UNIVERSITY OF GHANA

COLLEGE OF BASIC AND APPLIED SCIENCES

THE PLASTIC WASTE VALUE CHAIN IN GREATER ACCRA METROPOLITAN AREA: ASSESSING FLOWS AND SPATIAL PATTERNS OF RECYCLING

BY

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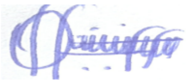
THIS THESIS IS SUBMITTED TO THE UNIVERSITY OF GHANA, LEGON IN PARTIAL FULFILMENT OF THE REQUIREMENT FOR THE AWARD OF MPHIL ENVIRONMENTAL SANITATION DEGREE

INSTITUTE FOR ENVIRONMENT AND SANITATION STUDIES

JUNE 2021

DECLARATION

I herewith declare that this thesis is the outcome of my own original research work undertaken under supervision, with the exception of citations from other sources that have been rightly acknowledged; and that it has not been presented either in part or whole for the award of a degree elsewhere.



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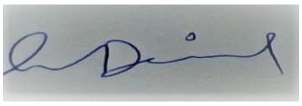

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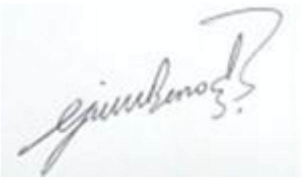

31st May, 2022

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ABSTRACT

Pollution from plastic wastes has become one of the global challenges and the threat to hundreds of marine species being the most visible and disturbing impact. As many regulations move countries towards circular economy models, there are real opportunities for future investments to combat the pollution from plastics. This study reports on assessing flows and spatial patterns of recycling in the Greater Accra Metropolitan Area using a variety of methods including review of literature, key informant interviews and administration of questionnaires to waste pickers, aggregators, recycling companies and Metropolitan, Municipal and District Assemblies. Thirteen (13) key informant interviews were done comprising of eight (8) Heads of waste management Departments at the Metropolitan, Municipal and District Assemblies, three (3) Non-governmental Organisations (NGO) concerned with waste management, the manager of the Kpone Landfill as well as an officer at the Environmental Protection Agency (EPA). Two hundred and ten (210) questionnaires were also administered, One hundred and sixty (160) to waste pickers, fifty (50) to aggregators (waste agents, small and large scale plastic waste recovery enterprises) and eight (8) plastic recycling companies. This was done to illicit responses on the plastic waste collection, the trading activities, the types and amount of waste collected daily, the interrelationship that exist between the stakeholders and the core competencies and operational capacities of the recycling companies. The demographic data from responses to questionnaires administered indicate that majority of the waste pickers (75%) are women with average age of 46 years. Majority (85%) of them have no formal education. Further, the results show that, the entire life cycle in plastic waste recycling in GAMA engages a very broad set of commercial stakeholders which includes waste management crew, street waste pickers, landfill/waste dump scavengers, plastic waste agents/ wholesalers, small scale enterprises and large scale enterprises playing diverse roles in the waste trade. Altogether the plastic recycling companies recycle/ process about 47 tons of HDPE, 41 tons of LDPE, 20 tons

of PET, 15 tons of Polypropylene and 5 tons of Polyvinyl-Chloride per day, the study also revealed that all the plastic recycling facilities interviewed were located either in a highly populated area, close to a landfill or dumpsite, or in an industrial area. Other less populated areas mainly are served by the aggregators collecting and buying waste from the communities to the recycling facilities. Two hundred and two thousand, eight hundred and twenty-four (202,824) tons of plastic waste is traded among the waste pickers and the waste agents or wholesalers during the study for a year, which is valued at GH₵ 91,999,464. A full-time waste picker makes between GH₵25.00 to GHC30.00 per day. The Current Ghanaian cedi to US Dollar exchange rate was GH₵5.76 to $1 at the time of the study. Even though the plastic waste trade activity provides employment and income to the local communities, not much attention has been given to it. It is recommended that, the Ministry of Environment, Science, Technology and Innovation (MESTI) should consider amending the National Plastic Management Policy to include plastic waste trade sector specific legislations, this will bring good recognition to the trade. Also, since the trade is dominated by women, there should be the creation of women-focused support from local and central government for plastic waste collection.

DEDICATION

This thesis is dedicated to my dear mother, Mrs. Janet Fiati and my father Mr. Jonas Fiati

ACKNOWLEDGEMENT

Firstly, I acknowledge God for helping me come this far in my academic life and for His protection throughout the period of this master's degree. I sincerely appreciate my supervisors Dr. Dan Nukpezah and Dr. Benjamin D. Ofori for their advice, inputs, support, sacrifice and patience during the whole period of my thesis and ensuring that I completed the thesis work successfully. The staff of the Institute including the entire faculty were wonderful during my entire study. I also acknowledge those who assisted me in collecting and analysing the data. I acknowledge my family members for always being there for me through their prayers and encouragements throughout the whole period of the study. Lastly, I thank all my colleagues for their assistance and contributions towards my thesis work and not forgetting all those that I have not mentioned for their assistance in one way or the other.

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LIST OF ABBREVIATIONS AND ACRONYMS

ADMA	Adenta Municipal Assembly
AMA	Accra Metropolitan Assembly
ASHMA	Ashaiman Municipal Assembly
EPA	Environmental Protection Agency
GAMA	Greater Accra Metropolitan Area
GCMA	Ga Central Municipal Assembly
GEMA	Ga East Municipal Assembly
GPAP	Global Plastic Action Plan
GPS	Geographical Position System
GSMA	Ga South Municipal Assembly
GWMA	Ga West Municipal Assembly
HDPE	High Density Polyethylene
KKMA	Kpone Katamanso Municipal Assembly
LADMA	La Dade-Kotopon Municipal Assembly
LANMMA	La Nkwantanang Madina Municipal Assembly
LDPE	Low Density Polyethylene
LEKMA	Ledzokuku Municipal Assembly
MESTI	Ministry of Environment, Science, Technology and Innovation
MLGED	Ministry of Local Government and Rural Development
MMDA	Metropolitan, Municipal and District Assemblies
MT	Metric Tons
NESSAP	National Environmental Sanitation Strategic & Action Plan
NGO	Non- Governmental Agency
NIPMA	Ningo- Prampam Municipal Assembly
NPMP	National Plastic Management Policy
PC	Polycarbonate
PE	Polypropylene
PET	Polyethylene Terephthalate
PHA	Polyhydroxyalkanoates

PLA	Polyacetic acid
PP	Polypropylene
PS	Polystyrene
PVC	Polyvinyl-chloride
SESIP	Strategic Environmental Sanitation Investment Plan
TWA	Tema West Municipal Assembly
WEF	World Economic Forum

CHAPTER ONE

INTRODUCTION

1.1 Background

Plastics are made or built from relatively simple units called monomers into group of polymers through polymerization process (Nuspliger et al., 1973). The processing of these large polymers into end products involves many physical phase changes such as solidification and melting (for thermoplastics) or a chemical reaction (for thermosets). Figure 1.1 below illustrates the process.

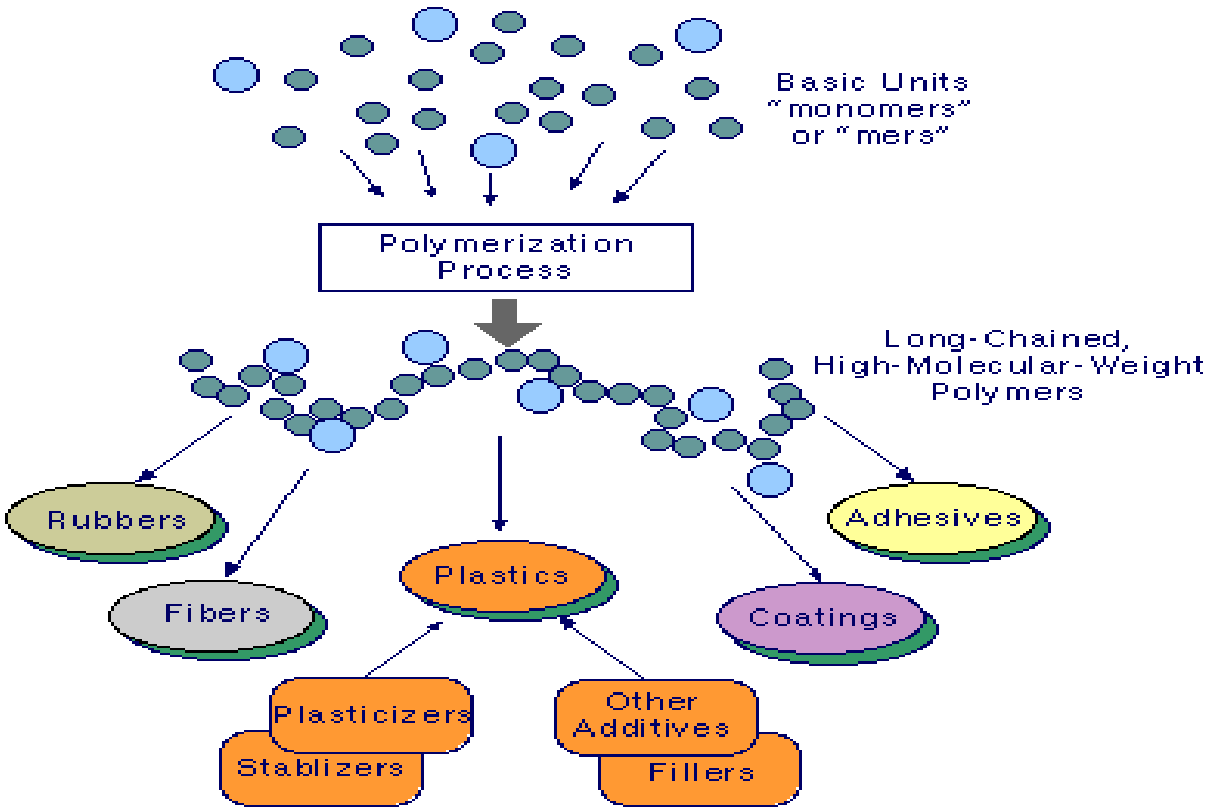

Figure 1.1: Polymerization process

From the figure 1.1 above basic monomers with low molecular weight are polymerized through a chemical process into long chained, high molecular- Weight polymers. Plasticizer's and other additives including stabilizers are then added to make the material possess its soft and flexible property. The additives also cause the plastic to increase its plasticity while decreasing its velocity and friction during its handling.

Generally, plastics are classified into two main categories, this includes the thermoplastics and the thermosetting. Thermoplastics are a group of polymers that melts when subjected to heat and gets hardened when cooled. (Eyerer & Gettwert, 2010). Repeatedly, these group of plastics can be reshaped and reheated. Examples of thermoplastics includes: Polyhroxyalkanoates (PHA), Polysterene (PS), Polyethylene Terephthalate (PET), Polyvinyl-chloride (PVC), Polyacetic acid (PLA), Low Density Polyethylene (LDPE), Expanded polystyrene (EPS), High Density Polyethylene (HDPE), Polycarbonate(PC) and Polypropylene (PP). (Eyerer, 2015).

Thermosets on the other hand are another family of plastics that go through chemical changes when exposed or subjected to heat, creating a three-dimensional network. Unlike the thermoplastics, thermosets cannot be re-melted and reformed (Wang et al., 2018). Examples of such plastics includes, Vinyl ester, Urea-formaldehyde (UF) resins, Phenolic resins, Epoxy resins, Silicone, Polyurethane (PUR) and Acrylic resins. Plastics play a very important role in the environmental, social and economic dimensions of sustainable developments. Unlike metals, plastics are light, durable, clean, versatile and therefore have mostly been used to manufacture and produce packaging, automotive parts, building, electronic and electrical products, etc. (Corn & Wong, 2010). But what makes plastic more convenient in our day-to-day lives is that it is cheap compared to other widely used materials. The production of virgin plastics, since the year 1950 has increased 200-fold and evidently has seen a massive growth rate of 4 per cent a year since 2000 (Hamilton et al., 2019). In 2018, the Global production reached 359 million metric tons (*Plastics - the Facts*, 2019). About 2 billion metric tons of carbon dioxide emission was generated as a results of the production of plastics in 2016. This figure represents almost six (6) per cent of the year's total global carbon dioxide emissions generation (Hamilton et al., 2019). Should the predicted plastic production capacity be constructed, and put into proper context, current production could potentially increase by 40 per cent by 2030, an assertion supported by (Ricardo Barra, 2018) who reports that, considering the current growth rate, the future global plastic production is estimated to double by 2035 and almost quadruple by 2050.

Plastic is not an intrinsically bad material; it is an invention that has changed the world in many ways. It essentially contributes to economic growth, and has provided safe and cost effective ways of packaging several products, but the current use pattern and production rate globally, on a linear model of 'take, make, use, and dispose', is a leading driver of natural resource depletion, waste generation, environmental degradation, climate change which have adverse human, environmental and health effects. The consumption practices as described above leads to the generation of plastic wastes in huge quantities, that the world is ill equipped or well positioned to handle mostly in developing countries (Hamilton et al., 2019). The proliferation of plastic use, and the poor waste management practices by state agencies and organisations as well as the local authorities mandated to manage waste has resulted in plastic pollution. Plastic pollution is observed to be in almost all the world's ocean basins, which includes remote islands, the poles and the deep seas, and an additional 5 to 13 million tonnes are introduced every year (Hoegh-Guldberg et al., 2015). Once plastics enter the oceans, they have a number of negative economic impacts as Marine wildlife is harmed through entanglement, suffocation and ingestion of plastics. This in essence has a devastating implications for the ecosystem health and overall sustainability of the fisheries economy. Coastal tourism is massively affected as tourists avoid beaches known to have high concentrations of plastic litter. Human health is also at risk to plastic pollution, although empirical evidence is limited, the presence of plastics in seafood, fish inclusive and the subsequent consumption by humans has led the concerns about chemical bio-accumulation in the food chain. (Thompson, 2015).

Plastic pollution warrants considerable attention for the reasons that, it accumulates in the natural environment and will only decompose over a long period of time, during which they fragment into smaller micro and nano plastics. The other reason relates to the uncertainty about the magnitude of the damages. Although data on the full impact of plastic pollution on marine and terrestrial ecosystems is patchy, some environmental and societal effects are already clearly visible.

Reliable and recent data on plastic consumption and plastic waste generation in Ghana are somehow limited in quantity and quality. According to the recent World Bank Ghana Country Environmental Analysis (CEA) report, published in April, 2020, Over 3,000 metric tons (MT) of plastics waste is generated every day in Ghana estimating to about 1.1 million MT per year. Miezah et al.,(2015) also reported that, plastics make up about 12-14% of the waste stream in Ghana, with an average per capita per day generation of plastic waste at the household level of 0.06kg. It must be stated that most of these data are estimates and projections based on literature and expert opinions which could be far from reality. There has been a gradual increase in the use of plastics products over the years leading to a proportionate rise in plastic waste in solid waste streams in large cities. (Quartey et al., 2015).

There have been several approaches, models and concepts readily available to address the environmental effects of the rapidly growing plastic production, use, and its disposal. In the first instance, attention has been given to the use of alternative materials in the place of plastics. Second, is the application of better waste management systems, which involves the facilitation of higher waste collection and recycling rates. This in essence would allow plastic waste to be captured even before creating problems. Plastic recycling allows the continuous realization of the beneficial aspects of the emergence of plastics use, while also addressing the associated adverse environmental side effects.

Ghana like many other developing countries on the road towards sustainable development, is placing more emphases on plastic recycling as a tool for managing plastic waste. Plastic recycling is defined as the process or method of recovering waste or scrap plastic and reprocessing the materials through a physical or chemical means into other functional and useful products (Aksan & Çelikler, 2019). The purpose for recycling plastic waste is to reduce high rates of plastic pollution while reducing the pressure on virgin materials and resources to produce brand new plastic products. The concept of plastic recycling and its approaches also are essentially to conserve natural resources and divert the path of plastics from landfills or unintended destinations such as oceans.

There has been series of programs and efforts by many countries to improve on the global plastic recycling rates. Notable examples for the developing world or economies are the sustainable and zero waste models in India using the concept of maximum resource recovery leading to the recycling of one-fourth of the country's annual 15 million tons' plastic waste generation (Pankaj, 2015). Similarly, the reverse logistics model in Indonesia increased the recycling rate to 24% (Putri et al, 2018). On the other hand, while Ghana has not achieved such high levels of recycling rate, it has established some regulatory frameworks for plastic waste collection and management through the Ministry of Environment, Science, Technology and Innovation (MESTI). Also, Ghana has become the first African country to join and collaborate with the Global Plastic Action Partnership (GPAP) hosted at the World Economic Forum (WEF) which is targeted at eradicating plastics wastes and pollution worldwide and also developing a road map for sustainably managing and reducing waste challenge posed by plastics. Quite a number of Ghanaians have also become engaged in the entire supply chain of the plastic waste recycling industry, from generation, collection and washing of the recyclable material to the production phase of pellets and other plastic products from these plastic wastes.

The Global plastic recycling rates are thought to be between 14 - 18% (OECD Environmental Policy Paper No.12, 2018). This is comparatively lower to other widely used materials like steel, aluminium, copper and paper with recycling rates above 50% (OECD Environmental Policy Paper No.12, 2018). Plastic recycling rates across different countries vary differently; some polymers are also more widely recycled than others. It must be emphasized that the plastic recycling industry in Ghana is wholesomely informal and community based where waste pickers work closely with the plastic recyclers. According to Professor Frimpong- Boateng, who was the Minister for Environment, Science, Technology and Innovation, in an address to commemorate the 2018 World Environment Day Celebration, "Ghana could reclaim and recover nearly one million tons of waste plastics from the environment and landfills, to be recycled into basic needs products valued at GHS2 billion per year creating many jobs across the economy". This was affirmed in the National Plastic Management Policy, (2019). However, the industry is faced with numerous challenges coupled with the weak market for recycled materials. To be able to create an understanding of the future development need of Ghana's plastic waste recycling industry, it is essential and very important to have a clear and better appreciation of the current plastic recycling eco-system as well as the flows of the plastic waste along the value chain, a research gap that needs urgent attention. This study therefore is to assess the flows of plastic waste and spatial patterns of recycling in Greater Accra Metropolitan Area.

1.2 Problem statement

The huge demand for plastic products, and the desire for safe ways of packaging food and other household consumables, coupled with the numerous challenges with plastic waste management have globally been identified as the main drivers of the continual increase of the share or proportion of plastic waste among solid waste in the waste streams. This situation is not so different even in developed countries in Europe. The scale of the problem linked with the improper plastic waste management in Europe is enormous, including the irreversible losses to the environment (Bernadeta, 2020). As a consequence of being the fastest growing plastic market, according to the Ministry of Environment, Forest and Climate change (MoEF and CC, 2016), major cities in India are facing major problems with managing plastic waste.

Developing countries are not spared of this problem. In Zimbabwe, South Africa and Zambia rubbish bags are a major eyesore (Chazan, 2002). In South Africa black polythene bags are often referred to as the “national flower” because they are left to cover the landscapes and can be seen in gutters and blocking the drains, whiles others are also left hanging on fence. (Chazan, 2002).

Ghana stands at the cross roads of unparalleled growth and potential economic growth. Working hard to attain the fastest economic growth among all nations in 2019 (World Economic Situation and Prospects, 2020), the government through other ministries has also shown remarkable and impressive leadership in championing and chattering new path and efforts to boost sustainability across its businesses and to rejuvenate its natural environment, and promote the wellbeing and livelihoods of its people, according to 2019 report of the World Economic Forum on Africa. At the same time, the insufficient infrastructure to effectively manage and reduce plastic waste has led to unsustainable levels of pollution and leakage of these wastes into inland water bodies, putting the wellbeing of both Ghanaians and biodiversity at risk. Urgent and collective action is needed to address this challenge appropriately.

Realizing the need to solve this problem, Ghanaians have reacted energetically to this challenge. The government of Ghana in 2019 enacted the National Plastics Management Policy (NPMP) to address the unsustainable adoption of single-use plastic. This has also sparked a willingness to pioneer and champion new approaches and models to plastic material design, recycling and waste management infrastructure, as well as the integration of sustainable business practices throughout the plastic value chains. A number of circular economy, green businesses and plastic waste management initiatives have also been established at the local level, example is the construction of affordable housing units using plastic wastes as a major material by Toahouse Company Limited and Nelplast Company Limited. Plastic waste has also been used for the manufacturing of furniture, tables etc.

Despite the present concerns and efforts of private individuals, waste management companies and the central government in ensuring proper plastic waste management, the country is still faced with serious plastic waste management problems as it is very common to see plastic (and other) waste, all over and piles of waste being burnt in the cities of Accra including the beach (Plate 1.1). Unless the combustion of these plastic waste is properly controlled, burning plastics release considerable quantities of polluting substances into the environment, which in effect causes health problems, like the respiratory related diseases. In many countries, bottles or packaging materials made from PET are the most recycled, but that is not the case in Ghana. PET bottles are everywhere; beaches are covered with them and those collected for the purpose of recycling are mostly exported to countries like Germany, Denmark, etc.

Plate 1.1: Plastic pollution at the beach in Accra

Studies have been carried out in relation to plastic waste management in the country: notable is the one by Miezah et al., (2015), which describes the characterization of the municipal solid waste and also quantified the waste as a means towards the effective waste management in the country. Another important study was by Fobil and Hogarh, (2016), who worked on the dilemmas of plastic wastes in a developing Economy: Proposals for a sustainable management Approach for Ghana. The study revealed that, the packaging revolution that has evolved, has not been correspondingly matched up with appropriate plastic waste management technologies and policies which has left many cities and areas in the country littered with plastic wastes; thus, creating public health problems and disgusting visual nuisances. (Bert, 2019) also wrote an article on Market Survey Waste and Circular Economy in Ghana. In all these studies the underlying structure and interrelationships between the various participants and actors as well as the flows of plastic waste that is fundamental for the sector to be successfully incorporated into the formal waste management has not been properly highlighted. Also little has been done quantify the impact of the plastic waste trading activities on the management of plastic waste in Ghana.

1.3 Aim and Objectives

The overall aim of this study is to identify and map the trade flows of plastic wastes and the spatial patterns of some plastic recycling companies in the Greater Accra Municipal Area of Ghana. The research involved several local authorities and other entities and stakeholders in the plastic recycling value chain within the study area.

1.3.1 Research Objectives

- Identify and profile the key plastic recycling players and analyze their core competencies;
- Identify plastic material and quantities currently being processed by the plastic recycling companies versus the full recycling capacity available;
- Analyse the recycling value chain, where the majority of the materials come from, who is collecting them and what are the quantities they collect;
- Identify the interrelationship between the plastic waste recycling stakeholders, which includes plastic waste collectors, recycling companies, local authorities, regulatory bodies, NGO’s, and other organizations.
- Map out some of the dominant plastic recycling stakeholders and also to determine the trade flow of plastic waste in the Greater Accra Metropolitan Area.

1.4 Justification of the study

Waste management has changed rapidly over the decades. Already, there has been massive calls for transition from landfill disposal to energy and material recovery and the current trend is towards more efficient material recovery and recycling processes (Haas et al., 2015). Regardless, most of Ghana's inland waterbodies and ultimately seas are seen with plastics, forgetting that, our oceans are fast reaching the point where there will literally be more plastics (by weight) in the sea than fish according to the World Economic Forum, Ellen MacArthur Foundation and McKinsey & Company, (2016).

