

## A REVIEW ARTICLE ON WASTE MANAGEMENT IN EAST AFRICA COMMUNITIES USING CIRCULAR ECONOMY

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**Abstract.** Solid garbage-organic, paper, plastic, and glass-makes up most East African waste. Only a small part of the East African Community's solid waste is managed and composted. The rest are dumped in an unsanitary landfill, an open land, or in inappropriate places. Proper waste management helps boost the economy and prevent the environment from being harmed. In Africa, poor waste management methods affect trash disposal, causing environmental and health issues (contamination of groundwater pore spaces). This study shows how circular economy can help manage waste in East Africa and its region. Almost all waste in developed and highly developed countries are well sorted, collected and managed. An integrated waste management method (Circular economy) should be established in EAC to help reduce waste, prevent the harmful impacts of improper trash collection on the environment and human health, and recover valuable products for recycling and reuse. The circular economy can reduce, recycle, and reuse waste in East Africa, providing job opportunities and keeping the communities clear of excessive waste.

**Keywords:** garbage-organic, composted, unsanitary, landfills, waste, environment, trash, recycling, reuse.

### Introduction

The “circular economy (CE)” is the model of production and consumption which involves the sharing, leasing, reusing, repairing, refurbishing and recycling of existing materials and products (waste). It also favors the activities that preserve value in the form of energy, labor and materials. Which means the designing for durability, reuse, remanufacturing and recycling to keep products, components and materials circulating in the economy. Durability, reuse, remanufacturing, and recycling must be considered during manufacture to keep goods in circulation. Sustainable production and consumption are essential for Africa's estimated 2.8 billion inhabitants by 2060.

The UN Statistics Division defines waste as non-usable materials. Waste is produced by extracting, processing, consuming, and human activities. Humans generate most municipal and commercial waste, which is damaging to the environment and human health. East Africa's solid waste is mostly organic (62%), followed by papers and plastics (19.6%), glasses (3%), and other debris (14.9%).

Waste is collected, transported, processed, dumped, recycled, and monitored. Waste management requires garbage reduction, enhanced collection, and conveyance to treatment facilities. Poor waste management in Africa and other part of the world has important consequence for the disposal of collected waste in dumps and the associated severe environmental and health related problems (contamination of groundwater pore spaces). Circular economy has proven useful in most developed countries such as Netherland, France, Italy, and Germany etc.

This study is to:

- Determine whether a CE may be successfully implemented in East Africa.
- Assist in decreasing the quantity of waste produced in East Africa by implementing circular economy practices.
- Develop a well-balanced waste management system that benefits local communities.
- Establish an efficient waste collection, recycling, and reusing system.

## 1. Area of study and methodology

### 1.1. Area of study

Pearson and Turner (2017) states that the East African Community (EAC) is an inter-governmental organization which includes Kenya, South Sudan, Rwanda, Burundi, Tanzania, and Rwanda. The United Nations Conference on Trade and Development (2018) classifies these states as developing or under-developing based on their revenue. In 2018, they had a population growth rate of 2.9%, a density of 80.6 individuals per square kilometer, and total inhabitants of 177.2 -million. A 2015 East African research predicts urbanization would rise from 39% in 2014 to 705 in 2050. The World Bank classifies all East African Community nations as low-income. East Africa produces a lot of municipal garbage, including plastic. East Africa can reduce environmental risk and poverty by embracing the circular economy to grow their economy and manage trash.

### 1.2. Review

This investigation uses government and NGO evaluations and published materials. The data was compared to other under-developed countries with similar living and environmental standards and advanced and highly advanced nations to learn about their strategies on how they manage waste. Waste management programmes were used to choose developed nations.

## 2. Results and discussion

Waste is poorly managed which results in loss of recyclable materials especially secondary raw materials such as glass, metal, paper, wood and plastic. Majority of the waste in east African countries are dumped in an open landfill where most of the materials are unrecoverable due to improper waste management.

### 2.1. Waste production

A community's lifestyle affects the type of waste produced, with organic waste (36%), paper (26%), and other waste types (plastic, glass, and metal) having lower percentage differences (Table 1). Community income greatly affects garbage volume and composition (Marshall & Farahbakhsh, 2013). Mbiba (2014), Henry et al. (2006) found that a significant portion of the East

African Community's population falls under the lower and low-middle income levels, indicating that a significant portion of their waste is organic, as supported by research linking waste generation to income level.

