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Chapter

Green Supply Chain in Solid Waste Management: Case Study of EcoCare H2H Waste Collection, Goaso, Ghana

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Abstract

Today, Green supply chain management (GSCM) has become a multidisciplinary concept by constructing environmental management practices in the context of various supply chains including waste management services. Environmental issues have become an important integration into the supply chain management, so that each step from organization's materials management and transportation functions to the end customer can be structured to include environmental awareness. The authors analyze the levels of application of GSCM in waste management value chain of Ghana and use our house-to-house waste collection model as case. Review of the social, environmental and economic impacts made by waste EcoCare and other solid waste management companies that incorporate circularity – at least a recovery and recycling channel at some point – into their service shows are setting a pace for understanding, adoption and replication of green supply chain management (GSCM) into waste management in the country. The authors recommend that private-public-partnerships for waste management in Goaso and other cities would be greener if they replicated the circular economy model implemented by EcoCare Waste Initiative and its H2H Waste Collection model.

Keywords: supply chain, environment, circular economy, sustainability, solid wastes, EcoCare, TBL, sanitation

1. Introduction

In recent years, the value that society places on reducing greenhouse gas (GHG) emissions and better stewardship of soil, water and wildlife is leading to consumer demand for climate-friendly production methods and supply chain. In addition there has become a greater level of the world's appreciation of the impact of climate change and environmental sustainability. There is also society's general consciousness of personal and public health in relation to products that they use. And then there is an increase awareness of the Sustainable Development Goals (SDGs) especially the SDG12 – sustainable consumption and production. Day in and out people are becoming more concern of environmental issues, consumers thus ask a lot of questions these days about the authenticity of products that they buy.

And we question how green producers manufacturing processes are, how big their carbon footprints are and how they recycle [1]. Various supply activities can have a significant threat to the environment. These threats vary but in terms of carbon monoxide emissions, discarded packaging materials, scrapped toxic materials, traffic congestion and other forms of industrial pollution [2, 3].

This means that we are heading towards a near future where, people are becoming so conscious of their health and the ecology that, if your production or ecological service does not have anything to do with protection of the earth's resource, along its supply chain, you will not survive on both international and local markets. Undoubtedly, across all sectors of the economy, we see that companies are being influence to reformulate their environmental and supply chain models due to increases in environmental problems caused by products. Therefore, the requirement to extend companies' environmental activities to include the whole supply chain has been instrumental in the concept of green supply chain management (GSCM) [4]. It is therefore, reasonable to say that the requirement to extend companies' environmental activities to include the whole supply chain has been driving force of the development of the GSCM concept.

Green supply chain management is basically the integration of environmental thinking into various supply chain management (SCM) models. In the broader sense, GSCM can be considered an environmental innovation [2]. This is because, it's ultimate goal is to eliminate wastages including hazardous chemical, emissions, energy and solid waste along supply chain such as product design, material resourcing and selection, manufacturing process, delivery of final product and end-of-life management of the product [5, 6]. Also, because GSCM has become a multidisciplinary concept by constructing environmental management practices in the context of various supply chains [7], whether they directly provided environmental services or not. And finally, because GSCM plays a vital role in influencing the total environment impact of any firm involved in supply chain activities and thus contributing to sustainability performance enhancement [2]. Therefore, with the environmental issues becoming an integral part of the supply chain management concept, we see the context being extended so that each step from organization's materials management and transportation functions to the end customer can be structured to include environmental awareness [8].

It is against this backdrop that green supply chain becomes very important when designing environmental impact initiatives especially within environment organization such as waste management companies, or any social enterprise that works at the national, regional or community level to impact the triple bottom line from a green economy context. And this disposition spurs the authors of this chapter to do a review of literature in relation to the theme while reflecting on their work on waste, at their organizational level, to establish or reestablish the gains in waste value chains to inform policy makers to rethink the current waste management practices to accelerate the socioeconomic development of the country.

This chapter therefore, analyses the waste management services as key green initiatives in Ghana; siting the case of how EcoCare Waste Initiative an environmental startup in Goaso, Ghana, achieves green supply chain in its attempt to offer community waste collection service, the lessons that could be drawn.

