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BEST PRACTICES WASTE MANAGEMENT SYSTEMS IN MYANMAR

Handbook



MVANMAR







Prevent Plastics Myanmar





Partners





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2. ABBREVIATION

3R	Reduce, Reuse, Recycle
EMA	Environmental Management Authority (formerly known as Pollution Control and Cleaning Department)
EU	European Union
MCDC	Mandalay City Development Committee
MONREC	Ministry of Natural Resources and Environmental Conservation
РРР	Public-Private Partnership
SMEs	Small Medium Enterprises
MSMEs	Micro-Small Medium Enterprises
YCDC	Yangon City Development Committee

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1. INTRODUCTION

Myanmar has been managing and applying its solid waste management with poor practices, unreliable and irregular waste collection services, lack of assessments on current practices, waste flows in important value chains, missing minimum standards for the collection, transportation and disposal of waste and the high expenditure, and insufficient revenues for the collection of solid waste that pose high risks to public health and the environment. There are three major city development committees in Yangon, Mandalay, Nay Pyi Taw. The Township Development Committees in the townships (of 330 townships countrywide) are responsible for waste collection and disposal in the country. The aim is to collect as much waste as possible to keep streets and neighborhoods clean. However, Myanmar does not have enough capacity and infrastructure to deal with the growing amount of waste due to rapid economic and population growth and urbanisation.

Although the collection keeps up with the growing amount of waste, we are just transferring the problem from the streets to landfill sites and some other locations by open dumping with improper waste disposals in the final disposal sites. Waste collection services, management activities, and segregation processes are not reliable and available for the community. That creates the biggest problem for both the environment and human health. Myanmar's environmental regulations are frail on waste management, and it becomes not as high a priority as other development priorities. As a result, the waste issue is becoming a major issue in the country. Therefore, Myanmar has required environmental programs and enforcement policies that should be in place to manage the waste supervision sector plus increase sufficient budgets for waste treatments and disposal options.

Myanmar has relied on manual collection with non-specialised vehicles, ranging from pushcarts to garbage trucks. There are six existing dumping sites in Myanmar; Htein Bin, Dawei Chang, Shwepyithar, Mingalardon, Dala, and Seikyi Khanaungato which merely have minimal capacity for disposal. The solid waste collection in Myanmar is also a labor-intensive and ineffective way of dealing with waste issues.

There are two types of formal and informal solid waste management systems that are practiced in most developing countries. Myanmar has been practicing only an informal system which consists of many actors such as waste-pickers, itinerant buyers, small scrap dealers, and wholesalers, who together recycle about 10% of the waste with lack of technical support and improper waste handling system by human forces¹. For instance, some recycled materials such as paper, plastic, metal, and glass are collected by waste pickers and sold to small paper mills and glass factories.

As the population increases, so does the waste generation problem. According to the World Bank report, 10.5 million tons of waste is generated each year in Myanmar² mostly in Yangon, Mandalay, and Nay Pyi Taw. Therefore, day to day waste generation by the community is one of the fast-growing problems in the country. Prevailing management strategies are inefficient, because of the complexity, cost, lack of public awareness and participations, technologies, and treatment options to minimize waste production in the country. As a result, improper management of these leads to public health hazards, pollution of air, and water bodies such as lakes or groundwater sources.

With the current waste generation and composition, and without a proper waste management system, Yangon's landfill sites will be completely covered in the next four years. Therefore, proposing a shift in the way to look at this problem to realise waste as a valuable resource while contributing towards environmental sustainability and to advance the quality of waste segregation at source practices, waste collection, transportation services, and keeping our environment clean.

^{1.} Hotta, Y (edited) (2014): Co-benefits of the 3R (reduce, reuse and recycle) of municipal solid waste on climate change mitigation, IGES, Japan

^{2.} World Bank, (2019). Country Environmental Analysis. Myanmar. Available at: http://documents.worldbank.org/curated/ en/464661560176989512/pdf/Synthesis- Report.pdf [accessed 26 Dec, 2020]

2. ABOUT THIS HANDBOOK

This handbook offers the following strategies which can implement and adapt the 3R (reduce, reuse, recycle) concept and practices in industries, Micro-, Small and Medium Enterprises (MSMEs), and governmental authorities involved in the waste management sector. We share various approaches that we found effective ways based on the local community in Myanmar to increase the product production rate and lessen waste minimisation. We believe that amending or refining the following process can assist not only to solve the current waste stream problems but also help to restore a greener and cleaner environment for all.

1. IMPROVE IN WASTE SEGREGATION, COLLECTION, AND TRANSPORTATION

- Share the best environmental practices in the separation of waste at the source.
- Train and raise awareness within municipalities regarding proper handling of domestic waste for separation at the source as well as for the need to minimise waste and promote recycling.
- Ensure that there are suitable storage and collection services and facilities in place for general, recyclable, and special waste.

2. DEVELOPING STRATEGIES FOR PROMOTING 3R

- Actively involve and collaborate with relevant stakeholders.
- Implement a waste management education programs for staff/employees in the industrial zones, SMEs, and MSMEs
- Implement waste minimisation, recycling, and composting initiatives.

3. INVESTING IN APPROPRIATE WASTE TREATMENTS OPTIONS

 Invest in the waste treatment and recycling technologies by turning waste to resources/ new products and repurposing the materials.

4. PLANNING, POLICY, AND ENFORCEMENT INITIATIVES

- Provide strong regulations and guidance for approaches regarding to segregation of waste at the source to different levels of industries/residential areas.
- Set measurable targets for waste reduction within the organisation over a specified period.
- Develop policies to ban certain materials, products, items, and productions for instance single-use plastics should be prohibited in the country.
- Formulate the monitoring body with relevant shareholders/authorities to ensure the polices are rolling into the actions.

5. SUSTAINABLE APPROACHES IN WASTE MANAGEMENT SYSTEM

- Create strong and stable markets for segregation. Segregation plays a major role in the recovery process. For example, encouraging or supporting local SMEs who are advocating and leading the green business.
- Recommend and strongly support the Circular Economy.

