UNIVERSITY OF GHANA
COLLEGE OF BASIC AND APPLIED SCIENCES

TOWARDS INDUSTRIAL ECOLOGY: AN ASSESSMENT OF ENVIRONMENTAL PRACTICES WITHIN THE PLASTIC INDUSTRY IN ACCRA, GHANA.

BY

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DECLARATION

I, Salwah Omar Gyabo declare that except for references to other people's work which has been fully acknowledged, this thesis is my original research work conducted at the Institute for Environment and Sanitation Studies under the supervision of Dr Daniel Nukpezah and Dr Adelina Mensah.

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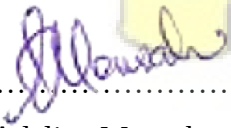

…….. 4th November, 2022

Dr. Adelina Mensah …….

(Co-Supervisor) Date

DEDICATION

I wish to dedicate this work to Almighty Allah for his mercies and grace throughout my study period. Secondly, to my husband; Jamaldeen Sumaila for his enormous financial and emotional support. Also to my parents and siblings for the awesome prayers, encouragement and commitment towards my wellbeing over the years.

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS

AMA	Accra Metropolitan Assembly
C2C	Cradle To Cradle
CEP	Corporate Environmental practices
CER	Corporate Environmental Responsibility
ECBAS	University of Ghana Ethics Committee of College Of Basic And Applied Sciences
EMAS	Eco-Management and Audit Scheme
EMS	Environmental Management System
EPA	Environmental Protection Agency
GSS	Ghana Statistical Service
IESS	Institute for Environment and Sanitation Studies
LCA	Lifecycle Assessment
MESTI	Ministry of Environment, Science Technology and Innovation.
MMDAs	Metropolitan, Municipal and District Assemblies
NADMO	National Disaster Management Organisation
NPMP	National Plastic Management Policy
PDCA	Plan, Do, Check, Act
PET	Polyethylene Terephthalate
SDGs	Sustainable Development Goals
SMEs	Small and Medium Enterprises
SPSS	Statistical Package for Social Sciences
USEPA	United States Environmental Protection Agency

ABSTRACT

The purpose of this study is to assess corporate environmental practices being implemented by plastic producing enterprises in Accra, Ghana. The study explores existing environmental practices at the enterprise level, examines the level of compliance with environmental regulations by plastic producing enterprises, examines perception of plastic producing enterprises on the influence of growing activism against plastic pollution from the public on their strategies and the opportunities and challenges of using industrial ecology to achieve sustainable plastic production and consumption in relation to sustainable development goal 12 (responsible production and consumption). The study employed methodological triangulation on data obtained from 18 plastic-producing enterprises within the Accra and Tema Metropolis in Ghana through questionnairre survey and informal interviews. Data was analysed quantitatively and supported with qualitative data. It was revealed that enterprises engage in environmental practices such as recycling, adoption of sustainable technology and environmental management systems (EMS), use of recycled materials, and energy efficiency. Compliance with environmental regulation was found to be high amongst enterprises with 17 of 18 enterprises having met regulatory requirements and therefore certified by the regulatory body (EPA). Further, enterprises did not perceive reduced sales and profits over the last 10 years though raw materials were perceived to have become more expensive due to scarcity of resources from the natural environment. Firms also professed to putting in measures to improve their reputation in the face of the public as a result of public activisms on plastic pollution. Additionally, existing national plastic management policy (NPMP), recycling, sustainability reporting and education and awareness provides opportunity for industrial ecology to be used to achieve sustainable plastic waste management, though some challenges in these areas persist. Ecosystem principles of roundput, was being implemented by majority of enterprises through engagement in recycling and locality principle was being implemented by a few enterprises.

Situating the study within the institutional theory, enterprises had normative, regulatory and cognitive reasons for engaging in environmental practices. Whereas based on the natural resource-based view (NRBV), enterprises derived competitive advantage in the form of improved efficiency and reduced cost of production, differentiation benefit and access to international markets, which were achieved through the product stewardship, pollution prevention and sustainable development practices being accomplished by enterprises.