2. Problems associated with unhealthy environments

It is noted that poor water, sanitation and hygiene, and indoor air pollution from burning wood for cooking and heating were as well as unconventional burning of wastes have been the cause of pneumonia and other common environmental related disease over and over again. In order to prevent these diseases, the environment

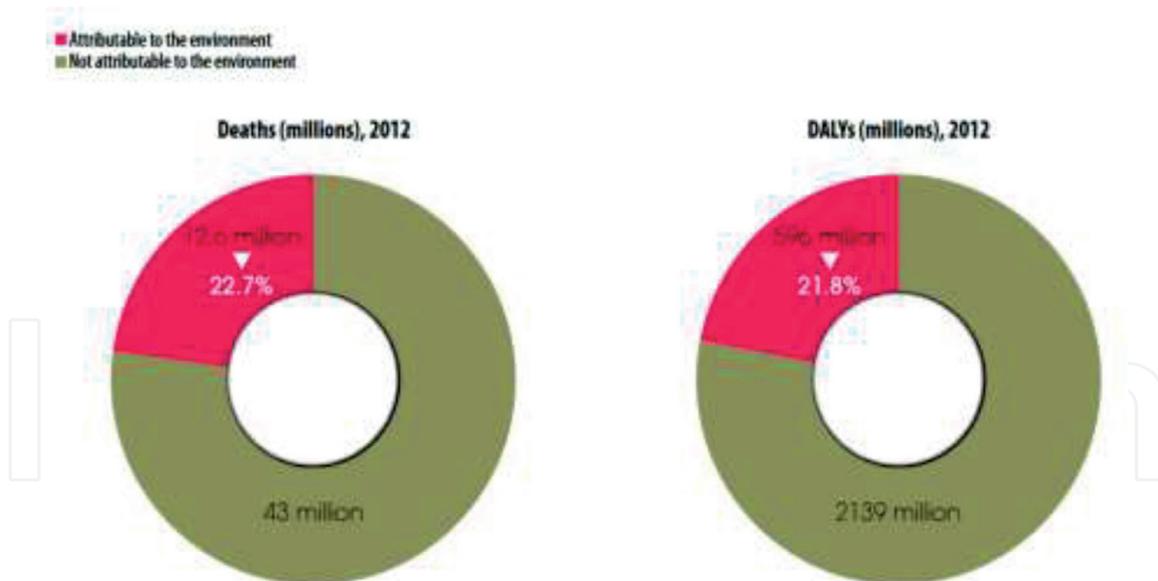


Figure 1.
Imagery illustration of the global deaths attributed to environmental factors (adopted from [10]).

needed to change [9]. The World Health Organization (WHO) estimates that, 24% of all global deaths – roughly 13.7 million deaths a year – are linked to environment risks such as air, water and soil pollution, chemical exposures, climate change and ultraviolet radiation. Beyond pneumonia and diarrheal diseases, these risks may contribute to more than 100 diseases and injuries [9, 10]. In sub-Saharan African region the 2.5 million deaths a year are attributable to environmental risks. Generally, the fraction of the global burden of disease due to the environment is 22% if we are accounting for both death and disability. And in children under 5 years especially, up to 26% of all deaths could be prevented, if environmental risks were removed [10]. These facts, show us the importance of ensuring that whatever product or service that impacts the environment is sustainable to give us healthy environments which will help prevent the greatest percentage if not all environmental related diseases.

Figure 1 below, adopted from [10] gives a nice patristic illustration of (i) the ratio of deaths attributable to environment to deaths by other facts, and (ii) ration of disability-adjusted life year (DALY) attributable to environment to DALY non-attributable to environment; globally in 2012.

3. Challenges with solid waste management

3.1 Problems with solid waste in developing countries

In the developing world, the private sector and various actors have been keenly involved in solid waste management over the past decades, yet there are still problems with solid waste delivery services [11]. The problems with solid waste in most urban cities of some countries have really become burdensome despite efforts being made by city authorities and governments. The problems of solid waste common in developing countries include the following but not limited to:

- inadequate service coverage,
- irregular waste collection,
- waste spill over from bins and storage containers, and

- lax attitude of people towards indiscriminate disposal at unauthorized places
- waste littering on streets and in gutters/drains
- indiscriminate burning of waste and
- pressure on dump sites (locally created landfills).

These solid waste problems are what consequently lead to environmental health problems, such as discussed in the previous section above. And not only do they impact environmental health, they also lead to esthetic nuisance, and environmental pollution in general [12, 13].

3.2 Challenges in solid waste value chains

One major challenge in handling solid waste problems is that these problems impact on each other and on the environment in a circular manner – which makes it difficult to only tackle only a single aspect of the solid waste value chain. For example, in Ghana, due to inadequate service coverage in many cities, rural settlements and slums, insufficient service coverage; the public dump uncollected solid waste into drains, rivers and surrounding areas, or it is locally burnt or buried. These practices lead to considerable environmental pollution and degradation, and pose serious health risk to the population. These problems impair, in the long run, not only the quality of life of the urban poorer communities but also affect the welfare of the entire urban population. These complexities are what make cities still faced with urban environmental health issues related to solid waste management [14].

