurate weighing at buying scrap" and id-3 mentioned that he "values long term relationship even if others give a higher price". Long- term relationships are often linked to trust in the fairness in weighing and valuation of waste. With a big asymmetry in the access to information (many waste pickers cannot follow price updates), this can be used against the waste pickers. Waste pickers can also be opportunistic, however, trying to manipulate the weight of recyclables, for example. Such opportunistic practices are common, and there are mechanisms for punishing unfair behaviour and mechanisms for checking fairness in trial selling. Id-9 mentioned that disloyalty in selling waste might be punished with worse prices: "if someone wouldn't sell to the regular shops and sell to the new shops, after that return to the regular shop but the price is reduced than before". When there is no trust between the parties, it is common for waste pickers to have small "trial selling" to check for fairness and pricing practices of scrap dealers.

Trade between scrap dealers and with brokers/end-users: Trade between scrap dealers and with brokers of end-users follows formal and informal agreements, mostly without advance payments. Relationships among scrap dealers start because of the trade between smaller and larger scrap dealers, where the latter establish direct links with the production companies. In general, relationships between scrap dealers are very competitive and price bargaining skills are important to receive a fair price but also to not lose the buyer. Although social platforms (Facebook, WhatsApp, and Viber) are used for sharing price information, prices are very unstable and subject to bargaining. Scrap dealer id-7 stated that "the price fluctuation is so high that the recycling shops are having trouble with price negotiation". Additionally, as id-4 mentioned, the traders and industries can control prices depending on the availability of waste and their predictions. More trust exists between businesses run by family members (brothers, uncles, sisters, and other relatives) or that have a long history of good collaboration. While the competition can lead to what scrap dealer id-4 called as "keeping secret the actual prices and no regular relationships", id-9 mentions that he also tries to keep his transaction prices and processing technologies as secret, but at the same time he is trying to find out the purchasing prices of "those big shops checking with voucher from others". He shares "the purchase price information only with their partnership shops but not share selling price". Only a small part of recyclables is sold in Bago (mostly plastics) to the industries, middlemen, and other scrap dealers, while most of the waste is sold to Yangon or Mandalay directly or through a trader/broker. The biggest scrap dealer (id-5) has some export connections with China and Thailand.

2.3.2.1. Use of digital technologies and information exchange

The early stages of the waste value chain, where waste pickers work, tend not to rely on digital technologies. Most waste pickers indicated that they could not afford a phone and that they get the market information from the scrap dealers and/or other waste pickers. Waste trade in the later stages of the value chain largely relies on digital technologies. There are plenty of Facebook/ WhatsApp and Viber groups dedicated to waste trading. Those groups are often dedicated to specific materials, e.g., iron, metal, zinc, paper, battery, and plastics. There are groups open to the public where everyone can join. Some groups are private where a membership request needs to be sent and approved by the admin. Admins are often businessmen buying and selling recyclables. Table 2.3 below presents some exemplary groups, their membership, and types of posts and information available in the groups.

Lots of information exchange is done through social media, in specific groups or bilaterally. It is common to check prices on Facebook groups and have follow-up negotiations by phone. Scrap dealer with id-4 says he is checks for "price update in Facebook group, Viber group, they share update price daily". Scrap dealer

id-5 follows “traders in Yangon and Mandalay upload daily price of waste in Facebook”. Scrap dealer id-6 noted that "nowadays, communication develops to know all the information in social media even if he hasn’t seen in person with the Boss in Yangon, he could do reliable business with him". Negotiations with buyers can take place in person, using digital means or by phone. Id-5, the biggest scrap shop owner in our sample, said that some sellers “check the price on Facebook firstly and call him for asking for price (...) if they agree with the purchasing price then they bring the waste to his shop”. He also shares pictures and “estimates the weight and decides for suitable price”. Id-5 complained about the daily price Facebook updates from traders in Yangon and Mandalay as this “is a problem for the scrap dealers and merchants” who “couldn’t buy at a low price to get profit”. Id-6 adds that “all the actors know the updated price upload by the traders/industries/companies at Yangon and in different regions” but there is some room for price negotiation with the traders.

No	Group Name	Items	Members in group	Posts/information
1	Kyaw Plastics and penang bags buying and selling group	Penang bags	5.5 k	Updated daily prices for penang bags, contact with merchants, selling penang bags sewing machines etc.
2	Plastic pellets, flakes buying and selling group.	Plastics	16k	Contacts with merchants/aggregators, updated daily prices for plastic pellets/ flakes, selling the machines, advertising services for setting machines etc.
3	Iron trading business (Admin is a businessman trading iron)	Iron	5.7 k	Advertise construction materials made of iron, contacts with merchants to sell iron etc.
4	Industrial materials Trading group Private Group (two businessmen are admins)	Iron and other materials	7.3 k	Sharing tender information from the Ministry of Electricity, admins upload daily updated price from Yangon Crown Company including contact phone numbers, some scrap dealers ask for the best price for selling their materials.
5	Iron, plastics and glass bottles buying and selling group	Iron, Plastic and Glass	2.3 k	Daily updated prices, discussing price fluctuation, contacts with scrap dealers, sharing industry’s closed days etc.
6	Myaungtaka, Yangon Iron business group Private Group	Iron	22k	Daily updated prices, contacts with scrap dealers, asking for the best price for selling the materials etc.

Table 2.3 - Exemplary groups on recyclables

2.4 Cross cutting issues, health risks, gender roles and social stigma

Socio-economic precariousness and the degree of marginality tend to be particularly high at the lower levels of the informal recycling chain (Gill, 2009) (UNEP/COBSEA/SEI 2019). As marginalisation of the vulnerable informal waste actors is a global problem, this section presents the three categories of health-related risks, gender roles, and social stigma by first referring to the relevant literature and later confronting it with the empirical evidence from the Bago Region.

Health risks

Informal waste pickers, collectors, and sorters are generally considered to be the most vulnerable to the inequitably distributed impacts of waste, because these stakeholder groups work in direct contact with potentially hazardous substances without adequate waste handling training and access to personal protective equipment (PPE) (Toxics Link 2016). Direct health hazards include illnesses, injuries, insect bites, and parasites (Ferronato & Torretta, 2019), while common diseases include tuberculosis, bronchitis, asthma, pneumonia, and malnutrition (Cointreau 2006). The lethality of these health risks can be determined by limited economic capacity and mobility to access health care services within informal settlements (Boo, 2012). In addition to these direct health hazards, informal sector workers operate without labour regulations and have, in most contexts, limited access to healthcare and government insurance schemes, which adversely impacts workers' health and wellbeing, as well as the efficiency of recycling processes (ESCAP, 2019).

The waste picker interview informants all complained about health problems. They frequently suffer injuries from broken glass, durian thorns, needles, broken bulbs, and hospital waste. Several waste picker informants complained about respiratory health problems or similar symptoms in their families living close to the landfill. All respondents from the landfill (from id-1 to id-16) complained about adverse impacts on their health. This applies also to their families, including children suffering from coughs and respiratory diseases. One waste picker was living with her baby aged 5 months in polluted surroundings. When the landfill was burning, waste pickers were also exposed to skin burns. Id-1 said "waste truck put the waste on the burning dumps, it is dangerous. Sometimes we lose all the waste because of burning". Id-5, aged 55, suffers from a bloody cough. Id-8, of the same age, complained about smoke, respiratory problems, and that she often feels sick. Id-17 mentioned headaches and dizziness problems, while id-18 mentioned asthma, dizziness, and over sweating. Respondents working on the landfill in the period when they needed to pay an entrance fee complained about sun exposure and no drinking water access. Id-18 mentions that "it would be better working conditions by working under shade (...) and providing water". It was also pointed out that working in the sun causes tiredness and weakness, and that waste picking under shade would be desirable. The respondent suggested that people drink contaminated water when they are thirsty, which represents a risk to their health and indicates that there is a lack of access to clean water and sanitary services in the landfill.

Another problem is related to chemical industrial and hospital waste. It was pointed out that it is problematic that hospitals do not segregate their waste. It was also pointed out that flammable materials that cause burning at the dumpsite therefore lead to respiratory diseases and air pollution. Most of the waste pickers indicated that they frequently feel sick, suffering from dizziness, headaches, respiratory problems, asthma, flatulence, aching, over sweating, and leg injuries from broken glass. One interviewee had taken a break from waste picking due to his health problems. Several of the waste pickers stressed the need for access to health care services and medicine, particularly in close proximity to the landfill they

operate. Most of the interviewed waste pickers indicated that they needed additional or updated equipment, including raincoats, boots, socks, masks, rakes, bags for collection, and temporary tents.

None of the interviewed scrap dealers reported having experienced any serious work-related health risks. However, considering scrap dealers' exposure to possibly contaminated materials under generally unregulated working conditions over time, it can be assumed that scrap-dealers could face occupational health risks across a longer time frame.

Gender roles

Previous studies have indicated that roles and responsibilities within the informal waste sector are influenced by gendered societal norms (Ferronato & Torretta, 2019; Krishnan & Backer, 2019). While occupations in the formal waste sector tend to be dominated by men, the participation of both women and men in the informal waste sector is comparatively equal (Chen, 2016). This divide can be seen because the participation of women in the labour market is often limited to informal or unregulated work (Krishnan & Backer, 2019). In both formal and informal waste related occupations, women tend to be concentrated in lower-earning and time-intensive activities such as recycling collection or sorting and separation of waste. For example, in Pune, India, studies have estimated that 90% of street recyclers are women (Chikarmane, 2014), while in Bengaluru, India, evidence suggests that there are no women working higher up the informal waste value chain, such as itinerant buyers or waste dealers (Chandran et al., 2018). In the instances where women are represented in male dominated recycling activities, such as scrap dealers, they also tend to get paid lower rates for recyclable materials (WECF 2017). The disproportional vulnerability of women in the informal sector is arguably a result of wider societal norms that persists through patriarchal structures, where women have become concentrated in unskilled and informal labour, suffering from the most abusive labour conditions (Harriss-White, 2020). This is important because it shows that women are over-represented at the lowest levels of the informal waste sector and are therefore more vulnerable to marginalisation and livelihood insecurities.

Women tend to deal with competing demands from domestic and childcare responsibilities, with the result of children often participating in waste collection activities with their mothers (Chen, 2016). Household poverty is recognised as the main factor contributing to the prevalence of child labour, defined as work which deprives children of their childhood, potential, and dignity, and that is harmful to physical and mental development (ILO, 2017).

Such evidence is also reflected in our research. Interviews with waste pickers at the landfill had more female than male respondents (11 and 7 respectively). This was not observed for waste pickers in the city centre where females were not working alone (but with partners or friends in the case of teenagers). Our findings confirm that women are less represented higher up in the value chain. Of the 26 interviewed scrap dealers, only 7 were female. Among shops without a license, women were overrepresented compared to the shops with a license. Women in scrap shops often work by supporting their male relatives who own and operate the business.

Some interviews also pointed towards discrimination of women and children, who typically cannot collect a larger amount of waste during a day because they cannot physically compete with men. In the landfill site in Bago, one female respondent, id-17, said that "MJT arranged waste picker need to draw picking numbers by chance for waste truck which are defined for 4 days in a week. On Wednesday, Thursday and Sunday, waste pickers do not need to draw and pick freely. In this case, women and children faced challenges compared with men who are stronger and pick quickly than women. So, women got small amount of waste".

Social stigma and discrimination

Individuals and communities working with waste are often susceptible to social exclusion and stigmatisation because occupations dealing with waste are associated with disease and uncleanliness (Chu & Michael, 2019; Ferronato & Torretta, 2019; Gill, 2009; Harriss-White, 2020). Waste pickers face most aspects of discrimination and harassment (WIEGO, 2018). This is largely confirmed in our interviews. Some of the waste pickers interviewed mentioned that when they are collecting waste from the roadside in the city, people think they are thieves. Many female waste pickers stated that they prefer to work at the landfill compared to the city because of social stigma. Id-7 states that "she was shy to collect in the city, afraid to ask for waste, misjudged as a thief, people look down for their appearance".

Waste pickers are also discriminated against by the police, easily accused of theft, and punished for not having a motorbike license. For example, Id-11 was arrested by police, spent a month in jail, and the police confiscated his three-wheel bike. Scrap dealers, although much less exposed to social stigma and discrimination, still face some unpleasant comments. Id-1 said that "he thinks that buying waste is a good job, cleaning all the waste in the surroundings, but people look down at his job".

2.5 Building on both formal and informal systems

As our analysis shows, the formal and informal waste systems coexist in the Bago region. The formal system is now built around the public-private partnership with the MJT company executing its mandate over household waste collection, transport, storage, and utilisation. On the other hand, a more informal system exists, anchored in local tradition and the practice of waste valorisation. Core actors here are the waste pickers and scrap dealers, both groups being mutually dependent. It can also be noted that the informal system becomes more formalised further up in the value chain.

Waste management in low- and middle-income cities is often perceived as a wicked problem, where good solutions are difficult to achieve due to the number and complexity of actors and their priorities, practices, and perspectives (Salvia et al., 2021). This can be related to the current waste management situation in the Bago Region. Here, we reflect on the way forward in building on both formal and informal waste systems. We discuss the hierarchical versus networked structures, formalisation processes in the informal sector, the role of socio-economic and environmental outcomes, and the issues of responsibility.

Hierarchies vs. networks

The formal and informal waste systems do not exist in a societal vacuum and there are many interactions between them. The formal waste management system is hierarchical and can determine systems and rules which involve and have an impact on the informal sector. The MJT company managing waste in Bago for certain tasks relies on the informal sector, such as when using their services in the areas where waste trucks are too big to enter. The company, struggling with its financial mechanism model, is also interested in recovering some of the value of the waste collected. This leads to competition between both systems. This can be observed at the Bago landfill. Waste pickers can collect recyclables from households, markets, and streets but the landfill is perceived as an attractive option. Before 2019, access to the landfill was free and unregulated. Since 2019, the company introduced new rules. For a period, it allowed some waste pickers to collect recyclables at the landfill for an entrance fee of around 40,000 MMK per month and required them to sell recyclables to the company scrap shop at the landfill. Recently, the company introduced new rules at the landfill by deciding to close it for waste pickers and to formally hire selected waste pickers (around 40 as of November 2023) to collect recyclables for the company's scrap shop. Although the conditions are perceived as exploitative by our respondents, the company easily finds a cheap workforce among the waste pickers. For the waste picker community who rely on valuable waste

for their livelihoods, the privatisation of the landfill in Bago and the restricted entrance rules have limited their access to recoverable waste.

The Environmental Justice Atlas has recorded more than 50 instances in which the livelihoods of waste pickers have been in jeopardy (Demaria & Todt, 2020). Approximately one-third of these cases involve the closure, privatisation, or suppression of waste pickers operating at landfills in Asia, Africa, and Latin America. The situation at the Bago landfill could be categorised as a similar case. The voice of the informal sector would likely count for more if the sector was more organised. Currently, our research shows that the informal sector has a loose network structure. More powerful actors (for example leaders among the waste picker community and the most successful scrap dealers) can be more influential in the network. Entrance into the system has a low threshold and even children can be part of it. However, skills related to waste collection, sorting, and valorisation and information on price allow some actors to be more successful, among both the waste picker and scrap dealer communities. On the periphery of that system are all those who lack knowledge, skills, and networking, and risk exploitation. Their daily challenges have been documented in section 2.3 and further discussed in the selected issues. Although some more skilled and successful individuals exist in the network, there are no signs of any organisation, representation, formalisation, and pushing for the groups' collective rights. Such action and formalisation of the informal waste sector have been documented in many countries and will be discussed it in the following paragraphs.

Formalisation of the informal sector

Field evidence shows that it can be counterproductive to design new waste management systems without considering the existing informal systems, and it is better to integrate current practices into more formalised and optimised waste management (Wilson et al., 2006). Involvement and participation of all the stakeholders and building on their skills would be a key factor for sustainable waste management (Joseph, 2006). This is what Gutiérrez-Galicia et al. (2021) call a Viable System Model, which recognises the informal sector and considers its special recycling activities and the territory's characteristics.

Considering that livelihood insecurities and working conditions remain a challenge amongst actors in the informal sector, formalisation is often considered a key step towards a just transition for informal sector workers (see ILO, 2015; Morais et al., 2022; Wilson et al., 2006). Formalisation can be understood as changes in the legal policy landscape to recognise and integrate the informal sector in law and in practice, and the process of extending legislative frameworks to cover labour and social protection for informal sector workers (UN-HABITAT and NIVA, 2022).

System formalisation should especially target the waste pickers through participatory processes. Due to their low economic and social status, their positive environmental and economic contributions are often undervalued. However, in recent years, their work has become more acknowledged and local governments and waste companies absorb waste pickers into their formal work (Asim et al., 2012). For example, in Brazil, national waste management laws treat waste pickers as professionals who must be included in waste management (Maiello, 2022). While formalisation of waste pickers has been pursued through government policies and integration initiatives (see, for example, Medina, 2010 for Brazil; Serrona et al., 2014 for the Philippines; and GAIA, 2019 for Argentina), it must be noted that contextual barriers and enabling mechanisms persist to channel sustainable and inclusive benefits through formalisation approaches (Aparcana, 2017). Examples illustrate that efforts to formalise workers without recognising and including the interests and network structures of the informal system may give rise to unintended socio-economic and environmental outcomes (see, for example, O' Hare, 2019).

A key step towards integrating the informal sector is recognising the variety of social, economic, and environmental benefits associated with informal recycling. This is followed by understanding the existing social networks and organisation of the informal sector. Building on that, informal recycling can be integrated into formal municipal waste management, ideally complementing each other, and improving both the efficiency and the working and living conditions of its members (Wilson et al., 2006). Morais et al. (2022) reviewed 45 papers on waste pickers published between 1994 and 2022 and concluded that formalisation has the potential to bring considerable livelihoods improvements (with legal recognition, safe working conditions and fair bargaining mechanisms). They distinguish four non-exclusive approaches in the formalisation process: legal recognition, improvement of salary conditions and benefits, more representation, and access to training and personal equipment (p.22). However, current formalisation approaches vary significantly across countries and often fail to provide these benefits. Navarrete-Hernandez & Navarrete-Hernandez (2018) claim more institutionalisation and coordination of waste pickers should go together with formal waste management systems (coordination with trucks and schedules), while promoting waste separation at households. These relatively inexpensive measures could largely increase the performance of waste pickers and the sustainability of the system. However, it needs to be noted that formalisation needs action from both the informal sector actors and from the public authorities.

