GAYO's Sustainable Community Waste Management Model: Impacts and Lessons For Circular Futures

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1 Introduction

Sub-Saharan Africa (SSA) is the fastest-urbanizing region in the world. The population of the region is increasing at an average rate of 2.7% per annum, causing many cities and towns to grow beyond their carrying capacities (OECD/FAO, 2016). As a result, city planners and authorities are unable to keep up with the rapid change and are faced with many governance challenges (Cobbinah et al., 2021; Erdiaw-Kwasie et al., 2020). Chief among these is improper waste management which is complicated by the unprecedented rates of waste generation and changing consumption patterns (Oduro-Appiah et al., 2019). This often results in environmental pollution, public health concerns and the degradation of

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ecosystems and their regulatory, provisioning and cultural services as lands and hydrological systems are turned into waste disposal sites (Cobbinah et al., 2021; Wantzen et al., 2019).

The case of Ghana is no different; waste generation volumes continue to increase and a sustainable method for final disposal has not yet been found (Debrah et al., 2022). The widespread model in many municipalities has been collecting waste from households and commercial areas with the assistance of waste management enterprises, both in the formal and informal sector, and disposing them in either designated or undesignated dumping sites (Kyere et al., 2019). For designated dumping sites, most are not engineered, neither are they properly controlled. Thus, they get full in no time and create a new chain of socio-ecological challenges, including public health exposure resulting from leachate runoff (Mudu et al., 2021). It is in view of these shortcomings that alternative waste management models, away from linear models like landfilling, have been proposed. One of these is the attempt to introduce the principles of circular economy into municipal waste management.

The adoption of the circular economy in waste management comes with many benefits. For instance, Gopinath (2020) reported that the implementation of circular economy in England led to an increase in recycling rates from 11.2% in 2000–2001 to 43.7% in 2016–2017. Potting et al. (2017) also reported that 93% of all waste generated in the Netherlands is processed for new uses with an estimated 79% of the quantity going into recycling. This, the authors attributed to the intensive application of circular economy principles in the country. Conlon et al. (2019) stated that implementation of circular economy creates an avenue for the creation of waste-based businesses which creates employment for local people. This is affirmed by Nkansah et al. (2015) whose research showed that incorporating scrap metals recycling into the manufacturing industry has the potential to create employment and subsequently reduce dependence on virgin materials for production.

City authorities in SSA are beginning to appreciate circularity, for instance, through composting and recycling with examples in Durban, Nairobi and Accra. Notwithstanding, such efforts have not made significant contribution to sustainable waste management regime (Grant, 2016). This is evidenced in how key stakeholders like waste collectors and waste pickers who are key in waste recovery, for instance, are not formerly recognized in the waste institutional framework (Oteng-Ababio et al., 2017). Moreover, earlier studies on municipal waste management and

circular economy focused on major cities which are often very complex (e.g. Mudu et al., 2021; Njoroge et al., 2014; Sakijege, 2019). This leaves a gap in peri-urban communities and presents the opportunity to test an improved waste management model in a location that is not as sophisticated, despite undergoing rapid urbanization, and to institute sustainable governance mechanisms before the area saturates.

Against this backdrop, the Green Africa Youth Organization (GAYO), a youth-led non-profit which works in environmental sustainability, proposed and piloted a circular economy waste management model, the Sustainable Community Waste Management (SCWM) model, in New Edubiase in 2018 (Ghana NPAP, 2022). The SCWM model was tested through a year-long project (Sustainable Community Project), to assess its contribution to sustainable waste management. The Sustainable Community Project envisions a sustainable community as a community where an incentive-based waste value chain is implemented for municipal solid waste management. The objectives of the project were to (1) enhance stakeholder collaboration and coordination in the waste management sector; (2) demonstrate and harness economic opportunities (green jobs) in sustainable waste management; (3) create an environmentally conscious society that practises sound waste management; and (4) promote zero-waste in the municipality. In this paper, we assess the SCWM model through a review of project reports and interview of project coordinators. Through this, impacts and lessons from the project are documented to inform replication of such sustainable waste management models in other communities in SSA. The findings presented are useful for planning and waste management governance.

2 Literature Review

2.1 Origins of Circular Economy Concept

Despite its present popularity in research and policy, disagreements remain over how circular economy should be defined. This could be traced to its diverse origins, having stemmed from disciplines like economics, ecology and environmental studies (Ekins et al., 2020). The concept of circular economy has gained popularity but is more debated among scholars in engineering and the sciences as well as organizational studies (Henrysson & Nuur, 2021). Governments; non-governmental organizations; national agencies; international organizations like the European

Union; industry players; and think tanks like the Ellen McArthur Foundation are increasingly championing circular economy in contemporary times (Kirchherr & van Santen, 2019).

A circular economy is defined as "a regenerative system in which resource input and waste, emissions, and energy leakage are minimized by slowing, closing, and narrowing material and energy loops" (Camilleri, 2019, p. 2). This can be achieved through long-lasting design, maintenance, repair, reuse, remanufacturing, refurbishing and recycling. This contrasts with the widely used linear economy model which is a "take-make-dispose of" model. The circular economy model has been proposed as a viable alternative and has been the subject of development debates since the mid-1900s when calls for environmental conservation started to gain momentum (Kreienkamp, 2019).