On the other hand the main causes of these waste problems in developing parts are not feasible to tackle in isolation because they are enormous, and complex interconnected social, environmental and economic factors. First, rapid urbanization poses a big problem to urban solid waste management. The rapid and unregulated urban growth and development in urban areas lead to a situation where solid waste services infrastructure lag behind the growth in population, or simply overpowers government strengths to fund municipal solid waste management.

Second, low cost of solid waste recovery as well as limited funds from central government is another constraint to solving the challenges in the waste management value chain in developing economies. Local authorities have difficulties in keeping pace with solid waste facilities development and in meeting the growing demand for solid waste services due to financial constraints.

Third, there is very low political will and priority given to solid waste service, Meanwhile most governments acknowledge immediacy and seriousness of solid waste problems to their countries. The lack of priority, political will, and public sector commitment limit rapid and sustainable improvements in the solid waste sector in developing countries like Ghana.

Fourth, there is also the factor of the enforcement solid waste management. This contributes to the lax attitude of the people towards indiscriminate disposal at unauthorized places, waste littering, and burning in open space. The enforcement of regulation by government officials appears to be weak and this may be due to lack of capacity, lack of resources and political will, and problems with the institutional set-up.

Finally, we have also noticed that there are problems with physical and human capacity for solid waste collection and technology operations in some countries. The human capacity of the public and private sector organizations may not be adequate and most of the few waste collection businesses that step in to contribute are usually not designed to be green, scalable and sustainable enough [14].

4. How green can waste collection be?

The root causes of solid waste problems have causal relationships with the various environmental and socio-economic factors that are already impacting the lives of populations living in these cities that are the most affected by the solid waste management challenge. That is why for our solid waste collection services to be sustainable enough, it must integrate social, environmental and economic impact models. If a waste collection service provider is able to consider the impact of their services on the triple bottom line – that is addressing social, environmental and economic variables – then we can say that the service is sustainable. **Figure 2** illustrates the interconnections of the social, environmental and economic variables that affect populations which when address makes a service sustainable.

First of all, the service must have measurable impacts on the social variables faced by the affected people and communities – that is to cause social change and improvement. This means for a waste collection services to be green it must address some social variables that deals with the community, education (e.g. increased awareness about effects of waste etc.), equity (e.g. reduction in child labor, increase in girl child education etc.), health, well-being and quality of life of the people.

Secondly, a green service must bring economic benefits to the populations involved. This means, not only must the service make some profits for its sustainable cash flow (to remain in business), the service provider must also factor the economic dynamics of the users when pricing its services, and the activities in the service must create jobs and employment opportunities. Thus they must offer a service that is available and affordable to all classes of the population.

Finally a green waste collection service must integrate protection of the environment at the core of serving the people and the economy. It must have considerations for saving natural resources, water, air quality, energy conservation and land use across all of its supply chains. If all aspects of a solid waste collection service – from procurement of logistics, collection of wastes and transport to disposal, are able to respect protection of the environments, reduce pollution and carbon emission, then we can say that such a waste collection service is green – it respects green supply chain management (GSCM).



Figure 2.
The interconnection of the elements of the triple bottom line concept (adopted from [15]).

5. Greening the waste supply chains: national to local contexts

Within the waste management industry a generalized broader way of defining waste would be: wastes are materials that are not prime products for which the generator has no further use in terms of his or her own purposes of production, transformation, or consumption and of which he or she wants to dispose [16]. And from national to local contexts we identify that:

- the extraction of raw materials,
- processing of raw materials into intermediate and final products,
- the consumption of final products, and
- other human activities are ways through which waste may be generated [17].

In Ghana particularly it is estimated that an average city generates about four thousand (4000) tons waste daily. To this end, the rate of waste generation in Ghana stands at 0.47 kg/person/day, which translates into about 12,710 tons of waste per day averagely [5].

The conventional methods of dealing with these waste in Ghana have included throwing into open dumps, wetlands, landfills, and uncontrolled dumps or in some cases are incinerated in the open air. Due to our current conventional approaches to dealing with waste, it is difficult to get a significant quantity of waste generated to go into recycling, composting or reuse to tap the potential end use value of solid wastes. However, if waste is properly managed – from generation to disposal – there are enormous untapped potentials that could be fully exploited. And this also have a consequential potential of improving greatly the quality of life for Ghanaians through energy generation, employment generation, income acquisition, and resource for goods production among others.