CHAPTER ONE

INTRODUCTION

1.1 Background

As countries develop and industrialize, there is dependence on the environment for resources for industrial activities, which also come along with waste and these have adverse impacts on the environment. Evidence of resource depletion and environmental change is unequivocal. However, long-established management objectives of industries have concentrated on economic benefits; viewing environmental and social issues as having less significant financial benefit (Pereira *et al*. 2013). Industrial activities have had both positive and negative impacts, bringing with it economic growth, as well as environmental destruction and social injustice (The World Bank Group *et al*, 2017; Sullivan *et al.* 2018).

Conventional position of businesses regarding resource availability and waste disposal as inexhaustible has shifted to market approval as necessity for survival. Industrial businesses, in the need to safeguard their businesses and to gain positive corporate image from the growing global environmental movements seeking sustainable development have developed sustainability practices to address environmental concerns. As such, sustainability practices such as industrial symbiosis, life cycle assessment, cradle to cradle and sustainability reporting have been adopted and implemented by some companies worldwide for profit, to boost their corporate image and to achieve societal confidence (Tilling & Tilt, 2010).

Industrial ecology; a module of eco-industrial parks is an approach that is being adopted to solve issues of environmental deterioration resulting from industrial activities. Graedel & Allenby (2010) describes industrial ecology as "*an approach to the design of industrial products and processes that evaluates such activities through the dual perspectives of product competitiveness and environmental interactions*". Industrial ecology aims at

achieving both economic and environmental benefits, and can be operated at three levels; firm-level, between firm level and regional/global level as described by Graedel and Lifset (2002) in Figure 1.