The concept has been deeply ingrained in the global development agenda: sustainable development goal 12 (sustainable consumption and production) (Conlon et al., 2019). Two key factors are paramount in transforming economies to become more circular: balanced utilization of resources and effective waste management (Smol et al., 2020). In that vein, the circular economy model aims at closing the product value chain at all phases of the product's life span and ultimately returns waste into the product value chain (Abad-Segura et al., 2021) Different aspects of these two factors relate to different stakeholders in the waste management sector such as governance institutions, producers, consumers, waste management service providers, researchers, innovators, the media, civil society organizations and more. Salmenperä et al. (2021) explain that dialogue between these multiplicities of stakeholders, resource and knowledge-sharing as well as the illustration of the economic benefits of circular economy are equally key to the successful implementation of the model. These key factors were inculcated into the SCWM model which was tested through the Sustainable Community Project in New Edubiase.

2.2 Circular Economy Adoption Across Regions

Literature on the adoption of the circular economy model in waste management has varied from region to region. For example, in Europe, Smol et al. (2020) opined that for the circular economy principles to be effectively incorporated into the water and wastewater sectors, the existing 4Rs (reduce, reuse, recycle, recover) needed to be extended to include "reclaim" and "rethink". The authors explained that the integration of

"reclaim" and "rethink" will ensure that all circular economy implementation in the wastewater sector will be more comprehensive, touching on the technological, organizational and societal aspects. In the production and waste management of tires through the circular economy model, Araujo-Morera et al. (2021) proposed the use of the 7Rs (reduce, reuse, recycle, redesign, renew, repair, recover). The authors expounded that for sustainable usage of the tires, they must be redesigned to reduce fuel consumption; pollutant emissions and maintain road safety. The authors also asserted that the tires ought to be manufactured from renewable sources (Russian dandelion and Guayule) to reduce the dependence on fossil fuels. The authors also proposed the reuse of alternative chemicals (fillers) in the manufacturing process whiles old and worn-out tires could be recovered and repaired for reuse. These measures will ensure that the components of the tires remain in the production cycle even after their lifespan has elapsed.

In Asia, Sri Lanka's approach to the implementation of circular economy in the waste management sector is through social entrepreneurship. For example, social enterprises in the country are empowered to upcycle discarded banana peels into waste fibres and other social enterprises also collect high-density polyethylene and low-density polyethylene plastics and upcycle them into plastic packaging materials, such as gunny bags, curtains and old sarees (Jayasinghe & Liyanage, 2018). In war-affected communities in the country, women receive second-hand clothing from the United Kingdom and redistribute them for reuse. This approach towards the adoption of circular economy principles in the country creates employment for women who are engaged in the reselling of these clothes. In so doing, materials initially considered waste are reintroduced into the production value chain. This helps to limit the amount of waste disposed into the environment (Conlon et al., 2019).

In the case of SSA, Buch et al. (2021) argued that inclusivity is key in the implementation of circular economy. This could be done through the establishment of cooperative organizations. The authors indicated that informal waste workers, such as waste collectors and waste pickers, play an important role in the waste value chain. They recover, refurbish, repair and reuse the waste in landfills to reduce the amount of waste discarded into the environment. Thus, they should be recognized by government institutions to incorporate them into the circular economy model. The authors explained that their recognition and integration into the formal

waste sector would help increase waste upcycling rates. In Uganda, Joshi et al. (2019) suggested a decentralized circular economy model of plastic waste management. The authors indicated that it is more cost-effective to patronize the services of waste pickers who sort through waste at dumpsites to recover sellable materials, including glass, plastic and metals in production. This approach is more efficient in many poor regions thus ensuring that disposal, collection, remanufacture and use of materials take place in the same community. In Tanzania, Aparcana (2017) also advocated for the inclusion of the informal sector due to their immense contribution to waste collection and disposal. In Kenya, the adoption of circular economy principles touched on the complete ban of deforestation for charcoal production and the recycling of organic waste, such as coconut husks, to make charcoal briquettes. This has helped reduce deforestation and generated employment in the production and sale of these briquettes (UNEP, 2019).

Ghana also adopted a renewable energy act (Act 843) which among others, has a goal to increase the renewable energy sources in the energy mix in the country to 10% by 2030 (GoG, 2019). This has incentivized many to explore the recycling of organic wastes like coconut husk and palm kernels into charcoal briquettes (Bonsu et al., 2020). Others also convert organic waste into compost, a practice which is gaining traction (Doe et al., 2023). Plastics are also recovered by waste pickers from landfill sites and sold to recycling companies through middlemen (Oduro-Appiah et al., 2019). These plastics are then recycled into products like chairs and bowls. Some are also upcycled into sustainable fashionable products like raincoats while old clothes are redesigned and resold on the market to prevent dumping in landfills (James & Kent, 2019). Scrap metals are recovered and either reused or repurposed for other functions, such as copper wires and iron rods (Nkansah et al., 2015). These various efforts are, however, sector specific and not well coordinated.

2.3 Towards Circular Economy Models in Sub-Saharan Africa

Many circular economy models have been proposed over the years. There have been decision-making support models (e.g. Ghinea & Gavrilescu, 2010; Karmperis et al., 2013), life cycle assessment models (e.g. Gentil et al., 2010; Kulczycka et al., 2015; Winkler & Bilitewski, 2007), input–output models (e.g. Towa et al., 2020), cost–benefit models (e.g. Di Foggia & Beccarello, 2020) and others have been integrated approaches

(e.g. Shamshiry et al., 2011). Most of these models have proven to be quite effective, however, they were proposed for the Global North. As a result, they may not fit the SSA context since there are geographic differences and waste compositions and volumes also differ. In developed countries, for instance, paper and cardboard make up the greatest percentage of waste (Karim & Wetterhan, 2020) but in SSA, organic waste forms the greatest component in the waste stream (Adu-Boahen et al., 2014). This suggests that a working waste management model has to be tailor-made for SSA cities.