Therefore, the municipal solid waste (MSW) collection model ran by the government and city authorities where waste is collected and simply dumped at landfills by only one government agent or contractor, could be remodeled to make it more green and sustainable. We can decentralize the entire municipal waste management value chain – using a zonation approach. Government in an effort to rid the respective metropolis of the mountain of filths, these metropolises contract private waste management companies in a joint venture termed public-private partnerships (PPP) which over the years have witnessed a considerable increase particularly as witnessed in the Accra Metropolitan Assembly, to assist in the collection and disposal of MSW at landfill sites [16, 17]. This PPP for waste management could be replicated at local levels in peri-urban centers where we are witnessing an exponential growth of startups and youth organizations committed to social entrepreneurship [18–20].

When the waste management value chain is decentralized, what it also means is that we will have many actors – even SMEs and startups – on the various points of the waste value chain. Some will specialize on the collection to ensure that communities achieve 100 percentage recovery of waste from homes and the public. Which will also make waste collection service relatively affordable for every household to subscribe. More people subscribed to waste collection means little or no more indiscriminate disposal of waste at unauthorized places like drains, bushes and water bodies; and no burying or burning of wastes by households. Secondly, at local (zonal) levels, waste management companies could partner, together with government initiative, and build one major community owned state-of-the-art landfill



Figure 3.
Conceptual framework for green waste supply chains (from EcoCare pitch deck [23]).

system or incinerator. This will ensure that waste disposal in each community is not scattered to claim more arable lands that could be used for farming. Finally, while some waste service providers focus on collection and disposal, some others could only invest in treatment and recycling. The waste collected by company A from the same city could be sold to company B as raw material to be converted into various end-user resources like upcycling plastic wastes into bricks, tiles and ceramics or processing to produce energy like combustion chambers, gasification systems, liquefaction etc. [16, 21, 22].

Here, the authors propose a conceptual framework for turning wastes back into production chains in a circular economy manner – to make national and local wastes supply chains green. From the triple bottom line modeling, we considered EcoCare activities that result in economic gains, those that impact the environment and those that lead to social change. For a given community as an entity if a waste initiative is able to link all of its solutions to economic and environment holistically, that service will indirectly take care of its social impact variables (Figure 3).

6. Factors affecting waste management supply chains in Ghana

6.1 Actors and elements of solid waste management (SWM)

Solid Waste Management (SWM) could be defined as managing the processes involved in solid waste collection, treatment and disposal of waste generated in households, commercial and business establishments, institutions, and non-hazardous industrial process wastes. Solid waste collection has evolved over the years from collection of unsegregated waste and disposal on dumping grounds to collection of source separated waste streams through formal and informal service providers. The management of the processes involved which was traditionally public has now become public-private-community provision and partnerships arrangements [24].

The direct activities in solid waste management could be grouped into six functional elements basically:

1. waste generation and characterization,
2. on-site storage and handling,
3. collection,

4. transfer and transport,
5. separation processing, treatment and resource recovery, and
6. final disposal.

These functional elements require planning and management in order to achieve high quality of service. Unfortunately, however, the waste management value chain has not contributed to greening cities because most cities' agencies responsible for SWM often pay too little attention to integrated management approaches based on adequate information systems, management approaches, methods, and techniques. The activities of service provision may be concentrated in one organization or fragmented over multiple organizations.

As mentioned in Section 5 above, if solid waste management in cities is decentralized whereby various actors of waste management initiatives (private and public) were contracted to work on different activities of the waste value chains, it would be easy for cities to achieve green waste management supply chains. It is noted by [11] that these activities of the waste supply chain could best be regrouped into four fragmented stages, and it is best if different actors worked on different fragments in the process of making solid waste management green. A diagrammatic representation of the four fragmented process of waste management is shown by **Figure 4** below.

From **Figure 4**, we discover that at least 4 groups of elements and 4 groups of actors run through 4 stages of the waste management supply chain. Again we can see that a waste management supply chain can take a linear pathway (as is being done in most cities) and a circular pathway (which has only been promoted recently to be the most eco-friendly and green approach).

The linear waste management supply chain will take a path in which waste moves straight away from stage 1 (primary storage points) through stage 2 (collection and transport) to stage 4 (final disposal). In some typical rural communities in Ghana, the linear model could even involve just stage 1 (waste generators store long piles of waste in their houses for a long time) and then move it straight away to stage 4 (a local community dump site, call "borla so" in local dialect). This means that in the linear model, most actors may be left out. In the Stage 1–4 linear approach for example, you notice that households, institutions etc. who generate their waste at stage 1, store the waste, and then later send it to dump