3. CURRENT WASTE SITUATION IN MYANMAR

Historically, Myanmar used to practice an uncontrolled waste disposal system and still commits to the traditional ways of waste management methods. Several dumping sites are used for waste disposal with one hectare of land. Those dumpsites' duration time is not sufficient to manage the waste landfill. Due to improper management practices and uncontrolled systems, these dumps were causing several health hazards from pathogenic organisms, insects, rodents, and air pollution from dust, accidental burning, offensive odours, as well as ground and surface water pollution through leachate. Waste generation is rapidly increasing every day and becoming a major issue for the environment and health.

In 1995, the Yangon City Development Committee (YCDC) designated the land to introduce a new main disposal site in Hlaing Tharyar Township named "Hteinbin" which is located 26 km west from the city centre with a capacity of 290 acres. At present, it has already covered 220 acres by landfill and about 70 acres of land are still left to be dumped in Hteinbin landfill³. According to the calculation of researchers, the whole Hteinbin landfill will be filled with rubbish by 2025, thereby resulting in a scarcity of land to waste disposal in Yangon⁴. In 2018, the Hteinbin dumpsite experienced a large fire outbreak due to heat and methane gas emissions from the bottom of the dump. Table 1 shows the operating dumpsites in Yangon and Mandalay region.

LOCATION	CONDITION	REMARKS
YANGON CITY DEVELOPMENT COMMITTEE (YCDC)		
HTEINBIN	Open dumping	Operating
DAWAI CHANG	Open dumping	Operating
SHWEPYITHAR	Open dumping	Operating
MINGALARDON	Open dumping	Operating
DALA	Open dumping	Operating
SEIKYI KHANAUNGATO	Open dumping	Operating
MANDALAY CITY DEVELOPMENT COMMITTEE (MCDC)		
KYAR NI KAN (NORTH)	Open dumping	Operating
THAUNG INN MYOUNT INN (SOUTH)	Open dumping	Operating
NEW BREWAY FACTORY	Open dumping	Closed in 2009
NEW KANDAWGYI LAKE	Open dumping	Closed in 2009
NEW ZANNGKALOW POND	Open dumping	Closed in 2007
CORNER OF N/E MANDALAY	Open dumping	Closed in 2013

Table 1: Major landfill sites in Yangon and Mandalay Cities (source: MCDC and YCDC 2016)

^{3.} Japan: IGES, Available at: https://pub.iges.or.jp/pub/waste-management-myanmar-current-statuskey [Accessed 10 Nov. 2020]. 4. Kaza, S., Yao, L., Bhada-Tata, P. and Woerden, F. (2018). What a Waste 2.0 A Global Snapshot of Solid Waste Management to 2050. Urban Development Series. Washaington, DC: World Bank.

4. IDENTIFY AND UNDERSTAND WASTE ISSUES

Myanmar is encountering significant waste management challenges at both national and city levels resulting from a range of technical, social, economic, and institutional constraints which together are contributing to soil and water contamination, air pollution, climate change, and impacts on biodiversity and ecological health. The core problems of solid waste management are the absence of policy reinforcements, enabling legislation, and environmentally concerned citizens. Several major issues are affecting the sustainable waste management practices in Myanmar.

1. Waste Generation and Disposal	 Increasing consumption of resources. Rapid increase in volume of waste generation. Increase and emergence of a variety of waste needing proper treatment. Shortage of landfill space and difficulties in finding suitable lands within city limits. Increase in waste management cost. Lack of basic data. Climate change and air pollution.
2. Policies and Enforcements	 Lack of policy administrations at both national and local levels. Weak enforcement of existing laws and regulations. Lack of policies to promote 3R and reinforcements. Lack of strategic planning and execution. Lack of new initiatives and no taxation on cleaning and waste collection. Weak coordination within and among different administrative layers. No regulations of carbon emission and policy for carbon credits.
3. Public Participation	 Lack of policies and awareness to promotes 3R. Lack of awareness on health risks of the informal sector. Lack of participation and coordination among stakeholders e.g., inter-agency collaboration at national/local levels. Lack of partnerships and restricting policies Lack of monitoring and reinforcement of laws Negative public perception and absence of participatory mechanisms. Limited research and practical application on new technologies

4. IDENTIFY AND UNDERSTAND WASTE ISSUES

4. Financial Aspects	 Revenue from collection of waste is low and cannot keep pace with the total waste management expenditures. Penalties are not strictly enforced. Lack of measurement for Public and Private Partnerships. Not enough budgets/finances for investments in waste sectors. Not sufficient support for green businesses operations.
5. Technical Aspects	 Low resources and technical skills to turn waste to energy or reusable resources. Limited know-how and capacity on suitable technologies adapted to local conditions. Limited resources including finance and expertise to invest in new technologies. Limited research and practical applications on new technologies. Lack of consultation and accurate database and record keeping. Limited waste disposal facilities specialised on hazardous waste.

Table 2: Waste issues in Myanmar

5. STAKEHOLDERS INVOLVEMENT

Development and implementation of sustainable waste management strategies requires to involve active participations from different major stakeholders in the process. Each party is responsible and entail vigorously to contribute their parts into this action and collaborate with other parties to make a difference for future generations.

The government body/committee should be formed by different stakeholders' groups so that they can all participate in the discussion and decision-making throughout the strategy development process.



- Use practical experience and local knowledge to improve waste management and recycling systems.
- Work in partnership with communities, local authorities, NGOs, INGOs, CBOs and the private sector.
- Improve working conditions to reduce health hazards.

and recycling waste at all levels.

provide infrastructure facilities.

implement the strategy.

the strategy.

Facilitate local authorities and industries to

Coordinate essential financial mechanisms to

Accommodate the role of informal sectors in

6.1.1 SEGREGATION OF WASTE AT SOURCE

The practice of source separation of waste needs to be encouraged: Separation of waste at source is the essential process in the 3R initiative. Studies have shown that recyclables with economic value such as paper, plastics, glass, and metal, are not segregated and are thrown on the streets by people, along with domestic/industrial/institutional waste. The materials can be contaminated and cause harm to the environment. Thus, without waste separation at source, the planning, designing, and implementation of waste management systems are not possible to develop a cleaner, greener, and healthier community for all.