Socio-economic and environmental outcomes

Formalisation initiatives aim to improve the socio-economic situation of the marginalised informal sector members. The socio-economic perspective must also be complemented with environmental goals. It must be acknowledged that waste of low economic value is generally not handled through informal waste value chains. While unsegregated waste is sometimes collected from households by informal waste collectors, contaminated and low-value waste is typically landfilled, incinerated, or left unmanaged in the environment and the informal sector can create secondary pollutants (Yang et al. 2018). It is the formal waste sector that considers waste as an environmental and societal problem and organises regular waste collection and storage at the landfill. The informal system is rather linked to a business model that treats waste as a valuable resource. It is closer to the circular economy perspective, albeit implicitly, as separate waste streams are cleaned, stored, and prepared for further reuse locally and in other locations. However, the informal system is not designed to handle environmental waste pollution or health risks associated with waste. A successful integrated waste management system needs to address both the socio-economic and environmental aspects.

Sharing responsibilities

Finally, waste management is also about sharing responsibilities across the whole value chain and needs a multitude of solutions where everyone contributes. Some important groups that should be better targeted here are local citizens and global value chains. For local citizens, it is crucial to provide some waste related education and awareness raising, with the result of improving source segregation and reducing littering and illegal dumping. Source segregation reduces waste contamination and improves recycling.

Global value chains should also be assigned responsibility for the local upstream realities. Most of the interviewed industries indicated that they were part of larger international trade links, for example exporting recycled materials and new products to Japan, Europe, the US, Korea, and China. This illustrates a broader dependency and cross-continental impact on global value chains. It is important to recognise the associated socio-economic and environmental impacts of the materials, particularly in contexts where waste is often inadequately managed.

3 A study on macroplastics in the Bago River

Plastic represents an important component of waste: the properties of plastic have led to widespread use across numerous applications in daily life. This is compounded by the prevalence of single use plastic products, product and material design that hinders recyclability (e.g., multi-layer plastics), and limited economical end-of-life handling solutions or logistical challenges. Leakages of plastic waste to the environment is now regarded as a global issue. This plastic pollution exists across a wide size spectrum where larger, tangible pieces of plastic litter (above 2.5 cm in size) are referred to as macroplastic.

River systems are key environmental recipients for macroplastic pollution and represent a transport pathway to other environments, such as wetlands, coastal ecosystems, and the ocean (Meijer et al., 2021). Accumulations of macroplastic in rivers can pose potential risks to aquatic and terrestrial organisms (Blettler & Mitchell, 2021), increase flood risk (Al-Zawaidah et al., 2021), and act as a source of microplastic (Liro et al., 2020). Understanding the loads and dynamics of macroplastic pollution in rivers can help to identify dominant sources, tailor effective solutions (source control and clean-up operations) and reduce the spread of plastics to the wider environment (Hurley et al., 2023).

The aim of this study was to characterise the loads, typologies, and spatiotemporal variabilities of macroplastic pollution in the Bago River. Within this goal, several objectives were established: i) to assess the role of Bago City as a potential source of pollution to the river; ii) to identify the dominant types of litter in the river; and iii) to understand the influence of seasonality on riverine macroplastic loads.

3.1 Monitoring riverine macroplastic pollution

Guidelines for monitoring macroplastic in rivers have been developed by several international working groups and research projects, which propose methodologies for monitoring in rivers from different geographic regions (e.g., Barnardo and Ribbink, 2020; González et al., 2016; González-Fernández and Hanke, 2017; Miliute-Plepiene et al., 2018; UNEP, 2020). Across these documents, as well as in the scientific literature, it is clear that no single method has emerged as the standard approach. This reflects the fact that none of the methods are capable of accurately detecting the full load of plastic in the river in a single measurement, as well as the significant variability in river morphology, hydrology, and geomorphology across the world (van Emmerik & Schwarz, 2019; Hurley et al., 2023).

Methods applied thus far can be broadly divided into two main categories: observation-based approaches and physical interception-based approaches. Observation-based methods are typically used to measure floating and near-surface macroplastic and employ either human analysts or technological solutions, such as cameras or drones. The proportion of the total plastic load that can measured by these techniques depends on the depth of the river and the turbidity and turbulence (which both affect the extent of visibility into the water column). Techniques which physically intercept litter – such as the use of nets, booms, or trash racks – capture litter which must then be retrieved from the river for quantification and characterisation. This represents an additional demand in terms of infrastructure, equipment, and personnel. The proportion of the total plastic load they measure depends on the conditions of their deployment. Booms typically trap floating litter but may include a net extending below the surface to also capture sub-surface flows of litter. Weights and buoys can be used to position nets at different parts of the water column, but the size of the net opening determines what proportion of the cross-section is actually measured. Trash racks typically extend across the full river cross-section but are limited to small streams as they can represent a significant flood risk as they accumulate plastics and other debris. Visual observation using human analysts and nets represent the two most commonly utilised approaches (Hurley et al., 2023).

In this study, the visual observation method using human analysts was selected. This approach allows for the cheap, rapid, and efficient collection of data on floating plastic litter moving in the river, including determination of source categories. It can be deployed following a harmonised protocol and using a standardised data collection sheet, which increases the comparability with data from other studies. It is also performed without the need for special equipment and without disrupting other activities or processes in the river, and thus does not require any permissions or extra safety considerations.

3.2 The study sites and the monitoring method

The Bago River catchment (5359 km^2) is located in southern central Myanmar. The river rises in the Pegu Yoma Mountain range and runs south along a length of 331 km before flowing into the Yangon River in the vicinity of Yangon city (Figure 2.1). The Bago River catchment is characterised by a tropical monsoon climate with an average annual rainfall of 3194 mm (Phue & Chuenchookin, 2020). There are distinct wet and dry seasons, with heavy precipitation falling in the months of May to October. The majority of the Bago River catchment falls in the administrative boundaries of the Bago District in the Bago Region. Bago City is located in the midstream section of the catchment (Figure 2.1b). Upstream of the city, the catchment area is characterised by forested areas, whilst downstream of the city the dominant land use is agriculture – typically grasslands (Nesheim et al., 2018).

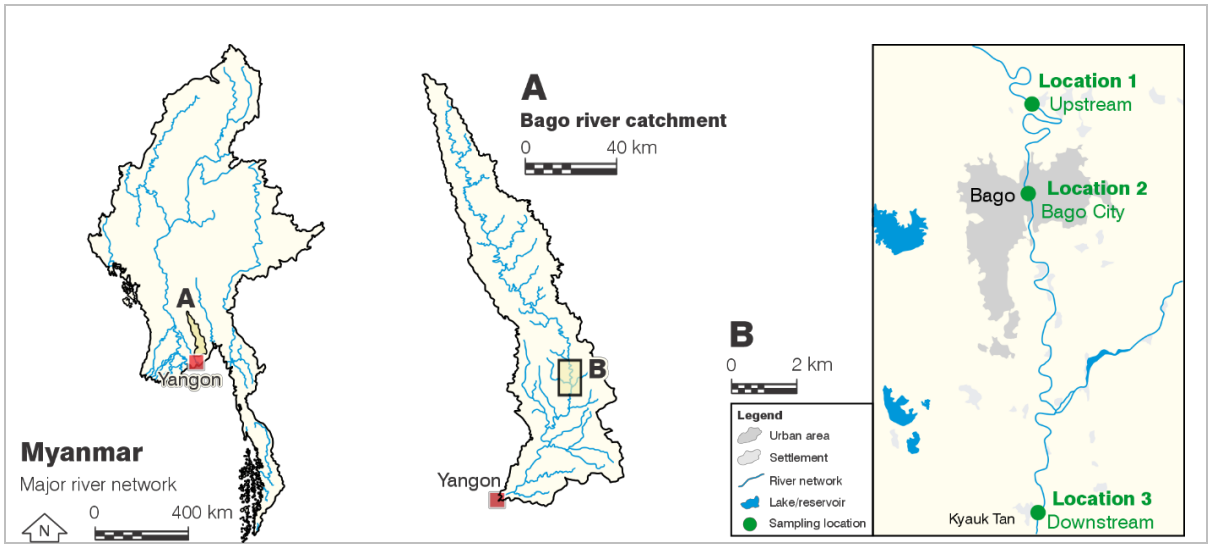

Figure 3.1. The major river network of Myanmar, with a map of the Bago River catchment (A) and a map showing the river passing through Bago City with the locations of the macroplastic sampling locations (B).

Bridges provide an important vantage position across the river width. Four bridges across three locations were identified for undertaking macroplastic monitoring. These comprised one bridge upstream of Bago City: Shwe Hlay, two bridges in close proximity within Bago City: Market Bridge and Bago Bridge, and one bridge downstream of Bago City: Kyauk Tan (Figure 3.1). Bridges were selected to give good spatial resolution to address the role of Bago City as a source of plastic pollution to the Bago River. Additionally, bridges below 20 m in height were chosen to facilitate effective monitoring and reduce the variability in visibility between bridges. The selection of bridges was also based upon accessibility and safety related to traffic densities. A description of the environmental context at the selected sites is provided below.

Upstream location: Shwe Hlay Bridge

Shwe Hlay Bridge is 10 km upstream of Bago City (Figure 3.1b). This site was selected to provide a baseline for floating macroplastic entering the city environment, and to identify the role of the city as a source of

pollution to the river. The bridge is situated in a rural area which is predominantly used for agricultural cultivation and is characterised by flat plains along the river with a very low population density (Figure 3.2b). No dumpsites were observed in proximity to the site. Close to the Shwe Hlay bridge is a railway bridge that was undergoing repair works for the duration of the monitoring period. A small settlement of railway workers had established close to the site (Figure 3.2d). The site also plays host to a large old vessel that is used to extract sand from the riverbed (Figure 3.2c).

Figure 3.2. Location 1 showing the Shwe Hlay bridge (a), the river channel at the site (b), a vessel used to extract sand close to the bridge (c), and the temporary settlement of construction workers fixing a railway bridge in close proximity to Shwe Hlay bridge (d). (Source, May Phoo, 2023).

City location: Market Bridge and Bago Bridge

Market Bridge and Bago Bridge are located in the centre of Bago City (Figure 2.1b). Bago Bridge is just 0.23 km downstream of Market Bridge, and the two bridges are clearly visible from each other along a straight stretch of the Bago River with no additional tributary inputs (Figure 2.3d). In the vicinity of the bridges there is a high population density, including commercial areas. Several markets are located close the bridge, including a large market near to the eponymous Market Bridge which receives busy traffic as it represents the main access route. A large waste dump and MJT composting facility is also situated in close proximity to Market Bridge. At both bridges, informal waste dumps and accumulations of waste from the river are present underneath the bridges and along the banks (Figure 2.3a,c,f-h). During the monitoring periods, people were observed discarding bags of waste directly into the river from the bridge. These bags are particularly visible in Figure 2.3c. In addition to this, litter was observed on the bridges themselves, including plastic cups, pipes, and Styrofoam items that were found on the walkway of Bago Bridge during the monitoring activities.

Figure 3.3. Location 2 including Market Bridge (a-d) and Bago Bridge (e-h). Waste dumped from the bridges and along the riverbanks can be seen in a, c, g, and h. Bago Bridge, located 230 m downstream from Market Bridge is visible at the right-hand side of image d, which is taken from the Market Bridge site. (Source, May Phoo 2023).

Downstream location: Kyauk Tan Suspension Bridge

Kyauk Tan Bridge is 41.86 km downstream from Bago Bridge on the Bago River, and 17 km as the crow flies from the lower boundary of Bago City. The bridge is located in a small village, Kyauk Tan, and the area between Bago City and Kyauk Tan plays host to several small settlements along the river. The area is largely agricultural, with a relatively low population density. This bridge was selected as the first bridge available downstream of Bago City from whence monitoring could be safely conducted. Fishing activity is typical in the vicinity of the bridge, although insights from conversations with the local population revealed that the availability of fish is currently low, linked with high turbidity in the river. Dumpsites were observed at both banks of the river underneath the bridge (Figure 3.4 a,c,d) and direct dumping of waste bags into the river was observed during the river monitoring.

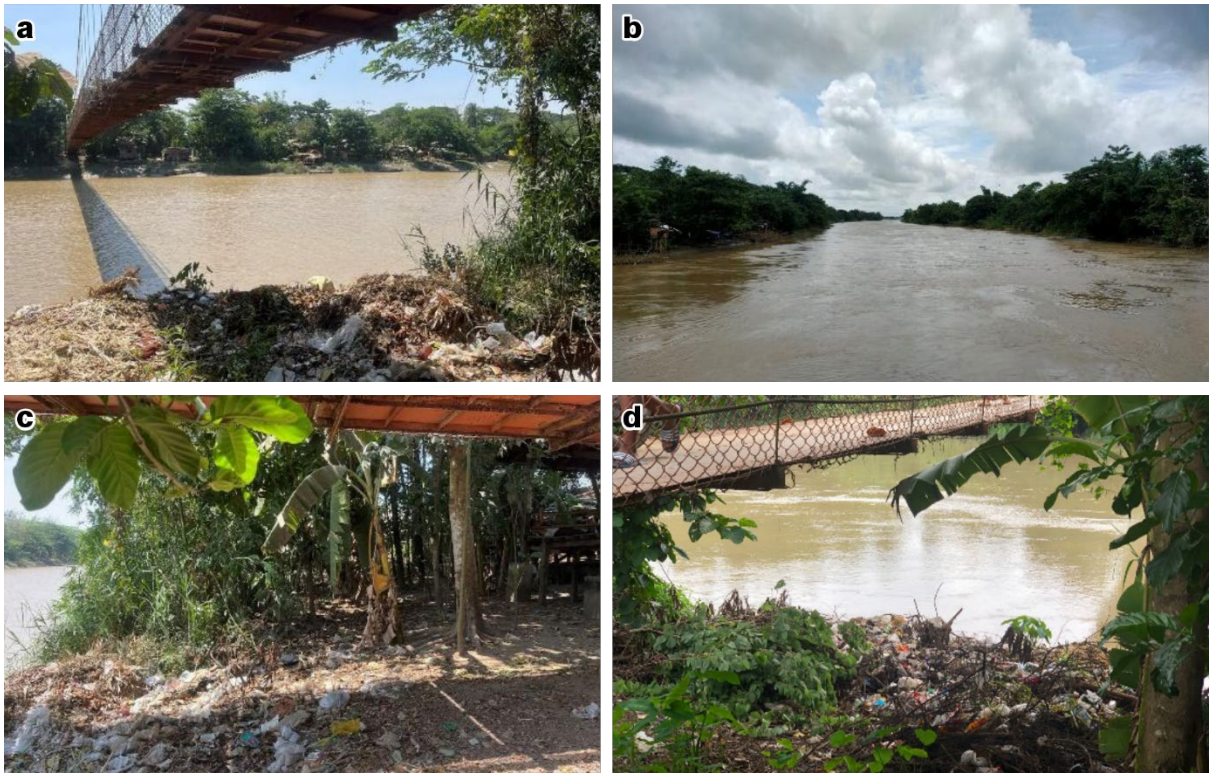

Figure 3.4. Location 3 and the Kyauk Tan Bridge. The bridge and river are depicted in a and b. Waste dumped and accumulating along the riverbank and under the bridge is visible in a, c, and d. (Source: photos a, b, c Kyaw Min San 2023, photo d, May Phoo 2023).

Monitoring method

Visual observations of visible macroplastic were undertaken between April and August 2023. At some sites, several measurements were included within a short temporal frame (1-3 days) to capture the short-term variability in plastic waste loads in the river. During each measurement, a minimum of two analysts stood in the centre of the defined observation width and faced opposite to the direction of flow. For most measurements, this meant analysts faced upstream but during some measurements the water flow was reversed due to tidal intrusion (flood tide) and so the analysts instead faced downstream. Additionally, for most bridges and measurements, the observation width refers to the full bridge width, as the width of the river, the flow velocity, and the plastic loads were all reasonable such that a single analyst could observe the full width at that site. At Market Bridge, the dimensions of the bridge and the flow velocity during some measurements exceeded the capacity of a single analyst to observe the full river width; therefore, the bridge was divided into two halves which were each observed separately.

During each measurement, one analyst was assigned to observe the river and count and categorise visible macroplastic, whilst a second analyst was assigned to record this information in the data collection sheet. Visual observations were conducted for a period of 15 minutes during each single measurement. For measurements where no plastic was observed within the 15-minute period, a second 15-minute observation was included (total: 30 minutes) to confirm the absence of macroplastic flows. Prior to the measurements, both analysts familiarised themselves with the visual appearance of plastic items in the different categories of the data collection sheet to ensure harmonisation of data collection. The data collection form is based on OSPAR guidelines for beach litter to facilitate harmonisation with other datasets globally (OSPAR, 2010). A copy of the protocol and data collection sheet is provided in Annex 7.1).

Prior to each measurement, the visibility (turbidity) of the river was estimated and the flow velocity was measured. Visibility was estimated by observing the extent of visibility of floating and partially submerged items. This was performed for several items by the analysts to achieve a reliable estimate. Flow velocity was measured using the "Pooh sticks" method, employing a piece of orange peel as an identifiable marker (Moss et al., 2021). Three measurements of flow velocity were taken, to allow an average to be obtained.