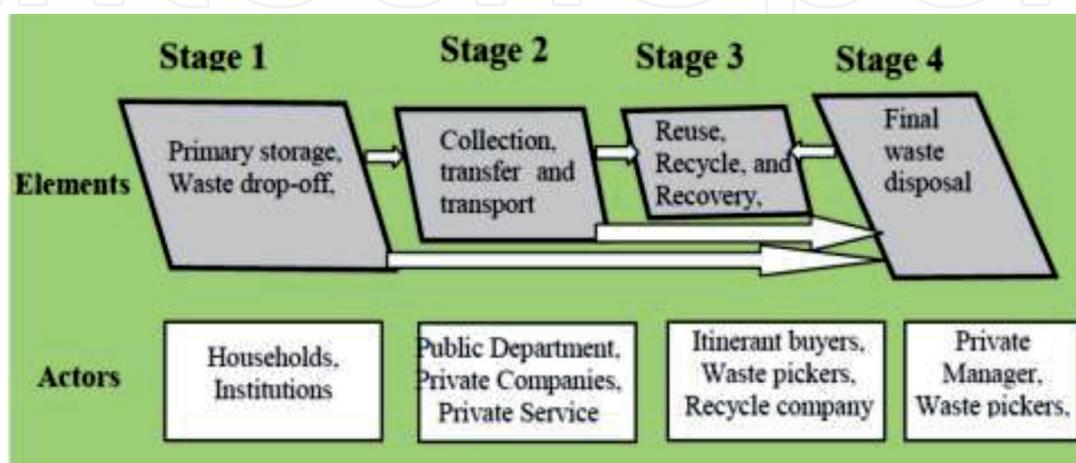


Figure 4. Elements and actors in the solid waste management supply chain (adopted from [11]).

site by themselves – cutting off public and private waste collectors in stage 2, and even recyclers in stage 3.

On the other hand, the circular waste management supply chain is one that progress from Stage 1 through 2 and 3 to 4, then back to 3. What happens here is that, after the waste reaches the final stage they are not disposed completely into permanent landfills, but all or some percentage of the waste is recovered back for reuse, recycling and other purposes of getting the waste material back into a production cycle again. These waste recovered could be repurpose into other end user goods and products through various means of treatment and processing – such as organic compositing, plastic recycling and upcycling, plastic extrusion, reuse etc. With this circular model of solid waste management, all the actors across the 4 stages on the waste supply chain get some work to do, and contribute to making the city’s waste management green and sustainable.

Table 1 gives an idea of how different types of solid waste could be repurposed in the circular economy waste management model.

Types of solid waste	Typical sources	Potential products	Methods (processes)
Agro waste (organic)	Rice, wheat, straw and husk, cotton stalk, saw mill waste, vegetable residues, nut, shells etc.	Organic soils and fertilizer, particle boards, insulation boards, wall panels, printing paper, roofing sheet, fuel, bricks, acid proof, polymer composite, cement board	Compositing, recycling, combustion, incineration, gasification
Industrial waste (inorganic)	Coal combustion residues, steel slag, bauxite red mud, construction debris	Cement, bricks, blocks, tiles, paint, concrete, ceramic products, wood substitute product	Combustion, liquefaction
Mining waste (mineral)	Coal washer waste, mining waste, tailing from iron, copper, zinc, gold and aluminum industries	Bricks, tiles, lightweight aggregate, fuel etc.	Combustion, liquefaction, biochemical esterification
Non-hazardous and other process waste	Waste gypsum, lime sludge, drains sludge, limestone waste, marble processing residues, broken glass and ceramics, kiln/oven dust (waste)	Cement clinker, super sulphate cement, hydraulic binder, blocks, cement, fibrous gypsum boards, gypsum plaster	Liquefaction, purification decontamination, recycling
Hazardous waste	Metallurgical residues, galvanizing waste, tannery waste	Cement, bricks, ceramic tiles and boards	Recycling, upcycling
Plastic waste* (various class of recyclable plastics)	Packaging, used plastic containers, oceans,	Reinforced fiber plastic, pellets, plastic beams, plastic artifacts, plastic jerseys, cement, plastic tiles and blocks, fuel, etc.	Recycling, upcycling, reuse, biochemical extraction

*We could not separate recycle and non-recyclable plastics as it is done commonly, so take these to be only plastics that could directly be recycled/or repurposed easily.
 [Source: authors’ construct based on synthesis of various prototypes and recycled products in literature].

Table 1.
 Types of waste and their repurpose potential in a circular waste supply chain.