In addition, circular economy initiatives in SSA have often been overly centralized, with workers in the informal sector poorly engaged and remunerated despite their immense contribution to waste collection and recycling (Oduro-Appiah et al., 2019). This is why Joshi et al. (2019) call for a decentralization of the waste management regime in SSA. Ghana National Plastic Action Partnership (Ghana NPAP, 2022) also advocates for effective collaboration between all stakeholders to promote good governance, behaviour change, innovation and resource mobilization for addressing plastic pollution in Ghana.

In Ghana, the Informal Service Chain model and the Extended Producer Responsibility framework were proposed by Oduro-Appiah et al. (2019) and Quartey et al. (2015), respectively. Despite the novelty of these models, they place emphasis on individual actors in the waste management sector, such as waste collectors or city planners. However, managing municipal waste in a sustainable way requires a careful consideration of the different actors and stakeholders in the waste management sector, their functions, their interrelations and how their roles coalesce in decision-making (Durán & Messina, 2019). Waste management touches on economy and ecology, and thus it is plausible that all relevant stakeholders are involved in its planning and operationalization.

3 Materials and Methods

3.1 The Sustainable Community Waste Management Model

The SCWM model adopts a comprehensive and systems approach to waste management (Fig. 1). It is premised on the argument that sound municipal waste management cannot be achieved without inclusive and active stakeholder and citizen involvement. While stakeholders often have decision-making powers, improving citizens' knowledge on waste

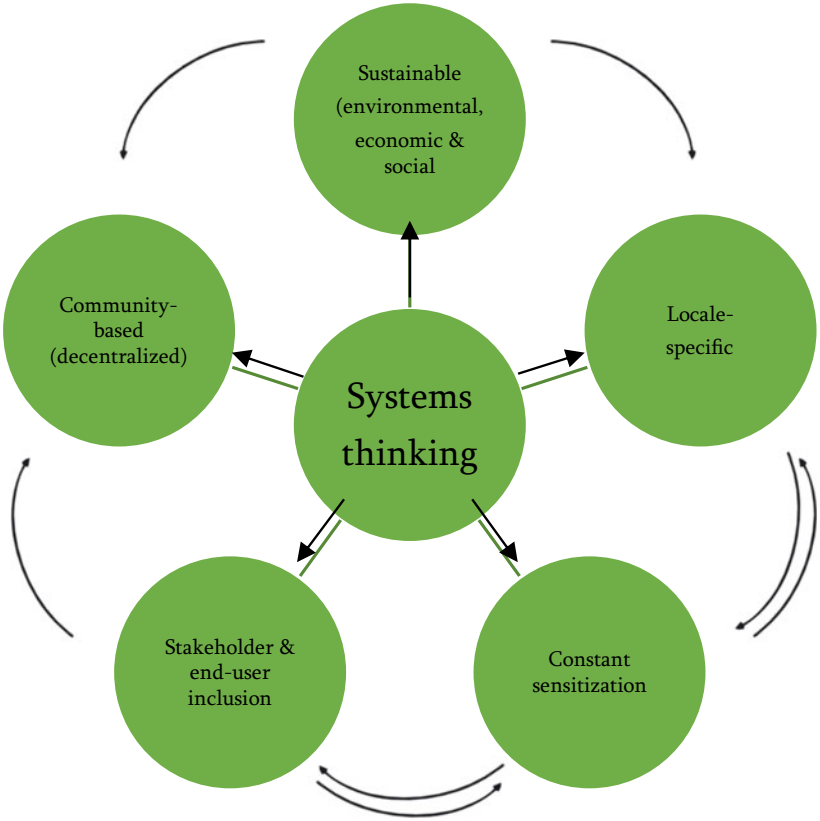

Fig. 1 Sustainable Community Waste Management framework

and the environment also promotes greater community responsibility in environmental conservation and helps make implemented interventions sustainable over the long term.

Sustainable municipal waste management is complex, traversing multiple sectors, including environmental management, health, disaster reduction and employment among others with the various stakeholders in these sectors. Systems thinking presents an approach for viewing these multiplicities of sectors and stakeholders, including end-users, and the interactions between them collectively rather than as individual parts.

This has been one of the main gaps in earlier circular economy waste management models.

The SCWM model is anchored on systems thinking, which is expected to promote sustainable waste management, providing optimized benefits for nature such as biodiversity conservation, society such as improved human health and economy such as employment and income. This may include promoting waste recovery and recycling. The sustainable waste management advanced must also be tailor-designed for the community in which it is implemented, considering the specific conditions in the community, such as the waste composition and which products could be recycled from them.

The model depends greatly on constant sensitization and engagement of both top-level stakeholders and citizens at the community level. This is expected to promote inclusivity of stakeholders from all levels and all sectors in waste management discourses, decision-making platforms and in dialogues. In practice, promoting inclusivity may include ensuring that economically vulnerable groups such as people with low skills, waste collectors and waste pickers, who are dependent on waste for their livelihoods are formally recognized, included and given room to operate in the waste management sector. This also includes ensuring that those who operate in the waste management sector, especially informal workers, are not exploited and promote their well-being. Additionally, it helps obtain feedback useful for promoting sound waste management as well as improving the knowledge of locals apart from ensuring that the waste management is not top-down.

3.2 Case Site Description: New Edubiase

New Edubiase is the capital of the Adansi South District in the Ashanti Region of Ghana (Fig. 2). The community has a total population of about 20,000 people, with the majority being youthful. Most residents of the town are employed in the agricultural sector and cultivate food crops like tubers and vegetables and cash crops like cocoa. A significant number of the populace are also employed in the services sector. New Edubiase also falls within the rainforest zone of Ghana and as such is characterized by semi-deciduous forests and thick vegetation. Notwithstanding, there has been significant land use change and little virgin forests remain outside the forest reserves in the outskirts of the town.