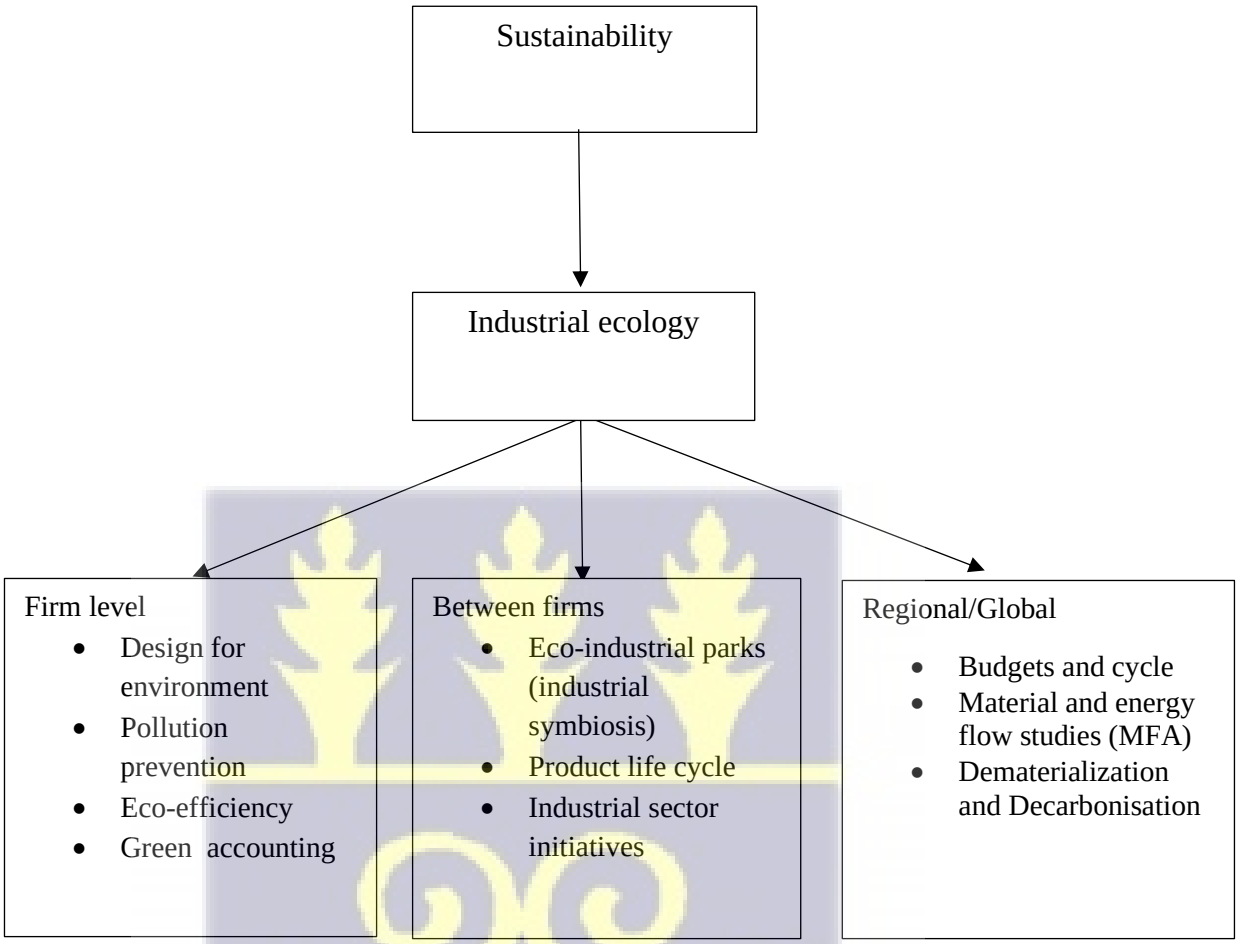

Figure 1: The element of industrial ecology seen as operating at different levels
Source: Graedel and Lifset (2002)

From figure 1 sustainability can be practiced through industrial ecology, which can be manifested at 3 levels; firm level, between firm level and at the regional/global level. According to Graedel and Lifset (2002), industrial ecologists seek to avoid and/or minimize environmental impacts by incorporating environmental aspects into product and process design, usually at the firm level. Pollution prevention, green accounting and eco-efficiency (material and energy efficiency) are industrial ecology aspects practiced at the firm level. Industrial ecology can also be manifested between firm level through eco-industrial parks

where industries located in close proximity to one another engage in material and energy exchanges termed as industrial symbiosis (Chertow et al. 2004). This is exemplified in the world-famous Kalundborg design; Denmark, where existing co-located industries developed interdependence and common belief (Valentine, 2016), leading to technological, economic and environmental success offering great relevance to the world (Gulipac, 2016). Industrial sector initiatives such as managerial and policy settings are also tenets of industrial ecology practiced between firms. Budgets and cycle, material and energy flow studies (MFA), dematerialization and decarbonisation are elements of industrial ecology manifested at the regional /global level.

Mimicking nature, industrial ecology seeks to close the loop by reducing waste and using waste as a resource. It avoids a linear system where there is dependence on natural resources and waste produced are disposed and not recycled or re-used. As such through industrial ecology, waste and carbon footprint, as well demand on natural resources are reduced. The reuse of by-products by industries reduces the amount of materials that goes to waste, as other industries serve as sink that absorb these by-products. This reduces the amount of materials that end up in the environment and their subsequent environmental impacts such as plastic pollution. Global plastics production has quadrupled over the past four decades (Zheng & Sangwon 2019) and is expected to grow by 30% in the next five (5) years (Charles *et al.*, 2021). Plastic production comes with it plastic waste, liquid waste, chemical waste and emission of greenhouse gases (GHGs). The growing demand for plastics due the convenience in its use has created a plastic pollution problem raising global concerns, hence, there is the need to stream it back into production to reduce its presence in the environment and its impacts.

In Africa, sustainability practices such as industrial ecology has not gained much prominence, as the citizenry are now becoming more cognisant of the idea of

environmentalism, though certain industrial ecology principles are being implemented informally; since exchange of materials among industries has been in existence for long (Desrochers, 2001).