6.2 Modes of solid waste collection services

According to [11] we can identify four modes of solid waste collection service¹ depending on the income levels of the people, housing types and the level of service required. They include:

- a. *Communal² collection mode is rendered in low income areas. The householders discharge their waste into communal storage containers at transfer stations or designated locations and collection vehicles pick up the containers full of waste at frequent intervals.*
- b. *Block collection mode is used where there are large apartment residential buildings. For this service, collection vehicle travels along a predetermined route at specific intervals (every 2–3 days) and stops at selected locations. The householders bring their waste bins upon hearing a bell sound and hand them to the crew who empties the bins and gives them back to the householders [11].*
- c. *Kerbside collection mode is rendered in middle and high income areas. The collection crew collects bins and bags of waste which are deposited at the kerbside on fixed days (e.g. 2 specific days in a week) when collection takes place. The householders leave their bins at the kerbside and collect them later in the day [11].*
- d. *Door-to-door or house-to-house³ collection mode is rendered in middle and high income areas. The collection crew enters each premise, takes out the bin and sends it back after emptying the waste into collection vehicles. No bins are left outside household premises.*

The residents served by the kerbside and house-to-house collection use standard bins to store waste. And this is what is practiced in the EcoCare H2H Waste Collection model.

7. The case of EcoCare waste initiative

7.1 The EcoCare story

A brief capture of the story of the EcoCare team and initiative could help paint a picture of how an environmental company could be born out of a passion to protect lives by cleaning and greening our environments. We capture this from an unpublished executive document of the EcoCare Waste Initiative [25]:

Jackson Nyarko the visionary of EcoCare had a friend who was part of the victims that lost their lives to the June 3, 2015 flood disaster in Accra, Ghana. One of the major cause of this disaster was later linked to a major drain that was choked by

¹ Take Collection service in general as the collection of solid waste from households in the municipality or from communal storage point.

² Communal collection: A system for solid waste collection in which individuals bring their municipal solid waste directly to a central point, from where it is collected.

³ House-to-house collection- Method of collecting domestic solid waste in which the house-holder is responsible for putting the waste (in a container) outside his property at the curb- or roadside at specified times for collection. The container should generally be kept within the property (definitions are adopted from [11]).

filth (plastic wastes especially) due to indiscriminate waste disposal. A year later, 2016, Jackson had the opportunity to participate in an Eco-enterprises development incubator. He was touched by his lost due to the indiscriminate problem to build a concept around Waste Management. In search of his first team members, Jackson first brought on board his Friend, Frank Yeboah, who also related to the loss of lives in that June 3rd disaster. So the 2 united their passion, loss and expertise to design EcoCare Waste Initiative. With the mission to challenge Ghanaians wasteful paradigm and throwaway culture. Then from there, their need to fill up the expertise gap brought in Felix Ankamah Yeboah (an environmental engineer), then later Isaac Sarfo Larbi, Maxwell Osei-Bonsu and the late Acheamponmaa Duffour.

7.2 The EcoCare business model

EcoCare Waste Initiative was set up with the sustainable development goal (SDG) 12 in mind first, then later partnerships (SDG 17) with other actors to integrate other goals – SDG 6 and 13 started running through the model. **Figure 5** below shows a non-updated business model of EcoCare developed by the co-founders which is used in modeling all the services and programs initiated by EcoCare since 2017.

7.3 Milestones towards a greening cities of Ahafo

Since the conception in 2016, the EcoCare team has been challenged by the daunting vision “to become a world class environmental company solving global sustainability and ecological problems and inspiring African excellence.” And driven by the mission “develop innovative technologies for managing wastes and protecting environments for people and communities,” EcoCare has moved through 3 growth stages:

Through 2017–2018: EcoCare first focused on social campaigns against plastics pollution and indiscriminate waste disposal – mainly on social media (virtual) and talk shows in and around Goaso. At this point it was quite difficult to identify on which of the four stages (illustrated in **Figure 4**) that the EcoCare was acting. But it served as a foundation process.

Through 2019: EcoCare added EcoEvents Cleanup to its business model – where we did waste Collection and segregation at source (people’s events like wedding receptions and funerals) - for revenue generation. Now it becomes clear to identify EcoCare as an actor at the Stage 2 and 4 – in a linear model of waste management.