#### 2.1.1. A comparison of the amount of waste produced by the major EAC cities

Most of the waste (solid) generated in east Africa community are majorly organic waste (Okot-Okumu, 2012; Mbiba, 2014). Table 2 reveals that Dar es Salaam, Moshi, Kigali, Lira, and Nairobi, Kampala and Jinja produced the most bio-waste. The amount of paper waste generated by Dar es Salaam, Moshi, and Kigali is higher than in other EAC cities. Nairobi has the highest number of plastic waste generation compared to other cities. In comparison to other cities, Kampala and Jinja generated the vast amount of bio-waste compared to Dar es Salaam, Moshi, Kigali, Lira and Nairobi.

#### 2.1.2. Projection

Based on population forecasts, the yearly waste creation in Dar es Salaam, Nairobi, and Kampala is projected to increase by almost 60% by 2030 and by 74%, respectively, with the generation of waste in Dar es Salaam Nairobi, Kampala being 1.970, 0.845 and 1.150-kg/capital/day (Table 3).

### 2.2. Waste, disposal, treatment and collection

Waste management begins with proper collection. Several developing and underdeveloped nations only collect a small part of their waste due to a lack of vehicle capacity and other means. As a result, most waste goes to landfills and dumps, and some is even dumped into the ground or water (Figure 1) (Oyoo et al., 2014; Guerrero et al., 2013; Lederer et al., 2017).

Waste collection in the EAC is a major issue for local governments due to limited resources and vehicles. The EAC produces less rubbish than other emerging nations at 1.22-kilogrammes per person per day (Achankeng, 2003). The Dandora dump in Nairobi and the solitary municipal landfill in Kigali, Nyanza, are still operating despite being declared full in 2001 and 2013, respectively (Isugi & Niu, 2016).

Excessive waste disposal endangers human health and all land resources, including soil and water. Waste in excess is exposed to water and soil. This circumstance

Table 1. Comparison between different waste materials in both low income and high-income instances (Ntagisanimana et al., 2010)

Income level	Organic (%)	Paper (%)	Plastic (%)	Glass (%)	Metal (%)	Other (%)
Upper middle income	54	14	11	5	3	13
High income	28	31	11	7	6	17
Low income	64	5	8	3	3	17

Table 2. Characteristics of solid waste generated in East African major cities (Ntagisanimana et al., 2010)

Waste composition (%)	Dar es Salaam/Tanzania	Moshi/Tanzania	Kampala/Uganda	Kigali/Rwanda	Jinja/Uganda	Lira/Uganda	Nairobi/Kenya
Bio-waste	71	65	77.2	68	78.6	68.7	65
Paper	9	9	8.3	9	8	5.5	6
plastic	9	9	9.5	5	7.9	6.8	12
Glass	4	3	1.3	-	0.7	1.9	2
Metal	3	2	0.3	2	0.5	2.2	1
Others	4	12	3.4	15	4.3	14.9	14

endangers people's health and causes air, water, and climate change, which harms the ecosystem.

Waste minimization is the key to effective African trash management. Waste separation, sorting, and resource treatment using the circular economy can help manage resources. The EAC should know how efficient waste management benefits the community. The government should emphasize community well-being over crude oil.

Table 3. Solid municipal waste components produced by the majority of EAC (Ntagisanimana et al., 2010)

Generation of waste per capita (kg/cap/day)				
City	2015	2020	2025	2030
Dar es Salaam	1.615	1.759	1.861	1.970
Nairobi	0.687	1.032	1.089	1.150
Kampala	0.396	0.557	0.712	0.845

Many factors are taken into consideration when determining whether a nation is developed or underdeveloped, including the strength of the nation's currency, the standard of living, the reputation of its companies abroad, and the employment rate. Table 4 compares villages in East Africa, developed nations, and highly developed

nations. In contrast to developing and Underdeveloped countries, developed and highly developed nations compost and recycle far more. While paper and plastics are placed second in terms of municipal garbage, organic waste still tops the list in rich countries relative to EAC and developing nations. In comparison to developing nations, the use of open dumps that are prohibited and unapproved by the government is more prevalent in the EAC. Leading the charge in the circular economy race are developed nations like Denmark, Japan, the Netherlands, Scotland, Sweden, Belgium, and Germany, which all aim for recycling rates of 70% to 85%.