3.3 Results and discussion

Bago City as a source of plastic pollution

A summary of the monitoring data is presented in Table 2.1. Across the monitoring period, the highest plastic loads were observed at Location 2 with an average of 4.20 macroplastic items flowing through the site per minute (not including data points where the flow direction was influenced by tidal intrusion). This is similar to the average load at Location 3, downstream of the city (3.34 macroplastic min^{-1}). The lowest average plastic loads were observed at the upstream site, Location 1, corresponding with an order of magnitude less than the sites within and downstream of the city (0.52 macroplastic min^{-1}). This demonstrates the role of Bago City as a source of plastic pollution to the river environment: both in terms of the increased plastic loads observed within the city and also the indication that these levels persist to the downstream site.

This finding is further reinforced by an increase in the diversity of macroplastic items observed after the onset of Bago City. There is a significant increase in the number of categories detected from Location 1 to Locations 2 and 3 (Table 3.1). Figure 2.5 summarises the dominant macroplastic categories across the three locations: these categories in fact remain largely constant. However, several unique litter categories are introduced by Bago City, including plastic cups, cup lids, cutlery, straws, sachets and other containers for personal cosmetic products, personal protective equipment and other Covid-19 related plastic waste, plastic ropes, and plastic phone covers – represented by the diversity of categories listed in Table 3.1. The greater diversity of plastic waste continues downstream of the city – diversity data from Location 3 corresponds well with Location 2. This indicates that Bago City represents a source of plastic pollution to the river environment, which persists downstream.

Table 3.1 Summary of monitoring data from the three locations (A-C) across the monitoring period (April-August). Location 2 includes data from two bridges in close proximity, these are marked using identifiers for Market Bridge (*) and Bago Bridge (†) in the date column. The time data represent the start time of each measurement. Diversity refers to the number of unique plastic categories from the data collection sheet that were observed during each measurement (Annex 7.1).

A. Location 1: Upstream (Shwe Hlay Bridge)						
Date	Time	River conditions		Macroplastic observations		
		Visibility (cm)	Flow direction	Total items	Items per min	Diversity (number of categories)
03.04.23	11:23 AM	30	Regular	6	0.40	3
09.06.23	2:51 PM	30	Regular	5	0.33	3
28.06.23	12:55 PM	8	Regular	3	0.20	3
21.07.23	9:50 AM	4	Regular	10	0.67	5
29.08.23	2:26 PM	5	Regular	15	1.00	7
B. Location 2: City (Market Bridge* & Bago Bridge†)						
Date	Time	River conditions		Plastic observations		
		Visibility (cm)	Flow direction	Total items	Items per min	Diversity (number of categories)
03.04.23†	1:20 PM	30	Regular	27	1.80	9
04.04.23*	9:30 AM	40	Regular	136	9.07	15
04.04.23†	1:23 PM	30	Regular	58	3.87	13
04.04.23†	5:26 PM	30	Regular	128	8.53	16
06.04.23*	10:22 PM	40	Regular	161	10.73	22
06.04.23†	5:30 PM	30	Regular	74	4.93	14
21.04.23*	11:25 AM	40	Regular	52	3.47	9
19.05.23*	8:22 AM	40	Reverse	271	18.07	26
19.05.23†	5:58 PM	30	Regular	17	1.13	8
20.05.23†	5:57 PM	15	Regular	15	1.00	6
09.06.23†	12:45 PM	8	Reverse	264	17.60	28
28.06.23†	1:53 PM	8	Regular	19	1.27	8
19.07.23*	9:30 AM	5	Regular	52	3.47	15
20.07.23†	9:10 AM	5	Regular	55	3.67	14
27.08.23*	1:01 PM	5	Regular	44	2.93	11
28.08.23†	2:00 PM	4	Regular	45	3.00	12
C. Location 3: Downstream (Kyauk Tan Suspension Bridge)						
Date	Time	River conditions		Plastic observations		
		Visibility (cm)	Flow direction	Total items	Items per min	Diversity (number of categories)
19.05.23	9:53 AM	20	Regular	0	0	0
29.06.23	10:05 AM	10	Regular	108	3.60	14
30.08.23	10:50 AM	5	Regular	193	6.43	26

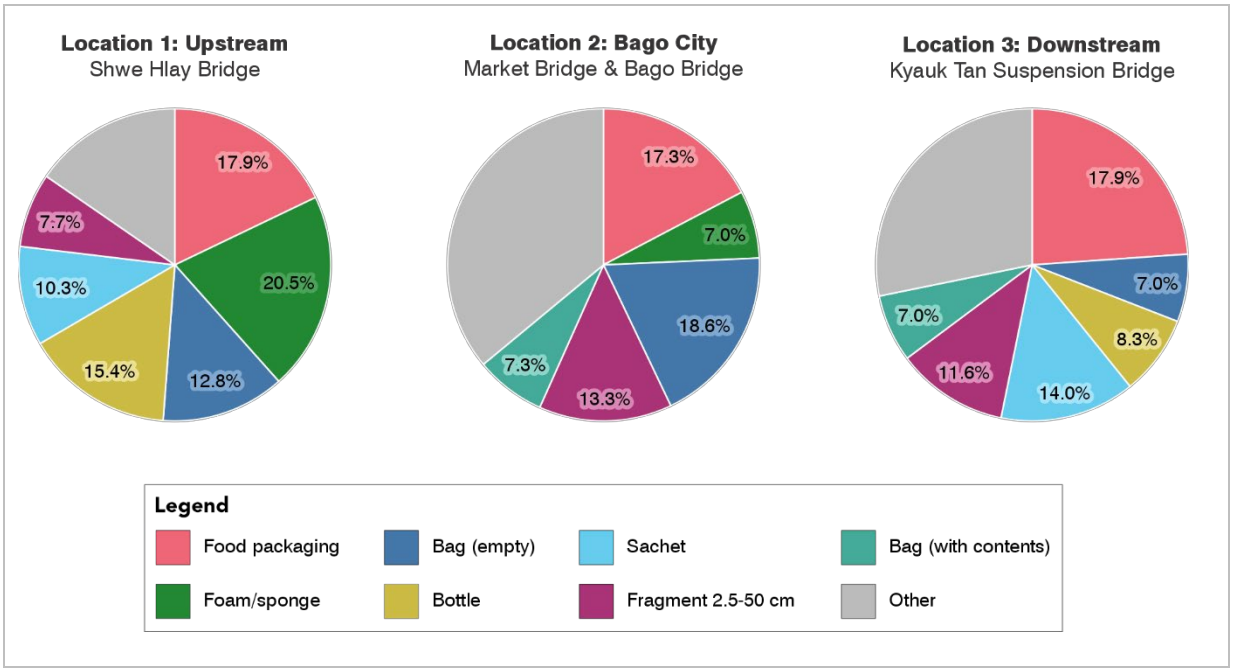

Figure 3.5 Dominant categories of macroplastic litter for each location. Pie charts represent the percentage contribution of each category to the total plastic items observed across all measurements for the full monitoring period. All categories that represent <5% of the total plastic load for a location are grouped into the "Other" category.

Dominant sources of litter in Bago River

Across all three locations and the full monitoring period, a total of 48 unique categories of macroplastic waste were detected. This reveals the wide-ranging diversity of plastic litter present in the Bago River. Yet, the dominant categories of litter do not vary substantially between monitoring locations (Figure 3.5). It is important to note that the number of categories used in the data collection could limit the emergence of important sources of plastic pollution as dominant categories – for example, where broader waste categories are divided into a larger number of individual categories to provide greater specificity about the observed waste. Further work is needed to identify potential, relevant waste streams or pollution pathways within the categorisation data to make more effective use of these findings.

Important categories of macroplastic pollution in the Bago River between April and August 2023 comprise plastic food packaging, foam/sponge (typically representative of expanded polystyrene (EPS)), plastic bottles, plastic bags that are both empty and filled, sachets, and fragments (2.5-50 cm in size) that could not be attributed to a specific category. This highlights several relevant sources of plastic pollution to the Bago River which may warrant further attention to reduce plastic pollution in the future.

Spatiotemporal variability of pollution

Within the city, plastic loads were highest during April. This precedes the onset of the rainy period in the region during 2023 – which started in May. The average plastic load in April was 6.06 macroplastic min^{-1}, compared to 2.35 macroplastic min^{-1} during the wet season. Turbidity in the river was low during April, which can enhance visibility and the detection of sub-surface macroplastic flows; however, this remained low into the onset of the rainy season so is less likely to be a factor that amplif dry season data here. Aside from measurements taken during tidal flow conditions, plastic loads all decreased during the rainy period within the city. Plastics loads also remained low prior to and following a large flood event that occurred on 10th August. During this time (July – August), the flow velocities were observed to be within the highest levels. The current data were not adjusted for variations in flow velocity between individual

measurements, but this would represent even lower plastic load values during these months based on the higher flow velocities during the period of measurement.

The influence of flushing of plastic litter has already been discussed in the literature (e.g., Cowger et al., 2022; Hauk et al., 2023; Pinto et al., 2023; Vriend et al., 2023). This flush effect may explain the temporal trend observed at Location 2, where heavy rains and flooding may have increased the connectivity between land-based sources of plastic and the river, and effectively flushed plastic waste stored on land and in or near the river channel further downstream early in the wet season. The temporal frame over which these flushing events occur is not yet known, but it is possible that they occur across very short timescales and were therefore not captured within the frequency of monitoring conducted in this study. Additional monitoring and research to characterise plastic loads during and following the first rain events and flooding would help to shed light on the temporality of plastic flows; however, it is important to note that monitoring is more challenging to conduct during those conditions. Namely, higher river flows and increased turbidity and turbulence can limit the ability to reliably observe, quantify, or categorise plastic in the river using the visual observation approach and it may even be unsafe to monitor during very heavy rains and flooding (Hurley et al., 2023). It would also be useful to better contextualise sub-surface flows of plastic during periods of higher turbidity using a complementary method – such as the deployment of nets at different depths – to identify whether total plastic loads across the whole river cross-section are indeed lower. The potential flushing effect is less evident at the locations both upstream and downstream of the city, where plastic loads are more closely associated with flow velocity. This may relate to the reduced complexity of plastic waste inputs and flows in rural versus urban areas.

Two of the highest observations at Location 2 (18.07 macroplastics min^{-1} on 19th May and 17.60 macroplastics min^{-1} on 9th June) were both associated with tidal flow conditions in the river; namely, the river was flowing in a reverse, upstream direction. This highlights the significance of the re-circulation and redistribution of waste within the river, where downstream locations can act as a source of pollution to sites further upstream – and this can be significantly higher than downstream flows. This trend has already been reported for other rivers systems in Asia and beyond (e.g., van Emmerik et al., 2019a,b; Ledieu et al., 2022). The sources of plastic waste and the dynamics of plastic transport associated with tidal intrusions warrants further study to better understand how plastic moves through rivers and to give improved context to the interpretation of monitoring data.

Some measurements at Location 2 were taken in close temporal proximity. This sheds some light on the short-term temporal variability in plastic loads in the Bago River. In some cases, this indicates consistency across short timescales, such as for the measurements taken on the 4th and 6th April at Market Bridge and the 19th and 20th June at Bago Bridge (Table 3.1). These repeat measurements reveal very similar plastic loads, indicating limited temporal variability across the level of days. Yet, measurements taken on the 3rd, 4th, and 6th April at Bago Bridge are characterised by more variable plastic loads. Whilst the first set of measurements described above were conducted at the same time of the day, the measurements taken in April at Bago Bridge were taken at different times of the day. This indicates that temporal variability may in fact occur across very short timescales, within hours. The changes in conditions in the river and potential plastic waste inputs *during a single day* appear to affect plastic flows more than the variability *across* days. Some studies have highlighted a similar pattern, where certain times of the day are associated with higher plastic flows (e.g., Aisyah et al., 2022; Requiron & Bacosa, 2022). This may be due to patterns of human behaviour, such as the timing of different daily activities or an increased prevalence for dumping waste in the river at certain times, or diurnal variations in flow velocity or weather conditions (Requiron & Bacosa, 2022; Bardenas et al., 2023). Further research is needed to better contextualise short term variabilities in plastic flows to provide insights into behaviours that may influence pollution levels or to facilitate greater accuracy in modelled plastic flows and estimates of plastic fluxes. Macroplastic

monitoring addressing these objectives could provide valuable data to tailor effective solutions to riverine plastic pollution.

3.4 Reflections and future research

This pilot study of macroplastic pollution in the Bago River has revealed several important insights. First, Bago City represents a source of plastic pollution into the river, indicated through both an order of magnitude increases in plastic loads and a significant increase in the diversity of plastic litter types – including the emergence of several unique litter categories – compared to the upstream site. These trends both continue to the downstream site at Kyauk Tan, demonstrating the persistent influence of the city on riverine pollution levels.

Plastic loads were found to be highest during the dry season; however, the temporal frame of this study may have missed critical flush events at the onset of the wet season, which may be important for macroplastic transport in rivers. This study indicates that flushing events likely occur over short timescales and are effective in reducing the available supply of plastic to the river. Further monitoring should aim to address this in more detail, to better understand the trends in plastic flows during the dry season and to capture and characterise high plastic flow events.

The influence of tidal flow in the river is important for the fate of plastic litter. This should be investigated further in the Bago River, as well as other relevant river systems globally, to better understand this important dynamic and potential implications for the redistribution of litter and quantification of plastic flux or spatial attribution of sources or release pathways.

The data provided here shed a light on several important categories of plastic litter to the river. This reveals which litter items within the waste that is generated end up as environmental pollution. By categorising litter items, it is possible to identify potential sources, waste streams, or release pathways for plastic pollution. Additional research should further characterise plastic pollution in the river, including further verification of diurnal trends noted here and a holistic assessment of floating, subsurface, and riverbank plastic to help identify relevant behaviours or activities that may contribute to pollution and tailor solutions or mitigation actions to address dominant sources of plastic to the river environment.

4 Pilot studies targeting sustainable waste management practices.

Chapter 4 presents the project's activities and achievements in promoting sustainable waste management practices and behavioural change through implementing four pilot cases. First, in section 4.1, theoretical concepts addressing behavioural change are discussed. This is followed by a description of different categories of policy instruments referring to approaches and techniques that governments use to achieve policy objectives. We then describe different types of measures, defined as practical activities to promote policy or project objectives within the Bago Township context. This reflects the measures that were implemented by the project: provision of infrastructure and awareness raising, knowledge building, and clean-up activities. Section 4.1 ends with a sub-section presenting the methodological concepts of action research, participatory research design, and adaptive management, representing the project's approach to the pilot studies. Section 4.2 follows by presenting the pilot cases that have been central to the project capacity building activities. Through clean-up activities, awareness campaigns, and support for waste management and composting infrastructure, the project grounded waste management capacities in existing socio-cultural institutions in the Bago Region. Section 4.3 systematises the reflections on the pilots through the theoretical lenses discussed in 4.1.

4.1 Theoretical concepts and approaches to the pilot studies

Theories on behavioural change

Capacity building projects often aim for societal change through infrastructure investments, dissemination of knowledge, and other measures. Promoting behavioural change as part of capacity building interventions has become more common in the last decades, as material investments alone rarely effect long-term societal change. Within health interventions, several theoretical approaches have been influential, especially cognitive psychological models like the Theory of Planned Behaviour (Ajzen 1991, 2020), Behaviour Centred Design (Aunger and Curtis 2016, Mugambe et al. 2022), and the Transtheoretical Model (TTM) (Prochaska and Velicer 1997, Petersen, Petersen, and Ahcin 2020). The focus of these models is individual behaviour, linking it to the personal intentions behind behaviours, and the social norms and social environment that condone and sanction these behaviours. The strength of these models lies in their ability to link individual motivations and decision-making processes to behavioural change. Their weakness can lie in a simplified vision of individuals separated from their social realities, as acknowledging that individuals exist and operate within social contexts is not the same as understanding how they impact and co-constitute each other (Smiley and Stoler 2020). In their review of behavioural change models in use in Water, Sanitation, and Hygiene (WASH) interventions, Dreibelbis et al. (2013) acknowledge the over-representation of individual-level behaviour in previous models of behavioural change. They develop an Integrated Behavioural Model (IBM), which promotes a "broader ecological model approach that positions individual behaviours within a multi-level causal framework" (2013:5). To effect behavioural change, a complex and comprehensive set of policy instruments and measures targeting individuals, families, communities, government policies, and infrastructures may be necessary, and it is important to understand how the different levels perceive and contribute to a problem.

All actors operate in a context (Vogel 2012) or environment (socio-cultural, material, political, etc.), that may constrain, or enable behavioural change. For example, a city may have existing infrastructures for waste management (context), but little awareness amongst people on how to access them. Vice versa, a community may be well-aware of a company polluting a local river but there are no laws or a lack of legal

enforcement to hold the polluter responsible. In many cases, especially in low-income countries, there is often a complex combination of a lack of enabling environment (constraining context), little awareness, and low capacity to generate change, that contribute to environmental problems like prolonged and extensive marine littering and plastic pollution. Through implementing the pilot case studies, the Bago Waste project targeted behavioural change at multiple (and intersecting) levels, i.e. different institutional levels and the individual level, by addressing the complex interlinkages between an enabling environment (including infrastructure and policy).

Policy instruments

Policy instruments refer to various incentives and interventions that are typically designed by authorities to influence change towards a more desired behaviour (Gneezy, 2011; Matter et al., 2015; Vatn, 2015). Vatn (2015) introduces policy instruments in the context of environmental governance, developing a typology of legal, economic, informational instruments. In the area of waste management, Vatn also points to the role of infrastructure in facilitating action (p. 343). Similar typologies are common in the literature (see EPRS, 2017), but Vatn's framework directly relates to environmental governance. Furthermore, adding the infrastructure component to the policy instruments is relevant for the pilot case context. Considering the formal and informal waste sectors to both have an important role in many countries, the types of policy instruments differ in reaching the formal and informal waste systems (Matter et al., 2015). Legal instruments typically reach the formal sector first, while economic (market incentives) also immediately reach the informal waste sector.

Most policy instruments (legal, economic, infrastructure) can be seen as creating external conditions (external rewards, expectations, punishment, social appraisal etc.), where individuals should perform better waste-related practices; below referred to as representing extrinsic motivation factors (Gilli et al., 2018; Gneezy et al., 2011). Policy instruments involving for example information and advisory services target intrinsic motivation factors being linked to one's own belief and satisfaction (Gneezy et al., 2011). People driven by intrinsic motivations don't expect external rewards for their actions. Below we describe policy instruments according to these categories, and we briefly present the respective situation for Bago Township.