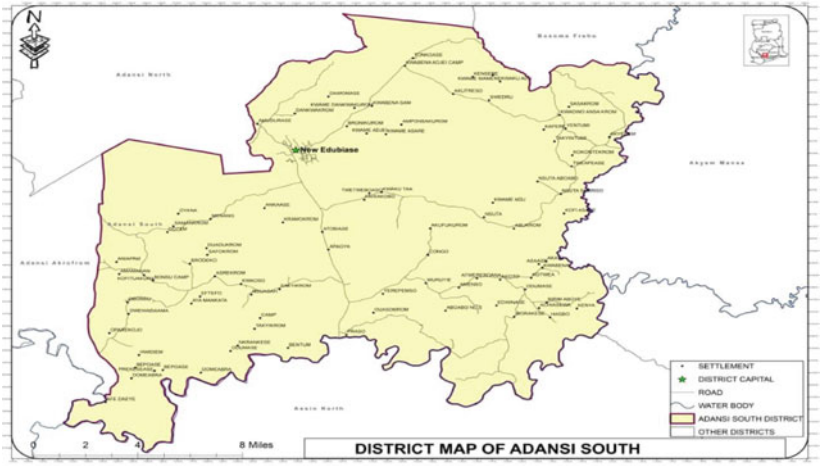

Fig. 2 Map of districts in Ashanti Region indicating the location of Adansi South District

The justification for choosing New Edubiase is that the town is one of the rapidly urbanizing areas in the Ashanti Region of Ghana and exhibits many of the characteristics of the average communities in Ghana. The town has been one of the communities sorely saddled with waste management challenges. It is asserted that only 1.6% of household wastes are properly collected and 61.8% of residents disposed of their solid and liquid waste through open space dumping, including into rivers and streams (ASD, 2014). A significant percentage also engages in open burning. While these practices lead to environmental pollution and ecosystem degradation, they also pose a multiplicity of health hazards such as high exposure to respiratory ailments and hygiene-related diseases like diarrhoea and cholera (Addo et al., 2017). A waste composition analysis was conducted prior to the implementation of the Sustainable Community Project which revealed that organic waste (44%) forms the greatest percentage of wastes in New Edubiase (Fig. 3).

3.3 Data Sources and Collection

A cross-sectional study design was adopted. Primary data was collected from project coordinators through interviews while secondary data was

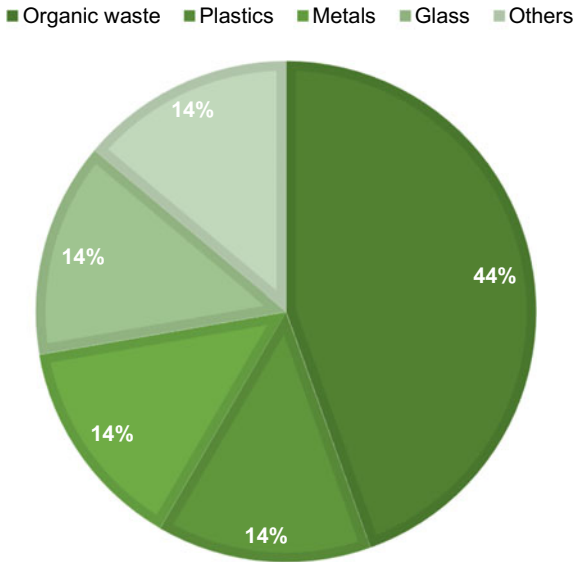

Fig. 3 Waste composition of New Edubiase before project implementation in 2018 (*Source* SCP Edubiase Final report)

obtained from project reports. The interviews were conducted virtually between April 25 and June 31, 2021. The collection of primary data was limited to project coordinators because some of the project reports were already prepared with the help of resident surveys. This way, the interviews conducted for this study helped to validate some of the results in the project reports as well as ask emerging curious questions. The sampling approach adopted then was purposive. Six project coordinators were interviewed in all in the English language.

3.4 Data Analysis

The interviews were analysed using the narrative analysis method according to Stuckey (2014)'s three-tier qualitative data analysis processes. A few key quotes from respondents were used as evidences to buttress some points that emerged. The data entry and processing were done in Microsoft Excel.

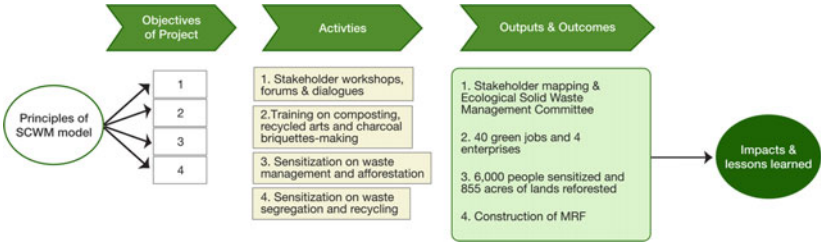

Fig. 4 Theory of change analytical framework

The theory of change framework was also used, as an evaluative framework, to assess the impact of the Sustainable Community Project, which was implemented from January to December 2018. The theory of change underlies most community-based projects either implicitly or explicitly. According to Morra-Imas et al. (2009), the theory of change is useful in that it helps in building "a commonly understood vision of the long-term goals, how they will be reached, and what will be used to measure progress along the way". By feeding the model with quantitative and qualitative data, the model helps to measure the results of an intervention against the baseline conditions that were initially encountered.

Since the SCWM model was tested through the Sustainable Community Project, the theory of change enabled us to show the link between the inputs, activities, outputs and outcomes of the project (Fig. 4). This helped to show the resulting impacts made from the project and consequently, the usefulness and potential of the SCWM model. The results were presented with a discussion of the four objectives of the Sustainable Community Project, including what was done under each, the outcomes and impacts achieved and the challenges and gaps that remain.