In Ghana, industrial ecology is still an emerging field, though there are few informal exchanges of materials among industries, this is not fully developed to close the loop (Nukpezah et al., 2019). The industrial areas in Accra and Tema are characterized by industries located close to one another, however the degree of exchanges at the firm and between firms have not been documented. It is therefore necessary to assess the firm-level industrial ecology and corporate environmental practices as a first step towards a deeper understanding of the adoption of industrial ecology among industries in Ghana. This will provide opportunity for the country to identify the potential for solving environmental issues it is being confronted with such as plastic pollution through industrial symbiosis; a component of industrial ecology

The plastic manufacturing industry in Ghana is characterised by enterprises producing an array of plastic products including packaging, single –use and multiple use plastic products. Injection moulding and blowing technologies are usually used in production with input materials usually imported and few enterprises using recycled materials.

In Accra, composition of plastic waste in solid waste increased from According to Fobil (2000), the constitution of plastic waste in solid waste in Ghana increased from 1.4% in 1979 to 5% in 1996/97 to 8% in 1999/2000, reaching about 501,875 tons of plastic waste generated in the country annually (Kortei & Quansah, 2016)

Accra is an industrious city consisting of many plastic producing enterprises, whose adoption of industrial ecology principles may contribute to addressing the plastic waste problem the country currently faces; firstly by re-using/recycling plastic waste realised at

the firm and putting in place measures to accommodate more plastic waste realised by industries in close proximity and then at the post-consumer level. The production and consumption of plastics come with it plastic waste both at the industrial level and the post-consumer level which may be recycled or re-used for production. A sustainable approach to tackling plastic waste is necessary in order to safeguard the ability of future generations to be able to have access to this illustrious material.

The 12th goal, of the Sustainable Development Goals (SDGs), that is sustainable production and consumption provides prospects to achieving other goals such as climate action (SDG 13), decent work and economic growth (SDG 8), affordable and clean energy (SDG 7), industry, innovation and infrastructure (SDG 9) and no poverty (SDG 1).

1.2 Problem Statement

Industry related environmental policy in Ghana can be said to be inadequate. Historically, Ghana's industrial strategies have focussed more on economic benefits than social and environmental benefits. The pre-economic recovery programme between 1965 and 1983 concentrated on solving balance of payment deficits, while Industrial policies between 1984 and 2000 focussed on privatizing the industrial sector and after the 2000s industrial policies focused on job creation and poverty reduction (Ackah *et al.*, 2016). The development of industrial parks in Ghana focused on privatising the manufacturing sector as such most of the industries are private owned micro and small firms with their own internal processes and little or no interactions amongst one another. As these industries focus on economic benefits, there is the possibility of the incidence of non-compliance to environmental regulations which is affecting Ghana's ability to meet the sustainable development goal concerned with responsible production (SDG 12). The study will therefore find out whether plastic produing enterprises comply with environmental regulations and how their activities can help meet SDG 12.

Plastic littering has been a major cause of concern for public sanitation situation in the country. Plastics are largely non-biodegradable hence, its presence in the environment has impacts on the physical environment; both marine and terrestrial. It is common to see drains being filled with plastic. It is estimated that about 4 to 12 million metric tons (Mt) of plastic waste entered the marine environment in 2010 alone (Jambeck et al., 2015). The transport of plastics into the ocean poses threats to marine ecosystem such as ingestion of plastics and suffocation to marine animals. Improper disposal of plastic waste such as burning causes the release of dioxins and carbons which contribute to the global warming and climate change (Asante & Amuakwa-Mensah, 2015).

Irresponsible production and consumption of plastic materials therefore is a bane to achieving proper sanitation, cleaner environment and sustainability as such efforts need to be put in place to solve, and solutions can be started from its source; plastic industry.

1.4 Justification of Study

Industries tend to make lots of strides in the economic and social aspects of sustainability without giving much substance to the environmental aspect of sustainability. It is evidenced that many companies compete with one another in terms of profitability and involvement in corporate social responsibilities without much recourse to environmentalism. Some forms of environmental practices do take place within industries, however, not much studies have been done on it especially in the plastic industry. This study will therefore bring to fore existing corporate environmental practices amongst plastic producing enterprises in Accra, Ghana, and how they can be sustainable.

Although some studies have been done to establish the benefits of corporate environmental practices especially in developed countries, studies on corporate environmental practices in

Ghana is inadequate, more so, are not based on industrial ecology which this study seeks to contribute to.