Legal policy instruments referring to traditional regulations of "command and control" instruments create the basis for national environmental policies (Bengtsson et al., 2010). They establish certain standards for compliance, often entailing sanctions for non-compliance by institutions and individuals. Legal regulations represent extrinsic motivation factors, i.e., conditions that actors must abide to (if enforced). In contrast, in a situation where rules and regulations are not defined for certain practices and behaviours, this could result in a negative impact on nature and society (unless strong social norms exist, i.e., Ostrom 1990). In the Bago Township, there is a legal contract between the township authorities and the waste collection company, specifying the duty of the company to collect waste from households. However, no legal rules for disposal of waste by households or industry exist.

Economic instruments are associated with market-based and incentive-based instruments that make practices or actions either more or less expensive. Economic instruments, in theory, leave people free to choose while, in practice, economic instruments such as taxation or subsidies may represent strong extrinsic motivation factors. Economic instruments are a common way for governments to motivate practices and behaviour. The reward can be in the form of a reduced fee if waste segregation is practiced and positive waste practices are observed when rewards are expected, for example for proper waste segregation (Schultz et al., 1995). In the Bago Township, no economic instruments are used by the authorities or private actors to motivate sustainable waste management by individuals or households. Households pay for waste collection to the waste collection company for the service.

Informational instruments are designed to fill the information deficit and increase public awareness and knowledge. It is expected that, with good information, certain changes in actors' behaviour will be achieved. Studies have shown that a lack of public awareness is a central obstacle to improved waste management, especially in low- and middle-income countries that are experiencing rapid economic change, urbanisation, and changing consumer practices (Adekola et.al. 2021, Wang et.al. 2020, Kanhai, Agyei-Mensah, and Mudu 2019). Informational instruments can be also seen as trying to influence personal (intrinsic) motivation. Governments can design waste related campaigns, and NGOs, community organisations, and schools often co-design and co-implement such informational instruments. While legal and economic policy instruments represent extrinsic motivation, informational instruments aim to motivate intrinsic motivations. In the Bago Township, no systematic informational instruments for sustainable waste practices, such as by education, are provided by the authorities. The waste collection campaigns being organised by local authorities such as for example the ECD and/or parliament members, though infrequent, can be mentioned as implicit information (Information local project partners, 2019, 2020; Figure 1.1). Waste collection provides systematic information on a Facebook page where waste related information and practicalities are announced[13]. This is also achieved through the app Waste Tax Collector developed by the company (Figure 4.2, in Nesheim et al., 2022).

*Infrastructur*e facilitates a change of individual behaviour by increasing accessibility and convenience for more sustainable waste practices. In some domains, physical infrastructure may be seen as key to facilitate environmentally friendly action. People cannot dispose of or sort waste if there are no facilities or if facilities are not available in their vicinity. Better infrastructure design, functionality, and convenience also create incentives for sustainable waste practices.

Table 4.1a. A summary of the policy instruments discussed in this section.

Policy instruments	Examples
Legal	Waste related laws and regulations
Economic	Waste related fees and taxes
Informational	Educational and informational campaigns on waste
Infrastructure	Infrastructure for waste collection, storage, transport, landfill etc.

Table 4.1.b. Intrinsic and extrinsic motivations for sustainable waste practices-

Individual incentives/motivation	Examples
Intrinsic	Not discarding, sorting waste because it is a right, pro-social and pro-environmental behaviour
Extrinsic	Nor discarding, sorting waste because there is some external pressure (from the project, community) or some punishments (fines) or rewards (selling of recyclables)

Key measures (awareness rising and capacity building)

Measures are variously defined in the scientific literature and reports (can be physical, technical, policy, etc.). Here, we refer to measures to describe practical activities, "translating" policy into concrete actions. While policy instruments often specify more long-term conditions, and typically the mandate of

[13] https://www.facebook.com/profile.php?id=100076766198440&mibextid=LQQJ4d

governments to implement, a measure can be a short-term practice, and can be implemented (within the context of norms and policy instruments) by authorities but also by private and civil society actors to reach different types of objectives.

Below, we describe the types of measures – knowledge building and awareness raising, provision of infrastructure, and clean-up – with the associated theories that were implemented by the project in the pilot studies. The project did not have any possibility to influence the development of legal and economic policy instruments, due to the sensitive situation in collaboration with public actors.

Awareness raising and knowledge

Awareness raising targets public perceptions, beliefs, and attitudes through appropriate knowledge dissemination (Eade 1997, Wang et al., 2020). Awareness campaigns and meeting forums that focus on knowledge transfer can thus help to tackle public misinformation and public perceptions of waste mismanagement as non-problematic (Adekola et.al. 2021). Focusing on awareness raising is often based on an assumption of a public "information deficit", meaning that project implementers assume practices will change if people only have "more" or "the right" knowledge (Suldovsky 2017, Pfeffer and Sutton 2000). Disseminating knowledge always begs the question of whose knowledge counts. Leveraging traditional environmental knowledge and the capacities of local knowledge holders are important from both a human rights perspective, and for effective and inclusive environmental governance (Tuck, McKenzie and McCoy 2014, Apraku, Morton, and Gyampoh 2021, Sillitoe 2002). Such an approach may also help to decouple knowledge on waste management from other political or economic ideological framings, like narratives of endless growth or economisation of sustainability (Hill et.al. 2020, Livingston 2019, Green 2020). Furthermore, research has shown that awareness activities are likely to be more successful when they involve the communities themselves in developing, tailoring, and disseminating the knowledge (Abunyewah et.al. 2020).

Awareness and knowledge, however, are rarely enough to produce change in and of themselves. As research – especially on climate change awareness – has shown, even those with much knowledge and awareness about the human impact on global warming have shown little ability to change their behaviour (Kellstedt, Zahran, and Vedlitz 2008, Norgaard 2011). Awareness measures must therefore be coupled with other types of incentives that help to shape an enabling environment. These may be support for policy and legal regulations, accessible financial instruments, new infrastructure, and support systems that enable and potentially reward positive behaviour change.

Infrastructure

Storage, collection, and recycling of waste requires adequate infrastructure that fits with the local site conditions, expectations, and practices. Important aspects to consider are the types, size and numbers, their location, access, and maintenance responsibilities. It is also important to note that the formal and informal waste sector develop specific infrastructures for waste collection, transport, and processing. Infrastructure should not only be seen as providing material tools but as crucial measures representing links between sustainable waste management and local waste practices. This type of measures needs to be considered in a broader system perspective, i.e., linked with individual behaviours in a multi-level causal framework.

Cleanup

Cleanup of illegal dumpsites is an important activity that restores polluted areas and improves the environmental status but also has a significant learning and demonstrating effect. Cleanup activities have a potential to bring diverse stakeholders together, build a shared vision of the area, and show that this is

possible to achieve. Finally, a successful cleanup site shows how the area can look like and be used in a new way. This should be inspirational for noting the difference between polluted areas full of waste, smell, and environmental pollution and those that can be an attractive community meeting place, with a healthy environment and green facilities for all to enjoy. A successful cleanup campaign shows that change is possible and needed, motivates change, and demonstrates concrete tools on how this can be achieved.

The approach to the pilot studies, action research and adaptive management

The design and implementation of the pilot cases are anchored in several concepts related to participatory research, namely Action Research, Participatory Approach, and Adaptive Management. All concepts imply research that is also designed, influenced, and co-developed with community support. The objective of such research processes is to address community needs and bring legitimacy to the project. The concepts discussed here partly overlap but point to various objectives that were important both for research activities and for promoting behavioural change and more sustainable waste management.

Action Research means that there is an aim to produce practical and applicable knowledge through interaction and problem-solving mechanisms. Following Farrelly and Tucker, who applied Action Research in the context of residential waste minimisation in New Zealand, the work addresses "practical problem-solving in real life situations where researchers work with and for people as opposed to objectively conducting research about or on them" (2014:16).

While Action Research implies a mission and problem-solving nature of the research intervention that serves certain purposes, the Participatory Approach (Chambers 1994, Narayanasamy 2009, Mussehl et al. 2022, Mosse 1994) assures that concerned stakeholders are represented in the research process. This acknowledges how social and behavioural change can only be affected if the relevant stakeholders are identified and consulted (Reed and Curzon 2015). A Participatory Approach brings legitimacy to the process and requires openness and change, as activities need to be continuously adapted based on stakeholder consultations, ensuring knowledge exchange, and promoting trust and community ownership over outcomes (Mussehl et al. 2022). This implies that pilot cases don't exist in a vacuum but belong to administrative and socio-cultural institutions that need to be understood and addressed.

Finally, the necessary flexibility of the project to correct action is captured by Adaptive Management (Pahl-Wostl 2002), which was primarily employed through the coordination efforts of the different pilot working groups. The project planning and implementation was developed through an iterative cycle in close collaboration with stakeholders, starting with problem definition, planning for different scenarios, acting on ideas, and observing and monitoring process and consequences, before reflecting on the process in dialogue (Snapp et al. 2023, Susman 1983). This dialogue would then lead to new problem definitions, initiating new iterative cycles. In this context, the project followed an iterative and step-by-step approach, based on learning from experience and modifying behaviours in light of that experience.

4.2 Implementing the pilot cases in Bago Township

This section presents the four pilot cases implemented by the project for the overarching ambition of improving local waste management practices and building awareness for affecting social change: (i) the River View cleanup, (ii) sustainable waste management system at the Phyazay market, (iii) sustainable waste management practices in selected monasteries, and (iv) decentralised waste management to make compost at the Tha Dhamma Gone Yi monastery. The rationale behind implementing these pilots has been to provide applied examples, by involving key decision makers and actors on multiple societal levels to work together on a 'project basis'. Drawing on conceptual thinking on behavioural change (section 4.1),

the pilots were approached as applied action research, seeking to build local knowledge capacity through applied project activities.

Working on a pilot case basis enabled addressing interlinkages between infrastructure and governance, individual behaviour, and awareness in the context of a wider enabling environment. The different pilot cases were identified and implemented in the Bago City area in collaboration with the local project partners: Justice for All and the waste collection company. The local project partners had a central role in each of the pilot cases in developing, managing, and evaluating the project activities and results. In each, working groups consisting of representatives from the project partners, and representatives from local stakeholders and authorities were established. The working groups ensured that interventions were appropriate and anchored initiatives and measures, including the provision of infrastructure, awareness raising events, general coordination, and information flow. Strong engagement by the head and deputy monks and the residents of the monasteries have been important in the monastery related pilots. The selected pilot cases were intended as highly visible interventions in the Bago Township to inspire and showcase to the ordinary public promising models of waste management.

The development of the pilots followed an iterative approach reflecting an adaptive management strategy (presented in 4.1), which included modifying activities in light of the experiences gained. The different steps and focus areas are described in the following sub-sections and for each pilot case according to: 1. The adaptive management and communication approach, 2. Infrastructure measures to support responsible waste management, 3. Awareness raising activities and other measures for change of practice, 4. Monitoring and follow up, and 5. Achievements, challenges encountered and take-home messages.

Before the military coup in February 2021, the project implemented activities for two of the pilot cases, namely the river side clean-up ("River View" 4.2.1) and waste management at Bago markets ("Phyazay market" 4.2.2). These pilot cases, which involved collaboration with government actors, were terminated following the military coup in 2021. Instead, independent work with monasteries was started, and continued over the remaining project period (2021-2023). All the pilots involved extensive collaboration including regular and frequent discussion of the work within the extended partnership including NIVA, Justice for All, and MJT waste collection company.

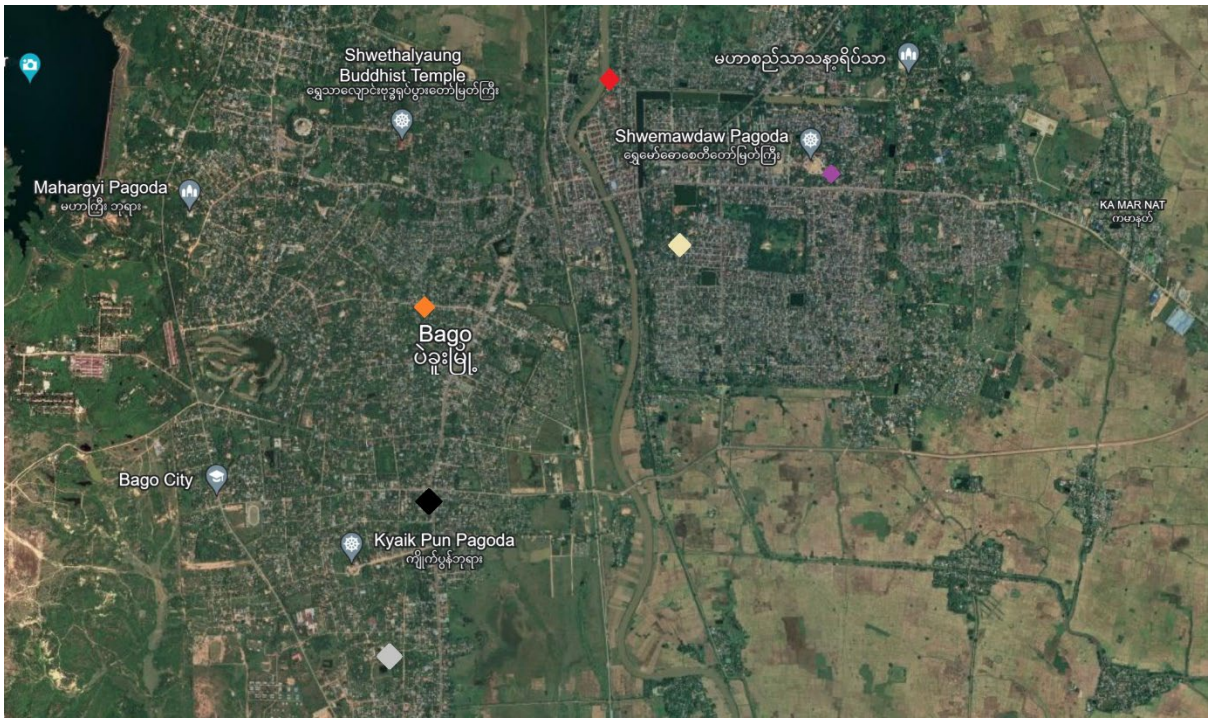

Figure 4.2. indicative map location for each monastery (colour coded). (Source, modified google maps, 2023)

Kya Khat Wine monastery	Leik Pyar Kan (nun) monastery	Win Neinmitayone monastery	Thar Manay Kyaw monastery	Thadamagoneyi monastic school, (nun) monastery	U Win monastery

Figure 4.3 Marked in River View and Phyazay market the first 2 pilot sites. (Source: modified google maps, 2023)

4.2.1. Cleanup of a river side waste dump

The Bago River flows through central Bago city over a stretch of several kilometres (Figure 4.3). Multiple land use zones are located along its banks. These range from agricultural and industrial to residential. Across these zones along the Bago River, several smaller but also larger waste dumps can be observed. The Bago River has several tributaries, creeks, and streams, with a considerable amount of waste transported by them. The waste dumps, i.e., sites of indiscriminate accumulation of solid, mostly household waste, constitute an important source of pollution that is only rarely addressed in a systematic fashion beyond occasional cleanups organised by civil society actors[14]. Considering this situation, it was discussed and agreed at a Bago waste project advisory board meeting in October 2020 to undertake the clean-up and restoration of a major waste dumping ground at a selected riverside area. While the clean-up of the waste dump was identified as an important task of the pilot, the overall aim of the pilot, as discussed at the board meeting, was to transform the usage of the area from a place of neglect where waste was thrown into an area for recreation and community use.

4.2.2.1 Implementation at the River View site

The riverside area selected for cleanup and restoration is located west of the main bridge in the Bago City area (Figure 4.3). It was estimated by the local partners that the designated area had started to become a site for waste disposal over a decade ago. The size of the River View site is approximately 150 metres in length and 15 metres in width, with the waste dump spread along the riverbank. It can be characterised as an intermediate sized waste dump. Some waste dumps can be much larger, as in the case of the waste dump beside the Myoma market. The area neighbouring the waste dump comprises a residential area, the Kyaw Khat Wine monastery, some fallow land, and the Myoma market. The Bago River flows from the North to the South, passing the Myoma market, the monastery, and the area of the waste dump addressed by this pilot case.

Activities related to this pilot – from initial discussions to finalisation – were implemented from October 2020 to February 2021. In the following sections the different steps for implementing the pilot are described. Achievements, challenges, and take-home messages are described in 4.2.1.2.

Figure 4.4 The waste dump alongside River View site (left hand side), and photo 2 is the waste dump of the selected river side (right hand side) (Source, Kyaw Min San, 2020).

[14] The large waste dump along the Myoma marked was removed in 2023 by MJT based on an order from the Bago Region authorities.

(i) Adaptive management and communication

The first step in the process to enable adaptive management was to anchor the pilot and to collect information from different authorities and actors with relevant responsibilities. This was done to ensure a common understanding of the situation by all parties involved, their respective roles and responsibilities, potential concerns, and policy objectives. Consultation meetings with the monastery and local community administration at the River View site were held beforehand. The Bago Waste Advisory board was an important platform for engagement and illustrated the commitment from the different local authorities, which thereby legitimised the project activities undertaken. It was important to ensure that there was continuous and proactive engagement. Information sharing and trust building with and among the different actors was therefore key.

A working group, including a Facebook messenger group, was established to ease communication among actors and to share pictures of activities. Among the actors involved in this group were the Municipal Department, the FD, the DWIR, representatives from the Bago TDC, the local project partners, and NIVA. These communication efforts were central for the development of an agreement on workplans, and the necessary updates at regular intervals. The pilot aimed to address the following objectives, (i) to raise awareness for the local neighbourhood including the monastery, (ii) to remove the waste and soil safely away from the river side, (iii) to avoid erosion of the riverbank, (iv) to restore the cleaned river side with vegetation, and (v) to transition the site from a waste dumping ground to a place for recreation and community use which will not turn back into a dumping ground in future.