### 2.3. Evaluation method

The evaluation method used in this research paper is the Life Cycle Assessment (LCA) which is a model that assess the environmental impacts of products and services throughout their entire life cycle, from raw material extraction to disposal. Most of the waste generated in east Africa are organic. Excessive generation of bio-waste in East African Communities (Dar es Salaam, Moshi, Kampala, Kigali, Jinja, Lira, Nairobi) could contribute to increase in health risk due to carbon emission. The environmental impact can be reduced with the help of

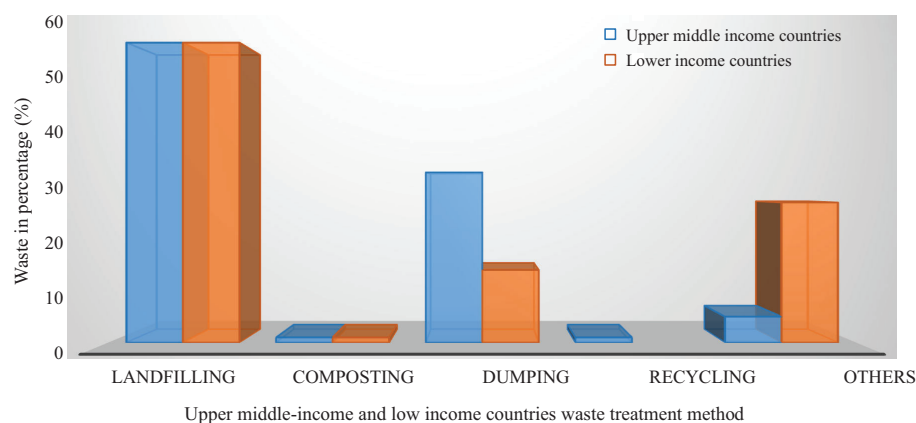


Figure 1. Waste management techniques used in lower middle-income and developing nations (Ntagisanimana et al., 2010)

circular economy by composting and improving the effective use of fertilizer.

#### 2.4. Steps involved in circular economy

- Reduce (Elimination of waste): in order to reduce waste, waste are collected prevent environmental health problems the collected waste are sorted into segments which are recyclable materials and not recyclable materials.
- Regeneration/Recycle: separate items that can be recycled (plastics, papers) from the total waste collected. Most of the resources we use in today's world are mostly recycled items, which also help in reduction of waste, increment in economic growth of a nation.
- Redesign & Reuse (Circulate products and materials): the recycled products are then taken to the

appropriate stage for redesign, retouch and are ready for reuse.

In East Africa communities, effective waste management is possible with the help of circular economy. This can be done with the help of the government and the citizen's involvement in the process of circular economy.

The concept of circular economy, as proposed by Stahel in 2016, aims to promote proper and effective waste management by encouraging people to reuse and recycle what they can, repair damaged items, and remanufacture those that cannot be repaired. However, due to low-income levels, poor awareness, and lack of government involvement, the practice of reuse, repair, and recycling in EAC cities is limited.

Figure 2 illustrates the circular economy process.

Table 4. Comparison between EAC and other developed countries (Ntagisanimana et al., 2010)

Economic status	Country	Waste composition (%)				Waste Management system (%)				References
		Organic	Papers and plastics	Glasses	Others	Landfill	Composting, recycling and Incineration	Open dumps	Others	
Developed and highly developing countries	Germany	30	37	10	23	0	100	0	0	Muhle et al. (2010), Pomberger et al. (2017)
	UK	38	25	7	27	57	39.7	0	0	Patrick (1985), Muhle et al. (2010), Wang et al. (2020)
	Belgium	35	38	5	22	0	100	0	0	Gentil (2013), Pomberger et al. (2017), Sharma and Jain (2020)
	China	58.8	20.5	5	15.7	63.7	36.3	0	0	Liu et al. (2017), Duan et al. (2020)
	India	51	17	–	32	93*	7	0	0	Malav et al. (2020)
	Italy	35	30	6	29	34	66	0	0	Ferraris et al. (2013), Pomberger et al. (2017), Ripa et al. (2017)
Developing countries	Bangladesh	74.5	12.6	0.8	12.1	86.5'	13.5	0	0	Shams et al. (2017), Islam and Moniruzzaman (2019), Alam and Qiao (2020)
	Algeria	64.6	26.4	2.8	6.2	0.2	2	96.8	1	Guermoud et al. (2009), Naima et al. (2012), Scarlet et al. (2015)
	Cameroon	70	16	4	10		5	95	0	Scarlat et al. (2015), Sotamenou et al. (2019)
	Niger	57	35	2	6	64*	4	–	32	Oumarou (2015), Scarlet et al. (2015)
	Thailand	65	27	–	8		11	–	–	Tuprakay et al. (2014)
	Bulgaria	64.3	16.5	4.4	15.8	74	26	0	0	Barata (2003), Inglezakis et al. (2012), Pomberger et al. (2017)
EAC countries	Kenya	65	18	2	15	75*	9	16	–	Henry et al. (2006), Gakungu et al. (2012), Waweru and Kanda (2012), Mugo et al. (2015), Palfreman (2015)
	Uganda	75	15	1	9	41*	8	51	–	Komakech et al. (2014), Yusuf et al. (2019)
	Rwanda	68	14	–	17	79*	10	11	0	Isugi and Niu (2016), Kabera and Nishimwe (2019)
	Tanzania	68	18	4	8	60*	10	30	–	Sharma and Jain (2020)
EAC countries	S. Sudan	35.5	33	4.5	27	–	–	100	–	Cowling (2013), Kasmiro Gasim (2019), Mohamed and Elhassan (2019)