3.5 Study Limitation

The study's main limitations were that many of the outcomes of the SCWM model implemented through the Sustainable Community Project were not statistically tested to fully understand the full benefits and disbenefits, if any, of the model. This was because of limited financial and human resources. Nonetheless, this review has offered insights into how a circular economy model adopting a systems thinking approach can be useful for sustainable municipal waste management.

4 Results and Discussions

4.1 Enhancement of Stakeholder Collaboration and Coordination

Many stakeholders are involved in municipal waste management, and each have their interests and functions. There are those with regulatory functions, such as government agencies; those with profit orientations such as producers and businesses; those with functions in the waste collection and recycling phase such as waste service providers and recycling companies; and those who are not-for-profit like non-governmental organizations and community-based organizations. Waste management may also have strong linkages with spatial planning (Cobbinah, 2017), environmental protection, water governance (Wantzen et al., 2019), employment among others (Bai et al., 2017). This underscores why it is necessary to bring all these different stakeholders together to work hand in glove to promote sustainable municipal waste management.

As a first step to piloting of the SCWM model in New Edubiase, a stakeholder mapping was done to identify who the main actors in the waste management regime in the town are and to develop strategies for engaging them. The local government administration, Adansi South Municipal Assembly, were the first to be contacted through writing which was followed up with in-person visits. They were first to be contacted because they have the legal mandate to manage communities under their jurisdiction, including New Edubiase, and they are recognized by the local people and have their trust (Musah-Surugu et al., 2019). Contacts were established with the Environmental Health and Development Planning departments as well as assembly members in the municipality who represent various electoral areas. Through a snowball approach, other stakeholders were identified, including traditional authorities and local waste management enterprises from both the formal and informal sectors. Table 1 details all stakeholders who were identified and engaged and their mandated functions. The exercise also helped to understand each stakeholder's interests and level of influence which helped to determine how each should be strategically engaged.

By rallying these multiplicities of stakeholders, including residents, around a common vision of promoting sustainable municipal waste management, it optimized the waste management regime in New Edubiase, with each stakeholder playing their distinct functions within the framework of the SCWM model. The Ecological Solid Waste Management Committee established which was made up of officers from the local

Table 1 List of stakeholders engaged in the project and their functions

Stakeholder	*Nature of role*	*Function*
Adansi South District	Planning/ regulatory	They have political and administrative authority under the 1993 Local Government Act 462 to lead planning and development in the district
Traditional authorities	Regulatory	They are customary institutions whose key function is promoting the welfare of their community members
Assembly members	Planning	They are elected officials who act as the link between communities and the local government administration, advocating for development
Informal waste workers	Waste collection	They are made up of individuals or small enterprises who use small or low-technology equipment, often engaging in waste collection, sorting, trading and even processing
Zoomlion Limited	Waste collection	Zoomlion is a waste management company in Ghana focusing on waste collection, environmental sanitation and more recently, waste recycling
Market leaders	Waste generation	They are vendors in the marketplace who have been selected by their peers to be leaders to coordinate their activities, often relating to the specific goods they trade in and represent their interests in forums
Households	Waste generation	Households comprise of one or several persons living within the same dwelling

government administration as well as traditional leaders, formulated by-laws for governing waste management practices in the town. This also helped to promote sound waste management practices.

Despite their different vested interests and varying powers, understanding of the benefits of the SCWM model such as the prospects of green jobs, incomes and other socio-economic benefits were key incentives that won stakeholders' cooperation. This helped to show that advancing waste management in an inclusive and systems way is likely to help achieve a sustainable municipal waste management regime. On another hand, promoting inclusion in waste management will also help to promote the interest of informal waste workers who often work in poor conditions, are abused and cheated (Oduro-Appiah et al., 2019). Studies have shown that ultimately, this promotes social cohesion and has positive implications for addressing crime and insecurity as people earn a decent living (Sembiring & Nitivattananon, 2010).

Due to their key position and powers as the development and spatial planning lead in New Edubiase, the Adansi South Municipal Assembly was expected to take a leading role among the stakeholders. The Local Government Act 462 of 1993 states that waste municipal assemblies are responsible for the management of all waste generated in each district. However, it was challenging getting departments like the Environmental Health and Development Planning to take the leading role as expected despite many efforts. The factors accounting for this were many. The national building regulation of Ghana, LI 1630 of 1996, states that "A building for residential, commercial, industrial, civic or cultural use shall have a facility for refuse disposal, a standardized dustbin, and other receptacles approved by the assembly in which all the waste generated shall be stored pending final collection by the trucks to final disposal site" (GAYO, 2021, p. 13). This policy evidences the linear model (landfilling) in waste management in Ghana which informs the development of the Municipal Medium Term Development Plan for most municipalities. In this sense, the piloting of the SCWM model became a conflict to the policy orientation of the assembly, which impacted the commitment of officers to the smooth implementation of the model.

There were also some scepticisms over the green job prospects available in the waste management sector. Although this was communicated with examples implemented in other regions at several forums from the onset of the project, it was not until the materials recovery facility (MRF) (Fig. 5) was constructed and the trainings begun that these outputs like the recycled products, including plastics backpacks and raincoats, could be seen. Thus, some stakeholders were not always high on enthusiasm, especially with their respective functions to attend to, which affected the project timeline. Green jobs were a key incentive in the project, beginning with the construction of the MRF. Even though it took time engaging traditional authorities and some assembly members to secure a piece of land for the MRF, it would have been better for the project if it was delivered early on. This implies that as important as communication is, it is not enough to maintain enthusiasm, especially when advancing a waste management model that goes against the status quo. Thus, in any future replication of the SCWM model, it will be plausible for outputs like the MRF and other green jobs and products to be delivered early on for stakeholder buy-in and cooperation.