However, a review of literature has revealed limited research on the plastic waste recycling ecosystem in Ghana. Existing studies on plastics including Fobil and Hogarh, (2016) and Bert, (2019) have relied on relatively coarse data which affects the quality of the research. Also, not much research has been done on the trade flows of plastic waste in Ghana.

This study will be useful to local authorities and the government at large in decision making considering management of plastic wastes. The research will make possible the identification of key stakeholders in the trade flows of plastic waste in the industry as well as the various roles each play in the plastic waste recycling supply chain in terms of policy making, implementation and follow ups. The study will also serve as a guide and reference point for academics and other researchers.

1.5 Thesis structure

This thesis consists of six (6) chapters. The organization of the thesis flows from the objective and goals, research process and importance of the research outlined in chapter one (1). Chapter two (2) reviews literature on plastic production, consumption, waste generation, plastic waste recycling value chain as well as background to the Ghana plastic recycling industry. A conceptual frame work is also presented in this chapter. Chapter three (3) looks at the methodological approach to achieving the stated objectives, this looks at all the actors involved as well as the flows as well as trading in the supply chain of the plastic recycling ecosystem in GAMA. Results obtained from questionnaires and field surveys are presented and analysed in chapter four (4). In Chapter five (5) key findings are discussed and situated in the context of theories and other studies, while chapter six (6) gives the conclusion drawn from the results and recommendations made, with relevant topics for future studies.

CHAPTER TWO

LITERATURE REVIEW AND CONCEPTUAL FRAME WORK

2.1 Definition of terms

2.1.1 Plastic Waste

Plastic wastes are discarded plastic material after intended use is over. It is the accumulation of these discarded wastes in the environment that leads to plastic pollution. Globally, of the seven billion tonnes of plastic waste generated so far, it has been reported that, 10% has been recycled, 14% has been incinerated, while the remaining 76% are in landfills, dumps, or the natural environment. (Taylor, 2019). With proper regulations and waste management infrastructure, coupled with financial support, these huge amounts of plastic waste that is generated could be managed effectively.

2.1.2 Trade and trade flows

"Trade is a basic economic concept or term that is used to describe the buying and selling of goods and services, with compensation paid by a buyer to a seller, or exchange of goods or services between parties". (Nicita et al., 2011). Analyzing Trade flow helps to examine routes and networks, direction of flows and vehicles or transport systems used for conveyance pattern of trade, trend of flow, concentration or the extent of diversification, and improvements required in particular destinations, value and supply chains. For this study, the trade commodity is plastic waste of all type. The main features in plastic waste trade includes routes and networks of the trade, direction of flows of vehicles and trucks (transport systems) used for conveyance.

2.1.3 Recycling

The European Union defines recycling of waste as "any recovery operation by which waste materials are reprocessed into products, materials or substances whether for the original or other purposes" (Geyer et al., 2017).

In the case of plastic, it is basically melted and then reshaped. There is a clear distinction between recycling and reuse, where an object is used again for the same or other purpose without altering its basic structure (like refilling a bottle, or using a jar as a pen holder).

Directly or indirectly recycling in essence is primarily to achieve the following:

- Conserve energy and natural resources
- Prevent or reduce waste
- Create employment

2.1.4 Circular economy

In early 1970's, the concept of circular economy was conceived, which was intended to promote a world where nothing is considered or regarded as waste. This concept has generally gain priority for progressive leaders. Reviewing several descriptions of the circular economy concept (Kirchher Reike et al., 2017), resulted in the following definition, which reflects a more holistic understanding:

"A circular economy describes an economic system that is based on business models which replace the end of life concept with reducing, alternatively reusing, recycling and recovering materials in production/distribution and consumption processes, thus at the micro level (products, companies, consumers), meso level (eco-industrial parks) and macro level (city, region, nation and beyond), with the aim to accomplish sustainable development, which implies creating environmental quality, economic prosperity and social equity, to the benefit of current and future generations." (Kirchherr, et al., 2017)

The concept challenges the traditional linear, "take-make-dispose" model and approach to production and consumption of products, where resources are extracted, mined, grown, manufactured, transported and used before disposal at the end of the value chain. The linear model was made possible by a system where input commodities were cheap and widely available, but that is not the case anymore it has become necessary to close the loop to achieve a sustainable growth for future generations, hence the circular economy concept.

2.2 Literature Review

To put the study in context, and to build up academic foundation for the study, this chapter presents review of relevant literature on plastic waste flows and the trade associated with it as well plastic waste recycling. It also reviews recurring concepts on the subject of the study and the body of ideas that guided the study.

2.2.1 Plastic economy and value chain.

Historically, polymers are obtained from resins derived from vegetable matter such as cellulose from cotton, furfural from oats hulls and various starch derivatives.(Corn & Wong, 2010). However, plastics today are produced from petrochemical.

The process of plastic production typically involves the extraction and refinery of crude oil. In 2012, it was estimated that up to 4 - 6% of the world's annual oil production is used to produce and manufacture plastic products (Clunies-ross, 2019). It is possible that this figure may have risen as population increase. The refinery process of crude oil produces derivatives for the production of plastics in "fluff" and then "pellets" forms, which are then moulded into different types of plastic material such as packaging materials, plastics for electrical and electronic apparatus, etc. Figure 2.1 illustrates the forward supply chain for plastics.

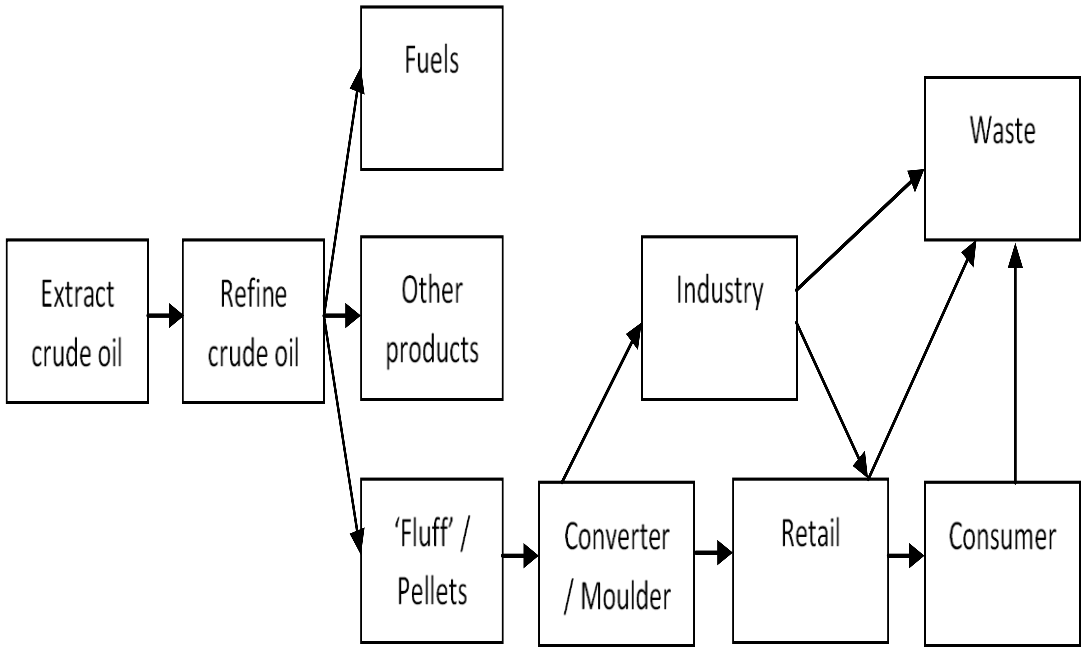

Figure 2.1: A typical forward plastic supply chain (Source: Corn & Wong, 2010)

From figure 2.1, the extraction of crude and the refinery process generates fluff or pellets as a by-product, these pellets are subjected to heat to melt and are moulded into preferred shapes or forms for industrial use or are being retailed where consumers can use and generate waste after use. Plastics have become an important material of the modern system, playing an integral part of the global economy and deliver many benefits. (Ellen MacArthur Foundation, 2017). The plastic economy is global, as it has become rare to go a day without the use of plastics. Indeed, the economy has received a lot of benefit from plastics as every conceivable sector and industry relies on it, according to Defruyt, (2019). The plastic industry has provided over 1.6 million people direct employment in Europe with a turnover of more than 360 billion euros in 2018 (*Plastics - the Facts*, 2019). Africa's overall economy is on a steady growth path hence makes it a key player and of keen interest to the international plastic and packaging industry where plastic goods are in high demands.

In 1950 the global production of plastics was 2 million tons (Plastic Europe Market Research Group (PEMRG) and conversion Market and Strategy (GmbH, 2019). Since then, annual production has increased nearly 200-fold, reaching 360 million tonnes in 2018. It has been estimated that, future plastic production will double by 2035 and almost quadruple by 2050 (Ricardo Barra, 2018). According to Geyer et al, (2017), the world by 2015 had produced 7.8 billion tonnes of plastic cumulatively. Figure 2.2 shows global distribution of plastic production. Historically, Europe and the United States were the known states to be the producers of plastics, however, this has changed and recently shifted to Asia, with China being the leading producer with 30% of global production in 2018 (Mian et al., 2017). The rest of Asia, which includes Japan, produces 21%. Hence, Asia produces little above half the global production in 2018 (Cao et al., 2016).

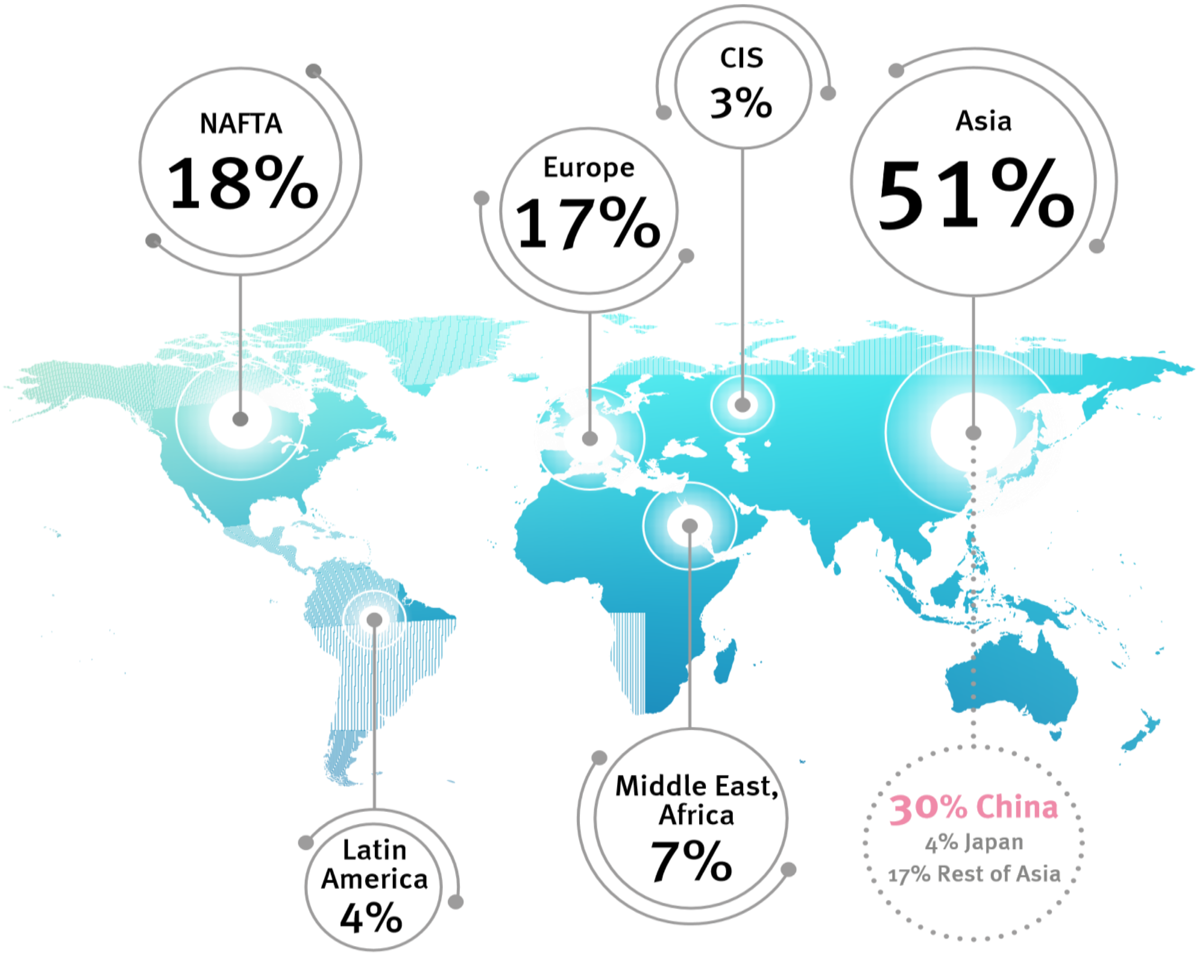

Figure 2.2: Global distribution of plastics production
Source: Plastic Europe Market Research Group (PEMRG) and conversion Market and Strategy, 2019.

2.2.2 Plastic consumption

The volume of plastics consumed by many industrial societies for different applications and for a variety of purposes is enormous as almost all aspects of our daily life involves the use of plastic in one form or the other. (Magnusson et al., 2016). According to Plastics Europe Market Research Group (PEMRG) and Conversio Market & Strategy GmbH, the main plastic using applications on the European market are packaging, building and construction, and transportation using 39.9%, 19.7% and 10.0% of the total annual plastic production respectively (Figure 2.3), other domain such as the electrical and electronics (6.2%), household leisure and sports (4.1%), agriculture (3.4%) and others (16.7%) consisting of plastic furniture, medical equipment, plastic furniture and furniture equipment, technical parts used for mechanical engineering and machine- building, etc. (Gewert et al., 2015) has also been reported. Katima et al., (2018) reports that, the consumption pattern in all the different application sectors are consistent in both developed and developing countries where over one third of consumption is in packaging application. For instance Mutha et al. (2006) reports that, 42 per cent of resin consumption was in the packaging sector in Indian.

A review of plastic materials consumption on a per capita basis shows that, there is a strong correlation between Gross Domestic Product (GDP) and plastic consumption, which can also be seen for African countries. The per capita plastic consumption in Africa for 2015 was 16kg for a population of 1.22 billion, whiles in most European countries, about 100kg of plastic per person per year is consumed (Statista, 2018). For instance, the per capita plastic consumption between 2009 and 2015 in Nigeria, Kenya and Ghana was 4.4-8kg/year, while in Algeria and Morocco was 13-19kg/year, and 24.5kg/year in South Africa (Babayemi et al., 2019).

Generally Plastic use and consumption is driven by modern life style and society's demand for eco-efficient manufacture of numerous valuable products such as protective packaging, lightweight and safety components in cars, mobile phones, insulation materials in buildings, medical devices, and key components for renewable energy production and protection in extreme conditions etc. (Corn & Wong, 2010). Other triggers of plastic consumption growth include rapid urbanization and economic growth where consumer demand for disposable product is fast growing. (Plastic Europe, 2018).

2.2.3 Plastic Waste Generation

The rapid increase in the amount of plastic waste generation as a result of economic development, industrialization, urbanization and public habits is fast becoming alarming.

These parameters in most cases are taken into account in estimating plastic waste generation globally (United Nations Environment Report, 2020). There have been different numbers and reports all in an attempt in estimating plastic waste generation.

According to the World Bank, 242 million tonnes of plastic waste was generated in 2016, making up 12 percent of all municipal solid waste (United Nations Envrionment Report, 2020). Asia in 2015 was the largest contributor to global domestic plastic waste, generating close to 82 million tonnes followed by Europe with 31 million tonnes and North America with 29 million tonnes, Africa and Latin America including the Caribbean produced 19 million tonnes of waste (Lebreton & Andrady, 2019).

A majority of plastic wastes are known to come from the post-consumer markets, the packaging, automotive, agricultural, construction, electronic and electric industry. Plastic packaging has the largest share (35.8 percent) in the market of plastic products with a short lifetime. It is also the largest plastic waste generation sector representing 46 percent of plastic waste generation (figure 2.3).

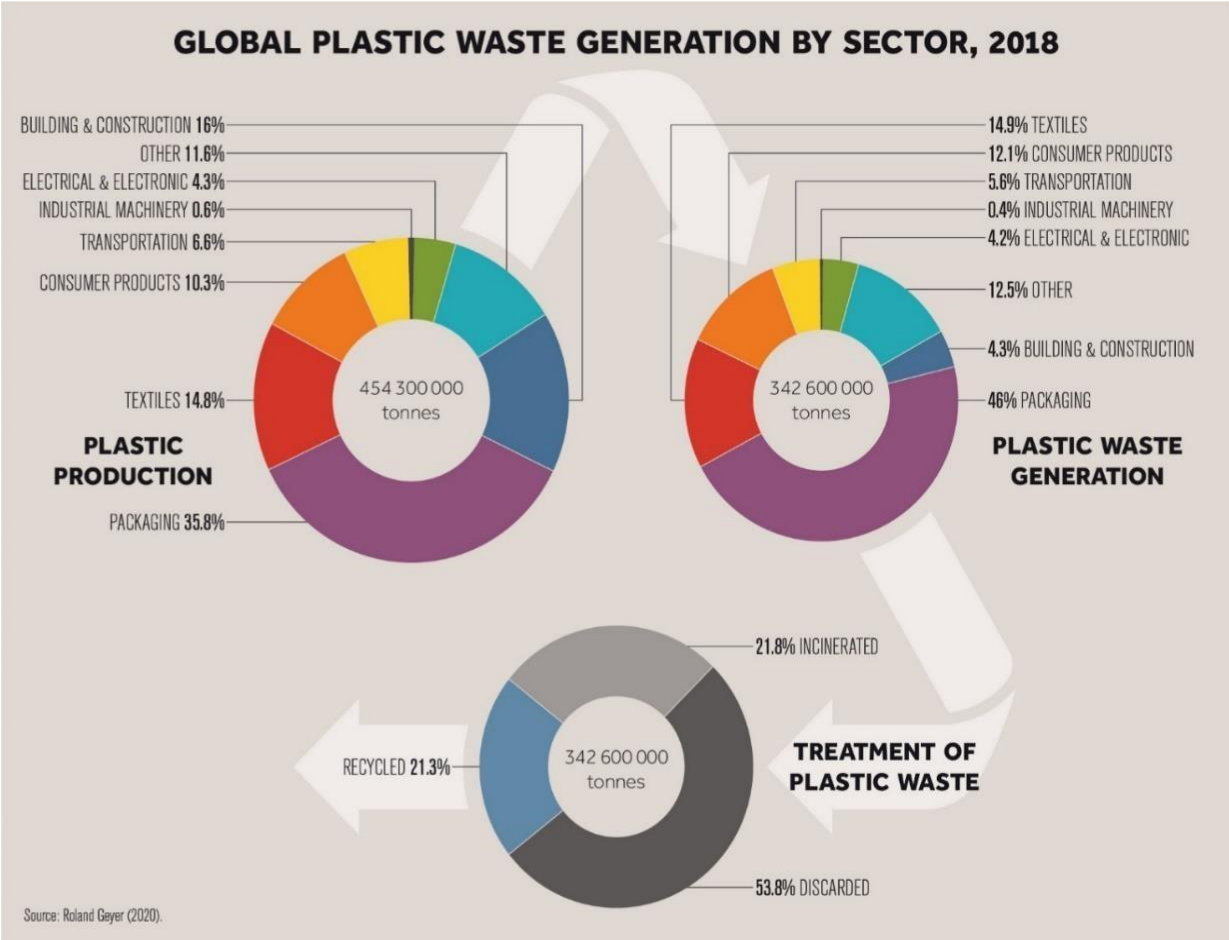

Figure 2.3: Global plastic waste generation by sector (Geyer, 2020)

Considering the rate of urbanization and economic development, data available show that the distribution of plastic waste generation is increasing which indeed is expected. By 2030, the global plastic waste generation is estimated to be 2.59 billion tonnes and 3.4 billion tonnes by 2050 (Geyer, 2017; Figure 2.4).

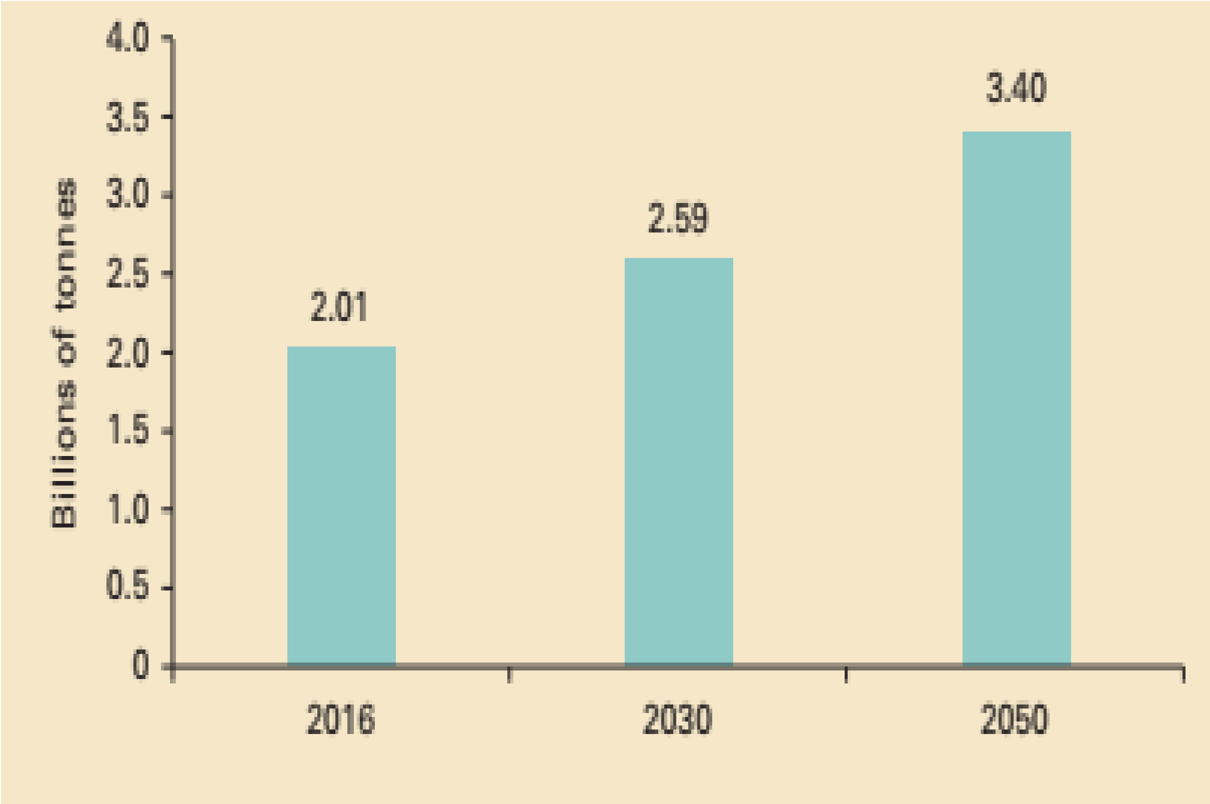

Figure 2.4 Global plastic waste generation projection (Geyer et al., 2017)

2.2.4 Legislation and Plastic Waste Management

Approaches to deal with and effectively manage plastic waste are grouped into three;

1. Governmental regulation (Ban, levies etc.)
2. Market Instruments (extended producer responsibility, alternative material promotion, circular economy etc.) and;
3. Behaviour change (public awareness, etc.)