The study is also necessary as it seeks to explore industrial ecology as a viable solution to the plastic waste menace within the country as other options, which focus on solving plastic pollution at end of life have not achieved the desired results; while the entire citizenry are being affected by the plastic waste problem. The study will therefore look at how plastic waste problem in the country can be solved beginning at the source; by identifying the role of the plastic manufacturing industry.

With increasing environmental concerns and the need to achieve the SDGs, understanding the need for corporate environmental practices towards industrial ecology especially in Ghana will be beneficial to Ghana's ability to attain the SDG12 targets and its rippling effects, as it seeks to explore industrial ecology as a tool for sustainable development. This goal also makes it possible to provide a sustainable approach to the production and consumption of plastics. The study will therefore look at the opportunities and challenges of industrial ecology towards sustainable plastic production in relation to SDG 12

Also the data collected through this research will have the potential to inform policy formulation and implementation, and will have the potential to support Ghana's policy on circular plastic economy.

1.3 Research Objectives

Main Objective

- To examine corporate environmental practices that align with industrial ecology principles in the Greater Accra region of Ghana

Specific Objectives

1. To determine firm-level environmental practices among plastic producing enterprises.
2. To assess level of compliance to environmental regulations by plastic producing enterprises
3. To examine the perception of plastic producing enterprises on the influence of activisms around plastic pollution on their activities.
4. To identify opportunities and challenges of using industrial ecology to achieve sustainable plastic production and consumption in relation to sustainable development goal 12 (responsible production and consumption).

CHAPTER TWO

LITERATURE REVIEW

2.1 Corporate Environmental Practices

There is no consensus regarding a standard label for pro-environmental practices implemented amongst industries. While Sroufe et al., (2001) have labelled pro-environmental practices as environmental management practices (EMP), Banerjee (2002), mentions corporate environmentalism and Sindhi and Niraj (2012) have called it corporate environmental responsibility (CER). To this end, there is no standard definition for corporate environmental practices. While Banerjee (2002) defines "corporate environmentalism as the organization-wide recognition of the legitimacy and importance of the biophysical environment in the formulation of organizational strategy, and the integration of environmental issues into the strategic planning process", Sindhi & Niraj (2012) define "corporate environmental responsibility as the precautions and policies organizations adopt to reduce and prevent hazards to the environment along with stakeholder participation to induce transparency". These authors therefore recognise the importance of the environment to internal operations and externally through stakeholder involvement.

Corporate environmental practices, as used by Kim (2018), with the fundamental idea that to improve both environmental and economic performance has gained popularity as businesses are putting in efforts to gain societal confidence. The business community came under immense pressure during the 1960s, when Rachael Carson published the book silent springs. This sparked interest in the academic field resulting in publications such as "Limits to Growth" and "The Global Report 2000"; which indicated the need for environmental action by industries, (Tibbs, 1992). This awakened environmental consciousness among industries though there were opposing views expressed in publications such as "A

Resourceful Earth (1984)" which contested the finiteness of the earth's resources. Banerjee (2002) opines that, amplified awareness of environmental issues by governments, policy makers, advocacy groups, business firms, and the public all over the world, over the last few decades has resulted in the development of policies, agreements and conventions to address these environmental concerns hence the idea of sustainable development.

Long-established management objectives of industries have concentrated on economic benefits; viewing environmental and social issues as having less significant financial benefit (Pereira et al. 2013). Sullivan *et al.*, (2018) observes that firms have traditionally regarded financial stance as superior as opposed to sustainability practices. Ingley (2008) relates that there has been heightened concerns about the environmental and social consequences of business activities leading to the demand for their sustainability information. Also, Deegan et al. (2002), recognises the importance of societal acceptability to the survival of any organisation. In a similar vein, Tilling & Tilt (2010) put forward that sustainability reporting is basically to achieve societal confidence.

Hence industrial firms in their need to gain social legitimacy, have adopted environmental practices although the motivation to adopting environmental practices have differed; some are only reactive while others are proactive.