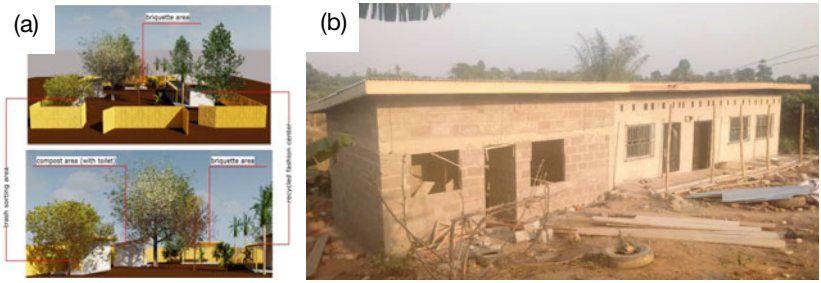

Fig. 5 Materials recovery facility **a** Plan. **b** During construction

4.2 Economic Opportunities in Sustainable Waste Management

By piloting the SCWM model, the economic potential in waste recycling was demonstrated. Under linear waste management models, economic opportunities largely exist in providing waste management services like waste collection and disposal. However, a circular economy model optimizes these and opens an array more in waste recovery, sorting and recycling.

In New Edubiase, informal waste collectors were trained to enhance their work while others were trained in waste sorting and recycling. Regarding recycling, some were trained in the recycling of plastic waste into products like backpacks, handbags, raincoats, curtains, aprons and other recycled arts products. Compost was also made from organic waste. Some of this compost was tested on vegetable farms near the MRF. The compost production received great welcome due to its potential usefulness for residents, majority of whom are farmers. The construction of the MRF also helped in changing perceptions around waste, including perceiving them as resources that can be used to make other useful products. For instance, the conversion of organic waste into compost impressed farmers in the community who find the cost of agrochemicals too expensive.

> *Some people cannot afford the government compost, so they find the compost to be very good for them, which is why we are increasing it [the production] since the project officially ended.* [Sustainable Community Project Coordinator, New Edubiase]

Some organic wastes were also used to make fuel briquettes for domestic use. Over the project duration, 500 kg of compost were produced while 20 tonnes of plastic sachet waste were recycled which were sold at an exhibition (Fig. 6a), raising GHC38,970 in revenue.

The project also had an output on green enterprise development. As part of this, there was financial literacy, sales and marketing training which were undertaken to help green entrepreneurs connect better to the markets and maximize profits. As a result, employment avenues were created, and four individuals were provided capital and technical support to start their own green business enterprises. The impact made in the enterprise development efforts were mainly providing employment avenues for individuals. In all, 40 people (26 females and 14 males) directly received employment through the project (Table 2). These beneficiaries were able to make income, including the project implementers successfully securing a €1000 deal for the delivery of over 100 pieces of recycled arts products to be sold at the Christmas Market in Köln,

Fig. 6 Recycled arts products **a** During launch and exhibition. **b** During sale at the Christmas Market in Köln, Germany

Table 2 Breakdown of direct green jobs created

	Male	*Female*
Briquette-making		6
Recycled arts	2	15
Compost-making	8	5
Project support	3	1
Total	13	27

Source SCP Edubiase Final report

Germany (Fig. 6b). The development of green business enterprises and training organized for waste workers also helped to erode some of the negative perceptions that cloud their activities such as waste work not being a decent livelihood, having poor remuneration and with people in the sector not having dignity (Coletto & Bisschop, 2017) since many community members expressed interest in enrolling in the training on making products from plastic waste, more than the project had capacity to host.

> *Before we completed the MRF, many parents and some of the stakeholders had already submitted names of their wards they wanted us to train to make the bags and aprons from the sachet waste, even though we couldn't train all of them at once. This was surprising because before, not many people wanted to work with the waste, even with Zoomlion.* [Sustainable Community Project Coordinator, New Edubiase]

Regarding gaps, although the compost yielded very positive outcomes when tested in vegetable gardens on the MRF, it needs to be taken through laboratory testing and certification is needed from the Ministry of Food and Agriculture, Ghana, before it can be made available to farmers on commercial basis despite their eagerness to use it. The project had focused only on making fuel briquettes and compost from organic waste. However, this can be expanded as organic waste can also be used to make animal feed for poultry farming (Truong et al., 2019) or used as biogas to produce energy (Atelge et al., 2020). In addition, recycled arts products like backpacks, raincoats and aprons were welcomed by the community during the exhibition; however, a market analysis is needed to understand its acceptability and to guide its uptake as a sustainable business. Furthermore, individuals trained in enterprise development within

the waste value chain will need a lot of support by way of technical and financial services. This can be provided by enhancing collaboration with the Ghana Enterprises Agency (formerly known as National Board for Small-Scale Industries) which has decentralized offices in districts across Ghana.

4.3 Promotion of Sound Waste Management Practices

A key part of the Sustainable Community Project in New Edubiase was residents' sensitization on waste and the environment and proper waste disposal practices. Since the project hinged on community members' ability and willingness to segregate wastes at the source and properly dispose of them, intensive house-to-house awareness-raising campaigns and school and media campaigns were embarked on. After a series of sessions, waste bins were distributed to households and a dry run was tested. Four people were engaged in the community waste management education over the duration of the project. Six thousand people from over 1300 households were sensitized on proper waste management practices and environmental conservation. This was independent of the periodic radio and school outreaches. As outcomes, these efforts helped to significantly reduce waste volumes sent to landfills and the improper disposal of wastes on lands and into hydrological systems (Fig. 7).