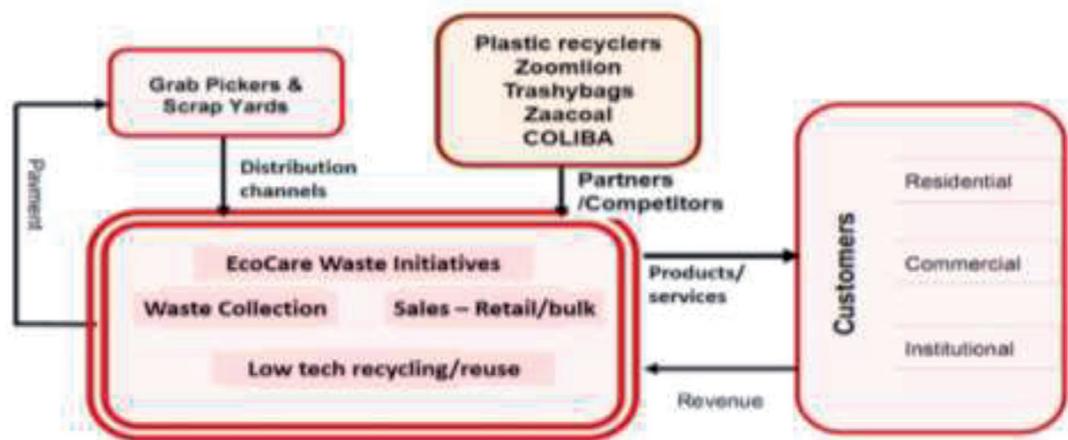


Figure 5.
 Business model of EcoCare waste initiative (from EcoCare pitch deck for TEDxAccra, 2017).

- In May 2020, we rolled out the House to House Waste Collection Service (called H2H Waste Collection) in 4 “elite communities” in Goaso. This business model though currently on a small scale, has elements of primary storage (with segregation at source), collection, and recovery of recyclables before disposal at authorized landfill sites. Now you can see EcoCare acting across the 4 major stages of green waste supply green chain – in a circular mode. The next sub-section (7.3) describes some details of how the H2H Waste Collection makes EcoCare contribute to greening the waste management supply chain of Goaso.

7.4 The EcoCare H2H waste collection model

The EcoCare House to House Waste Collection was designed to achieve six (6) goals, but which will cut across the social, economic and environment triple bottom line and have a tremendous impact in setting a new pace for green waste management supply chain models in Goaso. The six goals are:

1. support municipal waste collection to reach all neighborhoods in Goaso – *Social*
2. help every household to adopt the behavior of segregating their wastes – *Social*
3. ease families of monthly sanitation bills by cheap and easy payment plans – *Economic*
4. create direct and indirect jobs for waste supply chain in Goaso – *Economic*
5. ensure prompt collection and odor free neighborhoods – *Environment*
6. make Goaso the cleanest district capital in Ghana – *Environment*

So moving from the conventional linear approach to solid waste management, the EcoCare H2H Waste Collection has introduced a circular model by:

- a. supplying waste bins for storage of waste in households,
- b. supplying recycling bags for segregation of recyclable wastes at the homes (source),
- c. prompt collection of wastes on weekly basis,
- d. recovering and storing recyclables waste (e.g. plastics, glass, paper etc.) at our warehouse,
- e. transporting disposable waste to authorized community landfills and
- f. Distributing recovered recyclable wastes to partner recycling companies.

Without capacity to recycle, EcoCare is currently creating a distribution model for connecting with plastic recycling companies within Ahafo who will receive our recovered wastes as raw materials for the recycling plants. This will ensure that even while we do not have the capacity to complete our circular model, by partnership with other actors in the sector we could still make a complete green waste supply chain.

8. Results and lessons learned from EcoCare and the green initiatives

Most cities in Ghana continue to spend on solid waste management whereas others in other parts of the world persistently generate clean energy, income and raw materials and social development through the solid waste value chains. The common practice of waste management in Ghana since independence, which has been the linear supply chain approach – where we just collect and dispose – has not been very much beneficial until the last decade.

In recent years, some actors in the waste management industry have made efforts to transform Ghana’s sanitation services into a more sustainable development (circular economy) model – where different actors partner to work on different aspects of the waste value chain. By so doing, today, not only do we see collect and dump waste management services, but also there are being a crop of recycling initiatives coming in.

Initiative/ service	Status	Impact***		
		Social	Environmental	Economic
EcoCare plastic free campaigns*	Active in 2017–2019; No current active challenge in 2020	Impacting and influencing climate action and responsible consumption and production in 70 members	Saved 21,900 L of water in 2018–2019 by our community of 70 environmental lovers through the challenge	Several indirect jobs and revenue created for partners and suppliers – e.g. <i>media</i> houses, graphic designers, web/app designers
EcoEvent cleanup service	Operated in 2019; Not operated yet in 2020	Influenced the way event organizers manage their waste in Goaso	Reduced amount of waste that ended up at dump site in Goaso during weekends; Expected to save up to 6516 tons of CO ₂ -eq emission from waste burning by 2022	Created 11 direct jobs within, 2 outside; several indirect jobs
EcoCare DIY recycling training	Active 2018–2019	Influenced 600+ youth and students to consider waste as a resource for artifact creation	Prevented indiscriminate throwing of plastic wastes;	Provided skills for youth and women in plastic craft work
EcoCare H2H waste collection**	Rolled out in May 2020; Operated for about 10 weeks now	Served and impacted 16 households to choose paid waste collection service, learn to practice segregation of waste and control their waste generation	1800 kg of wastes collected and properly disposed in 8 weeks of active operation; 11.25 kg waste per household per week; Generation is fairly constant	Created 3 different direct jobs for transporters, collectors and recyclers; 1/3 of waste generated go into recycling for revenue creation etc.