In general, waste can be separated at three levels: 1) household and community level, 2) in the process of collection and transportation by municipal workers, and 3) at the waste disposal site by the workers and waste pickers from the informal sector. It is important to realize that the quality and efficacy of the recycling plants highly depend on the quality of segregated wastes. Especially the composting of organic wastes purely depends on the quality of waste separation.

Not to be neglected is education and awareness raising: In industrial zones, managers should train or raise awareness within municipalities regarding proper handling of domestic waste for separation at source as well as for the need to minimize waste and promote recycling.

Moreover, strong and stable markets for segregation need to be created. Segregation plays a major role in the recovery process, for example, encouraging or supporting local SMEs who advocate for a green business.

6.1.2 PROVIDE SEGREGATION BINS/TANKS IN PUBLIC AREAS WITH CLEAR INSTRUCTIONS



Figure 1: Segregation process bins and guideline (Source - PCH.Vector/Shutterstock.com)

Collection of waste and recyclables in separate containers should display segregation guidelines in public areas such as shopping malls or residential areas close to the end-user (usually within 100-200 meters). A spread in sufficient numbers across residential areas could benefit promoting segregation at waste sources and reduce illegal dumping.

The waste generator takes accumulated waste by foot or by car to a central location and drops it there into containers. The collection service should collect the waste in the places twice a day to make the city clean.

6.1.3 WASTE COLLECTION

There are different types of collection services that are effective and best practices for minimization of waste generation and composition. For instance, by providing regular and reliable collection services to waste generators (including sweeping of streets and public places and drain cleaning) and supporting the transport of waste (after collection) to the recycling facilities, treatment, or safe disposal, and offering this service in a socially acceptable, cost-efficient, and environmentally friendly way to the community.

The most operative ways are recommended as follows:

Optimise collection points and routing: Place collection points in strategic locations that should be placed in less than 200 meters (656 ft) to collection points/bins to improve and reduce the collection time of residents.



Figure 2: Placement of bins/points that where residents can throw away their waste

Plan efficient routes which will avoid traffic, save time and energy (fuel): The collection process will take less time to collect waste from the points and create more effective ways to handle waste issues.



Figure 3: Setting up a routing system to avoid traffic

6. IMPROVING EFFICIENCY OF WASTE SEGREGATION, WASTE COLLECTION AND TRANSPORTATION

Utilise larger loads for longer distance transportation: The methods will reduce workloads, time, and cost.



Figure 4: Using larger trucks to transport waste over longer distances (Source - Andriy Blokhin / Shutterstock.com Source - PradeepGaurs / Shutterstock.com)

How to Improvement the process. Set up the Taxation system on cleaning and collection of tax and revenue according to townships:

Central Business: collection fee is 200 kyats per day (6,000 kyats per month) Sub Urban: collection fee is 100 kyats per day (3,000 kyats per month) Urban Residential: collection fee is 50 kyats per day (1,500 kyats per month)

Call out research and proposal for new technologies and investments

Table 4: Process improvements

6.1.4 DESIGNATED COLLECTION TIME AND VEHICLES

Arranging and setting up designated vehicles for specific waste with collection time and dates will help to promote waste segregation and save time and money to manage the waste generation well in the cities.

For instance, blue vehicles will only collect recyclable materials and composting materials on Monday, Wednesday, and Friday from 4 am to 7 am and from 5 pm to 9 pm in each township. The blue trucks will only transport waste to recycle facilities and compost facilities to facilitate recycling.

Next, orange vehicles will collect trash on Tuesday and Thursday from 4 am to 7 am and from 5 pm to 9 pm from the waste stream before the workers collect waste from other municipal solid waste.

Next, the yellow vehicles will collect hazardous waste and e-waste on Saturday and Sunday from 4 am to 7 am and from 5 pm to 9 pm. Besides, a separate collection of compostable materials, recyclable materials, hazardous waste, and e-waste will allow facilities to handle the waste issue well.

6.1.5 WASTE DATA COLLECTION

Having accurate data collection is also essential to understand issues. It helps to build a solid foundation for developing concepts and for decision-making. However, the government and the relevant departments do not have proper waste data collection systems in place or have done any research on waste management practices on a country-wide level.

There are three committees which are dealing with solid waste in three cities: Yangon, Mandalay, and Naypyidaw community development committees, but EMA/YCDC is the main active actor in handling waste problems. Although there are six final disposal sites in Yangon City, EMA is normally collecting records from the two main deposits (Htein Bin and Htawe Chaung), but they do not collect from Shwe Pyi Thar, Mingalardon, Dala, and Seikkyi Khanaungto sites on the daily or monthly basis. Thus, they are always struggling to provide country-wide and detailed data of solid waste collection on a daily or monthly basis.

Therefore, establishing a proper data collection system will help to understand waste generation and composition in each region, find effective waste disposal systems, and encourage industries and SMEs to practice waste management in their workplaces. Collection guidelines provide concise instructions for recording waste data collection in any place.

	Waste Data Collection Plan																									
Industry																										
Date	Date																									
	Org	anic \	Naste (Wet	Wast	e)					Rec	ycling	Material (E	Dry W	aste)						Ha	zardous Ma	terial				
Domestic waste	Generation	Kg	Recycling	Кg	Reuse	Кg	Recover	Kg	Recyclable Products	Generation	Кg	Recycling	Кg	Reuse	Kg	Recover	Кg	Hazardous	Generation	Кg	Recycling	Кg	Reuse	Кg	Recover	Кg
Rice/noodles/ bread									Plastic Containers									Used Syringes								
Vegetable/Fruit Peels									Plastics Cover/ bottles/boxes, items									Injection Vials								
Cooked food/ leftover									Plastics cups									Medicines								
Egg shell									Paper cups and plates									Rubbles								
Rotten Fruits/ vegetables									Newspaper/ Magazines									Sol- vent-based paints								
Bones									Cardboard/ cartoons									Pesticides								
Tissue Paper									Food boxes									Batteries								
Rotten Meat									Paper Cups									Motor Oil								
Leaf plates									Stationery									Cleaning Chemicals								
Expire food products									Metal Cans																	
									Foil Containers																	
Total		I —				1			Total		I —							Total								

Table 5: Waste data collection guideline for each industry

There are various approaches and main features of promoting and adopting 3R strategies in the country.