> *At first, sights of heaps of waste in public spaces and the markets were very common but they are rare now. This has been one of the most visible impacts of the project*. [Programmes Manager, GAYO]

While most project outputs were implemented in a few weeks or months, the sensitization efforts lasted for about 7 months over the project duration, which the project's progression is significantly attributed to. Through the sensitization efforts and the collaborative work of the Ecological Solid Waste Management Committee, open burning was significantly curtailed while activities that pollute the environment, such as dumping of refuse into streams, were also reduced. This was because citizens became more environmentally aware, and more people behaved in a pro-environmental way which is important for the long-term sustainability of the project outcomes. Other studies by Alipour et al. (2015) using the case of Iran and Debrah et al. (2021) in a review of waste management in developing countries made similar conclusions and advocated

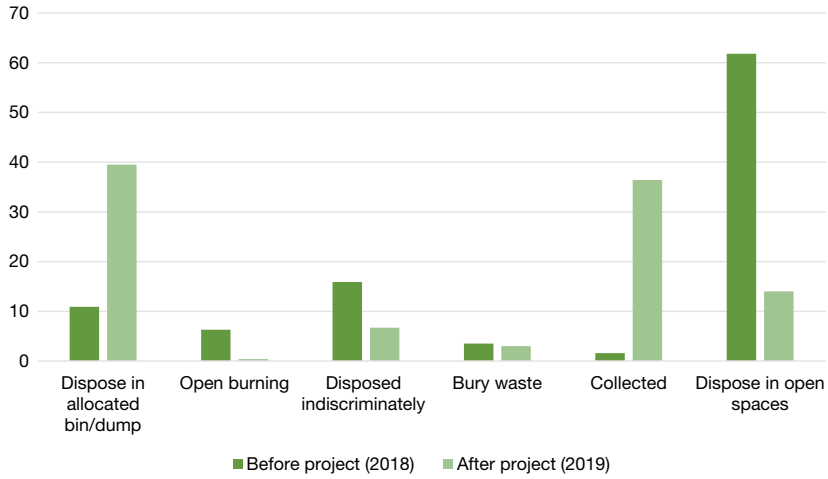

Fig. 7 Waste disposal practices (*Source* SCP Edubiase Final report)

for waste management and environmental education to be included in school curriculums. This notwithstanding, appropriate policy formulation and law enforcement are equally key to fostering and maintaining pro-environmental behavioural change in any community. The work of the Ecological Solid Waste Management Committee had helped to develop byelaws to guide waste management but enforcement was greatly missing due to human resources constraints.

In addition, some degraded forests were reforested. In all, about 855 acres of lands were reforested and planted over the duration of the project. These helped regulate the climate in the community and improve thermal comfort, conserve and foster biodiversity, improve air quality and increase the carbon sinks in the face of the global climate crisis. However, quantitative studies will need to be conducted to deduce the specific impact by way of ecosystem services delivery of these restored forests.

4.4 Promotion of Zero-Waste

In zero-waste, "We aim to send nothing to a landfill. We reduce what we need, reuse as much as we can, send little to be recycled, and compost what we cannot" (GAYO, 2021, p. 17). In the Sustainable Community

Project, zero-waste was primarily advanced through waste segregation at source and recycling. Several authors have demonstrated that most municipal solid wastes in Ghana are organics (e.g. Miezah et al., 2015; Richard et al., 2021; Seshie et al., 2020). With 67.4% of households depending on wood-based fuels as a source of energy (Bawakyillenuo et al., 2021) and 44.7% of people also engaged in agriculture (ILO, 2020), there is opportunity to advance the recycling of organic wastes into fuel briquettes and compost, respectively. Plastics, being one of the major waste components, are also recycled into recycled arts products such as raincoats and bags (GAYO, 2021).

Waste segregation at source, which was not widely practised at the time of the project onset, was introduced in New Edubiase which made recycling efforts more effective (Fig. 8). Several residents now practice waste segregation which helps enhance waste collection and recycling, which hitherto was little known in New Edubiase. These efforts also helped to improve waste collection since waste was better disposed of and waste workers had been trained on how best to go about their activities.

A major project output was the construction of the MRF. A 2-acre piece of land was procured with the assistance of the traditional authorities and some assembly members for the project. Arrangements were then

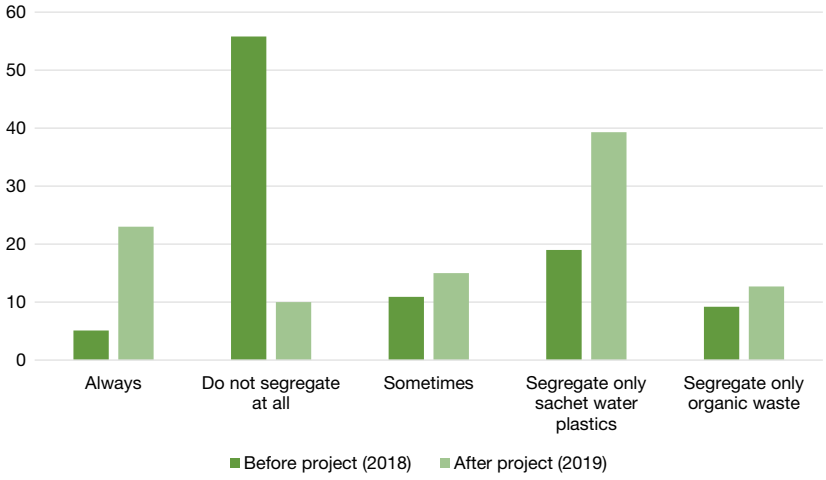

Fig. 8 Waste segregation practices (*Source* SCP Edubiase Final report)

made with some households and market women to divert their waste to the MRF rather than to landfills. The MRF had the capacity to take and process about 2 tonnes of waste each week which is why the volume of waste diverted there had to be controlled. At the facility, there were separate spaces for the processing of different wastes, be it organic or plastic. The MRF became an innovation hub for the project showing the usefulness of wastes and creating employment avenues for informal waste workers together with unemployed youth and women who were trained to recycle waste into various green products.