Governments globally are responding and are adopting several legislations, concepts and strategies in managing plastic waste, this has led to growing trend of restrictions and bans on some specific plastic use and the imposition of taxes or fees for single use plastics worldwide (Figure 2.5) By mid-2018, over 127 countries worldwide had enacted regulations, limiting the use of some plastics (United Nations Environment Report, 2020).

Figure 2.5: Specific plastic regulations in various countries (Frota et al., 2015)

Legend: Countries coded red have placed a ban on plastic bag use, countries in green have taxes imposed on plastic bag use, and the countries coded yellow have partial ban on plastic use and has also imposed taxes on plastic bags at the same time. Countries in grey have not placed any ban on plastic bag neither is there any imposition of taxes on the plastic bag use on the citizens.

Kenya, one of the first African country's to have placed a ban on the use of single-use plastic bags in 2017 and in June, 2018, restricted visitors from taking single-use plastics such as water bottles and disposable plates into national parks, forests, beaches, airports and conservation areas. (de Freytas-Tamura, 2017).

Zimbabwe on the other hand introduced a ban on food containers made from polystyrene in 2017, with fines of between $30 to $5,000 (Zimbabwean dollars) for individual who break the rules. (Ferronato, N., & Torretta, 2019).

United Kingdom, in the year 2015, introduced a tax on plastic bags and also in 2018 imposed a restriction on the sale of microbeads, shower gels and face scrubs made from plastics. Plastic straws, stirrers and cottons buds' sale and use are also prohibited. (Truelove et al., 2016).

New York, Hawaii, California among others have placed a ban on the single-use plastics bags, however there is no federal ban. (World economic forum, 2016).

The European Union has plans of placing restrictions on single-use plastic items such as straws, forks, knives and cotton buds by 2021. (Gokce, 2018).

The areas of interest generating plastic waste seems to be different from one country to the other, whiles the United States and other countries focus on plastic straws, stirrers and cotton buds, Ghana is struggling with PET bottles and water sachet. In 2015, government of Ghana made effort towards eradicating the menace of plastic waste by banning light plastic materials with less than 20 microns (one-millionth of a meter in terms of density): such as ones used in packaging sugar, gari (cassava grains) and porridge, this has not seen the light of day, after generating lots of debates among several stakeholders and actors in the plastic recycling.

Innovative policies concerning plastic demonstrated above in the various countries will not abate the challenges in the proper management of plastic waste without putting in place proper institutions, systems, and incentives. The world in total generate about seven billion tonnes of plastic waste and an estimated 10% were recycled, 14% were incinerated, while the remaining 76% are in landfills, dumps, or the natural environment. (Taylor, 2019).

Management of plastic waste has evolved over time. The main practice to treat plastic waste between 1950 and 1980 was disposal into landfill and open burning. Considering the environmental impact as well as the health hazards associated with unregulated waste management, other treatment methods including recycling were introduced as one of the best treatment methods especially for plastic packaging waste.

The waste management hierarchy (Figure 2.6) reveals an order of preference for action to reduce and manage waste. It is the cornerstone of most waste minimisation strategies including circular economy. The waste hierarchy prioritizes waste prevention in the first place, however in the case waste is generated, priority is given for reuse where recycling follows in that that order and then recovery. The last option is waste disposal (e.g. landfill), which is the least preferred option. The proper application of the waste hierarchy can have several benefits.

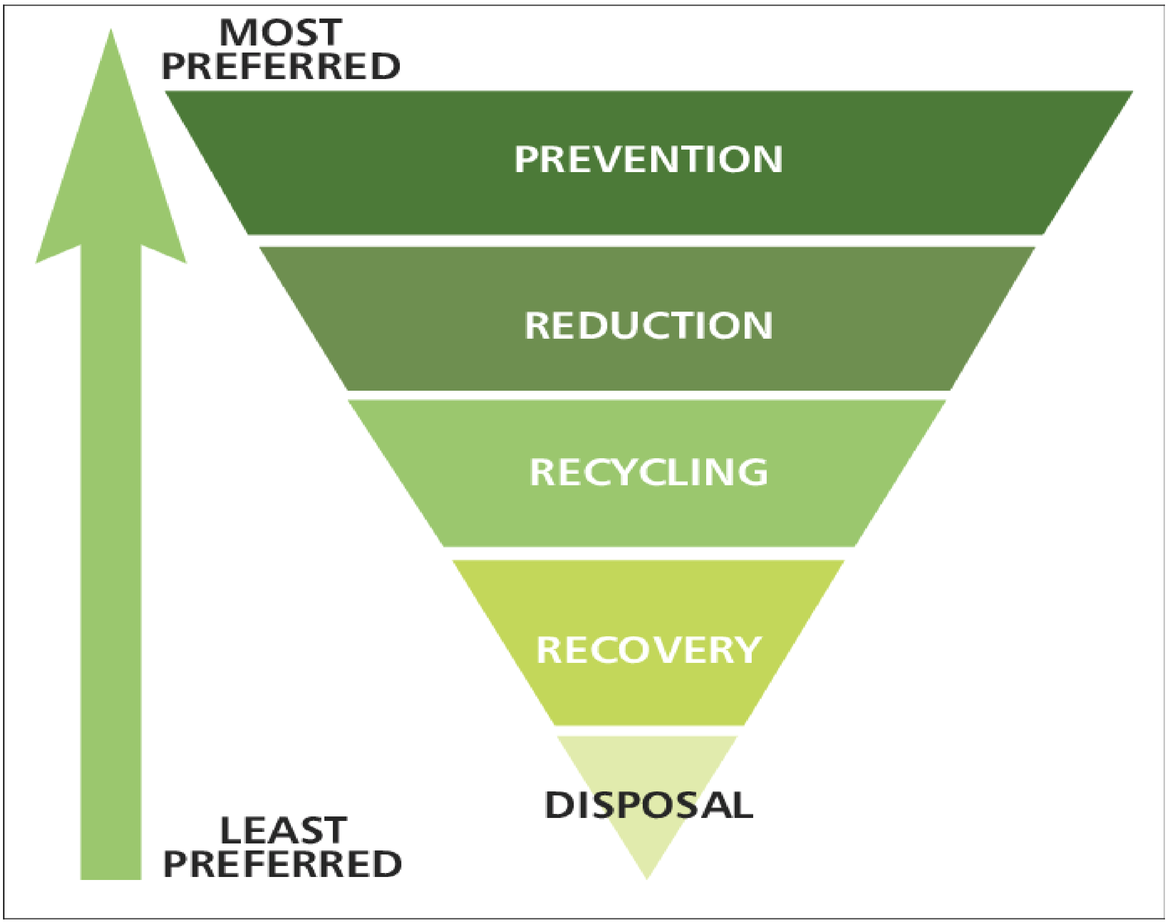

Figure 2.6 Waste management hierarchy

Notwithstanding the gradual increase in the global plastic recycling rate, a significant amount of plastic waste (56 percent) is disposed in landfills and dumpsites or escaped into the environment (Geyer et al., 2017).

Ghana is a good example of a developing country, where plastic waste management is often characterized by inadequate financial and logistical arrangement, poor service coverage, operational inefficiencies, dearth of skilled manpower, lack of enforcement or regulations, and poor cultural attitudes towards waste handling (Poletto et al., 2016, and Dias, 2015).

Currently waste management operations have seen a trend towards decentralisation and privatization with the belief that the involvement of more private individuals will improve the quality of waste manage services and also enhance cost recovery. (Post, 2001). Prior to privatization in 1995, solid waste collection service was a wholly state managed activity. By offloading over 80% of the operations to the private sector, the coverage of waste collection in the major cities has vastly improved (Oduro- Kwarteng, 2002). The same cannot be said for treatment and disposal as the situation remains extremely precarious, though some successes have been achieved through the involvements of private entities like Zoom Lion Ghana Limited, the leading waste management company in Ghana etc.

Ghana has sought to address and manage plastic waste through legislation and policies just like other countries and has attempted a coordinated national effort through the National Environmental Sanitation Strategy and Action Plan (NESSAP) and an accompanying Strategic Environmental Sanitation Investment Plan (SESIP) Policy Framework, which is being implemented by the Ministry of Local Government and Rural Development (MLGRD, 2010). Admittedly, progress has been frustratingly slow. A number of policies are already in place to address plastic waste in Ghana, notable is the National Plastic Management Policy (NPMP) which is to lay the foundation to enable the creation of an entirely new industry for redesigning, recovery and recycling plastics, preventing pollution or the environment and communities as well as creating many jobs in the green economy. However, it remains unclear as to how these policies have been translated into action and what progress, if any, has been made towards achieving their objectives and commitments in addressing plastic waste menace**.**

2.2.5 Plastic waste trade/market

The awareness on the importance of treating waste as a resource and a major trading good is growing by the day (OECD, 2018). According to the data provided by the European Statistics Office (EUROSAT) in 2015, the global traded volume of secondary plastics tripled over the period from the year 2002 to 2012 from approximately 180,000 tonnes per month to around 650,000 tonnes per month.

A significant amount of plastic waste is traded, both locally and on the international front (D'ambrières, 2019). Governments over the years have developed and implemented various stream of trade policy and regulation changes that enhance and promote growth of the plastic recycling sector. The flow of plastic waste trade starts with the capture through formal and informal collection. There are three different collection methods of plastic wastes (Wilson et al., 2005) that has been observed to contribute to the flow of the waste trade. These include:

1. Mono-Collection systems: for this system plastics are separated at source as one material fraction including more than one type of plastic, together or targeting specific types. This system is very common in a number of European countries.

2. Co-mingled collection systems: In this system, several types of source separated dry recyclables including, metals, plastics, paper. plastics etc. are collected together, and

3. Mixed Waste collection systems: for this system plastics are collected together with the rest of house hold waste. This system is very common in Ghana.

Plastic waste recycling systems are logistically complex (starting from collection, through to recycling or treatment) the cost involved are quite higher as compared to the traditional waste processing system. Just as with circular economy, sustainability of recycling is dependent on industrial demand for the plastic waste and the availability of market for the end product, which in this case is the recycled material. In addition to supply and demand, other factors that determine the trade flow of plastic waste are trade costs, geography, government policies and regulations.

Deere Birkbeck, (2020), in his study revealed that, the plastic waste trade is the way to facilitate effective waste management, especially as many countries, mostly developing countries lack the proper infrastructure to effectively, efficiently and safely recycle their plastic wastes. Further research on bilateral trade flows for different types of plastic products will add much-needed texture to the findings made by Deere Birkbeck.

The economic principle of demand and supply play a pivotal role in the plastic waste market, as the price of plastic waste depends on one hand on the supply and demand of plastic waste material. Recycling is expected, and truly has become an important sector of the global economy as direct revenues from the recycling constitutes considerable and constantly growing contributions (Foundation Knowledge Innovation Market, 2017).

The plastic market is quite complex, with the trading of Millions of tonnes of plastic waste globally. According to Wang et al. (2019) in a study of the structure of the global waste trade network (GPWTNs), the geography of the plastic waste trade has shown to be structured by Asia as the dominant importer of plastic waste, while North America and Europe are the largest source of plastic waste. It was also revealed in the study that cumulative trade volumes of plastic waste in Middle east, South America, Africa, the Middle East and Oceania showed an impressive growth and increased from 1.68 million tonnes during 1988–1997 to 14.19 million tonnes during 2008–2017 representing an 8-fold increase for the period. However, the proportion of these four regions with relative to the world's total trade volume was still small, accounting for 9.4%, 11.8%, and 9.2% of the global plastic waste trade from 1988 to 1997, 1998 to 2007, and 2008 to 2017 respectively. An assertion can be made that, Africa has a huge potential in this market if only a proper and effective plastic waste collection system is put in place. To date, little study has been done on the plastic waste trade or flows in the sub-region, especially to map the inter- and intra-continental plastic waste trade and also to quantify the impact of these trading activities on the global plastic waste trade and its management.

2.3 Conceptual framework

The study adopts the model of plastic waste recovery and recycling ideas and practices to explain the trade flows of plastic waste and patterns of plastic recycling for managing plastic waste on sustainable basis. Plastic recycling networks significantly vary between the various plastic types, and also from one place to the other. The framework (Figure 2.7) follows a linear movement of economic processes of value addition where upstream signals flows towards production and downstream towards consumption. The concept also focusses on institutional and other collective power of actors like regulatory agencies or authorities and non-Governmental Organization (NGO) and government agencies.

The sources of plastic waste generation are private households, streets and dumpsites, institutions and factories, however material transformation from plastic waste to recycling material and the trade flow generally start between waste pickers (itinerants waste buyers) and wholesalers who are located at the up-stream of the trade flow and engaged in intense sourcing of the waste material. Their activities include the collection, pre-sorting, aggregation and bulking of plastic waste materials from different places. This is mostly done by waste pickers who retrieve recyclable plastic wastes from Municipal Solid waste streams, households, public places, and landfill sites or waste dumps. Itinerants plastic waste buyers or wholesalers and agents who function as gatekeepers regarding volumes and homogeneity for plastic wastes purchase segregated recyclables and also sell them to plastic scrap shops for exports or recycling companies. The framework identifies all stakeholders involved in the plastic recycling network and explains the connections between them.

In order to also identify the social processes involved in the plastic waste trade system, the model is actor-oriented based which emphasizes on how the differences in social actions come about, and how they are reproduced and possibly transformed.

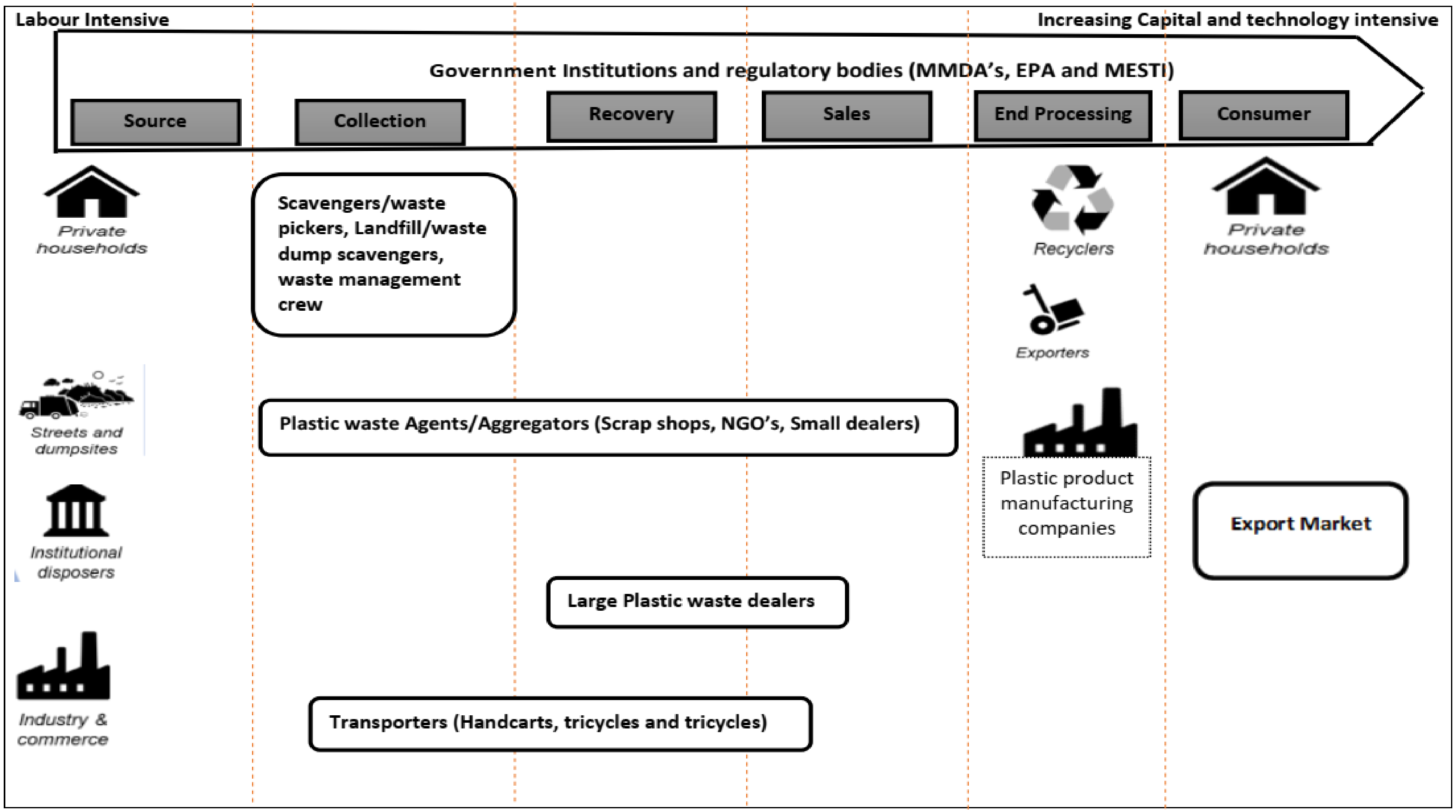

Figure 2.7 Conceptual framework

Source: Author's construct

CHAPTER THREE

MATERIALS AND METHODS

3.1 Introduction

The approach and study design are presented in this chapter. This involved description of the study area, specific geographic locations, sampling and sampling techniques. The chapter also describes how data was collected, analyzed and presented.

3.2 Description of study area

The study was conducted in the Greater Accra Metropolitan Area (GAMA) which is located in the southern part of Ghana along the Atlantic coast of West Africa. It occupies a total area of 3,245 square kilometres, and includes the capital city, Accra. It has a coastline of approximately 225 kilometres. GAMA falls within the dry coastal equatorial climatic zone with temperatures ranging between 20°C and 30°C.

The Greater Accra Metropolitan Area (GAMA) has been a very dominant urban center as a results of the high concentration of assets and economic activities. GAMA is also known to be a destination for most rural migration which is linked to a better quality of life and economic opportunities (World Bank Group, 2017)**.**

Recently, GAMA is now known as one of the fastest-growing areas in the West Africa (Farvacque-Vitkovic et al., 2008) where urbanization has far outpaced planning and available services and infrastructure, with implications for the inclusion and living conditions of the residents.

GAMA is the 'most developed' region in Ghana (Owusu, 2015), with the incidence of poverty at 5.6 percent lower than the national average of 24.2 percent in 2012/2013. However, Low-income communities in GAMA, find themselves living in informal and overcrowded housing with limited or no access to urban services like water supply, good sanitation and proper waste management services. The city is really challenged with haphazard urban development. Furthermore, GAMA faces a number of waste management issues that negatively impact the city due to its lack of capacity to manage waste effectively and efficiently. Figure 3.1 presents map of the Greater Accra Metropolitan Area showing all the Sixteen (16) Metropolitan, Municipal and District Assemblies.

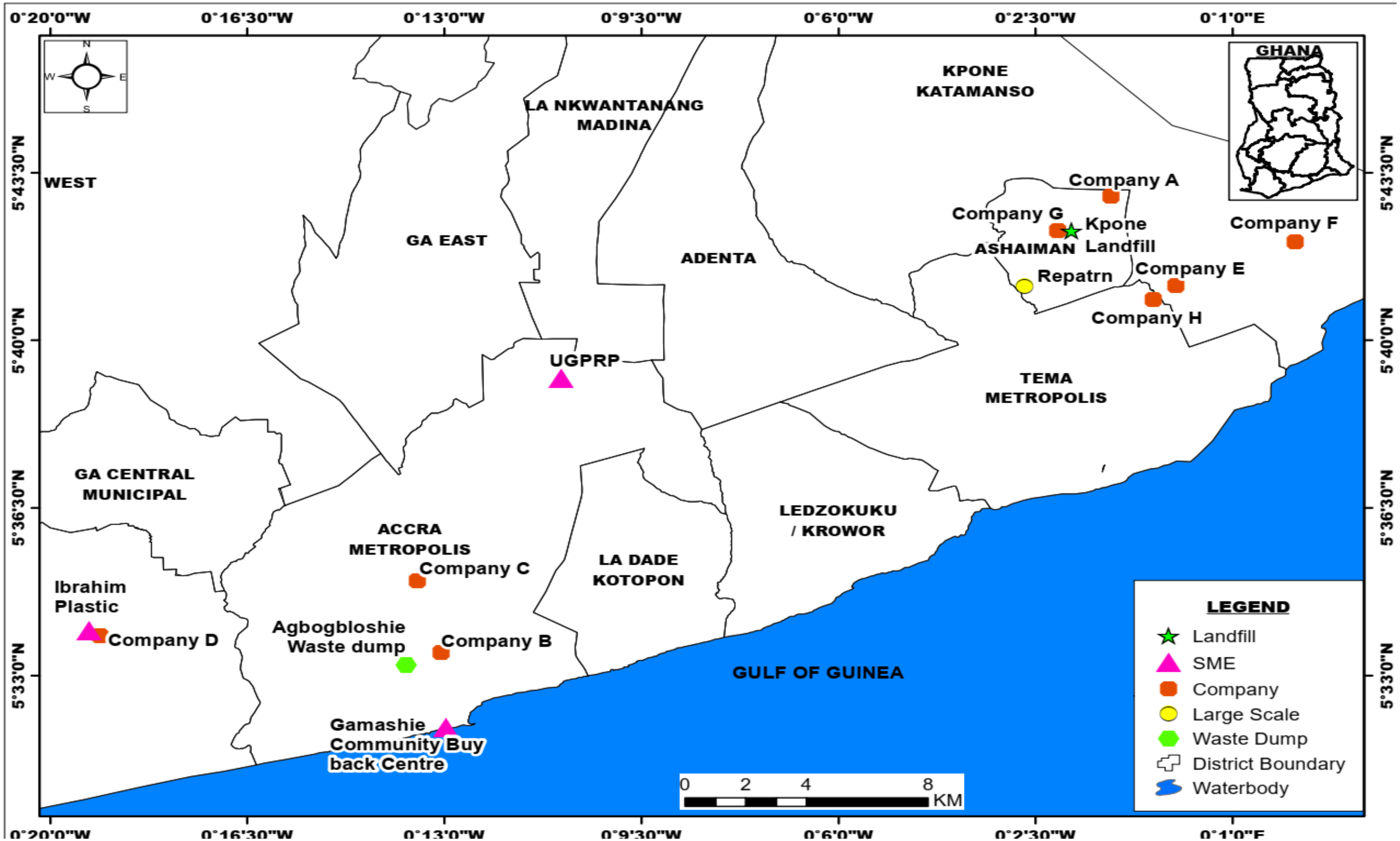

Figure 3.1: Map of Greater Accra Metropolitan Area with the sampled recycling companies and other sites

3.2.1 Demographics and Socio-economic Status

From the 2010 Population and Housing Census (PHC) results, GAMA in 2020 is projected to have a population of 4.6 million at an average yearly population growth rate o2 2.4 percent. This shows a 15 percent increase relative to the total population data in the 2010 (Owusu, 2015). The distribution of population and land mass across the 16 Metropolitan, Municipal and District Assemblies is uneven as shown (Figure 3.2).