Prior to the actual clearing and construction activities, a detailed activity timeline was drawn up that considered: (i) the necessary work order, (ii) the resource needs in terms of funds and equipment but also in terms of natural resources needed such as soil, seeds, and trees, (iii) existing schedules of core actors, and (iv) appropriate timing of activities to avoid the rainy season and reduce risks from erosion of the cleared and barren soil.

(ii) Infrastructure measures to support for responsible waste management

For this pilot, the infrastructure used refers to the machinery needed to remove the waste dump, clean the area, enact re-vegetation efforts (trees, seeds, grass etc) to restore the area, and associated construction efforts. Also, safety equipment was provided for the local community that took part in the waste collection campaign.

The MJT waste collection company had most of the machinery that was needed for the clean-up. A backhoe was rented for two days. In total, an area of around 76,2 m^2 (250 square feet) of soil and waste were removed, as well as several tonnes of waste. The Forest Department provided the soil, the seeds, and the trees that were planted. Care was taken to solely use native species. On the sides, structures were placed, and vegetation was planted to minimise the risk of soil erosion. Similarly, boards that warned against future dumping were erected.

The pilot case also garnered the attention of various government departments who contributed with their own resources to redevelop and rejuvenate the River View site. The Union level Ministry of Health and Sports (regional office) supported the restoration objective by providing funds for a playground through the demand from the local Member of Parliament (MP). In addition, streetlights were installed on this stretch and road works implemented by the local authorities to make the site safer and more accessible.

Figure 4.5. The picture (left) shows the "River View site" with new soil after the cleanup; the picture (rights shows a group of people that participated in the clean-up of the waste dump (before using the backhoe) (Kyaw Min San, 2020).

(iii) Awareness raising activities and other measures for change of practice

The measures implemented by the project for awareness raising and change of practice included involvement in cleanup activities and restoration of the area.

Involvement in clean-up activities: The clearing of waste was initiated through two days of waste collection campaigns from the 9th of December 2020. This involved members from the local neighbourhood (including schoolchildren). They were provided with adequate safety equipment beforehand and supervision during the task. After the manual work, a backhoe was rented over several days for the removal of layers of waste and contaminated soil. The whole operation lasted more than 10 days and was enabled through local engagement, support from authorities, and access to expertise and adequate equipment.

Restoration of the area for change of practices: Activities were undertaken to make the area attractive to people residing in the neighbourhood for recreational purposes. The restoration work included several tasks beginning with the placement of fresh soil to replace contaminated soil, followed by sowing of grass and planting of trees. Finally, playground facilities and benches were installed.

Awareness raising by communication to the general public: The wall area towards the monastery side was painted with artwork that provides messages about environmental conservation and waste management, which contributes to awareness raising. The focus here was on the immediate neighbourhood but was not limited to that. The news of the river site development was broadcast over the radio at the end of 2020.

Figure 4.6. Photo (left) children playing at the new playground, the Kyaw Khat Wine Monastery can be seen in the back; Photo (right) The River view site after restoration activities (Source Kyaw Min San, 2020).

(iv) Monitoring and follow up

Following the successful transformation of the area from a site of pollution and neglect towards one of renewed community use, the project team and local partners made efforts to ensure that there was regular monitoring of upkeep (through physical site visits and documentation). There was weekly and sometimes bi-weekly visits and meetings to ensure that the construction efforts remained stable, and that the vegetation was growing well. In addition, the local community who had participated in the cleanup and that enjoyed recreation in the area also wanted to protect the space from unwarranted waste dumping. The meetings and monitoring happened at high frequency until the end of February 2021, and at a lower frequency afterwards. Waste dumping at the site was significantly reduced (from regular dumping to isolated incidences). The Norway-based project team received regular updates and picture/video material until the end of 2023. Very soon after the completion of the work, the military coup disrupted some of the long-term planning and maintenance of the project, especially in terms of government participation and support to actively maintain the site.

4.2.2.2 Achievement, challenges encountered and take home messages

Achievements

Trust building and joint collaboration: This enabled expertise to be built on a multi-faceted project with a waste management focus. The physical and highly visible nature of this pilot in Bago Township showcased the possibility for positive change and the benefits of better waste management. The pilot's local anchoring promoted institutional trust building, as evidenced by the multi-agency effort to restore the site to a community space.

One less waste dump along the riverside: The scale of the project was significant (considering limited project funds and transfers). This pilot garnered support from authorities and the general public and served its original intention of displaying and facilitating people's participation towards improving waste management practices.

Knowledge by local actors on restoration of a river side waste dump: As a pilot to clear and restore an intermediate sized waste dump in Bago city, it also provided a template for issues that need to be

considered when doing so at other pollution hotspots along the Bago River. Significant knowledge was built here by local actors.

Challenges

The main challenge for the long-term success of this pilot case was the military coup, which implied replacement of local authorities and a stop on involvement of public actors. This also halted follow up of the activities. For all the pilot cases, the Covid-19 related restrictions were challenging for coordination during implementation, which was done remotely and required significant effort and near-daily interaction.

Take home messages

- Involvement of all necessary government departments is needed for their mandate and for permission to undertake activities.
- An area associated as a waste dump needs to obtain a different identity and function in the neighbourhood. This can be achieved when people are present and actively use the area, such as a park or a playground, for example.
- Responsible actors (e.g., authorities) with some resources are needed to maintain the playground or park area after the pilot is completed.
- To change behaviour, alternative means for the disposal of waste are needed.
- Publishing about the clean-up in local media and using the clean-up and restoration as an educational tool was found to be useful for transparency, participation, and awareness raising.
- Any long-term, successful approach at the municipal level requires waste to be tackled at source and involves sustained multi actor participation with support along the value chain. It also needs economically viable funding and infrastructure and should involve national, regional, and local state actors.

4.2.2. Waste management at the Phyazay Market

Small and medium scale shops and food courts in market sites represent important sources of waste generation, but most markets are only partly included or excluded from waste collection schemes (Dickella Gamaralalage et al. 2017; 2020). Market sites – defined as areas where small shops and restaurants are congregated in a specific geographic cluster – are, in Myanmar, typically governed by a market committee that decides the rules that renting shops must abide to. Rules address issues such as the cost of renting space, the location of different shop types, and may also include rules on waste disposal. For the project, addressing waste management at markets represented an opportunity to identify and roll out community-level waste management improvements (as opposed to targeting only households).

Prior to 2020, waste from markets in Bago City was only irregularly collected by public authorities (Personal communication Municipal department, September 2020) and MJT collection company mainly provided services for households (Nesheim et al. 2021; 2023). Considering this situation, the project advisory board (section 1.1) suggested that the project (in addition to the River View site) undertake a pilot on waste management in a Bago market. It was agreed to start with the Phyazay market, an intermediate sized market of around 150-160 shop keepers. Later, the project was to undertake a pilot at

the larger Myoma market[15], taking into account learning experiences from the work at Phyazay market. The motivation for a pilot at the Phyazay market was due to interest from local authorities, the market committee, and from MJT waste collection company in establishing more effective waste collection systems. In collaboration with location authorities, the project partners developed a workplan for the pilot, facilitated coordination, and funded selected infrastructure elements.

4.2.3.1 Implementing the Phyazay market pilot

The Phyazay marked is located south of, and next to, the Shwe Maw Daw Pagoda in the centre of Bago city (Figure 4.3). It is an intermediate sized market in relation to the average scale of Myanmar markets, and one of three larger markets in the city. Several other smaller markets also exist in the vicinity. The Phyazay market includes around 160 shops built on a cement floor, with a roof and with external walls in some areas (Figure 4.7). There are about 43 shops that sell meat and fish, 6 that sell flowers, 20 vegetables shops, 10 fruit shops, 30 that sell rice, oil, salt etc., 32 that sell clothing and cosmetics, 4 plastics products shops, 10 gold and jewellery shops, and 5 sewing and designer clothes shops (observation by authors, August 2023). The market is open daily and visited by several hundred people mostly from the local area (observation by authors, August 2023).

In August 2020, the Phyazay market committee was approached by the local project partners to inform about the project and to inquire about interest in being a pilot for implementing sustainable waste management at markets. Activities related to the pilot ran between July and November 2020, with follow up and monitoring activities in December 2020 and January 2021. The activities ceased with the military coup in February 2021.

Below are the different steps for implementing the pilot: (i) adaptive management and communication, (ii) infrastructure to support an enabling environment, (iii) measures including awareness raising activities for change of practice, and (iv) monitoring and follow-up. Achievements, challenges, and take-home messages are described in section 4.2.3.2.

Figure 4.7. Photo (left) shows the area outside of the Phyazay market that was to be restored (August 2020); the photo (right) shows the inside area of the Phyazay market in November 2023 (Source: Kyaw Min San).

[15] In December 2023 the Myoma market includes around 800 shops (Personal communication with MJT, December 2023).

(i) Adaptive management and communication

Adaptive management and anchoring comprised involving local authorities and actors, and as part of visits by the project's local partners to the market for observation and discussion with shop keepers in their actual environment. This provided common knowledge among the actors and the possibility to act immediately when needed.

The Phyazay market working group (hereafter the market working group) was established shortly after the market committee's confirmation of their involvement in the pilot and included Bago Township Development Committee (Bago TDC) representatives, the Executive Officer (EO) of the Municipal Department, and the project partners (JFA, MJT, NIVA). The group met regularly for planning and coordinating activities. A Facebook messenger group was established to facilitate communication and to share pictures. Finally, the working group also had regular communication with the Phyazay market administration and other relevant local authorities as the DWIR and IWUMD for anchoring and for ensuring input of expert knowledge and policy priorities. It was agreed with the market committee that the pilot was to address: (i) clean-up and restoration of an area outside of the market, (ii) infrastructure measures for shop keepers and improved collection services by the private company, and (iii) measures for awareness raising of shop keepers for aiming for waste segregation and clean shop areas.

(v) Infrastructure measures to support responsible waste management

At the start of the pilot, the area outside of the market was characterised by overcrowded waste bins and accumulation of waste in piles and in the drainage channels (Figure 4.8, left side). Only a few small waste bins existed inside the market itself. There was limited collection of waste, and no system for waste segregation. The market working group identified a need for waste bins for the shopkeepers at the market, and a large container where shop keepers could discard waste bags. The waste collection company would be responsible for emptying the waste from the container. Finally, the working group also identified the need to restore the drainage system in this area. It was also decided to construct a concrete platform to place the waste container onto. The Municipal department funded this activity. After discussing in the group for about a month – to enable input from the different local actors – cleaning with a backhoe began on the 10th of November 2020 and the cement floor was prepared a few days later on November 14th-16th.

A container on wheels – about four times the size of the previous bin – was provided by the project to the Municipal Department. The private waste collection company could, with the container, easily bring the waste from the market area to the landfill. It was estimated that the container could receive waste for about two days before needing to be emptied. The container was placed outside the market on November 27^{th,} 2020. It was to be owned by the township and managed by the private waste collection company.

Large waste bins enabling segregation of waste were provided for the shop keepers. Three types were provided: green for organic waste, blue for recyclable waste, and black for general waste. Plastic bags with different labels for the respective waste bins were provided so that the shopkeepers could easily bring the waste to the trailer, and to ease the segregation after collection. The practice of using plastic bags to segregate waste is a common situation in many countries, including Norway. There is a risk that this introduces additional waste into the environment, and the initiative also means additional costs associated with the supply of plastic bags and administration. Provision of such plastic bags was the responsibility of waste collection company, and it continued for only about half a year. It can be reflected on that the internal administrative system in place was not sufficiently prepared for this practice. The MJT waste collection company made individual arrangements with shopkeepers selling bananas for collection of banana peels/leaves.

Figure 4.8. The photo (left) shows staff from the cleaning section of the Municipal Department in Bago working to clean the drainage system in thes area; the photo (right) shows the area during its restoration. (Source, Ye Htun Aung, 2020).

(vi) Awareness raising activities and other measures for change of practice

Improving the waste management infrastructure was coupled with other activities to raise awareness among shopkeepers and customers in the market, and to the market administration committee. The project presented locally adapted information on the impact of waste on the natural environment, the effect of waste on odour and aesthetics, and on how a clean market area is good for business by means of informal dialogues between the project local partners and shopkeepers, videos and presentations, and flyers and discussions with the market administration committee. Waste collection events were also organised. The local media reported about the pilot on local television channels and in the newspaper in November 2020. Due the Covid 19 situation in 2020, campaigns and group events were severely restricted.

Involvement in clean-up activities: Cleaning of the area was organised by the waste collection company in collaboration with the Municipal Department. Shopkeepers also participated in this cleaning. Some shopkeepers later expressed that they expected more customers at the market after the clean-up because it was perceived to be more pleasant, with less odour and more attractive with less waste laying around.

Internal competition "The best clean shop": An informal and voluntary competition among the shopkeepers at the market for the cleanest shop was ran. The winner received a cup with the logo "Clean Bago". The cup was handed over by the local project partners in December 2020. The opportunity to use this clean shop competition initiative as a project measure to motivate awareness in a wider format was unfortunately restricted by Covid rules. The initiative, however, seemed to have potential.

Figure 4.9. The two pictures show the local project partners September 2020 in dialogue with shop keepers at the Phyazay market (Source both photos, Aung Myo Htut, 2020).

(iv) Monitoring, continued follow up

A system for monitoring waste on the street where the container was placed was developed. This included daily recording of large waste items, waste around the container, and waste on the trailer (Annex 7.2), undertaken by an assistant to the project. Data was collected for about three weeks. The monitoring results showed that less waste on the ground could be observed and shortly after the trailer was emptied.

Follow up of shopkeepers occurred by means of informal dialogues during visits from the local project partners. During such visits, the shopkeepers were asked about their practices and potential challenges. No systematic monitoring of the shopkeepers' practices occurred as the pilot case ended after only seven months. There was, however, an original plan to undertake continuous awareness raising and implement measures to motivate the shopkeepers, the market committee, and local authorities to continue the efforts.

The activities of this pilot case stopped with the military coup in early February 2021. After a state of emergency occurring for around 2-3 months, the majority of the previously involved local authorities were no longer in position. In November 2023, waste is collected from the market on a daily basis; yet there is no collection of segregated waste from this market. The plastic bag system for segregation of waste was abandoned due to costs and administration issues. Segregation at source of plastic and organic waste being collected by the waste collection company is practiced for two other markets in Bago City: The Myoma market and the Kone Sane Zay market. According to the waste collection company, collection of segregated waste from source at these two markets is not feasible due to access and space considerations.

4.2.3.2 Achievements, challenges, and take-home messages

Achievements

Increased knowledge and awareness: The pilot resulted in increased interest and willingness by the shopkeepers to take responsibility for the waste generated by their shop. Furthermore, the involvement of shopkeepers in the organised competition for a clean shop indicates that there was a sense of pride in having a clean shop and a clean market.

Less waste on the street outside the market: After November 27th, 2020, when the trailer for waste collection was placed, up until the coup on February 1st, the monitoring of waste on the street where the

trailer was place indicated less waste in the environment as an effect of the pilot. This monitoring ceased due to the coup in 2021.

Segregated waste: The aim to implement a system for waste segregation was only partly and to some extent achieved, and only for a limited period. The private waste collecting company uses organic waste to produce compost.

Joint effort for waste management: Waste management requires involvement of many different actors. Previously there had been little practice for joint efforts to reach objectives. The project achieved a practice of working together by different authorities, including the market committee, though only for about half a year.

Challenges

Activities for enabling change of practice for a sustainable waste management regime at the market was only organised for about six to seven months. Furthermore, this occurred when Covid restricted the gathering of more than five people outside. The inability to organise workshops with the shopkeepers to convey information was an important constraint. Another constraint for the pilot was the lack of rules and obligations from the market administration committee to take responsibility for waste generation. The military coup then implied a complete stop for the pilot activity.

Take-home messages

- Support from local authorities represents a mandate for undertaking a waste management pilot and is therefore fundamental for the resulting achievements.

- Willingness and interest by the market administration to participate in a pilot are needed. The market committee decides the rules for the shopkeepers renting space at the market. With committed administration and with a waste collection service in place, efforts for sustainable waste management can be implemented.

- Collaboration and involvement by the institution or the company responsible for waste collection service is necessary to identify relevant and realistic interventions.

- An approach needs to address both the actors at the market, i.e., the different shopkeepers, the market administration, local authorities, and the surrounding neighbourhood. Support from the local authorities provides a mandate for the pilot, as the market administration determines the rules for shopkeepers. The shopkeepers and the visitors to the market need to abide by the rules and practices for sustainable waste management.

- Change of behaviour for sustainable waste management requires large and continuous efforts over a long period.

4.2.3. Implementing responsible waste management at selected monasteries

Monasteries in Myanmar are central community spaces for education and represent cultural centres with a wide societal impact. The Bago Township alone has more than 200 monasteries. Each monastery represents a system of institutional autonomy where deputy monks and nuns govern in accordance with Theravada Buddhist rules. Few monasteries have rules and guidelines in place for waste management (Personal communication deputy monks, 2020). In response to this, the project enrolled selected monasteries as pilots for implementing responsible waste management. An important aim was for these monasteries to become 'model sites' for more effective waste collection and segregation. A total of six

monasteries were engaged as pilots, including four for monks and two for nuns (Table 4.1). The pilot monasteries have varied demographics, and range in size from 60 to 214 residents (Table 4.1). Some monasteries also house children and adolescents, while others attract more mature populations seeking to expand their knowledge and practice of Buddhism.

Awareness raising on responsible waste management included teaching about segregation of waste, composting and recycling, and reuse of various selected items. This was expected to have a positive impact on waste management, and thereby reduce litter, including marine and plastic litter. Prior to the initiation of the project, waste was irregularly collected from the monasteries by public authorities. None of the monasteries practiced source segregation of waste, and littering or dumping of wastes into rivers and waterways were common practice (*personal communication during initial surveys*). In the following section, we describe the selection of the monasteries and pilot implementations. Finally, achievements, challenges, and take-home messages from the awareness raising activities at the Bago monasteries are presented.