7.1.1 RAISING PUBLIC AWARENESS THROUGH MEDIA

Promoting public awareness largely depends upon our behaviours and attitudes and understanding towards waste disposal and management. The media can play a huge role in changing human behaviour and practices. For instance, it can allow people to realise how waste has a negative effect on the environment and health by creating a media platform for 3R concepts of waste characteristics, displaying regular information on source separation, sharing best practices and success stories on waste minimization and recycling, and publish on financial and environmental benefits of 3R to the public.

7.1.2 EDUCATION PROGRAMS

For lasting and long-term improvements, environmental education programs and curriculums can result in systematic capacity building and allow youth generations to reshape the way of thinking about waste generations. For instance, developing training courses, research projects, school competition within the local, regional, and national level of practices, and exchange programs will allow the youth to engage in the reforming process. The Ministry of Education must be actively involved with public and private schools to introduce environmental education into the school system. The school projects should be planned and implemented in parallel and in close cooperation with the capacity-building components of the 3R strategy plan.

7.1.3 DEMONSTRATION PROJECTS

Encouraging to call out demonstration projects on different technologies and best practices on 3R should be also established in the short and medium terms for domestic, institutional waste, commercial, agricultural, hazardous, and industrial waste. Moreover, the government should also support research institutions, universities, organisations, farmer networks, and NGOs are engaged and interested in the projects.

7.1.4 REDUCE, REUSE, RECYCLE

Public awareness and motivation are the key driver of practicing the 3R system in the community. Studies show that there is a correlation between the income and education level of waste management practices. The more income and education level citizens have, the more likely they treat waste in proper manners. It is also easier to encourage citizens to do so. When the citizens are urged and want to change, the producers must have to follow their consumers' preferences. Therefore, the first step is to bring public awareness of waste issues and how it impacts our health and the environment.

7. DEVELOPING STRATEGIES TO PROMOTE 3R

The second step to realise how recycling can save money and the planet lies with the government. The government should support the local green business by finances (from waste taxes) and technical assistance.

Development and implementation of a sustainable waste management plan are essential to minimise the environmental, social, and economical problems associated with present disposal practices. The 3R strategy is an effective practice system of use of resources and materials and a practical way of moving toward a sustainable future for all.

The principle of reducing waste, reusing, and recycling resources and products is known as the "3R."

- Reduce (minimum use of raw materials)
- Reuse (maximum reuse of products and components)
- Recycle (high quality reuse of raw materials)

The hierarchy illustrates a prioritisation of action for waste management activities; giving top priority to preventing the waste from being generated in the first place, followed by reduction through means reusing, recycling, recovering of energy through waste processing such as anaerobic digestion, incineration, and finally disposal at the resort.

Waste minimisation can be achieved efficiently by focusing primarily on the first of prevention, then "refuse or reduce," followed by "reuse" and then "recycle or compost" and then create or recover the energy process. The final step would be waste disposal with proper methods.



Figure 5: waste management practice structure that can help to improve waste reduction

(image sources: www.cleanupbritain.org)

7.1.5 HAZARDOUS WASTE TREATMENT AND DISPOSAL

Myanmar has only one private facility - Golden DOWA Eco-System - that is handling hazardous waste in the Thilawa Special Economic Zones in Yangon. However, there is no specific facility which is managing medical waste except for traditional treatment processes of incineration processes and submerge to deep well processes (Source: Government of Myanmar, 2013).

Furthermore, separate collection of hazardous waste is not always available or well promoted/ enforced allowing factories to mix it with their production waste. YCDC is not always up to the environmental standard needed to dispose of material.

Therefore, hazardous waste for treatment and disposal facilities are required to be deployed at once and waste segregation and collection must be promoted and enforced at the country level. Figure 6 shows the hazardous waste management practices on both local and national level. The promotion of waste segregation is very crucial for proper waste management in Myanmar.



Figure 6: How to manage and treat the hazardous waste in proper way

Myanmar has various challenges in the waste management sector due to the lack of awareness, technical knowledge, legislation, policies, and reinforcement strategies. The regional governments are required to strengthen their efforts to control the rapid growth rate of waste generation and to allocate adequate resources for waste management. Promoting reduction, recycling, reuse, and recovery should immediately be taken into realisation. Governments may also have to enhance the appropriate legislation to promote these measures with financial incentives. Moreover, an improvement in concise data collection must take place to achieve sustainable waste management.

Investing in environmentally friendly technologies such as waste to energy, anaerobic digestion, composting, and incineration methods would be the best way of embracing waste reduction. Those technologies are applicable in the context of prevailing socio-economic and climatic conditions of the country through collaboration among stakeholders such as national governments, local governments, private sectors, consumers, manufacturers, informal sectors, and research bodies should be promoted. For instance, investing in recycling technologies such as turning used plastics into new products and repurposing the materials by using plastic bottles in construction places such as eco-bricks, plastic, and sand bricks, or building roads could help to minimise the environmental impact.

8.1.1 WASTE TO ENERGY

With the current situation, Myanmar could not depend on waste reduction practices since it is nearly reaching the tipping point of waste disposal options. Thus, it requires to consider options and techniques to approach waste minimisations. There are waste treatments and technologies which can help to reduce, recover, and reuse the process of waste streams in the country. Yet, when we consider the future of waste management, it is clear to realize that continuing the landfill routine is not a viable choice, and it is not a sustainable practice for future generations.