The GAMA enclave accounts for about 25 percent of the national GDP and dominates formal (32 percent) and informal (28 percent) urban employment (World Bank Group, 2017). The governmental and commercial capital of the country is situated in GAMA, hence this makes it attractive for investments from foreign nationals, countries as well as expatriates who have plans of returning to the country. GAMA also is revered as the gateway for international trade attracting foreign direct investment.

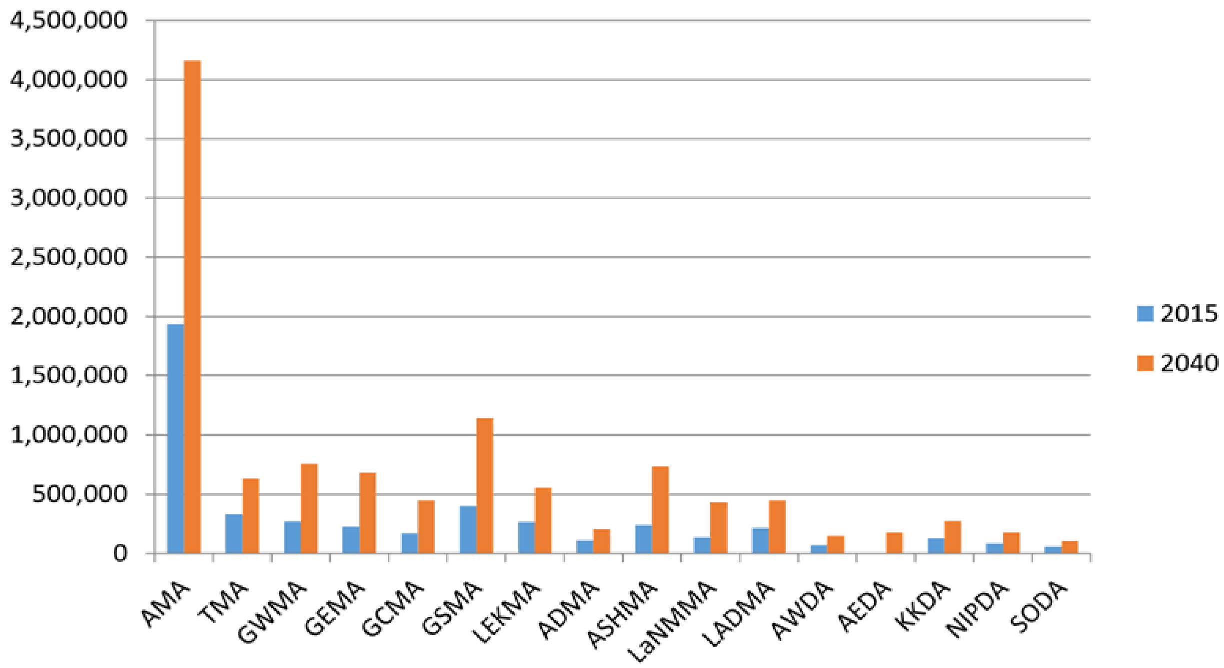

Figure 3.2: Population distribution by MMDAs
Source: Ghana statistical service, 2012

3.2.2 Governance

Based on the 1992 Constitution of the Republic of Ghana, the political administration of the area is through the local government system. Each Metropolitan, Municipal or District assembly (MMDA) is administered by a Chief Executive appointed by the president representing the central government, however the Chief executive derives its authority from the Assembly which is headed by presiding member elected from among the members (Local Governance Act, 2016).

The organizational structure as shown in figure 3.3 below is similar to all the Metropolitan, Municipal and District Assemblies in GAMA.

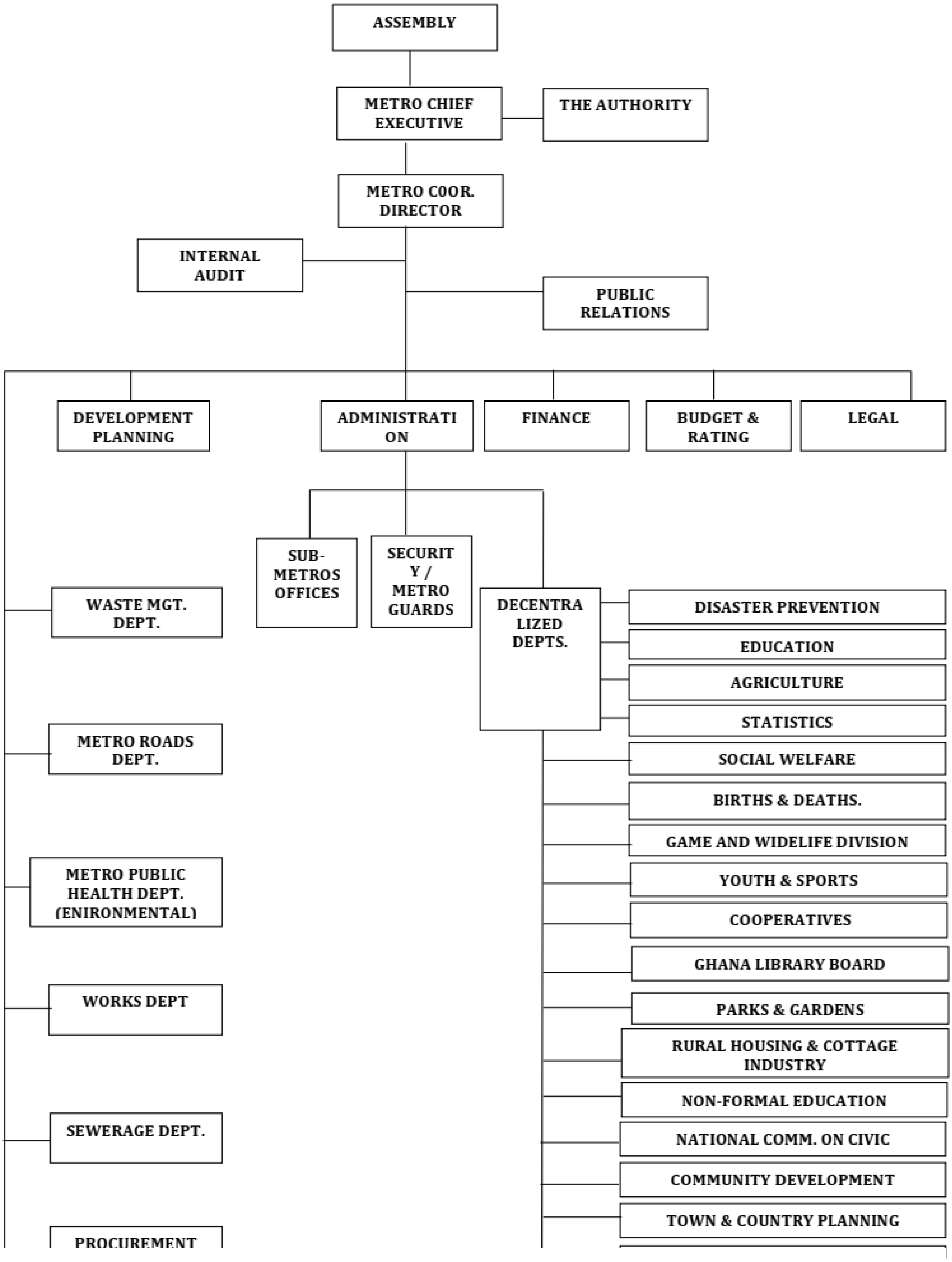

Figure 3.3: Organizational structure of MMDAs

3.3 Research design

The research design used was intended to provide an appropriate framework for the study. A mixed method research approach was employed. The first part of the study consisted of reconnaissance survey to the study area together with the participation in the activities of various stakeholders. This was followed by series of well-structured questionnaire (for management and employee's) and semi- structured interviews with stakeholders (industries, local government authorities, Non-governmental agencies) in participating organizations. Interview of stakeholders to know the relationship that exist between them was also conducted, which was complemented by field observations. To assess the trade flows of plastic waste and spatial patterns of recycling in Greater Accra Metropolitan Area, the study employed a descriptive research design.

3.4 Research Methods

Qualitative and quantitative methods and a combination of primary and secondary data were sourced to address the key objectives for the study. The qualitative data was used to support the quantitative data analysis and results. The data sources and, sampling techniques are discussed in the next section.

3.4.1 Reconnaissance study

In order to have a fair idea and a better understanding of the plastic waste trade flow, a reconnaissance survey was conducted in the study area. This was strictly an exploratory exercise to identify and familiarize with stakeholders and also to serve as a guide in choosing the appropriate research methods and approach for the study. Participation in the plastic waste collection with waste pickers, and the involvements in their trade revealed the various views some of them had about plastic waste management and the plastic waste trade.

Through the reconnaissance survey, other important stakeholders were identified, these include the Metropolitan, Municipal and District Assemblies, at this stage the Manufacturing Industry Department (MID) of the Environmental Protection Agency (EPA) was important as it has the list of all registered plastic recycling companies in the study area. A visit to the Landfill site (Kpone Landfill) revealed various scavenging activities were ongoing at the time. A brief discussion with these scavengers led to the discovery of series of plastic waste collection groups and networks.

After the reconnaissance survey, a conclusion was made on the use of snowballing sampling technique where participants in the survey were used to identify and build up the target population within the study area for this research. Snowball sampling is defined as "a nonprobability sampling technique in which an existing study subjects' recruits or appoints future subjects from among their acquaintances". (Abedsaeidi et al., 2015). This method was very useful in the case of the waste pickers and other stakeholders.

3.5 Data collection

3.5.1 Primary data sources

The primary data sources were obtained from industries working on the environment through observation and capture of scenes including photography as well as through the use of questionnaire. The stakeholders including recycling companies, NGO's, government agencies, local authorities and waste management companies were engaged through discussions and interviews using questionnaires.

3.5.1.1 Observation

Observation of some of the stakeholders was done as they ply their trade or perform their daily routines without being involved in their activities. This helped to identify what the different stakeholders were doing, with whom, using what and in what ways. Information was also obtained from participatory observation techniques. Participatory observation is defined as "a qualitative research method in which the researcher not only observes the research participants, but also actively engages in the activities of the research participants". (Dewalt et al., 1998). For this study the method was used to determine who interacts with whom and for what purpose, how the various actors communicate with each other, and also check how much time is spent on various activities.

3.5.1.2 Semi- Structured Interviews

The research employed a semi-structured interview as a method of collecting primary data or information. The questions were prepared ahead of time; however, the order of the questions was decided in the course of the interview. The interviewees were categorized into two groups:

1. Stakeholders directly involved in the plastic waste trade flow: (Plastic waste pickers, waste agents, wholesalers or aggregators, Non- Governmental Organizations, Plastic recycling companies)
2. Stakeholders not directly involved in plastic waste trade flow: (Metropolitan, Municipal and District Assemblies, regulatory bodies).

The interview questions were focused on gaining in-depth insight into the operations of the plastic recycling companies, as well as obtain information on the various views of all the stakeholders identified for the study. All the interviews conducted were on a face-to face basis at the offices of the interviewees. Based on the interviewee's preference, all the interviews were recorded and transcribed for interpretation. Appendices 1 and 2 show the sample questions and a list of interviewees respectively.

3.5.1.3 Administering Questionnaire

One standardized questionnaire was designed in a way to obtain both qualitative and quantitative data from waste pickers and other informal stakeholders in the plastic waste trade flow. It was also designed to get statistical data, their social organization and opinions on different aspects relating to their job, characteristics of each stakeholder identified and to a large extent their competence in the plastic waste trade as well as the relationship that exist between themselves and other actors. In the absence of a database of the actual number and the locations of waste keepers and other stakeholders in plastic waste recycling, this made it very difficult to know the exact sample size for the study. In all a total of 160 waste pickers across the 16 MMDAs, 60 waste agents, wholesalers or aggregators, 5 Non-Governmental Organizations (NGO), 8 plastic recycling companies designated A to H, and 10 MMDAs were administered with questionnaires.

The information contained in the questionnaire for waste pickers were different to that of aggregators and the plastic recycling companies. Relevant demographic and socio-economic information of waste pickers and aggregators, their trading activities, cost of operations as well as challenges they face were captured in the questionnaire. The questionnaire for plastic recycling companies was categorized into three sections. Section A talks about the company profile which includes the size of the business, number of employees, installed and operational capacities etc. Section B goes into the companies recycling operations and practices, and the final section probes the companies' trade, relationship with other stakeholders and the challenges associated with their trade.

Flexibility was required throughout the process, especially as the study was done during work hours, because the interviews were often interrupted halfway through conversations and trading activities in the case of the waste pickers.

3.5.1.4 Spatial Mapping

Using a Global Positioning System (GPS) device, (Astro 220 model), coordinates (Latitude and longitude) for preferable sites necessary for the development of the spatial map for the study were collected for the exact locations and documented in a record sheet. The data obtained was uploaded on a map and the locations are defined on the map as points for identification and the flows are indicated in the map as arrow with different colours depicting the various types of plastic material traded in the study area.

Plate 3.1: Garmin Astro 220 GPS device

3.5.2 Secondary data sources

Desk review of relevant material was conducted from various secondary sources like articles, books, journals etc. Literature and reports regarding plastic recycling was also obtained and used. Data was collected from companies reports and manuals and other documents which were used for desk top reviews. Books, journals, articles and magazines were also considered.

3.6.1 Population and sample size

The study population consist of plastic recycling companies, formal and informal waste pickers, plastic waste aggregators, MMDAs, Waste management Companies, regulatory bodies, Non – Governmental Agencies, experts in the Plastic waste management industry etc.

Taking into consideration the informality of the plastic waste trade in the study area, the exact number of informal plastic waste pickers in the study area was not readily available. According to Oteng-Ababio, (2012) plastic waste picking provides an opportunity for waste collectors to 'earn a living' and concludes that most of the practices of actors in the waste trade has become a survival strategy for the urban poor hence people join and move out of the trail as they so wish. To obtain an acceptable representation of waste pickers where there is no prior waste pickers and waste agents population data in the study area, the study allowed for sampling without a predetermined sample size, ten (10) waste pickers each for all the sixteen (16) MMDAs in the study area were used. Also, out of the twelve (12) plastic recycling companies (obtained from the MID department of the EPA) written to for approval to join the study, a total of eight (8) Plastic waste recycling companies responded positively, and two (2) exporters were also interviewed.

3.6.2 Stakeholders involved in the study

From literature and preliminary studies in the study area, the groups identified and described below are very important in the plastic waste management process. For the purposes of the study the groups are put into three categories:

3.6.2.1 Primary stakeholders

These are groups of people who are directly either negatively or positively affected by any process in the plastic recycling or the waste trade. These include citizens, households, Informal waste collectors and plastic waste pickers, waste buyers or middle-men or agents in the waste recycling trade as well as the waste reprocessors.

3.6.2.2 Secondary Stakeholders

These group play intermediary role and plays an important role in the plastic waste trade. These include the local government (Municipalities) and their employees, NGOs, Community Based Organizations, etc.

3.6.2.3 Tertiary stakeholders

These are not directly involved and may not be affected by the plastic waste trade, however they play a regulatory role or help with research. These include Environmental Protection Agency (EPA), Ministry of Environment, Science, Technology and Innovation, Experts, Academics and Professionals in the subject area. While conducting this study the position, interest, influence, networks and other characteristics of the various actors were considered taking into consideration their past, present positions and future potential. The process comprised of methods for:

(i) Stakeholder identification

(ii) Stakeholder classification

(iii) Interrelationship between stakeholders

Table 3.1: Planned versus actual coverage of the study

Activity	Planned	Actual coverage	Success level (Percent)
Reconnaissance Survey	3 days visit	3 days visit	100
Interview	13 personnel	13 personnel	100
Questionnaire Administration	210	210	100

The assessment of table 3.2 was based on the estimated sample size for the study.

3.6.3 Sampling procedure

To ensure that, each stakeholder in the plastic waste flow is fairly selected or has equal chance for selection a simple random sampling method was employed for the waste pickers and the waste agent. However, a non-probabilistic sampling method was used for the MMDAs and the regulatory bodies that is the Environmental Protection Agency and the Ministry for Environment, Science Technology and Innovation. Interviewees with waste pickers and other actors in the value chain were selected through the snow balling sampling technique.

3.7 Data analysis

3.7.1 Quantitative Data Analysis

Quantitative data obtained were summarized and coded in the statistical package for social sciences (SPSS) version 20. Descriptive statistical analysis was performed with central tendencies (means, variability and standard error), the student t-test was also used as type of an inferential statistic to determine if there is a significant difference between the means of the operating and installed capacity of the plastic recycling companies.

Statement of Hypothesis

H_0: Sample means are the same

H_1: Sample means are not the same

Test at 0.05 significant level

Coordinates of sampling points was used to develop a spatial distribution map of the various actors identified in the study area.

3.7.2 Qualitative data analysis

The observations made and interviews recorded were used to support the findings by subjecting the qualitative data to content analysis.

3.8 Challenges

The main challenges encountered on the field work were how to access some of the different stakeholders working in the trade flow, such as the waste buyers as well as foreign nationals like the Chinese and Lebanese owning plastic recycling facilities or companies. Obviously, they were curious of the intention behind the research. Several attempts were made to have meetings with them but all failed, except for few.

CHAPTER FOUR

RESULTS

4.1 Introduction

Chapter four presents the results or data acquired from the study from the various methods used i.e. literature review, key informant interviews, questionnaire administration, observations and collection and analysis of trade flows of plastic waste and spatial patterns of recycling in Greater Accra Metropolitan Area. It begins with the demographic characteristics of the waste pickers as well as the waste agents or wholesalers, a description of the various actors identified in the waste trade. It continues with observations made during field work on the trade regarding the waste and financial flow analyses of questionnaires and information on existing key policies, laws, regulations and institutions relating to plastic waste trade.

4.2 Demographic Characteristics of Respondents (Plastic waste pickers)

4.2.1 Gender

In table 4.1 is a summary of the demographic characteristics of respondents. A total of 160 questionnaires were administered to plastic waste pickers across the Sixteen Metropolitan, Municipal and District Assemblies in the Greater Accra Metropolis. A 100 percent response rate was recorded comprising of 120 women representing 75% and 40 men representing 25%. It can be concluded that, women dominate the waste picking sector of the entire trade in the study area.

4.2.2 Age

The survey showed that the respondents vary in age from 23 to 69 years old, with an average age of 46 years. Children under 14 years were seen picking waste as well (they were not interrogated). They were later identified as children of some of the waste pickers, who do so to help their parents on days they do not go to school.

4.2.3 Education

A large majority of the waste pickers have no form of any formal education. The survey conducted revealed that 136 representing 85% of the respondents' had no formal education, while 24 respondents representing 15% had a basic education. The highest level of education attended by those who went to school was primary four (4).

4.2.4 Marriage status

From the responses, 57 representing 35.63% of the respondents are single, 42 representing 26.25% are married, 32(16.88%) are divorced and 34(21.25%) are widowed.

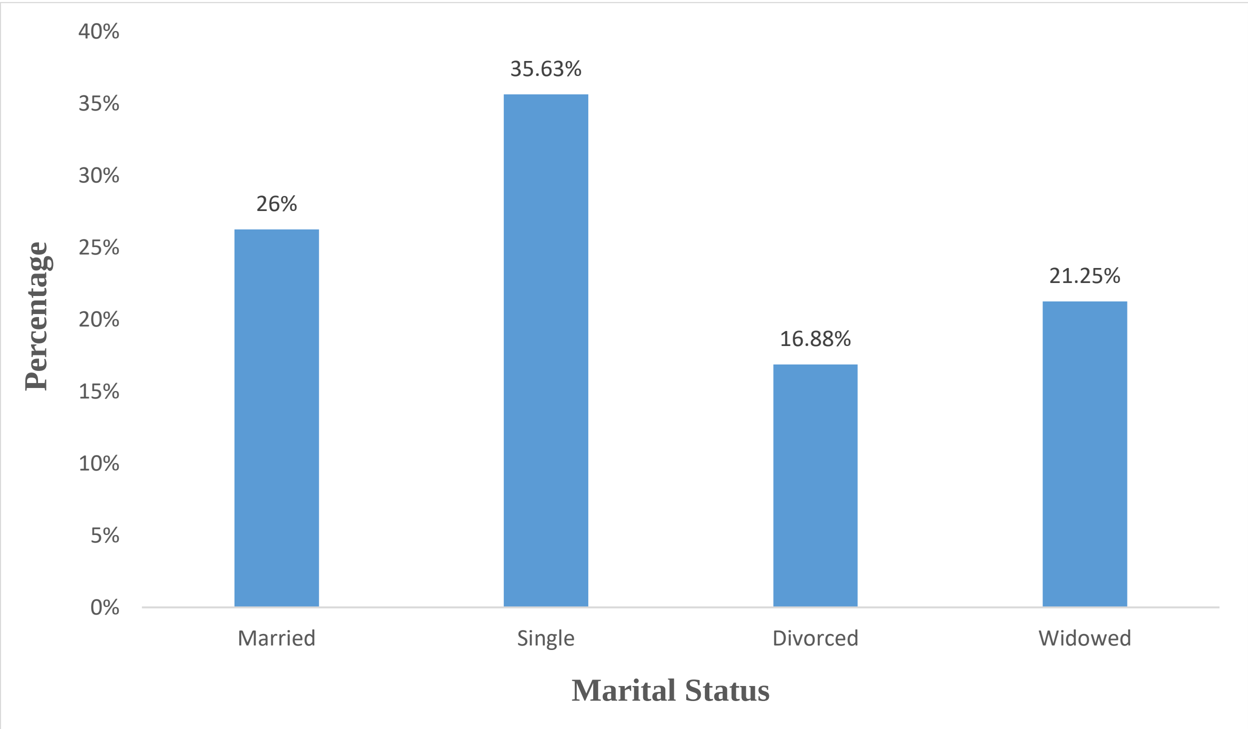

Figure 4.1: Marital status of the respondents

4.2.5 Other economic activities

A large number of the respondents answered in the affirmative when asked if they engage in other economic activities. One hundred and twenty-eight (128) respondents representing 80% engage in other economic activities to compliment the gains from plastic waste picking to support their families. Some of the waste pickers reported were reported to be porters or bearers (Kaya Yei), Construction workers, cleaners (Janitors) whiles others engage in petty trading. The 32 respondents who solely depend on waste picking activities for source of income are observed to be the aged (above 52 years) with underlining health complications.

Based on the questionnaires administered to the waste pickers, 100 of them representing 62.5% of the respondents believe that their socio-economic status after joining the scavenging activity has improved. Twelve (12) representing 7.5% of the members feel that their status is declining when compared to their previous situation and wish to stop the work should they get the opportunity. The remaining 48 representing 30% of the respondents consider their situation the same as before.