Figure 2. Circular economy as shown in a picture (source: The Porto Protocol, 2020)

Figure 2 shows the stages and sub stages in achieving an effective circular economy process.

## Conclusions

This study has shown how waste are poorly managed in East African countries with most of their waste products being dumped in an illegal and open landfill, thrown into the river, some are left within the environment (car parks, market place, etc.).

Nevertheless, with the help of circular economy, waste can be properly managed (reduced), pollution can be reduced, and employment will increase. The government should put up a pilot program (create a plan, set a goal and provide knowledge to educate the people) to help educate and sensitize the communities about the principles circular economy and its benefits.

## Recommendations

Ways in which waste management can be better in East Africa:

**Reduce waste at the source:** Communities can reduce waste by using products that have minimal packaging and are designed to last longer. This can be achieved by encouraging businesses to adopt sustainable practices and by promoting eco-friendly behavior among individuals.

**Encourage reuse and repair:** Instead of throwing away items that are broken or no longer needed, communities can encourage people to repair and reuse them. This can be done through initiatives such as community repair workshops or by creating a market for second-hand goods.

**Implement recycling programs:** Recycling programs can be set up to collect and recycle materials such as paper, plastics, and metals. These materials can be processed and turned into new products, reducing the

need to extract new resources from the environment.

**Composting:** Food scraps and garden debris can be composted and applied as fertilizer to farms and gardens. This reduces the need for chemical fertilizers, which can harm the environment and human health.

**Energy recovery:** Incineration or gasification can create energy from non-recyclable or compostable waste. This reduces landfill garbage and generates green energy.

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#### APŽVALGINIS STRAIPSNIS APIE ATLIEKŲ TVARKYMĄ RYTŲ AFRIKOS BENDRUOMENĖSE PAGAL ŽIEDINĖS EKONOMIKOS PRINCIPUS

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**Santrauka.** Daugumą Rytų Afrikos atliekų sudaro kietosios organinės atliekos, popieriaus, plastiko ir stiklo šiukšlės. Tik nedidelė dalis Rytų Afrikos bendruomenės kietųjų atliekų yra tvarkoma ir kompostuojama, likusi dalis išmetama į an-

tisanitarinę sąvartyną, atvirą žemę arba netinkamose vietose. Tinkamas atliekų tvarkymas padeda paskatinti ekonomikos vystymąsi ir išvengti žalos aplinkai. Afrikoje netinkami atliekų tvarkymo metodai sukelia aplinkos ir sveikatos problemų – užteršiamos požeminio vandens poros. Šis tyrimas parodo, kaip žiedinės ekonomikos principai gali padėti tvarkyti atliekas Rytų Afrikoje ir jos regione. Beveik visos atliekos išsivysčiusiose ir labai išsivysčiusiose šalyse yra gerai surenkamos, rūšiuojamos ir tvarkomos. Rytų Afrikos bendruomenėms turėtų būti pritaikytas integruotas atliekų tvarkymo metodas (viena iš žiedinės ekonomikos ypatybių), kuris padėtų mažinti atliekų kiekius, užkirsti kelią žalingam netinkamo šiukšlių surinkimo poveikiui, daromam aplinkai ir žmonių sveikatai, atgauti vertingus produktus perdirbimui ir pakartotiniam naudojimui. Žiedinė ekonomika gali sumažinti, perdirbti ir pakartotinai panaudoti atliekas Rytų Afrikoje, suteikdama darbo galimybių ir apsaugodama bendruomenes nuo perteklinių atliekų.

**Reikšminiai žodžiai:** organinės šiukšlės, kompostuotos šiukšlės, antisanitariniai sąvartynai, atliekos, aplinka, šiukšlės, perdirbimas, pakartotinis naudojimas.