4.2.4.1 The monastery pilots and measures implemented for sustainable waste management

Selection of pilot monasteries considered the following agreed criteria: (i) a location near a waterbody, (ii) willingness and interest of deputy monks and/or nuns to participate, (iii) easy access for private companies to collect waste and for clean-up, and (iv) no known connection with the military government. After a pre-screening of possible monasteries, considering the above criteria, the local project partners approached deputy monks and nuns to initiate a dialogue about being a pilot case in June-November 2021. The project partners developed informational material about responsible waste management in the Burmese language and undertook physical meetings and phone calls for questions and responses. The project first focused on one monastery to gain initial experience and explore possibilities to adjust approaches, before later including the additional five monasteries into the project (Table 4.1).

The initial phase focused on building trust and a shared understanding of the project. It was critical that the head monks, as the leaders of the monasteries, were motivated to participate. The components of implementing the case are described below. Achievements, challenges, and take-home messages are described in 4.2.3.2.

Figure 4.10 The photo (left) shows the entrance of one of the monasteries engaged as pilot in the project, photo (right) is from an introductory meeting with monks at the Tharmanaykyaw monastery (Source both photos, Kyaw Min San, 2021).

Table 4.1 Summarising key demographics and information about the workshops organized. Population numbers are average estimated based on information from the monasteries, numbers vary during the year (data collection in 2022).

Name of monasteries	Number of people	Area (acres)	Buildings	Workshop 1		Workshop 2	
				Date (mm/dd/yy)	Participants	Date	Participants
Kya Khat Wine	39	2,3	20	07.12.2021	108	29.01.2023	115
Thar Manay kyaw	20	1,5	13	20.07.2021	40	10.06.2023	172
Leik Pyar Kan (nun) monastery	6	0,61	12	23.10.2021	73	18.05.2023	101
Tha Dhamma Gon Yee (nun) monastery	6	1	6	24.10.2021	75	21.01.2023	236
U Win	5	4	5	08.01.2022	50	20.01.2023	45
Win Neinmitaron	13	5	20	20.11.2021	84	20.05.2023	150

(i) Adaptive management and communication

The different monasteries were engaged as pilots at different time periods, i.e., during June-December 2021, as it was important to enable learning from experiences and adjust approaches before involving a new monastery. After a monastery confirmed their engagement as a pilot in the project, informal interviews with key informants at each respective monastery were undertaken. Questions addressed the organisation of cleaning and maintenance, infrastructure including waste bins, and decision-making procedures at the monastery. The interviews identified key informants at the monasteries.

Monastery working groups: Working groups were established at each pilot monastery which consisted of the local project partners and selected deputy monks and nuns. Throughout the project case period, the Myanmar team held physical meetings with deputy monks, nuns, and other key informants prior to each event and activity, and used their insights to tailor surveys and questionnaires for these to be relevant and adapted to the monastery context.

(ii) Infrastructure measures to support responsible waste management

Provision of infrastructure for waste collection a step-by-step approach: Provision of waste bins was necessary to support waste collection, as bins were lacking in all the pilot cases. Survey questions were developed for key informants at the different monasteries to obtain information about the types and amounts of waste generated, waste disposal practices, and the need for different types of bins. The survey revealed the need for a relatively high number of waste bins, including different types of waste bins for different purposes – such as larger waste bins for the kitchen. Initially, only a few waste bins were purchased to gain experience on their usage before purchasing additional bins. Bins were purchased and provided to the monasteries in May 2021, October 2021, and December 2021. The waste collection company discussed the colour of the waste bins with the Region Environmental Conservation Department's before purchasing the waste bins; blue bins for recyclable waste, green bins for organic

waste, black bins for all other types of waste (Figure 4.11). To guide waste segregation, posters developed by the waste collection company were placed in connection with the waste bins (Figure 4.11). The need for additional waste bins and possible associated challenges were discussed in the respective working groups after about 6 months and 1.5 years.

The waste collection service: The waste collection company provided a schedule for collection, where organic waste was collected on Wednesdays and mixed waste on Mondays. The company was not always able to collect according to schedule, a situation that was worsened when the economic situation for the company became difficult because of the military coup and increased gas prices, etc. The waste collection service continued but collection of segregated waste was practiced for only a few months.

A quantitative tracking of the waste volumes and types of waste was undertaken and made available by the private waste collection company for a period (Annex 7.2).

Figure 4.11 . Left, Posters developed to guide segregation of waste. Photo (right) from U Win monastery of placement and colour of bins. (Source, left MJT, right Aung Myo Htut, 2020)

(iii) Awareness raising activities and other measures for change of practice

Awareness raising activities addressed waste and plastics as being harmful for nature and health, segregation of waste and its importance, and waste disposal, and occurred mainly during two half-day workshops organised at each of the six pilot monasteries. Awareness raising materials that were produced included flyers and videos addressing the wider problem of plastic waste management in Myanmar and Bago city and specific practices of source segregation[16]. All workshops opened with introductory speeches made by deputy monks and nuns – some of which made links to Buddhist teachings – and all workshops included group discussions (Annex 7.3 shows the questions discussed). Waste collection campaigns and clean up events were also organised at each monastery with the participation of monks and nuns and the local project partners, which contributed to raise awareness about waste and the benefits of a clean monastery compound.

The first workshops organised in October 2021 and July 2022 (Table 4.1) focused on increasing awareness on the environmental and social harms of plastics pollution. The concepts of waste reduction and source segregation were introduced to the monastery inhabitants at this workshop. Staff from the waste collection company and from Justice for All presented the project objectives and waste collection in Bago City. It was also explained that unregulated dumping of garbage at pagodas, market areas, along riverbanks, on roads, and at dump sites can cause blockages in the drainage system and river channels resulting in increased flood risk and water pollution in the Bago River. At the workshops organised in 2021, online videos focusing on how waste, including plastics, might harm animals and nature in general were shown. For the workshops organised in 2022, the video produced by the project presenting the waste

[16] In total three videos for awareness raising are produced by the project and available for download at, https://mnenvironment.com/bago-waste-project/

impact situation in Bago was shown[12]. The focus group discussions (FGD) addressed waste generated at the monastery. According to the FGDs, common types of waste generated at the monasteries include kitchen waste, food waste, plastic, and papers for wrapping, water bottles, plastic bags, and razors used to shave heads. In response to the question, "What do you think about waste segregation at the monastery?", the FDG revealed that "Segregation of waste is a new idea, but that this is good but a new practice for monasteries".

The second workshops organised during January and June 2023 (Table 4.1) built on the first workshops and addressed reduced waste generation by means of decentralised waste management, segregation of waste, and the use of organic waste to produce compost. At the different monasteries, it can be estimated that about half attended for the first time. Presentations included a focus on Zero Waste, drawing on experiences from India and the perspective "my waste is my responsibility". An overview of the different categories of waste collected by the waste collection company for two months in 2022 in Bago was also presented (annex 7.2), laying the ground for information about the processes of organic waste composting, including its benefits and usage as fertiliser and planting vegetables. A second video produced by the project was also shown, presenting waste management, segregation, and compositing in Bago City[15]. The FGD addressed, among others, the use of single use plastics by monks and nuns and as part of receiving visitors as exemplifying how monasteries can become examples and propagators of responsible waste management to the residents of Bago and younger generations. The FDG revealed that single use plastics could be replaced by steel food containers, tote bags, and glass or metal bottles. To the question about whether decentralised waste management would be feasible in the respective monastery, the response was positive, as "waste can be reduced by making organic waste into compost, in this way, it can help to prevent natural disasters". To the question about differences before and after being a pilot in the project, responses can be summarised by "There has been changing the ways of discarding waste. In the past, monks and young novices discard waste in many places of Monastery. Now, they throw waste into the waste bins. However, for themselves, it is a little bit difficult to segregate waste as the young novices discard waste without segregation, so it is still difficult to manage for them". It was also added that the best way to educate new monks is for older monks themselves to discard the waste systematically, which is then followed by the young novices.

During the first workshop, it was discovered that some monks and nuns were very young. For the second workshop, this was considered by adapting the discussion part for the younger attendants who were invited to draw and discuss the issue of plastics pollution. The drawings then represented a basis for dialogue. As the final awareness raising workshop in the project, refillable water bottles were provided to the second time participants and to the deputy monks and nuns that had been active in the project.

Figure 4.12. Left: Awareness raising session at Leik Pyar Kan nun monastery, May 2023. Right: Awareness raising session in U Win Monastery in January 2022. Figure 1. Interviews with head monks and nuns to improve the waste management system. (Source, Aung Myo Htut, 2022).

(iv) Monitoring and follow up:

For best practice implementation, follow up monitoring of actors was undertaken. Informal dialogues with deputy monks and nuns occurred regularly, while structured dialogues and surveys with key informants occurred twice – in February 2022 and between July-August 2022. Typically, however, monks and nun residents at monasteries change over time, so the project was only able to build on previous efforts to a limited degree.

The questions developed for the survey in February 2022 addressed the situation of waste bins, including the use and placement of bins, and the use of single use plastics. In total, 142 informants, including 5 deputy monks and nuns, 90 student's monks and nuns, 8 administrative staff, 13 teachers, and 26 kitchen staff responded to the survey (Annex 7.4). The survey revealed that most of the monks and nuns did use the waste bins, that additional bins were needed, and that more coordination efforts were needed both internally at the monastery and between the monastery and the staff collecting the bins. Issues identified included who should provide bags for the bins and who should bring the waste from the different locations at the monastery.

The questions for the for the survey in July-August 2022 were developed to identify expectations and perceptions of accountability between monasteries and the waste collection company (Annex 7.3). This survey revealed that the perception by the different actors was positive from the onset but that the project underestimated the need for available time and focus of all actors for change of practice. The survey further revealed that: (i) the number of waste bins are insufficient, especially for organic waste, (ii) that waste segregation is difficult and confusing for some monks and, in particular, older monks did not want focus on this, (iii) that young nuns don't know how to segregate waste and senior nun need to manage them, (iv) the interest of head at the monastery is important and waste management could improve with their authority and (v) for improved waste segregation, it is important to urge the supervisors or administrators of the monastery to follow up on this activity.

4.2.2.3 Achievements, challenges, and take home messages

Achievements

Monasteries as pilot studies for responsible waste management worked well: More than 388 novices and monks participated in the first round of awareness raising sessions, while 779 monks and novices participated in the second round of sessions. In the second round, participants were much more interactive and participated more in discussion and activities.

Awareness of the problem of plastics pollution on human and environmental health were achieved: In terms of increasing awareness and engagement on waste management issues and littering, monks and nuns reported seeing less litter around the monastery compound and having greater awareness of the problems with the landfill in Bago filling up during the final period of the project implementation (i.e., in the focus group discussions in 2023).

Awareness on the responsibility of monasteries in educating about waste: Several monks and nuns that participated in the survey reflected on the responsibility of monasteries to educate young monks and nuns on the impact of pollution from waste and about sustainable waste practices.

Challenges

The economic model for waste collection, whereby the company pays the local authorities for the right to collect waste, the history and practice of disposal of waste into the river, and the lack of mandatory policies and rules for waste management all represented important challenges. For some monasteries, and in particular with older monks, waste and waste handling practices are not seen as important focal areas for monasteries. Both Covid-19 and the coup represented important challenges for project implementation – on the ability to meet physically, for building and maintaining trust, and their impact on the economic situation of the waste collection company.

Take-home messages

- Negotiating a common ground and building trust and a shared vision requires platforms and significant efforts. An intrinsic motivation and leadership from the head monks/nuns for such schemes to succeed is needed.

- An adaptative management approach and close follow-up and trust-building with the participants allowed for effectively addressing and remediating actions. Clear expectations, ideally through contracts, between the waste management companies and the monasteries to foster accountability between the actors is critical.

- Responsible deputy monks/nuns in each monastery provide an important contact point and ensure that someone felt responsibility for the success of the pilots. They also specified responsibilities for emptying and bringing out bins for collection to one or more individuals in each residential building, with a similar purpose. It was also important not to involve more monasteries as pilots than the project had the resources to effectively follow up.

- More awareness raising and training, especially to supervise waste segregation for the young, are necessary. Monitoring of practices is also important.

4.2.4. Composting as decentralized waste management at a Bago monastery

In contexts where there are insufficient waste collection services, decentralised management of certain proportions of the waste can be a good solution. Organic waste lends itself well to decentralised management through composting, and separating organic waste from other waste streams like paper and plastics also ease handling for recycling or reuse. Decentralised management of organic waste furthermore reduces the amount sent to landfill. Reduced capacities of landfills to receive a growing amount of waste is an increasing challenge (Informal communication with MJT, 2022). Finally, from a sustainability perspective, creating small circular loops within which products are used and waste is handled for reuse or recycling has a good climate impact (Havas, Falk-Andersson, and Deshpande 2022).

In Myanmar, reports show that around 70 % of solid waste is composed of organic waste (MCDC and ECD, 2017; MONREC, 2018). In Bago City, records provided by the waste collection company in 2022 show that 65% of the collected waste was food and household waste, and that 15% was biodegradable waste (Figure 1.3; Annex 7.3). For the private waste collection company, collection of segregated waste was increasingly difficult during the second half of 2022 due to increased gas prices and the difficult economic situation in general and the fact that the landfill in Bago city was becoming full (personal communication with the waste collection company, 2022). In consideration of this context, the project aimed for a pilot case about segregation of organic waste to make compost. This was inspired by both (i) a visit in May 2022 by the local project partners to two waste companies (Hmwe Taungyi and Innlay Rose in Taungyi, Myanmar) to discuss ideas around waste segregation and the waste recycling process, and (ii) a study tour in October

2022 by the project partners, including NIVA, JFA, and the waste collecting company to Trivandrum, Kerala, India that focused on decentralised waste management initiatives[17].

Upon the return of the local project partners from India, deputy nuns and monks at the different monasteries were contacted in February and March 2023 to inquire about an interest in implementing a pilot for making compost. Among the contacted monasteries, the Tha Dhamma Gone Yi Monastery expressed an interest in being a pilot case study.

4.2.5.2 Implementing composting at the Tha Dhamma Gone Yi Nun Monastery

Tha Dhamma Gone Yi Nun Monastery (TDGY monastery) is situated in Ward 8 of Oakthar Myo Thit, Bago city, playing host to around 200 nuns that live at the monastery. These nuns, comprising young children, teenagers, and adults (Table 4.1), come from Shan State to participating in schooling and receive Buddhist education. The TDMGY, in addition to being a Monastic Buddhish teaching centre, also provides general school education. This represents an arrangement between this monastery and the Ministry of Education and Ministry of Religious Affairs and Culture[18]. Other nuns and some monks from other monasteries (including Leik Pyar Kan, which was a pilot in a different case), come to TDGY each day between 12-4 PM to receive a school education.

The monastery is located on a compound of just one acre in size, but this had sufficient space for constructing compost bins. The monastery had already participated as a pilot in another case for the Bago Waste project and since the local project partners first visited in September 2021, has been very motivated to implement sustainable waste management. In her introductory speech at the first awareness raising workshop for the other case, the deputy at this monastery referred to Buddhist teachings when presenting about the need for sustainable waste management at the monastery.

The pilot was undertaken with a preliminary phase during January-February 2023, followed by an active phase from March 2023 to August-September 2023. The monastery continues to segregate organic waste for disposal in the compost bins to produce compost. Below, the implementation of the pilot is presented.


Figure 4.13. Photo (left) the outside and the entrance gate of the Tha Dhamma Gone Yi (TDG nun monastery, photo (right) shows a workshop and awareness session about segregation of waste to make compost at the Monastery in March 2023. (Source: left, Aung Myo Htut 2022, right Kyaw Min San, 2023).

[17] The study tour was hosted by Thanal, an environmental trust that has been a driver behind zero waste initiatives, included field visits and discussions around locally appropriate, decentralised, and affordable waste management initiatives in Kerala.

[18] But teachers are volunteers not related with Ministries. TDMGY is private school not related with government.

(i) Adaptive management and communication

Following the initial expression of interest by the chief nun in December 2022 and discussions in January 2023, an awareness workshop about decentralised waste management and composting was organised at the monastery for January 21st, 2023. At this workshop, the nuns expressed an interest in taking part in the composting pilot. They reflected on the need for improving their waste management and the aim to grow vegetables using the compost represented an important motivation.

The chief nun confirmed their interest in participating in the pilot for composting shortly after, and a *compost working group* was established in the beginning of February 2023, consisting of the chief nun, two volunteer students at the monastery, the local project partner Justice for All, and a compost expert from the waste collection company. Two initial meetings for planning and to present information about the composing process were organised.

The first meeting on January 29th focussed on the different responsibilities and work involved, including the need for waste bins, segregation of waste in the kitchen, and later bringing the waste to the waste bins. The decentralised waste management system, including some issues related to composting (bad smell, lice, and tapeworms, carrying the waste from kitchen to tents, watering per week according to moisture, not including plastic in the waste, and so on), were explained. It was decided that three teachers and one nun would be in charge of the process, and that they would work together with the monastery kitchen management. The kitchen team would be responsible for transporting the organic waste from the kitchens every day using the monastery's three-wheelers.

The second meeting on February 1st discussed the location of the bamboo tents, considering factors such as distance from the kitchen, smell, pests, and the burden of bringing the waste from the kitchen to the tents. Their size, considering the estimated amount of organic waste that is produced, was also discussed.

(ii) Infrastructure measures to support responsible waste management

The monastery estimated that it produces three bins worth of organic waste per day. Waste bins for segregation of waste were already provided by the project in 2021.

Construction of bamboo tents: The project provided material for the construction of two bamboo tents. On March 13th, two tents were constructed in about two hours in a suitable location within the compound – far from the living quarters, while still being easily accessible from the kitchen. The expert from the waste collection company was leading the work with assistance from the others in the compost working group. Based on experience from other projects by the expert, the bamboo constructions were estimated to last one year. The composting process was estimated to require around four months to decompose and produce nutrient rich soil for the gardens.