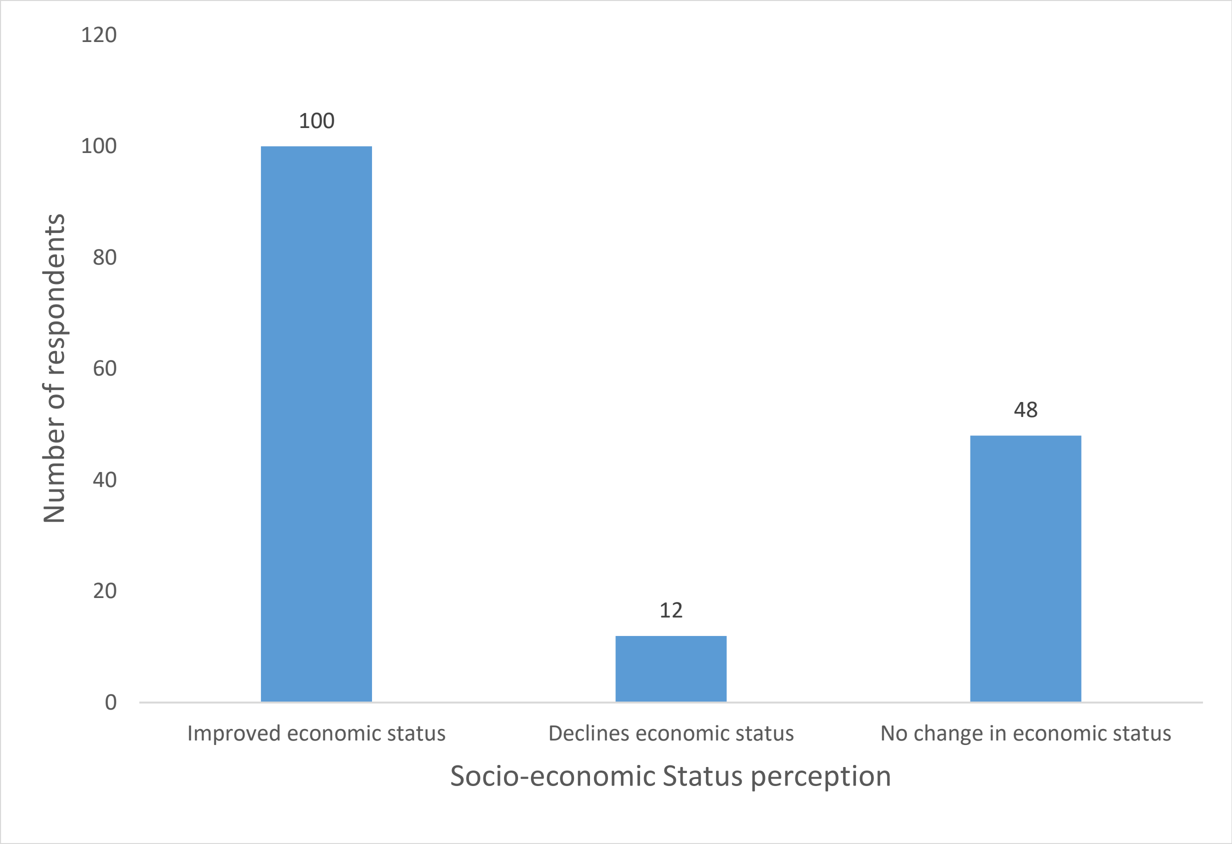

Figure 4.2: Socio-economic status perception of respondents

4.2.6 Years of waste picking experience

From the survey, 22 respondents representing 13.75% have been engaged in the waste picking activity for almost a year, 34 respondents representing 21.25% have done this for 1-3years, 61 respondents representing 38.13% have done this for 3-5 years, whiles 26.88% of the respondents has been in the waste picking business for more than 5 years.

Table 4.1 Demographic Characteristics of plastic waste pickers (n=160)

Variable	Frequency (F)	Percentage (%)
Gender		
Male	40	25
Female	120	75
Age		
18-24	18	11.25
25-31	27	16.88
32-38	30	18.75
39-45	25	15.63
46-52	32	20.00
Above 52	28	17.50
Marital Status		
Single	57	35.63
Married	42	26.00
Divorced	27	16.88
Widowed	34	21.25
Education		
No formal Education	136	85
Basic	24	15
Religion		
Christian	120	75
Muslim	39	24
Others	1	1
Years of waste picking experience		
less than a year	22	13.75
1-3 years	34	21.25
3-5 years	61	38.13
5 years and above	43	26.88

4.3 Demographic Characteristics of waste agents or wholesalers

4.3.1 Gender

In table 4.1 is a summary of the demographic characteristics of respondents (Waste agents/ wholesalers). A total of 50 questionnaires were administered to plastic waste agents, three from each of the Sixteen Metropolitan, Municipal and District Assemblies in the Greater Accra Metropolis. A 100 percent response rate was recorded comprising of 21 women representing 35% and 39 men representing 65%.

4.3.2 Age

The survey showed that the respondents vary in age from 31 to 53 years old, with an average age of 42 years.

4.3.3 Education Level

In terms of education level, some of the respondents had primary (basic) education (42.9%), while 46.4%, 7.8% and 2.9% had secondary, tertiary and no formal education, respectively.

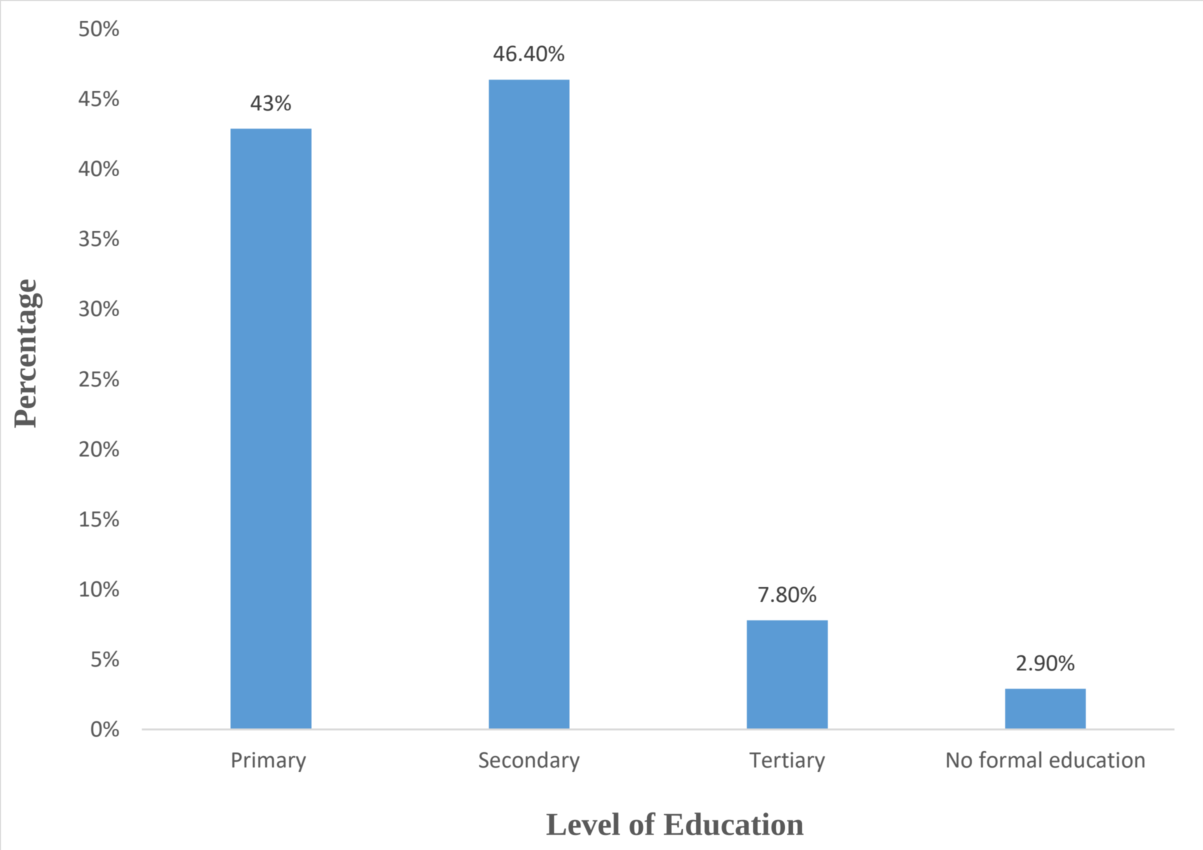

Figure 4.3 Level of education of waste agents/wholesalers

4.3.4 Marriage status

With respect to marital status, 66.7% were married, 20.0% were single while the remaining were divorced (10%) and widowed (3.33%).

4.3.5 Years of experience

From the survey, 26 wholesaler's/waste agents representing 43.3% have been engaged in the waste trade activities for more than 4 years, 22 representing 36.67% between 2-4 years and 20% for 1-2 years.

4.3.6 Socio-economic perception

All the wholesalers or plastic waste agents believe that their socio-economic status has improved after joining the trade.

Table 4.2 Demographic Characteristics of plastic waste agents/ wholesalers (n=60)

Variable	Frequency (F)	Percentage (%)
Gender		
Male	21	35
Female	39	65
Age		
18-24	0	0
25-31	4	6.67
32-38	17	28.33
39-45	19	31.67
46-52	15	25.00
Above 52	5	8.33
Marital Status		
Single	12	20.00
Married	40	66.70
Divorced	6	10.00
Widowed	2	3.33
Education		
No formal Education	2	2.90
Primary education	26	42.90
Secondary	28	46.40
Tertiary	4	7.80
Religion		
Christian	42	70
Muslim	18	30
Years of experience in plastic waste trade activity		
less than a year	0	0
1-2 years	12	20.00
2-4 years and above	22	36.67
More than 4 years	26	43.33

4.4 Actors within the plastic recovery and recycling system

The results obtained shows that, the entire life cycle in plastic waste recycling in GAMA engages a very broad set of commercial stakeholders - from waste management companies to diverse SMEs, and the informal sector, which includes waste pickers etc. Through observations, it was noted that, some actors or players are involved in several activities at the same time, while others are also involved in the system than others. For instance, some SMEs and NGOs like Environment 360, Plastic Punch etc., do not only train and educate the community on plastic waste management, they are identified as key stakeholders who trade by selling waste plastics collected after their clean up exercises. They in some cases serve as aggregators or agents buying plastic waste material from waste pickers where they export or sell to the recyclers. The actors identified with commercial stake can be categorised into three groups as listed below:

Group one (Waste pickers or collectors)

1. Waste management Crew
2. Street waste pickers
3. Landfill/waste dump scavengers

Group two (Aggregators)

4. Plastic waste agents/ wholesalers
5. Small scale plastic waste enterprises
6. Large scale plastic waste enterprises

Group three (Recyclers)

7. Plastic recycling companies

4.4.1 Waste management Crew

During the collection of municipal waste by formal waste management companies, the garbage collection crew were observed to be separating recyclable plastics from household's wastes they collect. These recyclable plastics are put in large containers at the back or on top of the waste trucks while it moves to other collection points. They sell the plastic waste to waste agents positioned near them at the end of the day, their intention is not to gather much. Through this they earn additional income aside their daily or monthly wage.

Plate 4.1: Waste management crew

4.4.2 Street waste pickers

This is another group of actors called street waste pickers, who move on streets with large polythene bags, reclaiming recyclables from mixed waste disposed in garbage bins or on the streets. Some of these waste pickers do have arrangements with households and commercial facilities (Shops) for access to already separated plastic materials. These street waste pickers prefer to work early in the morning from 6:00am to 10:00am to avoid the scorching effect from the sun and as well get early access to the plastic waste before their competitors, some also would like to attend to other businesses after the waste picking activities. With low or no formal education, they often enter the waste picking business as collectors due to its relatively no capital requirements. Street sweepers working with Zoom Lion Ghana Limited, a formal waste management company that provides waste management and environmental sanitation services in the country, are another marginal group operating in a similar fashion while on their daily sweeping activity. The average weight of plastic waste collected per day per waste picker was between 50 to 100kg. The quantity collected is dependent on the availability or quantity of plastics within their catchment.

Plate 4.2: Street waste pickers on their routine activities

4.4.3 Landfill/waste dump scavengers

Landfill/ waste dump scavengers make a livelihood from the collection of recyclables that ends up at the landfill and the waste dumps. Waste pickers from this category have a special use of organizational formats in the form of associations. Example of such associations include Kpone Landfill Pickers Association and Biakoye Waste Pickers Association. Similar to other waste pickers, they sell their materials to agents with weighing scale offering better price.

Plate 4.3: Waste pickers sorting through waste at the Kpone Landfill

4.4.4 Plastic waste agents or wholesalers

The study also revealed another group called the Plastic waste agents or wholesalers. This category of stakeholders operating informally as aggregators, buying plastic waste from waste pickers. They sell the plastic waste in bulk to recycling companies or larger enterprises for export. The plastic waste agents are considered a very important link between the informal and the formal plastic waste trade economy. Most of these agents have means of transport (Tricycles) locally called "*aboboya*" or "*bola taxi"*. These agents have operating capacity of about 500-800 kg/day for pre-processing which includes, washing, cleaning, and compressing to reduce the size and all these increases the value to the plastic waste that is to be sold to the recycling companies or other larger aggregators (Medium or large scale plastic recovery enterprises).

Plate 4.4:Plastic waste agent on a tricycle

4.4.5 Small Scale Plastic Waste Recovery Enterprises

These are another group of aggregators, but have been registered and are typically with well-constructed or established workshops or warehouse as operation base receiving plastic waste with an average capacity of between 2 -10 tons per day. (their ambition is to start small and later grow larger over time). The small enterprises are mostly Non-Governmental Organizations, community owned projects, or private enterprises etc. working closely with plastic waste agents and collectors alike. They also work as advocates in the waste management sector and engages in community and beach clean-up exercises. Their operations are mostly manual with between 3-5 working staff. They usually sell to large enterprises or to plastic recycling companies in close proximity.

Plate 4.5: Shops of a small-scale plastic recovery enterprise

4.4.6 Large Scale Plastic Waste Recovery Enterprises

Large Scale Plastic Waste Recovery Enterprises have larger capacity regarding operation size and market with the average capacity to receive more than 10 tons of plastic waste per day. These are registered organizations or businesses adhering to certain safety standards. They also use heavy equipment like forklifts, trucks etc. in their operations. Some of these large enterprises have accumulated enough capital to purchase plastic granulation/ crushing machine. Plastic waste obtained are sorted and compacted and later sent to factory for processing or exported. Ninety percent (90%) of them have plans of expanding their production activities by processing the plastic waste into pellets to be sold to plastic products manufacturing companies.

Plate 4.6: Compressed PET bottles to be exported by a large-scale plastic waste enterprise.

4.4.7 Plastic Recycling Companies

When plastic wastes are collected and aggregated, they are sent to the plastic recycling companies for further processing and treatment. The plastic waste is converted into pellets or granules. These companies are registered with the registrar general department and also have the Environmental Permit from Environmental Protection Agency (EPA) to operate in their respective capacities either to only pelletize the raw material for export or sell them to plastic products manufacturing companies or to produce the plastic products themselves. The plastic recycling companies identified and used for the study are designated A to H in table 4.3 below.

Plate 4.7: workers in a plastic recycling company

Table 4.3: Organisational characteristics of plastic recycling companies sampled

The table presents a brief description and operational overview of the recycling companies designated A to H.

Plastic recycling company	Organisational Characteristics
Company A	Company A is a licenced plastic recycling company located in Kpone in the Kpone-katamanso Municipality and owned by Indians. With an installed capacity of 22 tons/day, it recycles LDPEs into pellets and sell to plastic products manufacturing companies. The company has about 80 (both men and women) employers.
Company B	Company B is a licenced Ghanaian owned plastic recycling company located at the light Industrial Area in the Korley-Klotey District, owned by a Ghanaian. It recycles LDPEs into pellets and sells to plastic products manufacturing companies in Ghana. It has an installed capacity of 30 tons per day. Company B has about 25 workers (both men and women).
Company C	Company C is a subsidiary of a large company located at the light Industrial Area in the Korley Klottey District. Company C operates at 30% of its installed capacity of 450 tons per day. The company is owned by Lebanese, and employs about 200 workers (both men and women). It recycles both LDPEs and HDPEs into pellets which is transferred to the mother company for the production of plastic products.

Company D	Company D is a licenced plastic recycling company located at Weija close to the Weija waste dump. The company is owned by Chinese, with an installed capacity of 70tons/day. It receives averagely 10 tons of waste plastic daily and employs about 70 workers (both men and women). Company D recycles LDPEs and HDPEs into pellets which are sold to plastic product manufacturing companies in Ghana.
Company E	Company E is a licensed plastic recycling company in the Tema Heavy Industrial Area, and recycles HDPEs into Pellets and other plastic products. Company E has an installed capacity of 25 tons per day, employing 280 workers both male and female. The company is owned by Lebanese. The company receives waste from all over the country and also from neighbouring countries like Togo, Benin and Burkina Faso.
Company F	Company F is a licenced plastic recycling Company located in Kpone close to the Kpone Land fill site. The Company is owned by a Ghanaian, and recycles PPs and PVC which are mostly source from the land fill or imported from countries like Togo, Germany and Nigeria. It has an installed capacity of 40 tons per day, employing 20 workers (both men and women). The company recycles the waste collected into polypropylene sacks.

Company G	Company G is a licenced plastic recycling Company located at Kpone, in the Kpone- Katamanso Municipal Assembly and has an installed capacity of 30 tons per day. The company is Chinese owned and recycles LDPEs into plastic packaging bags. It currently has 30 workers, and operates about 33.3 percent of the installed capacity.
Company H	Company H is a licensed plastic recycling Company located at the Tema Heavy Industrial Area and recycles LDPEs into plastic packaging products. It employs about 150 workers (both men and women) with an installed capacity of 80 tons per day.

4.5 Sources of plastic waste

The results also indicate that; the sources of plastic waste can be clustered into four major categories. The graph below (Figure 4.4) displays the distribution of the collection sources referred to by the waste pickers in the field survey. Figures on top of the bar charts represent the number of interviewees who explicitly referred to the respective source. Most frequently mentioned were households as a source of plastic waste, highlighting the presence of the informal sector within residential areas, followed by streets and landfill sites, institutional disposers and industry and commerce being the least mentioned.

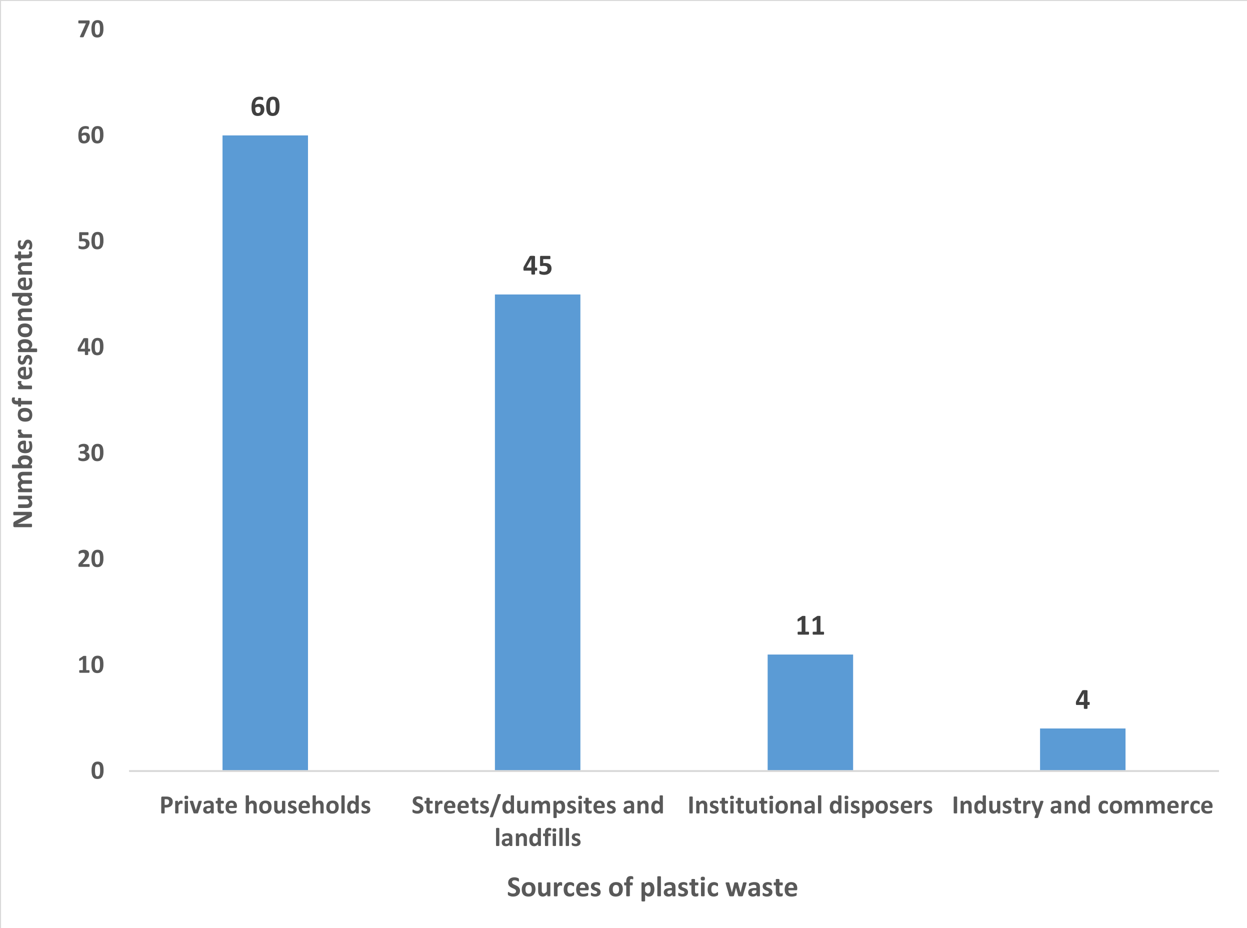

Figure 4.4: Sources for collection of plastic waste mentioned during interviews

4.6 Types of materials and quantities processed

Figure 4.5 below depicts the types of polymer and the quantity being processed by the eight (8) recycling companies interviewed. The companies, while specializing in one plastic type or the other, altogether recycles/ processes about 47 tons of HDPE, 41 tons of LDPE, 20 tons of PET, 15 tons of PP and 5 tons of PVC per day. The survey also revealed that 98% of them were processed by the recycling companies are sourced from the informal waste pickers through the waste agents/wholesalers. Recycled Plastics granules are used for a variety of products, ranging from bowls, cups, chairs, plastic packaging products, carpeting, clothing, films, strapping and bottles. They are also used in the building and construction sector as well. Surprisingly all the

PETs are processed, compacted and exported for granulations in countries like Germany, Italy, Denmark etc. according to the aggregators.