Incineration can be one of the best alternative ways to transform waste into energy. It generates heat and electricity that can be utilised for electricity and biogas and can help to minimize waste production. For instance, Singapore incinerates about 8,200 tons of garbage daily, reducing its waste volume by 90%. Their incineration plants, in turn, produce over 2,500 MWh of energy daily, enough to support 900 homes. Although it pollutes the air, Singapore's incineration programs recover reusable metals that can be sold for profit. However, the nation is amplifying its recycling programs⁵.

Although Myanmar is striving to practice the biogas production from animal manures and agriculture residue for electricity at a small-scale level, the process is requiring the technical assistance from the government.

^{5.} Integrated solid waste management based on the 3R approach - Scientific Figure on ResearchGate. Available from: https://www. researchgate.net/figure/Concept-of-Integrated-Solid-Waste-Management-based-on-3R-Approach_fig1_225707470 [accessed 26 Dec 2020]

For municipal solid waste (plastics) Myanmar does not have to reinforce regulations and policies to tackle plastics waste reduction. However, the Yangon City Development Committee (YCDC) collaborated with JFE Engineering Corporation (JFE) to incinerate 60 tons of waste per day from 200,000 people and producing 700kW of electricity. The operation process is not as effective as expected due to high density of moisture content from the waste and waste segregation process.

How to Improvement the process.

- To obtain effective result, waste requires to be separated as wet and dry waste.
- The waste generators must practice segregation at sources (require trainings and guidelines).
- The collection systems must be reliable and affordable (collection services with fees).
- Provide the segregation bins with guidelines
- Establish laws and legislations for electricity sale back to the grid
- Support recycling markets, factories, and companies.

Table 6: Improving waste processes

8.1.2 MECHANICAL-BIOLOGICAL TREATMENT PLANT (MBT)

Many developed countries are investing on sophisticated technologies and treatments for rapid waste. For instance, the mechanical-biological treatment (MBT) which is a waste processing facility that combines a sorting facility with a form of biological treatment such as composing or anaerobic digestion. The system is designed to process mixed household waste, commercial, and industrial wastes. However, the financial investment is considerably expensive.

Currently, one of the worldwide largest MYT projects by EUWELLE is interested in investing in Myanmar. The MYT plant is operating in Bangkok, Thailand and Ringsheim, Germany with capacity of 800 TPD. The MYT process has a two-stage fermentation process in which hydrolysis and methane formation, as well as waste separation process. This technology and treatment methods can ease Myanmar's growing waste issue problem and create revenues from this process.

8.1.3 ORGANIC WASTE TREATMENT PROCESS

Latest studies show that 77% of organic waste in Myanmar ends up in the landfill every day⁶. There is no specific infrastructure or treatment options for organic waste even though agriculture sector performance is key to economic growth and food security in the country. However, Myanmar has several organisations/networks which are practicing organic composting methods such as the Mitta Young Farmer Network, the Taungku Network, Orgaworld-Asia, or Boskashi Myanmar. Other small and medium scale farmers are shifting toward a sustainable cultivations' practices with not enough supports from the national and local government.

Today, many developed countries are realizing that utilising chemical pesticides and fertilisers are severely impacting our health and the environment. Therefore, many people are demanding to consume more organic foods, products, and items. Modern farmers' farming practices are shifting toward more organic cultivation with applying composting methods such as open-air composing, direct composing, tumbler composing, worm farm composing, EMO composting, combination composting, commercial composting, and mechanical composting. Their government is supporting organic farming and companies to increase the production with technical and financial assistance.

Although organic waste can naturally degrade through biological activity, biowaste can harm our environment and our health if it is not controlled or managed in proper methods or processes. These impacts are the pollution of soil, water and air, as well as in our health and ecosystem. Table 7 shows how biowaste can harm soil, water, air, and other pollution to the environment and health.

ELEMENT	ENVIRONMENTAL IMPACT	HEALTH CONSEQUENCE
SOIL	Soil degradation/erosion Lost soil nutrition Less microorganisms Contamination of soil through Leachate	Unsafe food production Deterioration of public and environmental health Economic costs
WATER	Contamination of groundwater through leachate Need for water treatment downstream	Threat of diarrheal diseases, including cholera and typhoid fever, and other water-borne illnesses Economic costs
AIR	Release of greenhouse gases (e.g.: methane, carbon oxide) Bad smell	Higher rates of cancer, heart disease, stroke, and respiratory diseases such as asthma
OTHERS	Increase/attracting disease carry- ing vectors (flies, rodents, etc.) Visual pollution	Deterioration of public health Tourism

Furthermore, there are relatively low-cost treatment methods to treat and transform bio waste into a resource such as biogas, heat and electricity, and fertilizers. Those technologies and treatments are available for residential and industry levels to practice in the most sustainable and resourceful way to recover the waste. The technologies can help to produce valuable products from biowaste and minimise the approach of open dumping and unsanitary landfilling.

Although there are various treatment options available in the market, merely windrow composing, and anaerobic digestion solution are the best fit for both residential and commercial levels for investing and considering practices in Myanmar. Table 4 shows the different treatment options with their operation process definition.

TREATMENT TECHNOLOGIES	DEFINITION
WINDROW COMPOSTING:	Microbiological process through which organic materials are degraded and stabilised into compost. This process occurs because of microbial activity under aerobic conditions (with oxygen). Biodegradable waste is piled up in long heaps (windrows) where the material is degraded. Heaps need to be turned to improve porosity and supply oxygen
IN-VESSEL COMPOSTING (AND BIN-COMPOSTING)	Microbiological process through which organic materials are degraded and stabilised into compost in rotating vessels. This process occurs because of microbial activity under aerobic conditions (with oxygen). Organic waste is introduced into rotating vessels, in which conditions (e.g., HR, Temp., etc.) can be kept stable. This accel- erates the composting process.
VERMICOMPOSTING	Biological process through which organic materials are de- graded and stabilised by the interaction of microorganisms and earthworms under aerobic conditions (with oxygen) into vermicompost. Surface worms are suitable for this technology, such as Eisenia <i>Fetida and Lumbricus Rubellus</i> . The complete life cycle of E. Fetida lasts 70 days.