*Plastic Free Campaign is global remote community (across 7 African countries) so impact are more global than local.

**Find highlights of impacts discussed in Sec 9 below, since H2H Collection is the main model discussed for this chapter.

***Some values are estimates from our unpublished Impact Assessment.

Table 2.
 Social, environmental and economic impacts of EcoCare’s green initiatives.

There are large scale companies like Zoomlion, Surfisana, and CleanTeam etc. contributing to this new revolution to transform Ghana's linear waste management supply chain into a more circular sector. And interestingly, the efforts of environmental SMEs which are even at startup stages but are more passionate about circular economy, are inspiring green initiatives in Ghana, and EcoCare Waste Initiative is the number one of such inspirations for the Asunafo North Municipality and almost the entire Ahafo region of Ghana.

Since 2017, EcoCare has been into advocacy and contributed a voice to speaking out for a change in Ghanaians behavior towards indiscriminate disposal of waste, plastic pollution, environmental depletion and a call for circular economy in the environment industry. And EcoCare Waste Initiative was the first the startup to inspire the small scale local green waste supply chain model in Goaso, which few other startups and youth groups are to replicating today in the Asunafo North Municipality.

Table 2 below shows the four (4) main initiatives that had been rolled out by EcoCare since incorporation in 2017; and the impacts that these activities have made across the social, environmental and economic development variables of Goaso and other.

9. Summary and way forward

From a careful review of the results and lessons learned from EcoCare and other solid waste management companies that incorporate circularity into their services, we found that incorporation of a recovery and recycling channel at some point makes them contribute greatly to greening their environments. And such services are setting a pace for understanding, adoption and replication of green supply chain management (GSCM) into waste management in the country.

Waste generation among the user communities of EcoCare's H2H Waste Collection, has been fairly constant. Meaning users are influenced to keep their waste generate at a moderation (in check) since the bin provided them is not the usual larger bins that public services provide. Also, the weekly collection and pay per pickup plan of the H2H Collection service influence users to not exceed their thresholds between weekly pickups.

Customer feedback tells us that the people prefer this service to the conventional collect and dump model. Feedback also suggests that a flexible and affordable payment plan has a potential to motivate more households to subscribe to paid waste collection services, rather than resort to their indiscriminate disposal of wastes.

A green supply chain model like the H2H Waste Collection also makes users (the people) feel a part of contributing to keeping their cities clean and green. This could be true because customers generally accepted the responsibility for the environmental pollution in their neighborhoods caused by the dumping of wastes at unauthorized places or long term storage of piles of wastes in their backyards.

The H2H Waste Collection model is highly commended for the fact that it connects multiple actors in the waste service, and opens door for more jobs and economic activities to be created in the city if the public municipal solid waste department adopts this model too.

Over all, if successful, we are optimistic that these four (4) green initiatives provided by EcoCare Waste Initiative could create 1000+ decent direct employment activities and 1000 change agents for the global goals on sustainable consumption and production (SDG 12) by 2022 from recycling model alone.⁴

⁴ Enayetullah and Sinha [26], TEDxDhaka estimates recycling 1ton of waste creates 2 new jobs for waste pickers etc.

The authors recommend that private-public-partnerships for waste management in Goaso and other cities would be greener if they replicated the circular economy model implemented by EcoCare Waste Initiative and its H2H Waste Collection model.

10. Conclusion

One key factor that affects green supply chain management (GSCM) is the integration of environmental value proposition. Environmental companies thus have little to do to achieve a green supply chain model, since their business models start with providing solutions to environmental problems, with consequential impacts on social and economic variables. EcoCare, a waste management startup in Goaso, Ghana, has proved that incorporating the triple bottom line, in municipal solid waste management – according to a circular economy model – is very possible, and that more cities have the potential to respecting the green supply chain management. Four main activities of EcoCare Waste Initiative – Plastic Free Campaigns, EcoEvent CleanUps Service, DIY Recycling Training and H2H Was Collection service – have been found to contribute to the greening the waste collection supply chain in Goaso, the capital of Asunafo North Municipality and the Ahafo region of Ghana. The House-to-house waste collection service (EcoCare H2H) ran by EcoCare is setting a pace for green supply chain management in Goaso.

Conflict of interest

The authors declare no conflict of interest.

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