The following issues were considered: (i) The pathway for people bringing the organic waste from the kitchen to the bins; (ii) storage space for dry leaves with proper coverage and locked to prevent cats/dogs from littering on them, (iii) storage for bins, (iv) wash-areas for bins, (v) the requirement for hosepipes for watering, and (vi) storage of all tools and EM Bokashi liquid for the composting process. Waste was to be carried with a three-wheeler. The smell could be controlled by adding dry leaves.

Figure 4.14. Photo (left shows the situation during the organized clean up to prepare the area where the construction of the composting bins will be constructed; the photo (right) shows the construction of the compost bins (Source both photos: Aung Myo Htut, 2023).

(iii) Awareness raising activities and other measures for change of practice

For this pilot, measures for change of practice included information and practical demonstration for how to prepare compost.

Practical demonstration: An orientation session and practical demonstration at the site was organised on March 14th by the local project partners. Ten nuns from the monastery, along with the chief nun, participated in the session. A second demonstration was organised on March 15th for the senior youth nuns who had participated in the demonstration session the day before. All the monastery's youth nuns participated in the session.

The practical demonstration addressed the following work tasks:

1. Branches are to be put on the bottom for aeration and to avoid water from gathering in the bottom section.
2. One bin of organic waste from the kitchen is put on top of the branches.
3. Some soil which includes bacteria are put onto the organic waste.
4. Dry leaves are put onto the soil.
5. A fair amount of water is showered onto the dry leaves.
6. The compost area is covered by a tarpaulin to maintain heat levels.
7. Watering the compost, and provision of EM Bokashi liquid in case of a need to speed up the composting process.

The local project team returned to the monastery twice for follow up in April. The composting process was going well, and the monastery's nuns in charge of the composting explained that the routines and information were easy to follow. The composting site had no distinct smell, and the bin was quickly filling up.

A clean monastery compound: On day three (March 15th), the local project partners together with the monastery organised a clean-up event, and the organic waste was brought to the composting site.

Figure 4.15. Photo (left) one of the two compost bins constructed, now about filled and ready to be covered, the blue pipes allow airing of the bins, (the photo (right) shows the vegetable garden prepared using the compost developed at the monastery (Source both photos: Kyaw Min San, 2023).

(iv) Monitoring and continued follow up

The local project partners conducted a FGD with five teachers and five nuns at the monastery in August 2023 to monitor and assess the situation as experienced by the people at the monastery, regarding benefits, challenges, and the future situation. The FGD revealed that the participants were initially worried about the extra workload, but that after a half year when harvesting the results, that the rewards from the compost are greater than the required work, and that it is a very good feeling to grow vegetables on the compost produced in-house. Overall, they appreciated the reduction of organic waste going to landfill and were pleased with the nutrient-rich organic compost they can use for their vegetable gardens. They also expressed happiness over having cleaner surroundings. The composting process has created an engaging atmosphere at the monastery, and they have shared their experience with friends at other monasteries. One of the teachers has also read up on composting and the benefits of using compost soil in vegetable gardens on social media platforms. Ashes from the kitchen were used during the rainy season, when there was lack of dry leaves to support the composting process.

The main challenges identified were: (i) the available time for the composting process in an otherwise busy schedule. It is especially time consuming to segregate mixed waste and, most especially, remove plastic which can become mixed in when other kitchen staff that had not received the same training or had the same level of understanding of proper waste management were present; (ii) a continuous focus on awareness raising on the process, in particular for young and new nuns, as the monastery regularly receives new students and young nuns; (iii) On rainy days, nuns could not carry the waste bins to the composting site, and grasses and bushes are also growing there; and (iv) dry leaves are not available in the rainy season, so they needed to instead add ash from the kitchen instead of the leaves.

Regarding future expectations, the participants in the FGD said that they would continue the composting process and that they look forward to planting more vegetables using the compost. Regarding composting in other monasteries, it was reflected on that this would be appropriate, if they are interested and if the monastery would be able to commit the necessary workforce. Regarding the purchase of infrastructure, it was not expected that this would be a substantial challenge, as they already have waste bins and rakes, etc. Other monasteries may also need technical assistance to support the establishment of the process. While some monasteries could try to buy necessary infrastructure, others may not be in a position to purchase materials. They suggested using instructional videos and guidance from a composting group in the first instance, with the hope that they would be able to continue alone from this point.

4.2.5.2 Achievements, challenges and learning points

Main achievements of the composting project case

Active involvement by the monastery: The monastery leaders, nuns, and teachers were engaged and motivated to make compost from organic waste throughout the pilot implementation. Deputy nuns supported the use of pilot for making videos as a guide for other monasteries.

Efficient segregation of organic waste: The segregation of waste at the kitchen and moving this waste to the waste bins as a collaborative effort between people at the monastery functioned well.

Production of compost: The project supported the physical infrastructure and technical knowledge and support for establishing and maintaining a composting site at the monastery, which was then used to develop a vegetable garden at the monastery.

Local awareness on the benefits of composting developed: The local project partners and the monastery nuns and teachers have been approached by other monasteries on the subject of duplicating the composting project at new sites.

Challenges

The few challenges experienced by nuns and teachers and staff at the monastery comprised the need to carefully remove plastic from the waste bin for organic waste, the need for continuous supervision of young nuns on how to segregate waste, and that, during the rainy season, it became difficult to locate dry leaves on some occasions.

Take home messages

- The constructed compost sites were insufficient in size to manage the large amounts of organic waste produced at the monastery. Future investments should be clear on expectation management, indicating whether the constructed composting site is to manage all organic waste or be set-up as a pilot.
- Composting activities should be coupled with extensive awareness training for both senior and junior staff. This may reduce the risk of different waste fractions being mixed in the kitchen and can thus reduce the workload of the people responsible for the compost, as they do not have to sort plastic or other waste fractions out of the organic waste.
- The monastery nuns wanted to participate in the Bago waste project and to spread awareness in the monastery on proper waste handling.

4.3 Analysing pilot cases' achievements for promoting sustainable waste management

The four pilot cases promoting sustainable waste management practices in Bago targeted different waste management challenges, contexts, and actors. While all the cases were developed and implemented by means of participatory research presented in 4.1, the actors' constellations and practices varied across the cases. This means that both the objective of changing behaviour for more sustainable practices and the building of local capacity on sustainable waste management have taken different forms. In the following sub-sections, the successes, and failures in promoting sustainable practices are discussed in context of the policy instruments, and the legal, economic, information, and infrastructure instruments present in the Bago Township. Then, we discuss the degree to which the measures, i.e., the practical

activities implemented in the pilot cases by the project, were successful in promoting sustainable waste management practices and we link this to theories of behavioural change.

4.3.1 The (non) existing policy instruments in the Bago Townships as context for the pilots

In the Bago Township, only few policy instruments for sustainable waste management were identified. The National Waste Management Strategy and Master Plan for Myanmar (2018-2030) adopted by MONREC (2018) specifies the responsibility of township authorities to manage waste sustainably. The document states that regions and states in Myanmar shall develop strategies for waste management (ECD and MONREC 2018). Also important in the waste context is the Environmental Conservation Rules (2014) that specify the requirements and objectives of the 2012 Environmental Conservation Law about environmental impact assessment and water quality standards. Regarding legal policy instruments, however, no rules specify the duty for consumers, households, industries, etc. to manage the waste that they generate.

While *legal rules* governing waste management practices to our knowledge do not exist, it is relevant to mention other conditions decided by the authorities that target waste related behaviour. Such conditions can give legitimacy to interventions and activities and may influence norms and practices in a society. An example is the agreement between the Bago TDC and the waste collection company (see chapter 2), which represents an expectation by the local authorities and the company to households to deliver waste for collection. Regarding *economic policy instrument*s, no such instruments addressing households or other actors have been identified. The main policy instrument implemented by local authorities refers to the waste collection infrastructure (i.e., the private public partnership for waste collection). Here, it is relevant to mention that the fee that the waste collection company must pay to the local authorities for the right to collect waste could be seen as an implicit economic instrument. The business model for the waste collection company implies the need to collect fees from households and other actors for the collection service and earning money from selling recyclable waste. The same instrument, however, reduces the company's economic ability to implement resources such as for example for awareness raising and information campaigns. Then, there is the information instrument, which consists principally of two main types: information from the company about the waste collection schedule on Facebook[12] and on an app, and waste collection campaigns being organised – though infrequently – by local authorities such as the ECD and/or parliament members (Personal communication 2019, 2020).

The lack – to a large degree – of legal rules and local policy strategies, i.e., external motivation factors addressing the duty and the obligation for households and small- and large-scale enterprises to manage their waste, represented a challenge for reaching targets associated with sustainable waste practices. In the different pilot cases, there was initially little existing local practice, or experience about sustainable waste management practices. For example, sustainable waste management practices had never been discussed before, neither in the market administration committee, nor at the monasteries. The majority of the actors involved in the pilots were interested in this topic, but the lack of local practices implied the need for the pilots to build knowledge from scratch for all elements, i.e. about what practices could be feasible from the perspectives of the general culture and norms at the institution, the daily practices and duties of individuals, and also considering the practices and norms of staff at the waste collection company. In this situation, the few external conditions set by the authorities represented challenges, as they implied that the pilot studies mainly could rely on the actors' intrinsic motivation.

For the Phyazay market and the river cleanup cases, it can be argued that the presence and engagement of the local authorities and, in particular, the Bago Region MONFREC Minister and the Executive Officer of the Municipal Department, gave legitimacy to the project initiatives to introduce sustainable waste activities. Without the mandate from the local authorities and the involvement of the waste collection

company, the project would not have been able to undertake the cleanup of the waste dump at the river side and alongside the market, or to introduce measures for change of behaviour.

4.3.2 The impact, or the lack of impact, of measures implemented in the pilot cases

The project did not have the possibility or the mandate to influence rules or conditions, or to provide financial measures to incentivise behaviour. The measures available to the project comprised awareness raising and knowledge building, and some provision of infrastructure. In general, these types of measures aim to increase the intrinsic motivation of actors to change of behaviour.

Awareness raising and knowledge building activities as measures, e.g., videos, presentations, focus group discussions etc., were regularly implemented during the pilots (Table 4.1) and led to an in general increased understanding and interest by local authorities, shopkeepers, and monks and nuns related to the need to manage waste sustainably. Confirmation that the activities contributed to individuals' intrinsic motivation for change of practice, came from statements by monks and nuns (sub-section 4.2.3) and is indicated by pictures presenting clean and attractive areas (Figure 4.6). While not being a measure, it can be added that the project's focus on action research and participatory approaches involving local authorities and actors in close dialogue when planning and coordinating activities, were likely compulsory for the achieving results. Only then could the project target the activities towards the realities of the actors in the different pilot cases.

The context for the awareness raising activities differed among the pilots, influencing the level of achievements. For two of the pilots – the Phyazay market and the river side clean-up – the awareness raising activities needed to address a high number of people, including different types of local authorities, in addition to the market shopkeepers and the larger community in the area. Still, achievements in January 2020 can be considered to be high for these two pilots due to the high commitment levels and efforts committed by the actors involved. During the second half of 2020, the pilots in these areas included intense collaboration between different authorities with different responsibilities, such as the Municipal Department, the DWIR, the IWUMD, FD, the quarter administration, the waste collection company, and others. This participatory approach with the involvement of different types of actors, enabled the project to gain the information for planning and coordination needed, reflecting an Integrated Behavioral Model (IBM) approach (Dreibelbis et al., 2013).

As mentioned, statements by monks and nuns reflect increased awareness and intrinsic motivation for sustainable waste management practices; however, good systems for effective waste collection and segregation of waste were in, most parts, not achieved. Considering the Integrated Behaviour Model approach, it can be argued that the pilot did include the main actors and elements of the system; however, external conditions causing increased gas prices and economic constraints for the waste collection company, and an underestimation of the time and the effort needed by all actors to change practices and behaviour constrained results. A good system for decentralised waste management was achieved for the monastery that engaged in the pilot focusing on the segregation of organic waste to make compost. Some important differences between the "compost pilot" (sub-section 4.2.4) and the pilot case aiming for sustainable waste practices at monasteries (sub-section 4.2.3) included (i) a higher initial intrinsic motivation at the monastery to undertake the compost pilot, and (ii) the fact that the compost pilot implied a simpler, less complex system. The compost pilot required the development and input of technical competence, but the activities needed did not depend on the practices of other actors, i.e., the waste collection company.

Clean-up activities organised by the local project partners in collaboration with representatives from the pilots need to be seen in connection with the awareness raising activities undertaken. It can be argued that the project's focus on clean-up as an integrated part of the pilot cases supported the awareness raising achieved. In the surveys and interviews, the informants emphasise their appreciation of the "clean

local environment" (the monastery compound and the market environment) and the need to continue sustainable waste management efforts. It can be reflected on that successful clean-up could likely only be achieved in combination with the provision of infrastructure and awareness raising. For the larger clean-up of the riverside waste dump (sub-section 4.2.1), it was evident that the clean-up and restoration after the cleanup were needed to promote change of practice.

Various infrastructure investments including waste bins, bags, information posters, steel water bottles, and construction materials for waste bins, were provided by the project as measures to enable waste management practices. Undertaking pilots also induced provisions by Myanmar authorities of other types of infrastructure, such as the playground along the riverside clean-up area (Figure 4.6) and the rehabilitated drainage channels by the Phyazay market. This situation further legitimised the sustainable waste management objectives of these pilots.

While infrastructure such as wastebins were identified as measures needed to reduce littering, and for the storage and collection of segregated waste, the pilots emphasise that successful provision of infrastructure must be built on the knowledge, needs, and practices of different parties. This was experienced to be more complex than expected, due to the little previous practices of using such infrastructure. The project applied a step-by-step and adaptive management approach, understanding that knowledge could only be gained after trial, i.e., a learning by doing. It is argued that change of behaviour in many situations requires provision of infrastructure, but that achievements also depend on intervention that is coupled with successful awareness raising and an adaptive management approach.

4.3.3 Some reflections on the pilots

The four pilot cases to promote sustainable waste management practices differ in important aspects. The Phyazay market case and the riverside clean-up case were both implemented in 2020 prior to the military coup, with strong engagement from both local authorities and private actors in Bago Township. The pilot cases were highly visible in the township and addressed behaviour both of specific actors, e.g., the practices of local authorities, and that of people and society. Important support for these pilots came from the board established in 2020 for the project, that enabled discussion of project plans and activities, and made decisions on which activities to undertake. This situation gave important legitimacy and mandate to the project and the activities implemented. However, the participatory approach with local authorities was only a temporary situation; the advisory board was dissolved following the coup.

The two remaining pilot cases – namely, sustainable waste management in the monasteries and the decentralised waste management by composting – could not have been implemented with the support of Myanmar authorities. These pilot cases instead received mandate from the leadership in respective monasteries – chief monks and nuns – to undertake activities and establish working groups in each engaged monastery for planning and coordination of activities. Another difference that can be highlighted were constraints caused by the economic depression in the country that hit harder in 2021, particularly for the waste collection company. The unique context of the monastery pilots is that each monastery represents an autonomous and hierarchical system. While they do not have the position to enforce legal, economic, and infrastructure policy instruments, monasteries provide education and are important religious authorities. As such, these pilots were able to reach people from the wider society and provided a moral-normative incentive for many to change practice.

A final lesson is that, when aiming for change of practices and behaviour, there is a need for a long-term perspective, a mandate to implement and legitimise activities, high commitment levels and efforts, and endurance, in parallel with a project approach that includes participation, action research, and adaptive management. Apart of this, however, achievements will be vulnerable to risks posed by external conditions, such as economic depression and to changing government priorities and personnel.

5 Conclusion

Several environmental challenges exist in Myanmar, with waste management being key amongst them. The issues with respect to waste management include insufficient and ineffective waste collection – i.e., waste collection services do not target industries, small and medium scale enterprises, and markets, as well households in rural areas. There are also a limited regulatory environment, infrastructure, and informational policy instruments specifically at the regional governance level, with a lack of capacity and awareness on best waste management practices. This is also important considering the economic growth that Myanmar experienced prior to 2021, with a growing consumer culture, and Bago Township emerging as a hub for industrial activities. It may be noted that there was a trend towards improvements, especially considering the drafting of environmental and waste management policy at the national level. However, the coup in 2021 halted or derailed some of these processes. Given the adverse socio-economic and environmental impacts that inadequate waste management has, there is an urgent need for improvement with realistic and practical solutions that are contextually anchored.

This report comprehensively details and analyses various aspects of waste management practices at the local and regional levels, that are documented through the project pilots to leverage more sustainable waste management practices. The study of the formal and informal waste sectors reveals a complex ecosystem of actors in the waste value chain, with waste pickers, scrap dealers, waste management companies, industries, municipal actors, and households interacting closely – but often on unequal terms. The relationships, practices, and cross-cutting issues that were examined relate to gender, class, social stigma, and health risks. The findings also stress the need for a nuanced approach that recognises the vulnerabilities within the waste management workforce and the importance of labour rights, social justice, and economic remuneration within the context of the SDGs and ongoing negotiations towards an international legally binding instrument to end plastic pollution. In an emerging economic context, both formal and informal sectors have strengths and weaknesses that need to be acknowledged, contextualised, and addressed.

The study on macroplastic pollution in the Bago River identified Bago City as a significant source of plastic pollution. Through visual observation methods, this research analysed the plastic loads and diversity of litter types upstream, within, and downstream of Bago City. It further shed light on temporal variabilities and litter categories that can be important for designing effective mitigation strategies. This study was the first of its kind in the Bago River, Myanmar.