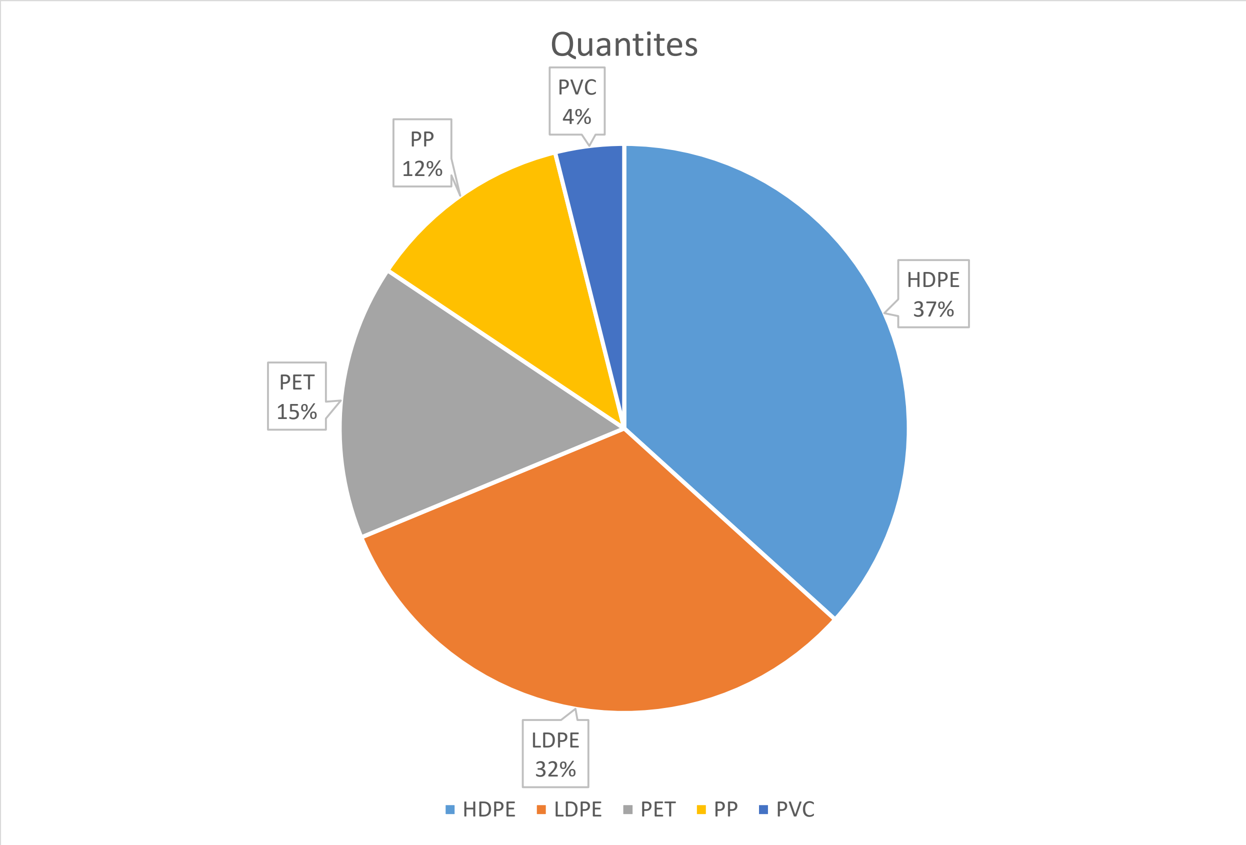

Figure 4.5: Quantities and types of plastics recycled per day by recycling companies

4.7 Installed Capacity and operating capacity

In all, the recycling companies process 268 tons (26.2%) of the 648 tons of plastic received daily. Company C with the largest installed capacity of 450 tons per day processes 135 tons (30%) per day of the installed capacity. Figure 4.6 below shows the volumes of plastic waste processed daily as against the installed capacity for each recycling company. All the processing companies operate far below their installed capacity. The main reason for such occurrence, according to the recyclers, was due to lack of reliable supply of waste material in quality and the nature of their operation, which is 80 percent manual.

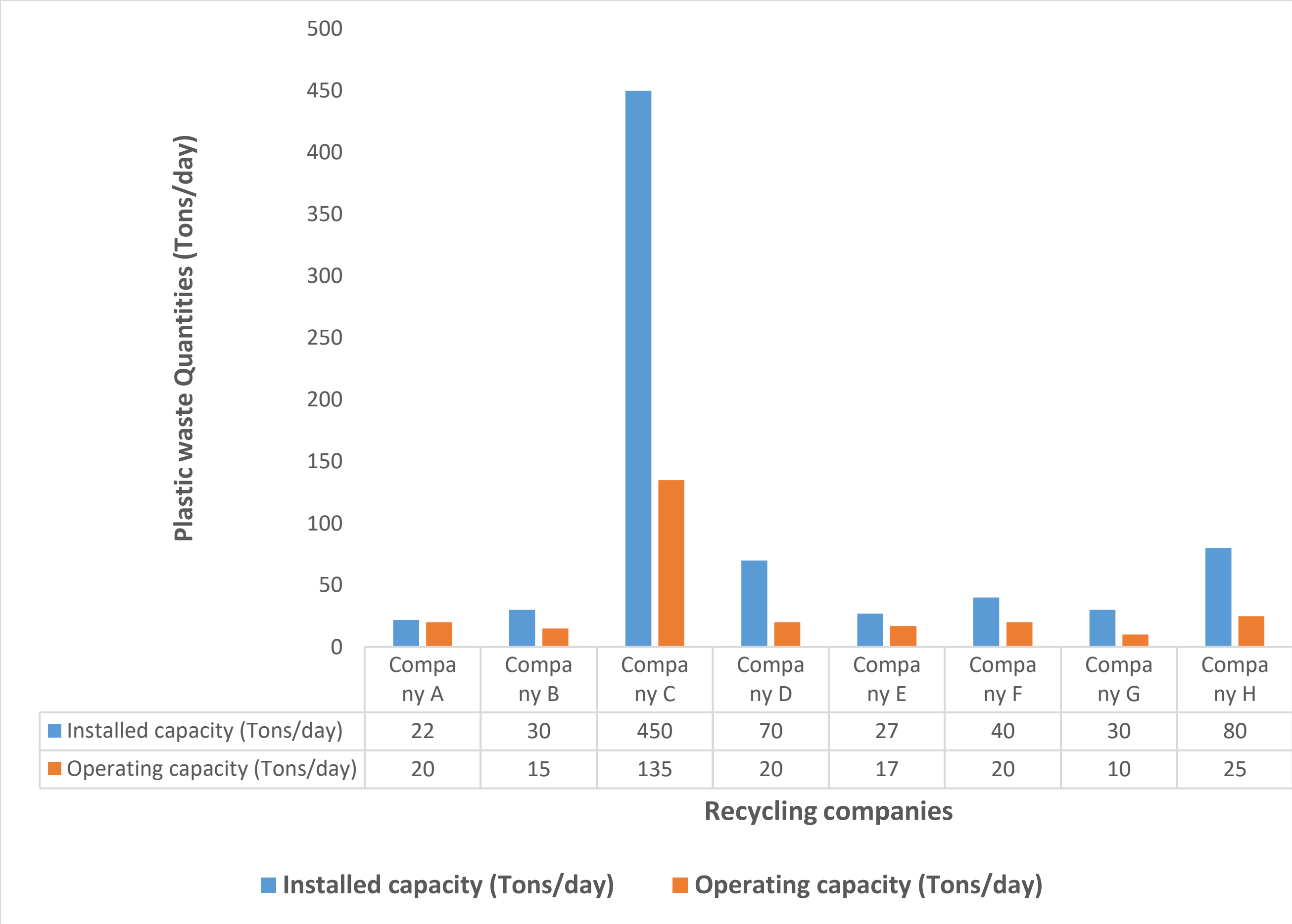

Figure 4.6: Installed Capacity vs. Operating capacity of recycling Companies

4.7.1 Test of statistical significance

Table 4.4: t-Test: Two-Sample Assuming Unequal Variances

	Variable 1	*Variable 2*
Mean	93.625	32.75
Variance	21183.98214	1726.214286
Observations	8	8
Hypothesized Mean Difference	0	
Df	8	
P(T<=t) two-tail	0.288229928	
t Critical two-tail	2.306004135	

Decision Rule

If p-value is less than the significant value of 0.05, we reject the null, or if otherwise accept.

Conclusion

Since the p-value of 0.29 is greater than the significant level of 0.05, we fail to reject the null and conclude that we have strong evidence that the means are the same. Since the means are the same the plastic recycling companies were producing just at their capacity hence, they are being efficient.

4.8 Structure of the plastic trade network

Drawing from the information collected during the field survey, the plastic waste trade network reflects the trade relationship among the several stakeholders identified in the study area. A cyclic generic flow was observed and presented in figure 4.7 below. Generally, the flow starts with plastic product manufacturing companies or importers of plastic products, these group are responsible solely for all plastic products in the study area. The consumers then use the plastic products, generating waste after the intended use are over. The waste management companies are tasked to collect and manage the waste generated, however there is seemingly a marginal group of people ambiguously called the informal sector comprising of waste pickers, scavengers etc. playing a very important role by recovering plastic recyclables from various sources including the homes, streets, waste dumps etc. All the recyclable plastics collected are then aggregated and sent to processing plants and recyclers. The pellets or plastic granules produced from the plastic waste are then exported or sold to the plastic product manufacturing companies.

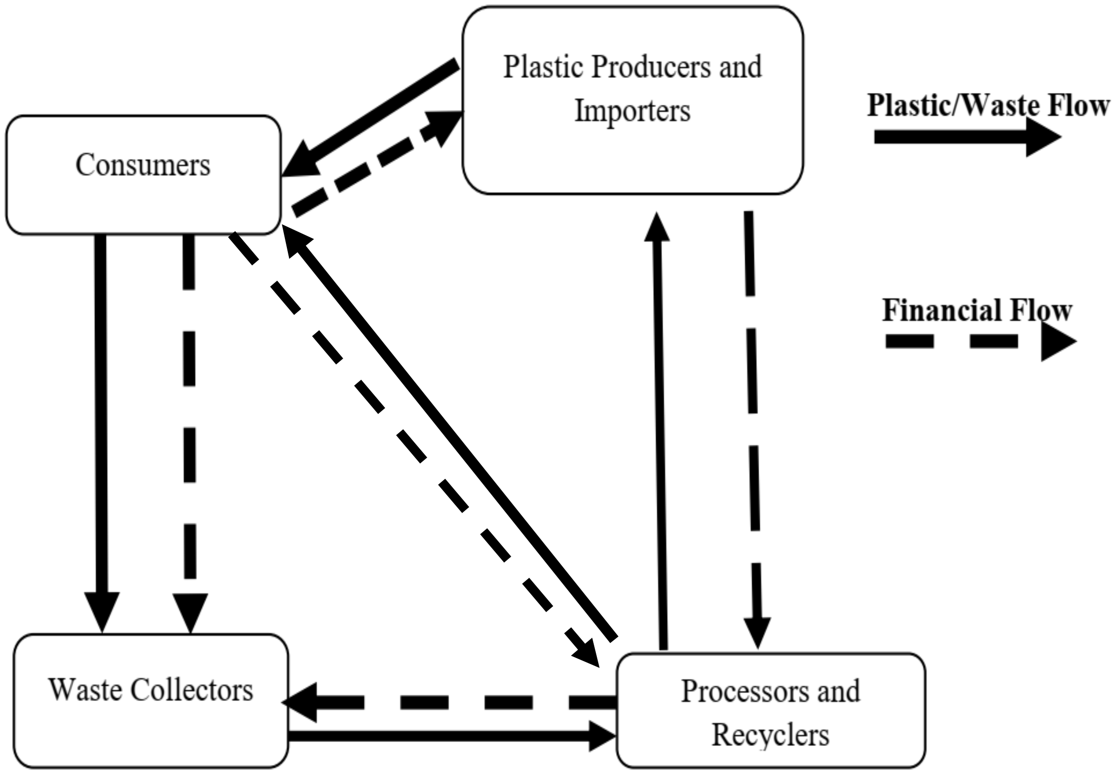

Figure 4.7: Generic plastic/waste flow in GAMA

In between the generic plastic waste flow are complex hidden networks and relationships among several actors identified during the study. The relationships among the actors were mapped revealing a complex network, where the boxes represent the actors and the connections (arrows) in between are the trade relationships (Figure 4.8). A wide range of stakeholders are involved along the value chain of plastic waste trade in a linear style from waste sources, through collection, recovery, sales and end processing. However, the various components in the cycle are interconnected with several feedback loops.

The plastic waste flow starts from the waste source which includes households, communities, restaurants, landfill and dumpsites. Waste pickers (landfill/waste dump scavengers, street waste scavengers and waste management crew) go round picking these waste and sell them to plastic waste agents/ wholesalers, the waste agents will aggregate waste collected by different waste pickers and may either sell to small plastic waste enterprises or large scale enterprises or even to the recycling companies directly, this is dependent on proximity to any of the actors required. The small-scale plastic waste enterprises also trade with either a large-scale plastic waste enterprise or directly to the recycling companies close to them. The large-scale plastic waste enterprises who are at the final stage of reclaiming also trade directly to the recycling companies or may either export the waste to countries like Germany, Italy, Denmark, etc. for recycling. Figure 4.8 shows the schematic flow of plastic waste recycling/trading system as observed in GAMA.

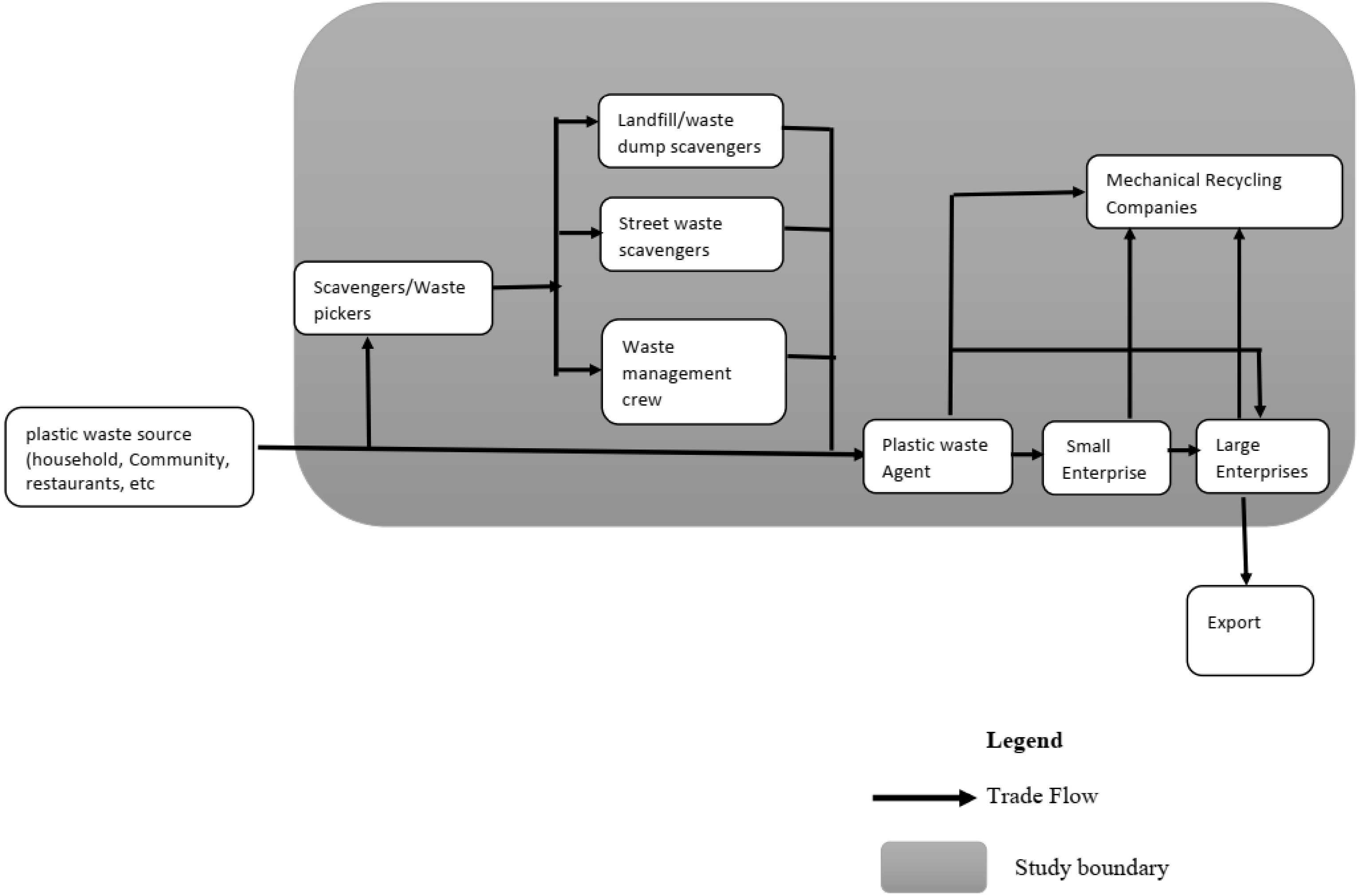

Figure 4.8: Schematic flow of plastic waste recycling/trading system in GAMA

4.8.1 Capital and labour

The field investigation revealed that, capital is not required for waste pickers, however the average working capital of GH₵1,200.00 for waste agents or wholesalers comes mostly from own sources. Forty-four (44) respondents, representing 88% of the waste agents or wholesalers rely exclusively on their own funds for their business activities. The remaining 12% obtained credits from family and friends to start the business. Although majority of the traders rely on own funds to finance their operations, they report that those funds are insufficient however 81% would like to see their funds increased though grants or loans.

Asking the respondents why they do not apply for formal credit, 5% of the respondents revealed that, they do not know the procedure in requesting for a loan from the bank, while 34% of them say the application procedure for loan acquisition is too complicated. The rest either consider the interest rate too high (51%) or do not possess any collateral (10%). However, it was observed that, there was a positive correlation between firm size and educational status and some level of reliance on formal financial institutions.

With the exception of the plastic recycling companies, who require large labour force (Plate 4.8) to function effectively and efficiently, most of the plastic waste traders employ very few people other than themselves, their work force includes one permanent employee, unpaid family helper and a casual worker. The results also indicate that, the waste agents/ wholesalers have little or absolutely no external help in their business and they seem to do most of the trading on their own. The large-scale traders make more use of permanent and temporary employees and also use the services of collecting agents. In the recycling companies, the work is shared in a way, women are responsible for activities such as sorting, packaging and cleaning the area or facility, while the men do the material transportation, loading of bags and handling of machinery.

Plate 4.8: Labour force in a plastic recycling company

4.8.2 Financial flows with trading prices

The survey revealed that, the major incentive by the plastic waste collectors is monetary, some of the respondents also mentioned that, trust and good relation plays a role as many households and commercial facilities prefer to keep their plastic waste for a few loyal collectors for no fee. The survey also revealed that, there are no fixed prices for the plastic waste at the upstream, however they are negotiated depending on the buyers bargaining power as well as the type and quality of the waste material, the knowledge of the parties also plays a role. The value of the plastic waste increases as they move from one stakeholder to the other in the trade flow. The findings of the average cost for a kilogram of plastic material as it gets transformed along the chain can be seen in figure 4.0 below.

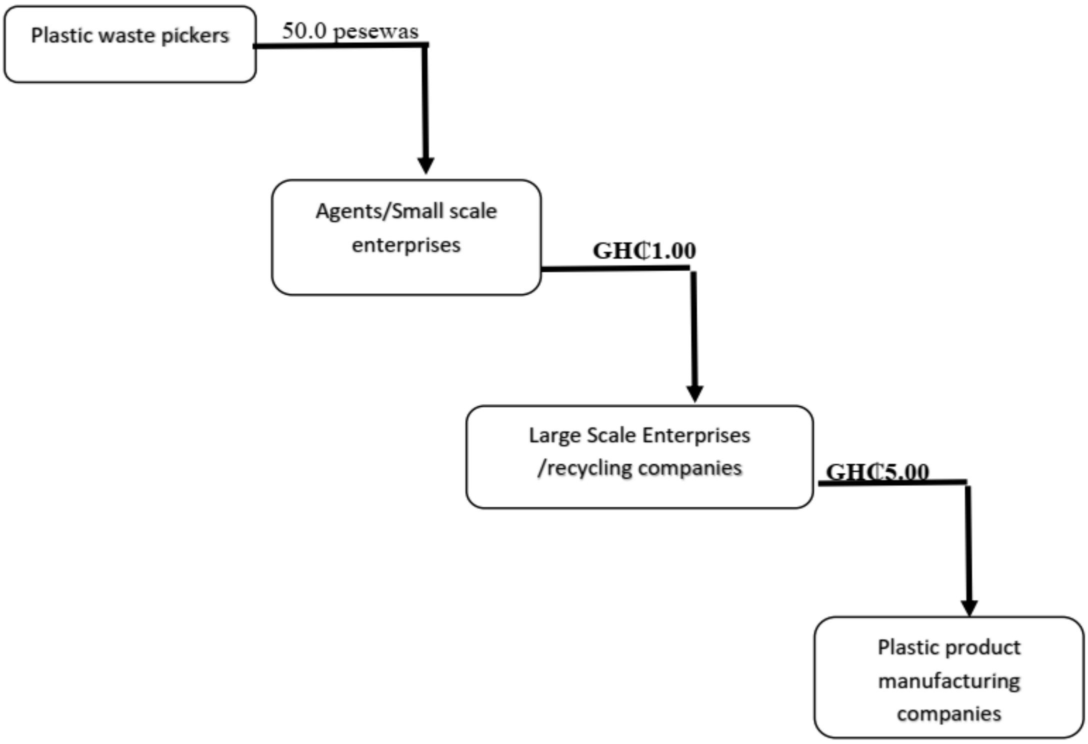

Figure 4.9: Average cost for a kilogram of plastic material along the chain

The plastic waste agents buy a kilogram of the waste material at 50.00 pesewas from the waste pickers who then transport the material to a recycling company for a fee of GH₵1.00 per kilogram. After the plastic waste are processed and pelletized they are sold to plastic product manufacturing companies at GH₵5.00 per kilogram.

4.8.3 Income generation

The results indicate that, the income generation rates in the plastic recovery system in GAMA differs sharply between the various groups at different levels within the system. The data from the field survey indicates that a full-time waste picker makes between GH₵25.00 to GHC30.00 per day, which is more than the Ghana's national daily minimum wage of GH₵11.82 (Ghana Statistical service, 2019). Because the waste agents and aggregators do not keep their trade records, while others were hesitant to communicate their effective turnover to outsiders, it was difficult to estimate the actual income from their activities. However, it was clear from the interviews with them that they were satisfied with the income they generate, though they wish to get more.