World Bank, (2019). Country Environmental Analysis. Myanmar. Available at:http://documents.worldbank.org/curated/ en/464661560176989512/pdf/Synthesis- Report.pdf [accessed 26 Dec, 2020].

ANAEROBIC DIGESTION	Microbiological process through which organic materials are decomposed while generating a fuel gas (biogas) and nutrient rich digestate. This process occurs because of microbial activity under anaerobic conditions (without oxygen) in airproof reactors called digesters. 3 types of digesters considered in the manual. All are one- stage, wet, continuous and mesophilic
SLOW PYROLYSIS	Thermochemical process which transforms organic materials into char, liquid and gas. Result of heating (300-600°C) under anaerobic conditions (without O2). Relative proportion between end-products depends on the characteristics of the waste, pyrolizer design and operating parameters (heating rate, final temperature, residence time, etc.)
BLACK SOLDIER FLY PROCESSING	Biological process using larvae of BSF to transform organic waste into insect fat and protein. Result of larvae of BSF actions under aerobic condition (with oxygen). The BSF feed on the biowaste and develop through 6 larval instars. They are harvested in their last larval stage when they crawl out of the moist feed source in search for a dry pupation site.

Table 8: The different treatments options with their operation process definition (EPA.gov, 2016)

8.1.4 COMPOSTING

Composting is a green and great way of disposing of organic waste. According to the IGES report, in the composition of the solid waste generation, 76 % of the solid waste is organic, 10 % is plastic, 4 % is textiles and papers, and another 10 % is wood, rubber, leathers, metals, glasses, and crockery and stones. Figure 7 shows the waste compositions from the study.



Figure 7: Waste composition and characteristics in Yangon (IGES, 2016)

Various biowaste treatment technologies have been successfully practiced in both developed and developing countries. Each treatment technology generates different products of value and has a unique recovery process as well as financial input.

8.1.5 WINDROW COMPOSTING

Windrow composting methods are a long pile of stacked biodegradable materials that transformed into a stable, dark brown, soil-like material. This process occurs by way of microbial activity under aerobic conditions in the presence of oxygen. The oxygen needs replenishing during the process. Otherwise, the pile goes anaerobic in the centres, following a different decomposition process and producing odours.

This method is suited to treat a large volume of bio-waste and produce large amounts of compost. It is required to make sure that the material is porous enough for air to pass through. This method also requires low initial investment and maintenance. However, it needs a massive space because the windrows have sloped sides and cannot sit close together. The composting process is time-and labour-intensive.

The final product is a fretiliser that can be used in gardens to support soil amendment. The quality depends on the feedstock and quality control during the process. Its use depends on the quality of the final products and legislation. Besides compost, other output products emitted during the composting processes are leachate, water vapor, and carbon dioxide.

Since 1990, Myanmar farmers have been utalising chemical products such as pesticides and fertilisers for producing more products and still practicing it more than ever. Due to high demand usage, soil erosion and depletion are occurring in most regions. Besides, many farmers and consumers have affected their health from it. Thus, to refurbish the soil richness, Myanmar farmers must reshape to practice applying organic farming methods and slowly move to avoid pesticides.

The adoption of technologies and practices that are more mindful of landscape and ecological resources is fundamental to sustainable agricultural production. Many years of poor agriculture and land management practices have led to serious land degradation issues. Soils have an extensive ecological structure with living organisms and characteristics that impact moisture availability, crop nutrient supply, and physical support for crop growth. Organic matter is a key component of soils and directly impacts the yield capacity of soils. The living organisms in the soil continually break down minerals and organic matter to fortify the nutrient content of the soil. Soil nutrient restoration can be accomplished to a limited extent through application of organic materials, such as crop residue, animal manure, and green manure.

8.1.6 ANAEROBIC DIGESTION

Anaerobic digestion (AD) is a process like composting, but it does not use oxygen. AD allows the treatment of organic waste and sludge in the absence of oxygen.

It is a slower process in comparison to composting, but it can have far more useful results. Anaerobic digestion process provides biogas, which is a renewable source of energy that can be used for cooking, generating heat, and even producing electricity for the home. AD can be able to practice in various households, on-farm, and industrial level. It is not rocket science to practice it at the household level. It will only require sharing technical knowledge and options with the public.

Many developed countries are shifting toward being a green nation and strive to prevent global warming and climate change. Myanmar has the potential to be leading the greenest country in Asia. It has a massive flat landscape with solar energy potential, hydro energy, ocean energy, wind energy, geothermal energy, and biomass energy as well. However, it is still struggling and failing in every sector. Myanmar is relying on fossil fuels such as coal, gas, and oil. The main issue is the absence of investment in green energies, public-private partnerships, and policies. AD technology can reduce not only waste compositions, but it also can generate biogas that can be utilised for electricity. Table 5 shows the pros and cons of AD investments.

Pros	Cons
Continuous digestion process can ensure a steady source of electricity generation.	Expensive: Installation costs, operation, main- tenance costs are expensive
Waste products from animals and humans are produced continually.	Time-consuming
Can offer beneficial by-products, compost, and fertilizer.	High land use
Processes can reduce smell to levels below unprocessed waste odour levels.	Must have a reliable source and the process must run efficiently
Improved water quality helps to remove phosphorous, and which would otherwise contaminate water supplies if left unattended.	
Minimizes the amount of Greenhouse Gases reduction.	

Table 9: The advantages and disadvantages of AD investment.



Figure 8: Illustration of an AD System, Showing Feedstocks and Byproducts (source: U.S. EPA 2018a)

9.1.1 PURPOSING THE POLICIES AND TIME FRAME

Composting is a green and great way of disposing of organic waste. According to the IGES report, in the composition of the solid waste generation, 76 % of the solid waste is organic, 10 % is plastic, 4 % is textiles and papers, and another 10 % is wood, rubber, leathers, metals, glasses, and crockery and stones. The study showed that waste compositions in figure 2.