2.1.1 Reactive and proactive corporate environmental practices.

Baneerjee (2001) notes that environmental practices among firms is said to be reactive when they simply abide by existing regulations, however, if firms go further to introduce environmental initiative then they are said to be proactive. Firms that are reactive tend to restrict themselves to regulatory compliance such as pollution and waste reduction (Macedo, 2016). While being proactive goes beyond compliance it serves as an opportunity to minimize regulatory compliance costs, as well as respond to stakeholders, enhance revenues

and improve competitive advantage (Esty and Winston, 2006; Nakao et al., 2007; Berry and Rondinelli, 1998). Firms that are proactive incorporate environmental issues in their overall business strategy and invest in innovation for product design and processes (Walls et al. 2011). According to Berry and Rondinelli, (1998), firms have evolved from being in a stage of crisis by attempting to control damage resulting from their activities, through to being reactive, where they struggled to comply with rapidly changing government environmental regulations, and are now proactive in responding to environmental concerns by to anticipating environmental impacts of their operations, taking measures to address them and finding positive ways of taking advantage of resulting business opportunities. However Macedo (2016), suggests that firms at an early stage were reactive, by being regulation compliant, then evolved to being preventive that is being efficient in the use of resources through reuse and recycling and are now proactive; by making environmental issues inclusive in the firms` business strategy. Adding that firms may go beyond the firm to involve actors within their supply chain in environmental issues by adopting processes such as life-cycle assessment, Eco design and industrial symbiosis.

Therefore firms that advance from being reactive to being proactive are able to meet regulatory requirement and are presented with opportunities to improve their reputation and make profit. The use of recycled for example, presents an opportunity for firms to reduce the cost of their input materials as recycled materials comes at a cheaper cost than raw virgin materials. The consequent result being cost advantage or improved revenue.

2.1.2 Benefits of corporate environmental practices

Margolis and Walsh, (2003), Orlitzky et al., (2003) and Albertini, (2013) found environmental performance and financial performance positively related. Further Albertini, (2013) used a minimal confidence interval (0.08-0.09) in his study, hence showing a strong relationship between corporate environmental practices and financial performance. Barnett

(2007), also finds that there are financial benefits of engaging in environmental practices which offset the costs involved in the long run.

Claver et al. (2007) also established a positive relationship between environmental strategy and competitive advantage. Competitive advantage can manifest in two forms; cost advantage and differentiation advantage (Hart, 1995). Hart (1995) further states that cost advantage arise from efficiency in production while differentiation advantage results from product design and developing environmentally friendly products. Differentiation advantage creates the potential to increase product selling prices which results in higher revenue (Reinhardt, 1999 cited in Albertini, 2013), and additional sales received due to a good environmental reputation (Sindhi & Kumar 2012). Morales-Raya *et al.*, (2019) concludes that both low and high external visibility such as the development of beneficial products and services, and environmental management systems, contributes to favourable environmental reputation, which has been found to be beneficial in terms of increased sales and revenue.

Stafford (2007) states that self-regulatory firms in terms of environmental management were able to reduce their attention from regulation enforcement agencies, thereby reducing environmental and legal risks which could come as costs to the firm.

Therefore, the adoption of corporate environmental practices by firms helps firms to improve their reputation and revenue by differentiating them from other firms that do not adopt corporate environmental practices, and also gives them a competitive advantage through reduced production costs and increased product selling prices. These benefits further act as a motivating force for organizations to pursue pro-environmental strategies. Thus, it becomes a two-way process.

2.1.3 Motivation and barriers of corporate environmental practices

Industries have different motivation for adopting environmental practices. Studies have found several factors that influence the adoption of corporate environmental practices. The most common being regulatory pressures, market or stakeholder pressures, competitive pressure, self-regulation, and organisational structure. Sindhi & Kumar (2012) categorises these factors into internal factors and external factors; classifying self-regulation, market pressures, stakeholder pressure and regulatory framework as external factors and internal factors as the features of the organisation. Bansal and Roth (2000) identify competitive advantage, legitimation, and ecological responsibility as the three main motivation factors for the adoption of environmental practices. The motivation may stem from the desire to increase competitive advantage and its consequent profitability, or the desire to improve their reputation and be noticed as legitimate or the need to indeed protect the environment (Walker et. al., 2014).