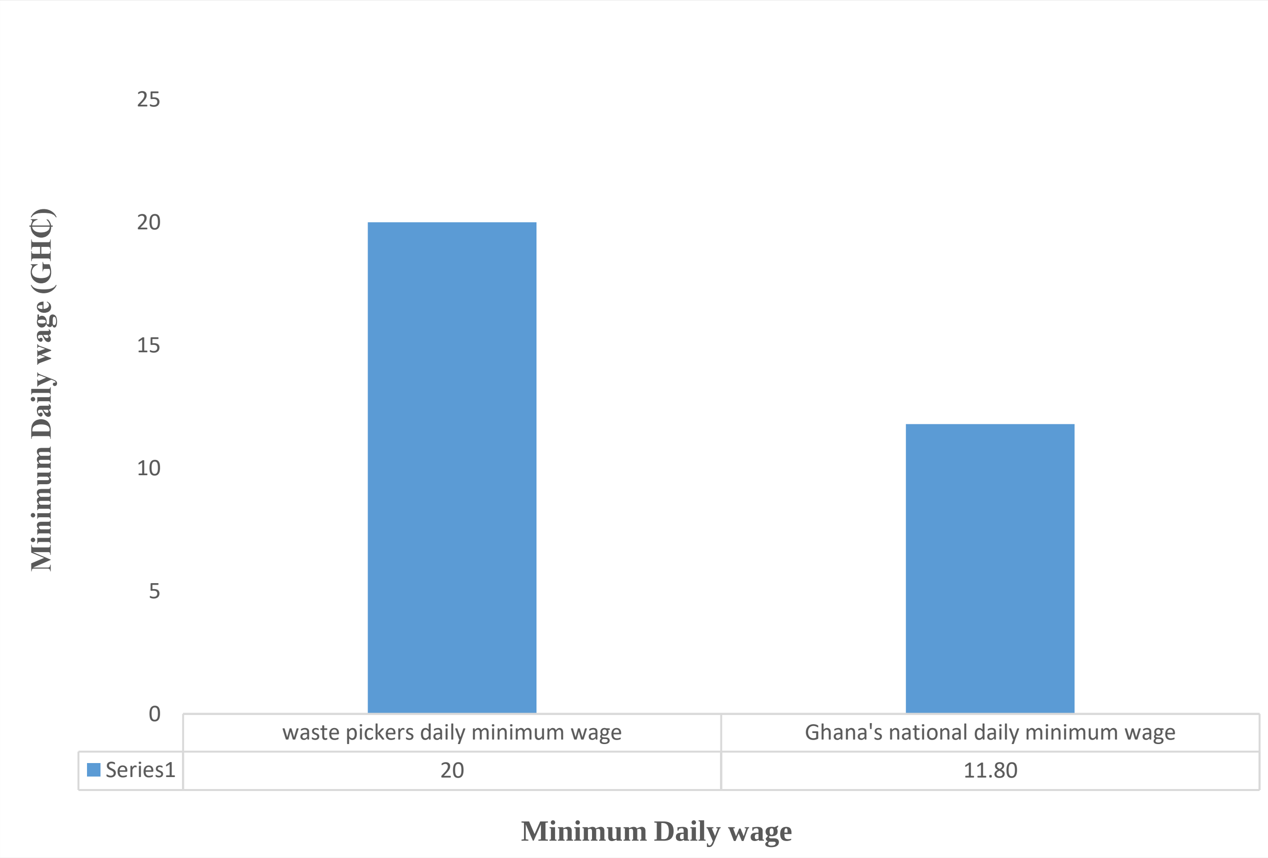

Figure 4.10 Waste pickers daily minimum wage vs. Ghana's national daily minimum wage

4.8.4 Logistics and transport system

The movement of plastic waste in the trade as observed was facilitated by trucks and tricycles. Thirty (30) percent of the aggregators (waste agents, small and large scale plastic waste recovery enterprises) did not have their own means of transport so they relied on other people for transport services. Forty-three percent (43%) of the waste agents use tricycles, locally called "aboboya" (Plate 4.9 and 4.10) and the remaining 57% of the waste agents / wholesalers use large trucks. From the survey, the tricycles are the preferred option for transporting plastic waste of about 350kg and below over a short distance. According to the respondents, it reduces their cost.

From the waste agents and interviews with key persons in the trade, a frequent challenge mentioned is the cost of transportation. The respondents (waste agents), complained about the cost of transporting waste to recycling facilities and the cost of transporting processed waste (pellets) to buyers mostly in Accra and Tema. Many mentioned that transportation cost constitutes up to 50% or more of their operating cost**.**

Plate 4.9: Tricycle for transporting plastic waste

Plate 4.10: Truck for transporting plastic waste

4.8.5 Trade Volume

From the responds, a clear trend in the trade of plastic waste was that, it had substantially grown in size, trade partnerships, and trade mass when compared to the previous year (2019). The waste pickers, agents, both small and large plastic waste enterprises all agree that a lot more people have joined the trail and it is even more difficult to tell or estimate the number of waste pickers in the study area, since they all operate informally. The plastic recycling companies also say that; their trade partners have also increased over the year. From the survey the Average Daily Trading Volume (ADTV) between the waste pickers and the aggregators used for the study was estimated to be 648 tons (587,856 kg). In order to calculate the annual trade value among the waste pickers and the aggregators, assuming the waste pickers work 6 days a week, which translates to 313 working days in a year, the Annual Trade Volume in Kilogram was multiplied by the cost for one (1) kilogram of plastic waste.

$$\mathbf{ATV} = \boldsymbol{ATVo} \times \boldsymbol{C}$$

Nomenclature

ATV= Annual Trade Value

ATVo = Annual Trade Volume in Kilogram

C= Cost for a kilogram of plastic waste in GH₵

ATVo = 313 × 587,856 kg = 183,998,928 kg

ATV = 183,998,928 kg × 0.5p = GH₵ 91,999,464

This means that 202,824 tons (183,998,928 kg) of plastic waste is traded among the waste pickers and the agents for a year, which is valued at GH₵91,999,464 (1 kilogram of plastic waste = 0.5 pesewas) between the waste pickers and the waste agents only, taking into considerations all seasonal variations.

This shows a rapid increase when compared to the plastic waste trade volume in 2019 (Obtained from the plastic recycling companies) as indicated in the graph below. The most dominant trade community in the study area was Tema, Kpone- Katamanso and Korley klottey. This was attributed to the relatively high number of recycling companies present in those areas.

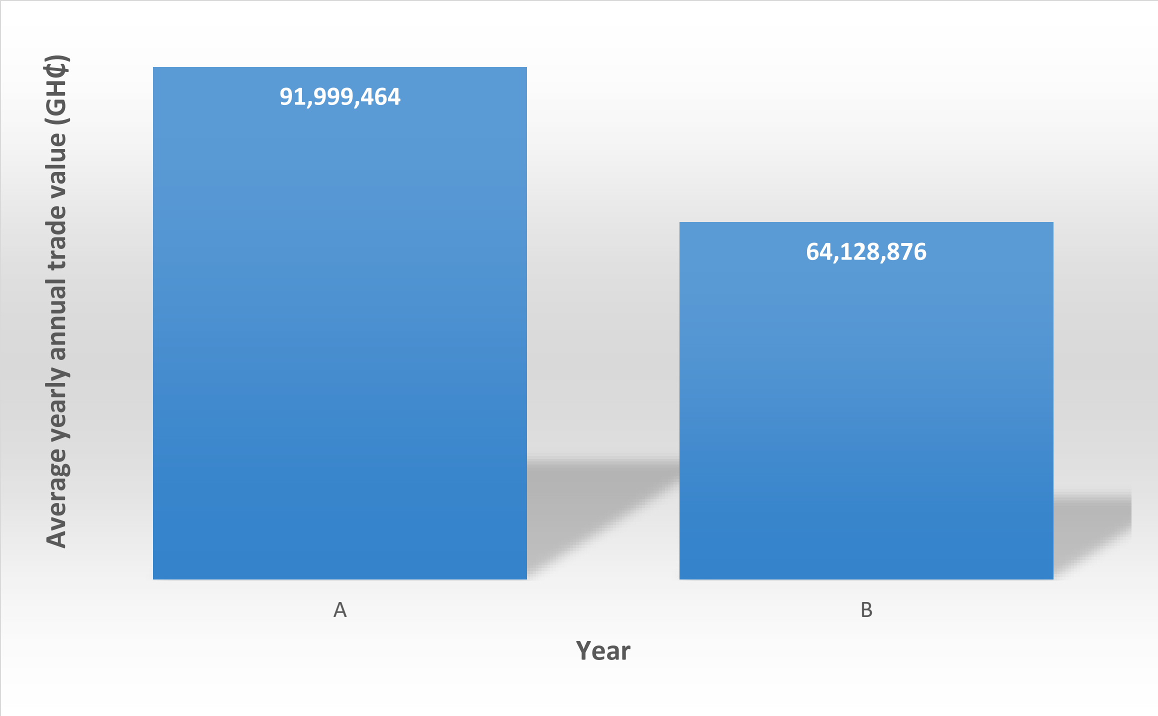

Figure 4.11: Average Yearly Trade Volume

4.9 Spatial Distribution of some Plastic recycling actors in GAMA

The survey indicates that, all the Metropolitan, Municipal and District Assemblies do not own material recovery facilities (MRFs); they are all owned solely by private individuals. Figure 4.12 below shows the spatial distribution of the eight (8) out of a list of twelve (12) recycling companies obtained from the Manufacturing Industry Department of the Environmental Protection Agency, some other stakeholders as well as other relevant sites aiding the plastic waste trade. It was revealed in the study that all the plastic recycling facilities interviewed were located either in a highly populated area, close to a landfill or dumpsite, or in an industrial area. Other less populated areas mainly are served by the aggregators collecting and buying waste from the communities to the recycling facilities. They say, cost of transport impedes their trade.

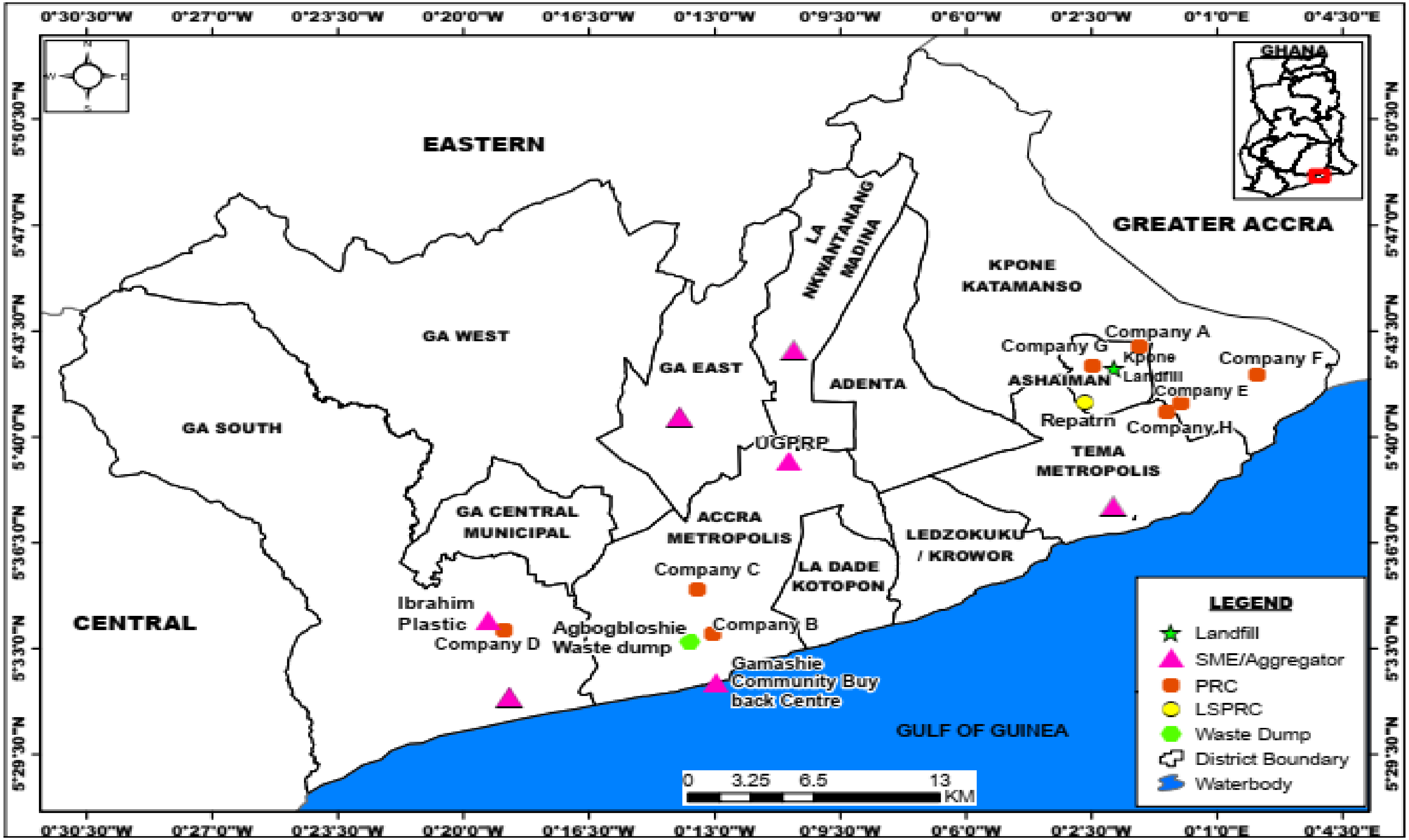

Figure 4.12: Spatial distribution map for some actors in the waste trade in GAMA

To understand the material flows of the plastic waste, the data obtained from the various interviews and the questionnaires administered on the inventory of the market sales for the plastic waste traded was used to map the movement of the plastic waste in the study area**.** Figure 4.13 provides the flow of plastic waste trade in GAMA.

- The red circles represent the plastic recycling companies (PRC)
- Arrows show the movement of plastics and trade networks among the various actors identified in GAMA.
- The colour of the arrow corresponds to the type of plastic traded:
  - ✓ The yellow coloured arrows represent trading of LDPE’s
  - ✓ The blue coloured arrows represent trading of HDPE’s, PVC and PP
  - ✓ Violet coloured arrows represent trading of PET

The flow indicates that majority of the waste trades were between actors located in different Local Assemblies. For instance, an aggregator in Ga south laments that, he has to travel through 4 (four) different local Assembles to trade with a plastic recycling company in Tema. And this is similar to an aggregator in the Accra Metropolis trading with a large-scale plastic waste recovery enterprise in Kpone Katamanso Metropolitan Assembly.

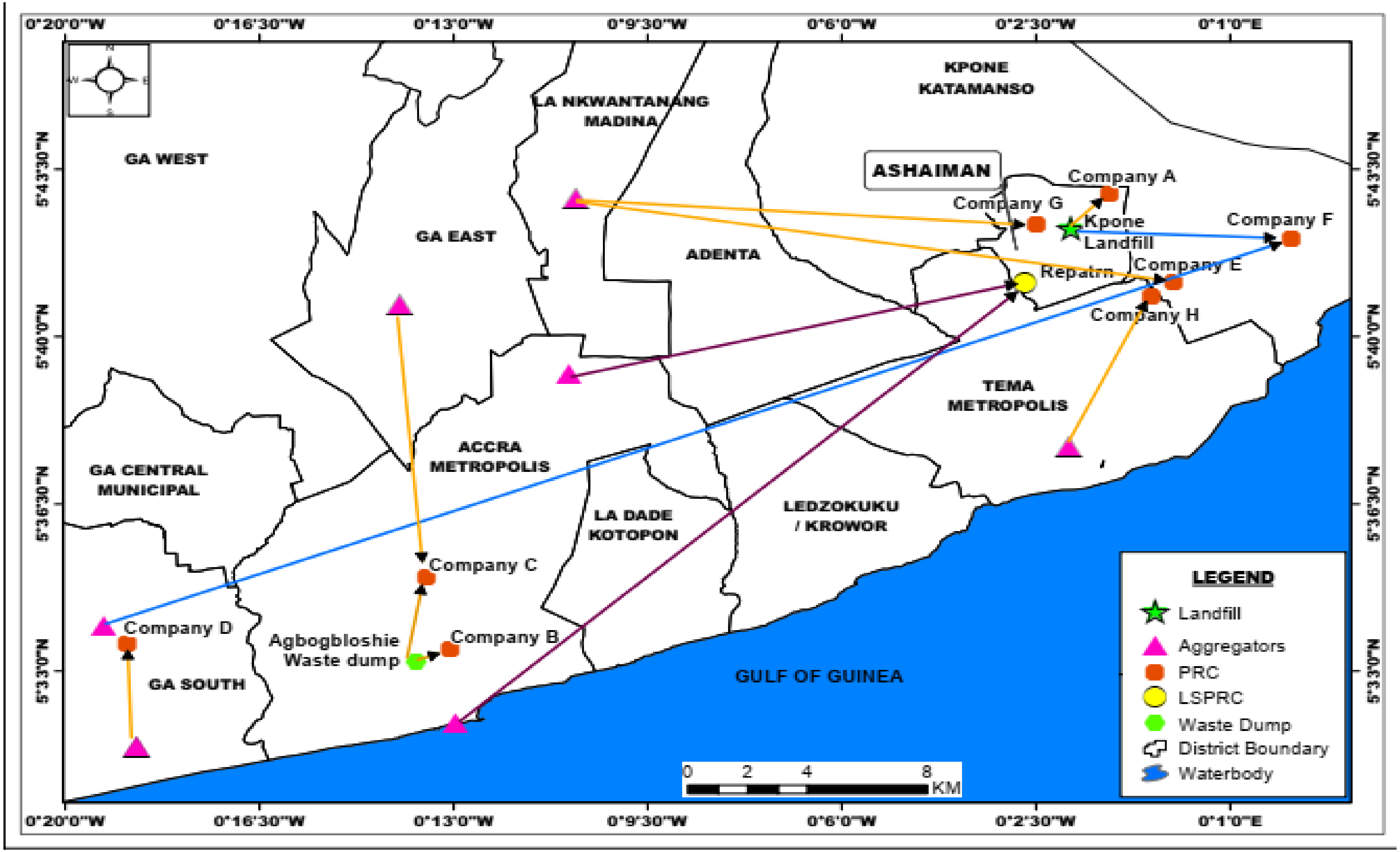

Figure 4.13: Flow of plastic waste in GAMA

4.10 Plastic waste collection schemes by the MMDA's

Regarding plastic waste recovery, only 2 out of the 10 (constituting 20%) of 16 MMDAs who allowed for interview, had collection schemes and schemes in place for plastic waste recovery. These two includes the Accra Metropolitan Assembly and Korley-Klottey Municipal Assembly. From the Waste management departments of AMA and the Korley Klottey, plastic collection, plastic waste collection schemes are only available in state Institutions at the Ministries and schools. All the MMDAs complained of financial constraints and the lack of human resources as a major challenge in instituting proper plastic waste recovery.

The recycling capacity of the MMDA's by virtue of the presence of plastic recycling facility in each MMDA in the study area was also studied and it was revealed that, not all the MMDA's have a plastic recycling facility present in their jurisdictions. Table 4.3 shows the Plastic recycling capacity of the MMDAs through the Plastic recycling plants identified in each of the MMDA's in the study area.

Table 4.5: Plastic recycling capacity of the MMDAs

Local Authority	Number of Plastic recycling facilities	Total Recycling Capacity (Tons)/day
Accra Metropolitan	2	480
Tema Metropolitan	2	105
Adenta Municipal	0	0
Ashiaman Municipal	1	54
Korle Klottey Municipal	0	0
Ledzokuku/Krowor Municipal	0	0
Ga East Municipal	0	0
Ga Central Municipal	0	0

Kpone Katamanso Municipal	3	93
La Nkwantanan-Medina Municipal	0	0
Ga South Municipal	0	0
La Dade- Kotopon Municipal	0	0
Ga West Municipal	0	0
Ga Central Municipal	0	0
Ga East Municipal	0	0
Tema West Municipal	0	0
Total	**8**	**732**

4.11 Relationship between the various actors in the plastic recovery system

Key informant interviews revealed that, the relationships that exist between some of the various actors within the plastic recovery or trade system can be categorized as a client-patron relationship, which is mainly founded or based on mutual trust and on trade levels, where all the actors want to gain more than the other in any transaction. Within the plastic recovery system in GAMA, clients (waste pickers) are a business secret to the aggregators, thus according to an aggregator. They in most cases do not share information about the trade with each other.

The relationship between the local authorities and the waste pickers was revealed through the survey to be non-existent in some of the MMDAs. Little or no partnerships or any form of engagements exist between the two.

4.12 Knowledge of the existing policy, legal and regulatory framework

All the waste pickers were not aware of any existing policy or legal and regulatory framework in the management of plastic waste in the country, this is purely attributed to lack of education. Forty-five (45) representing 75% of the waste agents (wholesalers/aggregator) were not aware of any policy regarding plastic waste management. Of the twenty-five (25) of the waste agents who were aware, three (3) mentioned the National Plastic Management Policy**.** All the recycling companies were all abreast with policies regarding plastic waste management, the policy documents referred to by most of the actors interviewed were:

1. National Plastic Management Policy
2. Environmental Sanitation Policy

CHAPTER FIVE

DISCUSSION

5.1 Introduction

This chapter entails the discussion of the results obtained from the study. It includes discussion on the general organizational and categories of actors in the plastic waste trade, the core competencies and operational capacities of the recycling companies and Interrelationship between the plastic waste recycling stakeholders. The existing policy, legal and regulatory framework regarding plastic waste trade would also be discussed in this section.

5.2 Organization and categories of actors in the plastic waste recovery system in GAMA

The Organizational system of the plastic waste trade in the Greater Accra Metropolitan Area is in the form of division of labour and labour processes based on the degree of interest and specialization. The plastic recycling chain is made up of several stakeholders (directly or indirectly) who operate in both informal and formal economies.

In most cases the activities carried out in the plastic recovery system in GAMA, to a greater or lesser degree find place in the informal sector. However, it is difficult to categorize or group the plastic recycling trade in GAMA strictly into either the formal or the informal sector. Some of the actors such as the plastic recycling companies, as well as some small and large scale plastic waste enterprises can be classified as formal industries (these companies are formally registered, remitting taxes and contributing to the country's economy), yet most of their activities were observed to operate under informal circumstances (Plate 4.8). Therefore, there is not a strict a clear distinction or boundary between the formal and the informal sector in the plastic waste trade. This finding concurs with that of a study of the cycle of plastic waste: An analysis on the informal plastic recovery system in Addis Ababa, Ethiopia (Camila, 2005). It was stated in the report that, the plastics factories and some of the micro and small waste enterprises fall into a grey zone between the formal and the informal sector. They usually operate on the formal side of the law because they require licenses such as the Environmental Permit, Certificate of incorporation from the Registrar General Department, certificate to commence business, etc. to operate, but at the same time they operate in an informal way when it comes to activities concerning plastic recycling.

All the waste pickers as well as the wholesalers and waste agents make up the informal economy with no regular working hours and wages. In the second half of the 1990s many scholars started to use the term “informal economy” instead of “informal sector” to refer to a broader concept that includes enterprises as well as employment in developing, transition, and advanced developed economies (Zúñiga, 2003). The International Labour Organization (ILO) also defines the informal waste workers as “individuals or small and micro-enterprises that intervene in waste management without being registered and without being formally charged with providing waste management services. Based on the results and data gathered in this survey, the informal sector shows the following basic characteristics, which corresponds with the definition of the ILO:

• There exist no or very low entry barriers;

• local resource use;

• Mostly dependent on family or self- employed individuals;

• Labour-intensive and local technology adaption;

It is evident from the study that, there is not much a strong evidence of a successful collaboration between the informal waste pickers and the formal actors in the waste recovery system in GAMA. From the survey 98% of all the materials collected for recycling are from the waste pickers who work individually. This finding deviate from that of the results from a similar study in Thailand by Simachaya (2017). It was revealed that in Thailand the waste pickers work together as cooperatives. Interestingly, all the plastic recycling companies presently do not have any waste segregation or plastic collection initiatives nor scheme. They largely depend on the waste pickers for material to feed their processing plants. This brings to bare the important role the waste pickers, play in the plastic recycling industry and all the trade associated. Thus, it is acknowledged that the informal waste sector often reveals a great development potential in the waste plastic recovery system. Studies by SWAPP (2016), Oteng-Ababio et al. (2014) and Bel et al. (2019) in Thailand, Ghana and Kenya respectively through their findings recommended that, the informal sector be integrated into the formal sector to form a solid waste management system due to their immerse contribution in waste managements.

A noteworthy development is the low interest in waste segregation initiatives by the recycling companies, to them the material to feed their plants are made readily available by the waste pickers. Though there are challenges with the quality of material sourced, contamination[1] is minimal and manageable.