	Policies	Time Frame
1	 Segregate waste at source. Develop guidelines for classification of waste into different categories. 	Long-term and short-term (Two years to 5 years)
2	 Cultivate policies for certain substances, products technologies, and restrictions. 	Short-term (6 months to 1 year)
3	 Provision of take-back of specific discarded products. Subsidies for secondary products/taxation of quarry products. 	Long-term
4	 Set up collection, reuse/refill, and recycling targets. Develop recycling acts and take-back-provisions for single-use plastics bottles. Planning at micro level to rationalise doorto-door collection routes and designated vehicles. 	Short-term and long-term
5	 Reinforce polluter pays principles. Waste pricing: pay-as-you-throw approach. Landfill restriction targets. Disposal taxation. 	Long-term
6	 Adapt feasible technologies and treatment options for waste management in terms of environmental, society, economy, and technical aspects. Establish laws for carbon emissions, carbon credit, and polluter pays systems. 	Long-term
7	 Establish a monitoring and reinforcement body for waste management sector in each township. Increase reinforcements to follow segrega- tion rules and guidelines. 	Long-term

9.1.2 ENFORCEMENTS

Local Level

Every city development committee should establish the leadership and responsibility for planning and implementing the city's waste management strategies and action plans in consultation with relevant stakeholders, including citizens and civil society groups, the informal sector, small- and medium recycling associations, academia, as well as other key departments.

The first strategy should prioritise to extend reliable and affordable waste collection services or systems across all areas of towns and cities, including informal communities and urban areas. The local government should establish proper mechanisms to control the current illegal dumping and open burning of waste, and make efforts to improve final disposal sites from open dumping to controlled and sanitised landfills.

The second strategy should execute to develop resource management strategies, indicators, and action plans based on a waste hierarchy, which includes waste prevention, maximisation, reuse, recycling, and composting, and recover energy before final waste disposal by the city development committee. The implementation body should involve promoting recovery, repair, and reuse practices, and moving toward a sustainable economy. For instance, rethinking to recover food waste from landfill to repurpose methods, such as composting techniques and bioenergy generation, and maximising the participation of communities by engaging informal and small-scale entrepreneurial recyclers in the conventional waste management sector.

The third strategy is city development committees should collaborate on a more all-inclusive approaches for controlling all residual waste by implementing pollution control measures such as tackling emissions and hazardous waste that affect human and environmental health. Although financial and human resources play the crucial role of succussing these strategies, building partnerships with relevant stakeholders, encouraging citizen participation, and raising awareness to promote behaviour changes would help to reach the goals.

National Level

The Ministry of Natural Resources and Environment Conservation (MONREC) and other relevant government departments and ministries should formulate the establishment of an effective legal framework, supported by enabling policies, financial mechanisms, and an operational monitoring/enforcement system on waste management at the national level. This should include developing waste management performance indicators and the basic methodology to track the progress of city waste management strategies and its performance of maintaining the national waste management rules and guidelines.

MONREC and its partners should collaborate with local government branches to improve waste management through national awards and certification programs. The national waste guidelines must be established regarding waste classification, compositions, and generation.

In addition, influencing public policy reinforcements are also required from government bodies to support and advocate on the transition process to sustainable waste management practices. For instance, the government must set up the initiatives which will help tackle for waste maximisation and generations by banning specific substances, technologies, and products such as single-use plastics usage in 2025. Most importantly, government bodies must reinforce the guidelines to ensure that everyone adhere to comply with them. The government must also establish an enforcement body that will monitor the actions and processes on national and local levels. The enforcement body will vouch the cities and community to become a greener, cleaner, and healthier place for all.

10. SUSTAINABLE APPROACHES IN WASTE MANAGEMENT SECTOR

Myanmar is still filling landfills and opens dumpsites in the waste management sector although there are various effective ways to handle waste generation. However, the government does not practice and support formal recycling, but the private sector helps the junk shops and individual purchasers. The Recyclable products (glass bottles, newspapers, cans, and metal) are stored at the household level and sold to the nearby junk shops and the to door-to-door individual buyers as well.

In addition, sustainable waste management consists of collecting, sorting, treating, and recycling. Yet, when waste is properly managed, it can be provided as a source of energy and resources and can create jobs, improve waste management methods, and decrease the impact of human activities on the environment, thereby, improving the air and water quality. Hence, Myanmar's waste segregation sector must be the top priority for the sustainable waste management system. The suggested solutions are practical and beneficial ways of promoting a reduction in waste management practices and bringing everyone on board.

Proper waste management is also a fundamental component in any manufacturing or production enterprise, for instance comprehensive and proactive waste management practices can result in not only a socially responsible community but also it helps to promote a greater community acceptance for any operations. Moreover, the concepts of product–life extension and the service economy require to practice at all industrial levels for the ecology approaches to closing the loop in industrial or consumer systems.

Approach 1: Support for cleaner production is the continual effort to prevent pollution; reduce the use of energy, water, and material resources and minimize waste in the production process.

Action:

- Rethinking, redesigning products' components, and processes to achieve sustainable production.
- Analysing and understanding the input-output flow of waste generation within the production process.
- Promoting the use of alternative and sustainable packaging.
- Producing the high-quality standards in production processes.
- Initiating a take-back-product system.
- Setting up waste data collection of the materials and development of performance indicators.
- Establish measurable targets annually or quarterly.
- Supporting local raw materials and promoting local businesses.

Approach 2: Empowering the Public Participation.

Action:

- Conducting training and workshops in public areas through information, education, and demonstration projects.
- Improving reinforcements to follow segregation rules and guidelines.
- Attracting people's attitudes towards waste into resources; rethink about our habits, our needs, and our requirements.
- Reducing by waste generation Repairing, Reusing, Sharing.
- Setting up a recycling guide and make it available to the community.

Approach 3: Establish policies and guidelines on waste segregation nationwide

Action:

- Setting up segregation facilities at transfer stations for recyclables and organics.
- Selecting appropriate recovering technologies for food waste into biogas, electricity, and composting.
- Providing collection services in a socially acceptable, cost-efficient, and environmentally friendly way.