The report also presented four pilot cases that target sustainable waste management practices. The pilots (informed through action research) were designed to target interventions for river clean-up, new waste management practices at the Phyazay Market, waste management in monasteries, and decentralised composting at Tha Dhamma Gone Yi monastery. The achievements and challenges outlined in the pilot cases provide valuable insights into the effectiveness of infrastructural improvements and awareness raising initiatives. Although the pilot studies have made significant efforts in transforming waste management practices in the Bago Region, systemic challenges persist. A systemic approach would require all presented policy instruments (legal, economic, informational, and infrastructure) to coexist and influence each other. Regulatory frameworks, policy mechanisms at the federal level, the delicate balance between private companies and public responsibility, and the military coup all highlight the vulnerability of the waste management system to political disruptions. All the above issues are important challenges that require careful consideration to sustainably transform waste management practices. Despite these challenges, the pilot sites have provided inspiration for positive change by creating public spaces, building trust, and enhancing the awareness of the general public to the importance of effective waste management.

As Myanmar strives to address its waste management challenges, the lessons learned from the Bago Waste Project provide valuable insights not only for local stakeholders but also for national policymakers and international entities seeking to promote sustainable waste management practices.

6 References

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7 Appendix

7.1 Protocol and data collection sheet

Protocol
Materials

- Stopwatch
- Data collection sheets, with clipboard and pen
- Pieces of orange peel

Protocol

1. Identify a suitable sampling site (See: *Identifying a sampling site*, below).
2. Assess whether the observation can be performed for the full river width in one go or if sections are need and whether the observation should be performed facing upstream or downstream (See: *Identifying a sampling site*).
3. Record metadata for the site in the data collection sheet: date, time, location, analysts, bridge height, weather conditions, visibility (See: *Data collection sheet* and *Measuring visibility* for guidance).
4. Position two analysts in the central point of the bridge or bridge section.
5. Record the average flow velocity of the river/river section before starting each visual observation measurement and record in the data collection sheet (See: *Measuring flow velocity*).
6. To begin the visual observation, identify one analyst as the observer and one as the recorder.
7. The recorder starts a timer for 15 minutes.
8. Once the timer has started, the observer carefully scans for plastic litter visible in the river.
    - Before starting the measurement, the observer should familiarise themselves with the different categories on the data collection sheet.
    - The observer should familiarise themselves with the visual appearance of litter items in the different categories using Google or other guidance document, e.g. OSPAR.
    - Establish a strategy for scanning the surface that allows all plastic items to be detected and avoids double counting the same item. This will depend on the amount of plastic and the flow velocity.
9. When a plastic item is identified, the observer calls out the category (e.g., bottle) and the recorder records this on the data collection sheet.
10. Continue observing the river and recording the plastic litter until the timer alarm sounds.

Guidance

Identifying a sampling site

To perform visual observation of macroplastic, a vantage point is required. This is typically a bridge. Ideally the bridge height should be no more than 20 meters from the water surface. The bridge should also be accessible to pedestrians, and it should be safe to stand on the bridge and watch the water surface without facing dangers, e.g., from traffic. You should also be able to look down at the river from the bridge – i.e., the walls are sufficiently low and there are no barriers to accessing the edge.

Assess whether the full width of the river can be reliably observed by one analyst. This will depend on how wide the river is, how fast the water is flowing, and how much plastic is in the river. If there is too much plastic, it is flowing too quickly, or it can't be reliably identified from the central point of the bridge, divide the bridge into sections (for example, in half). Observe these sections separately: *either* use multiple teams of analysts to observe each section simultaneously *or* use one team of analysts and observe each section one after the other.
Assess whether you should face upstream or downstream to undertake the visual observation. This will depend on the shape of the river channel, the water depth and speed of flow, and the weather conditions (e.g., whether there is sun glare on the surface of the water). Select the direction that allows the best uninterrupted view of the water surface.

Measuring visibility

Visibility (turbidity) refers to the depth to which items in the river can be detected. It is related to the suspended load of the river and the light conditions. Visibility can be measured using a Secchi disk if one is available. Alternatively, visibility can be estimated for low visibility waters by estimating how much of different floating objects can be observed from a vantage point. If you are using the estimate method, repeat the estimate on several identifiable objects (e.g., litter, plant matter) to obtain a more accurate result.

Measuring flow velocity

Flow velocity is the speed at which the water in the river is flowing. Flow velocity can be measured using a flow or current meter if one is available or, alternatively, using a piece of orange peel and a stopwatch following the float method described below:

1. Measure the width of the bridge used for visual observation. (NB: the width is measured parallel to the river, as opposed to the distance between the two banks which is the bridge length).
2. Position one observer on the upstream side of the bridge and a second observer in the corresponding location on the downstream side. The second observer should look over the bridge directly down at the water surface.
3. The upstream observer drops a piece of orange peel directly below the upstream side of the bridge and starts a timer when the peel hits the river surface.
4. The downstream observer calls out when the peel becomes visible at the downstream side of the bridge. The upstream observer stops the timer when the downstream observer calls out; thus, recording the time required for the peel to travel the width of the bridge.
5. Record the time and repeat this process 4 more times to obtain an average flow velocity measurement in meters per second.

Data collection sheet

Visual observation for macroplastic in rivers
Complete one data collection sheet for each 15-minute visual observation measurement.

If you chose to divide the bridge into sections, each section should have its own measurement and corresponding data collection sheet.

The recorder adds a tally in the relevant category each time the observer calls out a plastic item. At the end of the 15-minute measurement, count all the tallies for each category and record the total.
Space for extra categories is provided at the end of this form. Use this for additional plastic litter categories that are not included in the form but represent identifiable categories of litter that are observed during the measurement.

Measurement details	
Date:	
Time:	
Location name:	
Location (GPS):	
Section number: *If applicable*	
Analyst names:	

Measurement conditions	
Height of bridge from water surface:	m
Visibility:	cm
Flow velocity:	meters per second

Additional comments about site/measurement:	Weather conditions:

Category	**Tally**	**Total**
Plastic bag (empty) *e.g., a shopping bag*		
Plastic bag (with contents)		
Plastic bag fragment *i.e., a broken/torn piece*		
Plastic bottle		
Plastic bottle lid		
Plastic cup		
Plastic cup lid *e.g., from a takeaway cup*		
Plastic straw		
Plastic yoke *i.e., for holding cans together*		
Plastic cutlery *e.g., fork, spoon, chopstick*		
Plastic food container *e.g., takeaway container*		
Plastic food packaging *e.g., candy wrapper, chip packet*		
Plastic sachet (food) *e.g., coffee portion, condiment*		
Plastic sachet (cosmetics) *e.g., shampoo portion*		
Plastic cosmetics container *e.g., shampoo bottle*		

Plastic cleaning container *e.g., detergent bottle*		
Large container/drum/jerry can *e.g., for oil or water*		
Plastic sack *e.g., for vegetables or fertiliser*		
Plastic crate		
Other bottles or containers		
Other container caps or lids		
Plastic cigarette lighter		
Cigarette butt		
Plastic pen		
Plastic comb/hairbrush		
Plastic toys		
Plastic balloon *e.g., party balloon*		
Plastic glove *e.g., for washing up, medical*		
Face mask *e.g., Covid-19 PPE*		
Covid-19 test		
Other plastic PPE *e.g., apron, other face covering*		
Shoes/sandals		
Rubber boots		
Clothing		
Other textiles		
Plastic fishing line		
Plastic fish box		
Plastic bucket		
Nets and pieces of net <50 cm *e.g., fishing net*		
Nets and pieces of net >50 cm e.g., fishing net		
Plastic sheeting or film <50 cm		
Plastic sheeting or film >50 cm		
Plastic rope *diameter >1 cm*		
Plastic string/cord *diameter <1cm*		
Plastic foam/sponge		
Rubber tyre or belt		
Plastic piece 2.5-50 cm *Unidentifiable origin*		
Plastic piece >50 cm *Unidentifiable origin*		
Other plastic item, specify:		

7.2 Monitoring of waste on the street of the Phyazay market

Over a period of three weeks a local person was employed by Justice for All to monitor the level of waste in the street where the container was placed. The table presents the results from this monitoring.

Area	Time	Date		
		30.11.2020	**05.12.2020**	**12.12.2020**
Container at the time of emptying: full container *(FC)* , half full (*HF*)?	Morning	**Empty**	**Empty**	**Empty**
	Afternoon	FC	FC	
	Evening	FC	FC	FC
Situation around container (Clean /little waste (*C):* some waste (SW): quite a lot of waste (LW	Morning	C	C	C
	Afternoon	SW	SW	SW
	Evening	SW	SW	SW
Percent of street covered with waste	Morning	zero	zero	zero
	Afternoon	5 %	5 %	5 %
	Evening	10 %	10 %	10 %
Big waste objects, plastic waste objects: Zero large waste objects (ZW), between 1 and 5 large waste objects (1-5), more than 5 (5->)	Morning	1-5	1-5	1-5
	Afternoon	1-5	1-5	1-5
	Evening	1-5	1-5	1-5
Street of container (Clean /little waste (C): some waste (SW): quite a lot of waste (LW)	Morning	C	C	C
	Afternoon	SW	SW	SW
	Evening	30.11.2020	05.12.2020	12.12.2020
Distributed plastic bags being waste (yes / No)	Morning	Empty	Empty	Empty
	Afternoon	FC	FC	
	Evening	FC	FC	FC
Waste in the container from other sources	Morning	C	C	C
	Afternoon	SW	SW	SW
	Evening	SW	SW	SW

7.3 Waste collection by MJT in urban areas of the Bago Township

Waste Collection by MJT (2022) Total Waste in ton

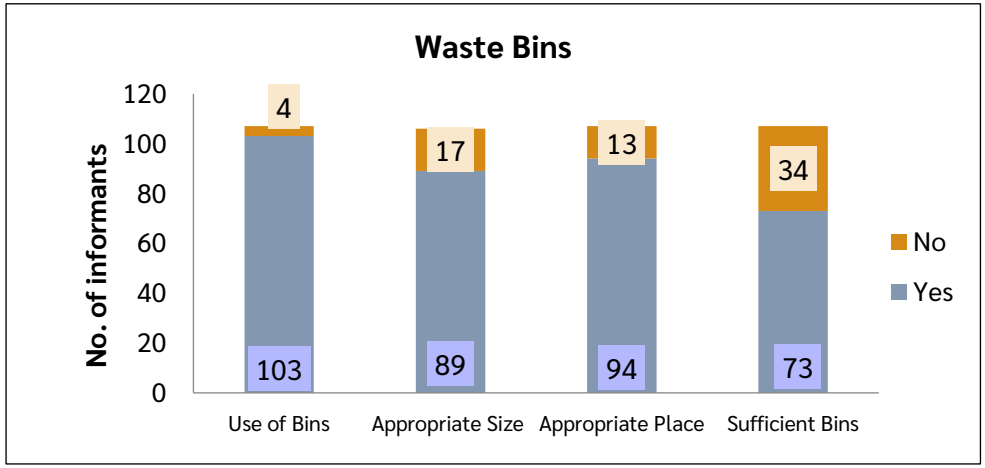
No.	District	Month	Year	Total Waste collected by MJT (ton)	% of waste outside MJT collection (ton)	Biodegradable Waste (ton)	Destroying Waste (in ton)			Reuse waste (ton)	Non-compostable waste from textile industry (ton)	% of Waste Collected by MJT
							Burning Medical Waste (COVID - 19) (ton)	Recycling Food Waste/Household Waste (ton)	Destroying Textile Waste from Industry (ton)			
1	Bago	January	2022	99	**5 %**	4.9 (5%)	9.85 (10%)	64(65%)	-	2.95 (3%)	16.75(17%)	**1**

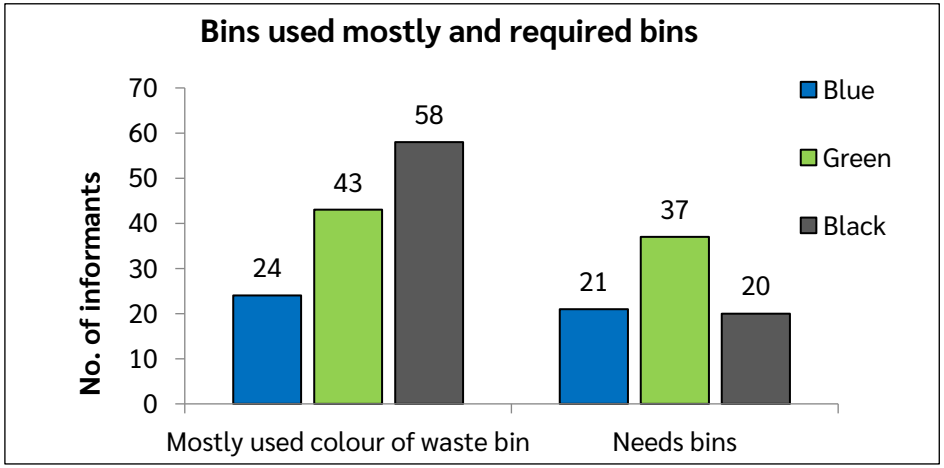
Waste Collection by MJT (2020-2021) Total Waste in ton

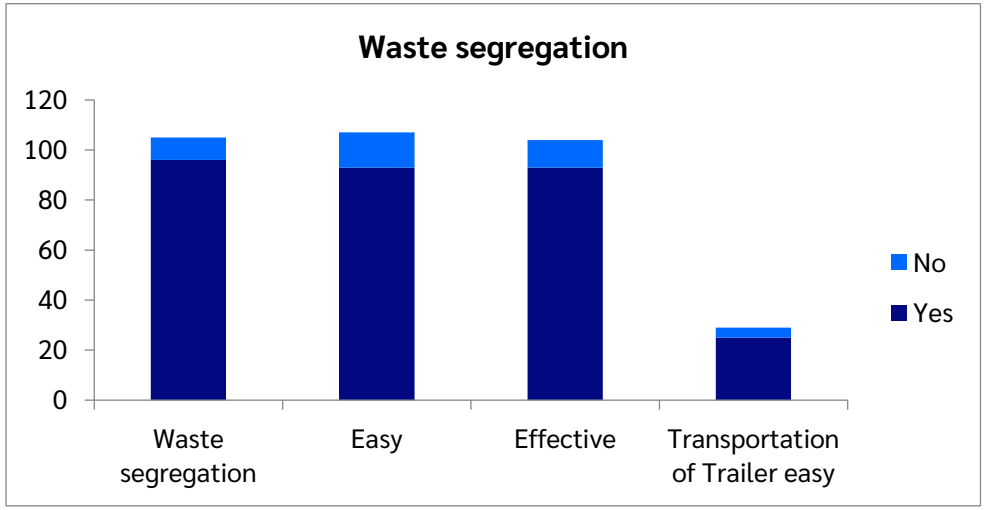
No.	District	Month	Year	Total Waste collected by MJT (ton)	% of waste outside MJT collection (ton)	Biodegradable Waste (ton)	Destroying Waste (in ton)			Reuse waste (ton)	Indecomposable Waste from Textile Industry (ton)	% of Waste Collected by MJT
							Burning Medical Waste (COVID - 19) (ton)	Recycling Food Waste/Household Waste (ton)	Destroying Textile Waste from Industry (ton)			
1	Bago	Oct	2020	3 276	**5% - 10%**	163,80	163,80	2 129,40	491,40	98,28	163,80	**90% - 95%**
2	Bago	Nov	2020	2756		137,80	137,80	1 791,40	413,40	82,68	137,80	
3	Bago	Dec	2020	3016		150,80	150,80	1 960,40	452,40	90,48	150,80	
4	Bago	Jan	2021	3016		150,80	150,80	1 960,40	452,40	90,48	150,80	
5	Bago	Feb	2021	3016		150,80	150,80	1 960,40	452,40	90,48	150,80	
6	Bago	Mar	2021	2756		137,80	137,80	1 791,40	413,40	82,68	137,80	
7	Bago	April	2021	2184		109,20	109,20	1 419,60	327,60	65,52	109,20	
8	Bago	May	2021	3276		163,80	163,80	2 129,40	491,40	98,28	163,80	
9	Bago	June	2021	3120		156,00	156,00	2 028,00	468,00	93,60	156,00	
10	Bago	July	2021	3198		159,90	159,90	2 078,70	479,70	95,94	159,90	
	Total			29 614		1 480,70	1 480,70	19 249,10	4 442,10	888,42	1 480,70	

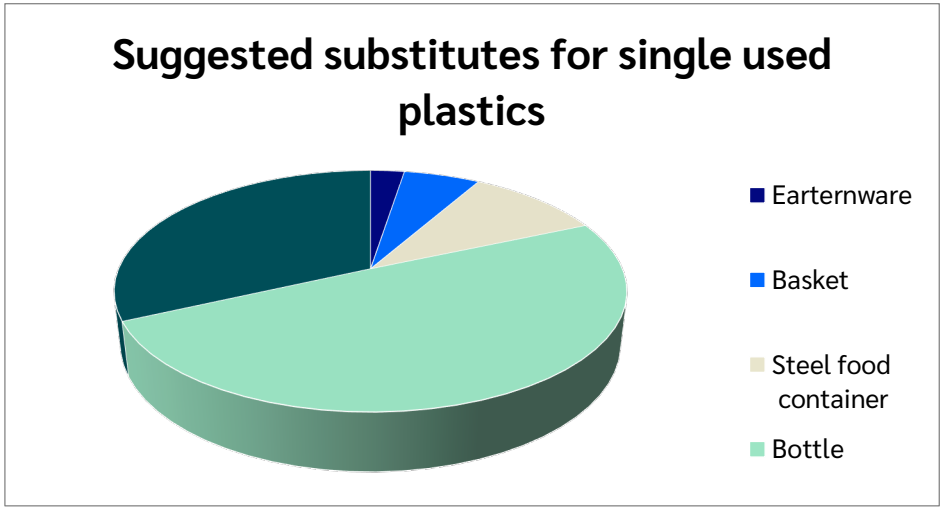
7.4 Results form a survey of nuns and monks at monasteries engaged as pilots

In total 142 informants, including 5 deputy monks and nuns, 90 student's monk and nuns, 8 administrative staff, 13 teachers, and 26 kitchen staff responded to a survey in February 2022 that addressed the situation of waste bins, including the use of bins and placement of bins, and the use of single use plastics.









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