5.3 Trade in waste material (Plastic waste market)

Plastic waste trade in GAMA has shown not to differ from basic economic principles facilitating the emergence of any commodity trade: First, there must be a demand for recovered plastic materials, second there must be a constant supply in quality and quantity of the recovered plastic material. Lastly, there must be the human resource who will be willing to participate or be involved in such activities.

From the study, the market for plastic waste trade is quite complex and involves different stakeholders as discussed in section 5.2 above. The relations among the actors are often direct with other stakeholders one step away from them in the value chain as discussed below.

[1] Contamination is caused by waste that cannot be recycled e.g. Food waste, and other types of plastics

The first sub-market is between the waste pickers and the consumer who produces the plastic waste. The supply of plastic waste is seen to mostly come from private households, waste dumps and the streets. Providing a clean waste plastic for collection by waste handlers is basically not existent according to the waste handlers.

The second sub market is between the waste pickers and the waste agents (middle men). At this stage of the trade, the interest or focus for both parties is to achieve the best price or the lowest cost.

The third sub-market is between the waste agents and the recycling facilities. The recycling facilities interest here is to achieve the highest recycling rate which is not the same as achieving a good price in the case of the middle men or waste agents. The waste agents prefer to sell their products to recycling companies in close proximity to them. Geographically, the closer the recycling facility, the lower the cost for transportation. Chee (2010) reports that, the transportation of plastic waste consumes a substantial amount of fuel and also suggests that transportation activity provides the major environmental impacts through fuel consumption and Greenhouse gases emissions.

The recycling companies after forming pellets or plastic granules with the plastic waste, could either sell, export or have the capacity to produce plastic products. This becomes the fourth and last sub market in the plastic waste trade.

While it is possible to map the main trade flows of plastic waste trade in GAMA it is much more problematic to accurately gauge the scale of the trade, both in terms of volume and value. This is as a result of the dearth of reliable and accurate information and data on the scale of the trade, a similar challenge in the mapping of trade, even in the electronic recycling trade system, reported by Masoom et al. (2016). As can be seen in the spatial distribution map (Figure 4.12), the observed distribution of the recycling companies shows an interesting trend regarding their locations, where they are either sited close to a landfill/ dumpsite or in an industrial area. Their location makes it very easy to reach them. However, MMDAs who do not meet the criteria recommended for citing plastic recycling companies are disadvantaged are served by small scale and large-scale plastic waste enterprises.

5.4 Economic and social benefits: Employment and value creation

Recycling development from this survey has proven to foster local growth by way of employment within a territory or an area. Typically, a plastic recycling company producing about 30 tons per day employs about 50 people directly. This is quite significant as compared to those jobs created by sending an equivalent amount of waste to landfill or incinerating it. This assertion is similar to a recent study by D'ambrières (2019) titled Plastic recycling worldwide: Current overview and desirable changes.

Considering the trade flows of the plastic waste recycling, there is always an emergence of a local industry any time a system to recycle plastic waste is set up. There are financial advantages for engaging in waste trade. It serves as an avenue for livelihood and employment for marginalized, impoverished and vulnerable social groups or individuals (Medina, 2000). It must be emphasized that, though the trade allow those involved to survive and be employed in regions that often have high unemployment., it however has particularly adverse working conditions associated it. From the profiles of all the eight plastic recycling companies, approximately 1,025 people both female and male are employed by these companies. The study has shown and proven that the trading activities between the waste pickers and the aggregators along the entire value chain is profitable with an Average Yearly Trade volume of GH₵91,999,464 distributed among the waste pickers only. However, the total earnings in the entire trade was not established in the study. This study suggests that not all worker of this sector belong to the poorest of society. Indeed, the waste pickers on average, earn about three times the daily minimum wage in Ghana per day, this is very significant in pursuit of socio-economic growth by the country. According to Scheinberg et al., (2010), the average informal sector worker earns more than formal sector workers in Cairo and Quezon City, and less in Pune, Lima, Lusaka, and Cluj. In all these cities, however, average earnings in the informal waste sector are up to four times higher than salaries of unskilled labour in industry, which are normally lower than the wages of the formal waste sector.

5.5 Core competencies and operational capacities of the recycling companies

The installed capacity for plastic waste treatment or processing is about 234,437 tons per year for the eight (8) recycling companies used for the study. But they currently process 46,604 tons representing 22.8% of the full operational capacities. The current operational capacity is insufficient to handle the increasing quantities of plastic waste generated annually. This research supports the claim made by Bert, (2019) that Accra Metropolis recycles about 140 tons of plastic waste per day which translates into 51,000 tons per year. The contribution made by these companies in saving the environment from the plastic waste menace is better placed in a proper perspective when compared to the plastic waste generated in the GAMA. Miezah et al.,(2015) has reported that the average weight of plastic waste generated per capita per day (kg/person/day) is 0.06kg in 2015. For a population of 4.6 million in the study area, the total amount of plastic waste that will be generated daily is projected to be 276,000kg, which is far below the plastic waste collected in the study area as reported in this study. It stands to reason that, the average weight of plastic waste generated per capita per day may have increased over time or the average weight of plastic waste per capita per day must be looked at again.

However, in a multi-stakeholder dialogue by the UNDP, organized as part of activities of the Waste Recovery platform, Ghana recycles about 22,000-55,000 tons of plastic wastes annually. This brings to bare a huge disparity in the right figure regarding annual plastic recycling rates in Ghana. Bert, (2019), also reported an annual plastic recycling of 116,800 tons.

All the companies stated that they are not limited on the supply side. According to the companies, one major challenge in running a sustainable pre-processing and processing business in plastic recycling lies in the area of human capacity and quality of collected material for processing, thus, securing sufficient quantity of quality plastic waste for treatment. Although this challenge has been identified, the recyclers have not instituted any collection scheme to abate the quality material supply challenge they are faced with.

5.6 Interrelationship between the plastic waste recycling stakeholders

Partnerships and good relationships among the various actors are a key element to working successfully in the plastic waste trade and that working together with multiple stakeholders plays a special role in this sector. First of all, everyone has some interaction with waste. Everyone produces waste – at home or at work – and is thus a consumer or recipient of a service such as waste collection (albeit not everywhere). Then there are the major waste producers (industry, businesses or even institutions) and the private or municipal service providers that collect, transport or treat and dispose of this waste. Interest groups such as environmental NGOs also play a crucial role. As a result, a complex landscape of stakeholders exists in which not everyone shares the same interests.

Partnerships between certain stakeholders are self-evident, while others are not so immediately apparent. Some of the stakeholders during the study shared some examples of successful partnership between them and other stakeholders in the recycling industry. The Waste Management Department of the Tema Municipal Assembly works closely with some NGO's to educate pupils in the basic school on waste segregation. Also, the Korley Klotey Municipal Assembly in collaboration with Jekora Ventures which is a waste management company in the country, provides some selected communities and offices with waste bins at the Ministries for waste segregation specifically plastics. The sustainability of such collaborations leaves much to be desired as both parties have different interests when interviewed.

Generally, the level of engagement and the interrelationship between the MMDAs, NGO's, recycling companies and other actors have been good to a point, but information access and sharing has been poor as the MMDAs do not have data on plastic waste collected and recycled in their various districts, which could easily be assessed from the various waste management companies and recycling companies operating within their jurisdiction. From observation and interviews, the relation that exist between the actors is based only on trade. According to McKinnon et al., (2018) "Working with recycled plastics and developing the right material to use for production requires a great effort from both sides (supplier and consumer of recycled plastics) in order to secure a proper sourcing of the material in quality and quantity". There is also no communication beyond the two directly linked process of collect and take between the waste pickers and the recycling facilities. The recyclers either accept or pay less the containers with plastic waste if it does not meet their standards or requirement, while rarely paying the right amount for them.

It was also made known from the study that, 7 representing 87.5% of the recycling companies are owned by expatriate notably Lebanese and Chinese, who are not ready to disclose information about their facility, operations and productions for the fear that, the information might be used against them by way of tax or other levies. In any case this claim was not established in the study.

5.7 Potential linkages between plastic waste trade and the circular economy

As a concept, circular economy has to do with the efficient use of resources across their life-cycle by ensuring that the loop is closed, which leads to reducing the dependence on primary raw material consumption from economic growth. In practice, plastic waste trade could be one of the effective and sustainable way of facilitating effective waste management. The recovery of plastic waste for recycling into other products like making bricks and composites, furniture etc. has been demonstrated widely. Waste (Plastic waste) to energy cycle has also emerged strongly. All these are backed by the circular economy concept of seeing waste as a resource. Though in the survey the main motive behind the waste trade is fundamentally for economic gains, the whole trade system is founded on the principle of circularity.

5.8 Difficulties in gaining access to finance

Various waste agents/ wholesalers reported that they are constrained by their small capital base and lack of access to financing support from lending institutions. The aggregators particularly explained that the nature of the plastic waste trade business – paying cash instantly to suppliers of plastic waste – means that they always must have larger sums of money readily available else they lose out to their clients to other aggregators. Aside the working capital, some respondents mention that they are seeking capital to expand their business or purchase vehicles and machinery. Others need capital to rent or buy larger lands or to build more durable and spacious workshops. Required capital investments in the range of GH₵ 15,000 to 50,000 were mentioned. Many agreed that the challenge of access to financing for plastic waste dealers at the collection level is compounded by the fragmented and informal nature of their businesses which is perceived as highly risky by lending institutions. In addition, virtually all waste agents' associations do not only lack financial resources but also lack proper organization and credibility to negotiate with financial institutions for loans on behalf of their members.

5.9 Challenges in plastic recycling

The challenges faced by the plastic recycling companies in GAMA is similar to the views shared in the United Nations Environment Report (2020) stating that, high contamination levels, cost-effectiveness and mixed plastic streams (Polymer cross contamination) are the main challenges faced by the plastic recycling companies. The findings relating to why most of MMDAs are not able to implement any waste segregation initiatives nor even partner with the waste dealers, causing wastes to be sent to the landfills comes down to three big issues:

1. The first is that, it is a very huge challenge for the municipality to implement proper segregation at source, especially with regards to small and medium waste generators like households, apartments and small businesses.

2. It’s quite an expensive process for the municipality to organize collection of segregated material at the neighbourhood level.

3. The municipalities are challenged with human resource to effectively plan and execute waste segregation.

CHAPTER SIX

SUMMARY, CONCLUSION AND RECOMMENDATION

6.1 Introduction

This chapter presents conclusions and makes the key recommendation that could inform policy and interventions which can promote the plastic waste trading systems in Greater Accra Metropolitan Area.

6.2 Summary

Plastic waste trade has become an option for the management of the growing amount of plastic waste in GAMA, considering the weakness and inefficiencies of the waste management companies and the willingness of recycling companies among other actors to trade in the plastic waste value chain. The study provides a qualitative and quantitative measure of the trade flows of plastic waste in GAMA as well as the spatial patterns of some of the actors involved in the trade. It also provides daily and annual trade volumes and the corresponding monetary value between the waste pickers and the wholesalers or agents. A mixed method research approach was employed, the first part of the study consisted of reconnaissance survey to the study area together with the participation in some activities of various stakeholders. This was followed by series of well-structured questionnaire (for management and employee's) and semi- structured interviews with stakeholders (industries, local government authorities, Non-governmental agencies) in participating organizations. Interview of stakeholders to know the relationship that exist between them was also conducted, which was complemented by field observations.

The study identifies waste management crew, street waste pickers, landfill/waste dump scavengers, plastic waste agents/ wholesalers, small scale plastic waste enterprises, large scale plastic waste enterprises and plastic recycling companies as the main actors in the plastic waste trade in Ghana. It also highlights the growing recognition and awareness on the importance of treating plastic waste as a resource. This is mainly because this trade has become an important source of economic survival for many in GAMA these actors. The economic benefit of the trade is that the high degree of labour intensity of the reclamation processes calls for or enables numerous actors to earn some kind of income, since no one will be rejected by anyone should they want to get involved. Therefore, the informal plastic recovery system clearly has shown to provide significant employment opportunities for a large number of individuals who would otherwise be jobless such as the collectors and wholesalers. This do not only increase or boost national recycling rates and to a large extent the global recycling rate, but also serve as a great source of employments and revenue generation to the states should the system be properly formalized and regulated.

Altogether the plastic recycling companies recycle/ process about 47 tons of HDPE, 41 tons of LDPE, 20 tons of PET, 15 tons of Polypropylene and 5 tons of Polyvinyl-Chloride per day. The most recycled plastic is the LDPE making up to 32% of the total recycling material. The findings also confirm with other studies that, majority (98%) of the main feed stock (plastic waste) for all the plastic recycling companies are source from waste dumps, private households and industry or commerce by the informal sector. None of the 8 recycling companies have been able to operate to their maximum or installed capacity and the reason is largely attributed to technical barrier and the lack of human resource. There is evidence to believe that material supply to these recycling plants is not a challenge, however quality of these materials to be recycled remains questionable.

Inference made from the spatial distribution map (Figure 4.10) of the recycling companies is that they are located either close to where activities of waste pickers abound or in an industrial enclave or in a densely populated area. The mapping of the actors involved in the trade has also shown an increasing involvement of many in the trade.

The waste dealers hardly keep proper documentation on inflows and outflows of plastic waste and revenues. Although the majority of them have a rough sense of what they make by way of revenue in the business, they do not keep consistent records. This worsens the already bureaucratic registration procedures meant to streamline their activities. They add that they lack coherent technical, business and safety training, which hinders an understanding for formal documentation processes.

All the MMDAs were aware of these waste dealers and their practices yet, none of the local authorities have initiated an intervention regarding the plastic waste trade in their jurisdictions. Meanwhile, local authorities have been empowered under L.I. 2250 to begin local initiatives. Sub-regulation 9(4) of L.I.2250 states that "A District Assembly may establish or facilitate the establishment of collection center and a take-back system". This presents a clear opportunity for local authorities to initiate their own innovative municipal/community plastic waste programs and take-back centers.

The plastic waste value chain has shown to be very fragmented with all its many actors. Even though adjacent actors- say there exist a productive and collaborative relationship between them, it's only seen on the premises of trade and not information sharing. There is a severe lack of communication and coordination between the recycling facilities, Municipalities, waste pickers and other stakeholders. The Municipalities also do not engage effectively with these recycling facilities and the waste dealers within their jurisdiction on proper and effective waste segregation initiatives for mutual benefits.

6.3 Recommendations

The following recommendations are made, based on the study conducted:

Because the livelihood and well-being of these waste pickers and the aggregators are tied to the plastic waste trade, government through the local authorities should foster formation of plastic waste dealer associations in all districts and streamline registration procedures to accelerate formalization and strengthen their bargaining power in the trade. Also because the waste pickers are dominated by women, the local and central government should create women-focused support by way of training and education as well as creating opportunities to access governmental programs, funds and grants to expand their trade.

Since not all the Metropolitan, Municipal and District assemblies have plastic recycling facilities within their jurisdiction, the MMDAs in this position through the L.I. 2250 should encourage private individuals or through Public Private Partnership (PPP) establish plastic recycling facilities within their jurisdiction. This will reduce the cost of transporting plastic waste materials and will make the trade more attractive for others to join, with the ripple effect on the national plastic recycling rate.

Considerations should also be given for amendment of the National Plastic Management Policy by the Ministry of Environment, Science, Technology and Innovation (MESTI) to include plastic waste trade sector specific legislations. This is key because according to an official from the Waste Management Department of the Accra Metropolitan Assembly, this will bring good recognition to the trade.

The study also recommends that, the Ministry of Environment, Science, Technology and Innovation through the local government should create awareness and strengthen monitoring and enforcement of laws to create a level playing field amongst all actors in the plastic waste trade value chain. Also MESTI should continue to engage with recyclers to ensure their future cooperation.

Boosting the rate of plastic recycling is not only about improving and increasing the rate of collection both in quantity and quality, but also in increasing the market demand for plastics in the country. In view of this the study recommends that government through the Ministry of

Trade and Industry and the Finance Ministry must reduce the value added tax for products containing recycled plastics. This will give financial and economic encouragement to the various actors in the trade.

Once the various stakeholders or actors in the entire plastic waste trade has been identified and the trade volume assessed, there will be future improvements and iterations to come, hence it is recommended that the local authorities must through a systematic, standardized and timely reporting format track and provide and publish yearly the trade statistics among the various stakeholders within their jurisdictions. This will help create a data base and provide a trend in the plastic waste trade that can be used to inform policies in the recycling sector.

Finally, the study recommends that, buy back depository mechanism must be practiced by the plastic producing companies with a predefined and specified buy back price printed on plastic products, so that consumers of such products will receive a specified amount of money when returning the used plastic products. To make this effective plastic manufacturing companies needs to set up collection centres with reverse vending well equipped to collect such used plastics and send them to recycling centres for processing. This will not only motivate and incentivise consumers from littering but also encourage producers to recycle more.

6.4 Areas for Further Studies

Areas for further studies include:

- Mapping logistical, ecological flows and the transport systems in plastic waste trade to identify opportunities and logistics solutions to improve the efficiency of plastic recycling supply chain in Greater Accra Metropolitan Area must be evaluated.
- The market systems in plastic waste trade is not really known and appreciated, hence a study to evaluate the system and the roles of the Local authorities (Metropolitan,

Municipal and District Assemblies) in the plastic waste trade in Ghana must be conducted.

- Profitability analysis of the entire plastic waste trade taking into consideration all commercial stakeholder in the plastic waste trade in Ghana must be researched into to know the contribution of the trade in the local economy.

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APPENDICES

APPENDIX 1

QUESTIONNAIRE FOR AGGREGATORS

My name is Kelvin Edem Fiati, an MPhil Environmental Sanitation Student of the Institute for Environment and Sanitation Studies, College of Basic and Applied Sciences, University of Ghana, Legon. I am undertaking this research as part of my thesis work which seeks to understand the role of the recycling companies in the plastic waste industry.

I will be most grateful if you will take some time off your busy schedule for this interview. This should not take more than one hour to conduct. I wish to assure you of anonymity and your personal details will only be used for the purpose of this study.

Your participation in this interview will go a long way to inform policy and decision makers' relevant decisions for the growth and development of the industry.

Your consent to participate in this is paramount and you are free to withdraw at any time during the interview session without any consequences.

SECTION A: Company Information

(1). Name of Aggregator or Enterprise: ……………….....................................

(2). Contact name: ………………………………….........................

(3). Contact email: ……………………………………………..

(4). GPS coordinates: Longitude……………………………..

Latitude……………………………………

(5). Size of NGO (number of employees): ………………………………………...

(6). General description of activities

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(7). What is the nature of your operations and does it involve plastic waste collection?

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(8). What types of plastic material do you collect?

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(9). What is your collection capacity?

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(10). Which recycler do you sell your collected plastics to and where are they located?

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(11). Do you have Partnerships/initiatives with recycling companies and the local government?

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(12). Which informal group(s) do you work with or engage and where are these group(s) located and operating from?

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(13). What challenges do you face working with plastic recycling companies?

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(14). What are the sources of funding for the enterprise?

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(15). What are some of the support systems made available by MMDAs or regulators to your enterprise?

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(16). Describe your relationship with the waste pickers?

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(17). What are the challenges you encounter in sourcing waste plastics from informal collectors?

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APPENDIX 2

QUESTIONNAIRES FOR RECYCLING COMPANIES

My name is Kelvin Edem Fiati, an MPhil Environmental Sanitation Student of the Institute for Environment and Sanitation Studies, College of Basic and Applied Sciences, University of Ghana, Legon. I am undertaking this research as part of my thesis work which seeks to understand the role of the recycling companies in the plastic waste industry.

I will be most grateful if you will take some time off your busy schedule for this interview. This should not take more than one hour to conduct. I wish to assure you of anonymity and your personal details will only be used for the purpose of this study.

Your participation in this interview will go a long way to inform policy and decision makers' relevant decisions for the growth and development of the industry.

Your consent to participate in this is paramount and you are free to withdraw at any time during the interview section without any consequences.

SECTION A: Company Information

(1). Company name: ………………....................................

(2). Contact name…………………………………........................

(3). Contact email: ………………………………………………..

(4). GPS coordinates: Longitude………………………… Latitude…………………………

(5). Size of business (number of employees): ………………………………………...

(6). General description of company:

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(7). What were the factors considered in siting the location for the production facility?

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(8). What does the company deal in primarily? (please tick one box)?

☐ Recycling of plastic packaging;

☐ Recycling of plastic packaging and other plastics

☐ Recycling plastic packaging and manufacture of plastic products

☐ Exporting plastic packaging waste for processing or recycling

☐ Or other/a combination (please state): …………………………………………………..

SECTION 2

(9). What are the plastic recycling processes? (please tick all that apply)?

☐ Washing

☐ Flaking

☐ Shredding

☐ Grinding

☐ Pelletising

☐ Manufacturing plastic products from pellets obtained from recyclers.

☐Other processes (please state): ……………………………………………………………..

(10). Where (formal or Informal) do you source your plastic waste from and the quantities obtained?

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(11). What are some of the Municipal waste segregation initiatives/actions taken by the company?

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(12). What is the Annual average plastic waste you receive by polymer type and/or plastic grade? How much do you pay for each category of material? (please complete the table below)

Product type eg. Bottle, film, bag, etc	Polymer type, i.e. PET, HDPE, PVC, LDPE, PP, PS.	Plastic grade, e.g. clear or coloured	Annual Tonnage received	Price per tonne

Please indicate the units used.

(13). What proportion in percentage or quantity of the input material is rejected and regarded as contaminated?

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(14). What are some of the challenges you face in the recycling industry?

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(15). What is the total yearly or monthly tonnage of plastic waste recycled, by polymer type (please indicate units used)?

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(16.). What is the installed capacity for your recycling facility (e.g. in tonnes/year or kg/day – please indicate units used)?

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(17). What do you do with the pellets (please tick all that apply)?

☐ Used for on-site plastic product manufacturing

☐ Sold to plastic product manufacturing companies or facilities

☐ Exported

SECTION 3- Production of Plastic Products

(18). Does your facility produce plastic products? Yes ☐ No ☐

If yes, what is the average quantity of plastic products produced per year? (please complete the table below).

Product category	Annual tonnage produced
TOTAL	

(19). What is the ratio of virgin plastic material versus waste plastic used in your production?

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(20). What is the relationship between you and the Local Government and What kind of support do you get from them?

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(21). General comments?

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APPENDIX 3

LIST OF INTERVIEWS

INTERVIEWEE	NUMBER
Heads of waste management Departments (MMDAs)	8
Landfill Manager (Kpone Landfill)	1
Plastic recycling companies	8
Waste Pickers	160
waste agents	50
Environmental Protection Agency	1
Non-governmental Organisations	3

APPENDIX 4

TEST FOR HYPOTHESIS

Test of Hypothesis for Variance.

Statement of Hypothesis

H_0: The two populations variances are the same

H_1: The two populations variances are not the same

Test at 0.05 significant level

Test of Statistic

Table 4.1: F-Test Two-Sample for Variances

Mean	103.8571429	34.57142857
Variance	23737.47619	1982.952381
Observations	7	7
Df	6	6
F	11.9707747	
P(F<=f) one-tail	0.004068899	
F Critical one-tail	4.283865714	

Decision Rule

If p-value is less than the significant value of 0.05, we reject the null, otherwise accept.

Conclusion

Since the p-value of 0.004 is less than the significant level of 0.05, we reject the null and conclude that we have strong evidence that the variances are not the same.