While some industries adopt environmental practices due to the benefits they derive from them, others adopt corporate environmental practices due to their inclination towards environmental protection. Walker *et al.*, (2014) found a positive relationship between environmental proactivity and environmental responsibility. Halkos and Evangelinos (2002), for example, purport that firms that implement environmental management system (EMS) had managers who were abreast with the benefits and effects of adopting and not adopting it. This goes to suggest that firms whose management do not know the importance of EMS will be a barrier to its implementation. Lee *et al.*, (2018) inter alia, identifies sufficient organizational capabilities in terms of asset and human resources relevant for the implementation of environmental practices

Walker *et al.*, (2014) also found a positive relationship between environmental proactivity and regulatory compliance which is consistent to the findings of Sharma and Henriques,

(2005) and Jones (2010). This is accurate for developed countries which have well established regulatory and enforcement regimes; unlike developing countries where enforcement of mechanisms are poor (Nwabuzor 2005). Costs of compliance could be a barrier to implementing corporate environmental practices (CEP); especially for firms with little investment capacity (Sindhi & Kumar 2012), nonetheless, positive incentives such as tax breaks and investment subsidy could prompt greater compliance (Priyadarshini and Gupta, 2003).

Studies have found different relationships between competitive advantage and environmental practices. Ervin *et al.,* (2013) finds a significant positive relationship between corporate environmental practices and competitive advantage, similar to Claver et al., (2007) and Hart (1995) who also suggested that the enforcement of corporate environmental practices resulted in competitive advantage. Walker *et al*., (2014) on the other hand, found a non-significant correlation between competitive advantage and environmental proactivity. This notwithstanding, many business leaders are appreciating the importance of environmental responsibility to their international competitive advantage hence are being proactive by integrating environmental concerns into their corporate strategy (Berry & Rondinelli, 1998).

Freeman (1984) defines stakeholders as "any group or individual who can affect or is affected by the achievement of the organization's objectives". Ye and Zhang (2011) and Li and Zhang (2010) conjecture that stakeholder pressures are rife in developed economies than in developing markets, where the idea environmentalism is still daunting. In their study Walker *et al.,* (2014) also establish that the role of stakeholder pressure in driving corporate environmental practices was not significant. This contrasts the position of Lee *et al.,* (2018) that stakeholder pressures from governmental and non-governmental organisations have significant impact in the adoption of corporate environmental practices

by firms. Remarkably, Walker et al., (2014) conducted their study in China; a developing country while Lee et al., (2018) conducted their study in South Korea; a developed country. This goes to support the position of Ye and Zhang (2011) and Li and Zhang (2010) that stakeholder pressures are stronger in developed economies than in developing economies. The adoption of environmental practices by companies due to stakeholder pressure could be to gain legitimacy from stakeholders as mentioned by Bansal and Roth (2000) that legitimacy is a motivation factor in the adoption of corporate environmental practices.

The characteristics of an organisation can also be a motivation or a barrier to the adoption of corporate environmental practices. A firm`s features such as size, internal revenue, position within the value chain, difficulties in modifying non-environmentally friendly practices, a lack of environmental awareness among organizational member and age (Sindhi and Kumar, 2012; Ervin *et al., 2013* ; Delgado-Ceballos *et al.,* 2012) can enhance or bar the adoption of corporate environmental practices. For example in their study of antecedents of adopting corporate environmental responsibility and green practices amongst logistics companies in South Korea, Lee *et al.,* (2018) concluded that the availability of internal organisational resources and the quality of human resources facilitated the adoption of corporate environmental practices and green practices amongst logistics companies in South Korea. Therefore the lack of financial capital could be a barrier to the adoption of corporate environmental practices especially because they require upfront payments (Berry and Rondinelli, 1998; Ervin *et al.,* 2013) which is often lacking amongst small businesses who would instead invest in their primary business activities than environmental practices.