Despite the potential of fuel briquettes, such as helping to reduce deforestation, having better heat value and being healthy for use since they emit minimal smoke, residents were not as enthusiastic about them as they are about the compost. This needs to be studied to understand how their acceptability can be improved as better alternatives to traditional charcoal and firewood. Education on the dangers of firewood through smoke emissions also needs to be increased.

In addition, the MRF was sited quite distantly (about 6 km) from the central areas of the town as it was difficult to secure land near the town centre. Although it is plausible to have waste disposal sites in the outskirts of communities, the nature of the MRF not posing the health dangers landfills may pose and being an innovation and recycling hub also implies that it is better to have it close by so that recycled products are readily available to the market. Thus, the remote location increased the cost of transporting wastes to the MRF. This defeated the benefit of keeping waste management decentralized so that wastes are managed, included sorting and recycling, at the community level rather than kilometres away so costs are kept minimal as well as for local people to exploit the opportunities available. Also, the MRF was not easily visible to stakeholders and community members which meant that the project team had to put in extra effort to communicate the project's outputs. Perhaps, if the MRF was located close enough to the busy areas of the town, it would have helped to gain even higher cooperation from the community since evidence of the benefits of the project could easily be seen.

In the Sustainable Community Project, waste reduction was not explored as a key output as part of advancing zero-waste. However, there is opportunity to cut down on single-use food and drink containers, reuse old clothing as done in Sri Lanka and replacing especially plastic packaging with reusable bags (Conlon et al., 2019). In a broader sense,

this requires policy re-orientation at the national level such as a ban on single-use plastics.

5 Conclusions and Lessons Learned

This study was advanced to review a circular economy model, the SCWM model, which was piloted in a project dubbed the Sustainable Community Project in New Edubiase, Ghana. The model was developed to enhance stakeholder collaboration in the waste management sector, demonstrate the economic opportunities in sustainable waste management, foster sound waste management practices and promote zero-waste.

From the review, we note that factors such as inclusiveness of both stakeholders and the community as end-users as well as intensive sensitization, which were key principles of the SCWM model, helped in raising environmentally conscious residents and promoting sound waste management practices. We also make the conclusion that despite the importance of communication, delivering visible and tangible outcomes of zero-waste such as green jobs and products early on help to maintain stakeholder enthusiasm and support. This is critical as the status quo of the waste management regime does not directly support zero-waste and as such that promise of better need to be evidenced early on. The economic opportunities in zero-waste such as waste sorting and recycling plastics into bags, curtains and aprons and organic waste into compost and fuel briquette help to change negative perceptions around work in the waste sector.

Specific lessons learned include the following:

1. Advancing a circular economy waste management model at the local level in Ghana is challenging because it contradicts the present linear model which relies on disposing wastes in landfills. However, adopting a systems approach and promoting inclusivity as was done in the SCWM model in New Edubiase helps to obtain stakeholder buy-in and cooperation. This helps to leverage on the expertise and resources of stakeholders, including district assemblies, assembly members, traditional authorities, formal/informal waste workers, the media, residents, among others to promote circular economy.
2. Even so, delivering key benefits of circular economy such as the green job prospects available in waste collection, sorting and recycling early on helps to give more impetus for the adoption of models

like the SCWM model and to maintain stakeholder interest and cooperation. In this sense, green jobs available in circular economy are key incentives for stakeholders and residents and the earlier they are produced, the better.

3. A circular economy waste management model, even the SCWM model, works best when it can be modified to suit each distinct locale. This is because waste compositions may differ from place to place and as such the same interventions may not be applicable for every community.
4. While waste such as plastics and organics can be recycled into various products like backpacks and compost, respectively, deciding on which ones to invest in a circular economy model ought to be informed not only by the municipal waste composition but also by which products will likely be in demand. In the case of New Edubiase for instance, the charcoal briquettes produced under the SCWM model were not as well received by the community as the compost.
5. A municipal waste management model that is sustainable ought to factor in urban environmental change and population growth especially in the city or town's context in the planning processes. This will help in the siting and allocation of enough space for the collection and transportation of waste and the development of infrastructure such as MRFs. In the experience of New Edubiase during the piloting of the SCWM model, the MRF had to be sited 6 km away from the town centre as the urban plan had not made provision for handling waste management.
6. Decentralizing municipal waste management and allowing local stakeholders to play active roles helps make waste management more effective and enable local people to harness the opportunities available in circular economy. Notwithstanding, having the support of central government, such as in instituting legislations like banning single-use plastics, can help make implementation at the local level easier.

Future research can focus on undertaking quantitative studies to fully understand the benefits of some of the outcomes of circular economy models like the SCWM model such as the tonnage of waste reduced that would have otherwise ended up in landfills and the associated cost savings

as well as forests conserved because of the use of charcoal briquettes recycled from organic waste rather than traditional charcoal produced through deforestation and associated ecosystem services. Accessing the acceptability of recycled products such as fuel briquettes, compost and recycled arts products like bags, aprons, curtains and raincoats through surveys can also be studied. Furthermore, future research can explore the feasibility and cost–benefit analysis of reducing single-use plastics, including for packaging.

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