10.1.1 CIRCULAR ECONOMY

The more the world's population increases, the more there is demand for raw materials. Thus, many countries are establishing and promoting a more sustainable economy known as circular economy which can help to reduce environmental degradation. Due to the scarcity of resources, the circular economy offers a new approach, a new way of product design, make and use resources to satisfy the needs of the increasing population.

Many developed countries are promoting to fight climate change and help to practice sustainable business and waste management structure in the countries. Thus, adopting a circular economy and committing to sustainable waste management can provide and create opportunities and benefits to both the economy, society, and the environment.



Figure 9: How the circular economy function in the market system. (source: https://bit.ly/2JI3yHz)

10. SUSTAINABLE APPROACHES IN WASTE MANAGEMENT SECTOR

With the aim of minimising waste and making the most of resources, practicing the circular economy will be beneficial for Myanmar's economic system. However, segregation at the source is very important, especially when we talk about the circular economy concept.

The model implies the way of reducing waste to the minimum and strengthening the product's lifespan. For instance, when a product reaches the end of its life, its materials are kept within the economy wherever possible. These can be productively used again and again, thereby creating further values for new products. Figure 9 shows how a circular economy functions in the market system.

In addition, shifting towards a more circular economy could deliver benefits such as reducing pressure on the environment, improving the security of the supply of raw materials, increasing competitiveness, stimulating innovation, improving economic growth, creating jobs, and other opportunities.

A circular economy would benefit a decent amount of funding annually from more effective resource management because the cost of raw materials will decrease substantially while promoting employment and innovation. This way, producers can provide consumers with more durable and innovative products that will increase the quality of life and save them money in the long term. Moreover, transition into a circular-economy structure and practicing in the companies/industries could secure more value from resources and to provide customers with better experiences.

The national government must establish circular economy guidelines for SMEs and MSMEs and support their productions to enhance the revenue for the country and its people.

10. SUSTAINABLE APPROACHES IN WASTE MANAGEMENT SECTOR

10.1.2 SUSTAINABILITY TRANSFORMATION THROUGH PRACTICAL TOOLS AND SOLUTIONS

1. ESTABLISHING A NATIONAL FOCAL BODY FOR WASTE MANAGEMENT

- Setting up a well-organised focal body to guide the promotion and implementation of 3R strategies in the country.
- The focal body will be monitoring the progress in the implementation of 3R strategies and for multi-level communication with government bodies.

2. STAKEHOLDERS' INVOLVEMENT

- The successful implementation of the 3R strategy requires all stakeholder's involvement from development stage throughout the implementation, monitoring, and evolution stages.
- Community participation plays a major part of restructuring toward the sustainable nation and community. The process will involve local government branches, agriculture, education, finance, commerce, media, and energy sectors. Every successful project requires team effort and teamwork. They must work closely for the promotion of 3R and the implementation of 3R strategies at the ground level.

3. INVESTING IN AFFORDABLE AND APPROPRIATE TECHNOLOGIES AND METHODS

- Investing on low-cost treatment technologies options instead of sophisticated technological solutions for waste recycling and recovering which can create job opportunities and recover material costs.
- A technology advisory group should be formed at the Ministry of Electricity and Energy to assess the technology for promotion of 3R and supporting the technologies which are beneficial to the communities. Since a major portion of municipal waste is organic, technologies that can covert organic waste into organic fertiliser or biogas (which may then be used for electricity generation) should be encouraged.

4. BUILDING PARTNERSHIPS WITH NGOS AND CIVIL SOCIETIES

• Local governments should build well-developed partnerships with NGOs and civil society organisations because they always have strong technical and community mobilisation skills for promotion and implementation of the strategy.

5. RULES AND GUIDELINES

• Develop appropriate and clear rules and guidelines for source separation of waste. It must be mandatory countrywide along with populators pay systems. They must be placed for generation of waste beyond certain limits along with incentives for generation of less waste, as well as refusing, reducing, reusing, and recycling practices.

6. CAPACITY BUILDING

• Generate capacity building and training programs for local government bodies, factories/ industries, and SMEs on different approaches. A focal body could manage and help to provide the trainings and workshops through online and offline.

7. RESEARCH AND DEVELOPMENT (R&D)

- R&D is the essential part of generating better approaches in supporting for greater practices for the environment and energy industries for resource efficiency and sustainable waste management.
- The government should encourage relevant bodies to operate R&D by providing grants through non-profit institutions such as universities, research institutions, industry institutes, and by companies themselves for R&D expenditure, so long as a result will be publicly available.

8. COST RECOVERY

 Establishing appropriate waste management practices acquire better systems, infrastructure, facilities (such as waste bins), the construction cost of primary and secondary waste collection points, sanitary landfills, taskforces of trucks for the collection of wastes, waste treatment, and recycling facilities, etc. With proper waste collection system and practices, the facilities can recover the cost from recyclable materials and products which can be sold back to the factories/industries.

11. CONCLUSION

This handbook identifies a series of waste management practices and challenges, and provides implementation processes and strategies to deploy step by step recommendations to waste minimization at the national and subnational levels in Myanmar. Myanmar should invest in appropriate technologies and treatment options by collaborating with international communities, private companies, and relevant players to seek funding and technical assistance for waste management. With their cooperation and coordination, it can deploy economically affordable and appropriate waste treatment technologies to the local circumstances which can modernise its waste systems over a longer period.

At the same time, Myanmar citizens can also strengthen their knowledge and performances of the public sector with a view towards establishing more inclusive approaches, such as the endorsement of proactive policies, regulations, and sound institutions that ensure that the country is equipped with the competencies and skills to deliver sustainable, locally supported waste management systems.

Therefore, supporting community awareness activities, implementing policies and enforcements to promote the 3R approaches, bringing public participation, and investing on appropriate technologies can enrich Myanmar's waste management sector and create a greener community for all of us.

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