In essence, motivation to adopt environmental practices differ by organisations. To gain reward or avoid punishment for regulatory compliance is a motivating factor for the adoption of corporate environmental practices. Also some industries adopt environmental practices due to the benefits they derive from them, while others adopt corporate

environmental practices due to their disposition towards environmental protection. However, financial constraints, inadequate knowledge of management on environmental practices, amongst others can restrain the adoption of environmental practices by firms.

2.1.4 Forms of corporate environmental practices

Firms manifest corporate environmental practices in many ways, from material efficiency to energy efficiency. To operationalize the definition of corporate environmental practices, Chrun, Dolˇ and Prakash (2016), identifies five (5) mandatory principles for which a firm can be referred to as "green". These principles are outlined as follows.

- Compliance with Legal/regulatory requirement,
- environmental management system (EMS),
- Proactive in the use of environmental strategy rather than end-of-pipe strategy.
- Conduct life cycle assessment
- Material and energy efficiency through use of renewable energy and biodegradable material, recycle, as well as reduce waste emission of greenhouse gases (GHG) and toxic substances throughout their production process and management of waste in an environmentally friendly manner.

1.1.1.1 *Compliance with legal/regulatory requirement*

Compliance with legal regulatory requirement as an environmental practice is recognised by Chrun, Dolˇ and Prakash (2016) as an environmental practice that requires that firms meet all environmental regulations and have no pending environmental lawsuit. However, environmental regulation can be at the corporate level or at the governmental level. Karassin and Bar-Haim (2019) concludes that generally, regulation positively influences corporate environmental performance. Though corporative regulator had the strongest positive effect on corporate environmental practices (CEP) in their study, coercive regulatory practices

reduce the internal motivation for compliance and does not encourage environmental proactivity, yet the firms may be incentivised by the avoidance of punitive measures. Walker et al., (2008) notes that, fines may not be punitive enough for SMEs as they may be less expensive than the cost to implement and maintain environmental practices and therefore suggests a more collaborative approach such as tax incentives for small and medium enterprise participation in environmental practices.

In their study on corporate environmental management initiatives in Ghana, Nukpezah, and odoom (2017) found that enterprises engage in pollution control and resource conservation, through conservation and efficiency of energy use, reuse and recycling of process water, meeting EPA standards, emission /effluent control and monitoring, waste separation at source, replacement of obsolete machinery and use of alternate source of technology. Nukpezah, and odoom (2017) further found that enterprises were less committed to making voluntary investments in pollution control than meeting regulatory requirements.

In essence regulatory compliance can be said to be an environmental practice if it influences overall environmental performance, but its usefulness can be optimised through collaboration between firms and regulatory institutions as punishment may retard or reinforce non- compliance. Regulatory compliance can be a motivating factor in the adoption of environmental practices and result in the benefit of reduced attention from regulation enforcement agencies, thereby reducing environmental and legal risk. Though a coercive factor, compliance with regulations can be a self-motivating environmental practice that can improve reputation and revenue of firms as firms avoid environmental and legal costs when they comply with regulatory requirement.

2.1.4.1 Environmental management system (EMS)

According to the USEPA (2021), an "environmental management systems is a set of processes and practices that enable an organisation to reduce its environmental impacts and increase its operating efficiency". Walker et al (2008) reports that well-known environmental management systems such as ISO 14001 and Eco-Management and Audit Scheme (EMAS) are typically designed for large business not small business as the implementation and maintenance of these systems are expensive. Citing a European study, Walker et al., (2008) notes that the limitation to the implementation and maintenance of EMS amongst small and medium enterprises (SMEs) was more of a problem of inadequate human resource rather than financial constraint.

The implementation of EMS is done in stages of a phase of planning, doing, checking, and acting, usually known as the PDCA cycle.

Having an environmental management system (EMS) is therefore an environmental practice industry can monitor and resolve environmental impacts of their activities. However, EMS are largely designed for large industries and costly making it challenging for smaller businesses to adopt.

2.1.4.2 Proactive in the use of environmental strategy rather than end-of-pipe strategy.

In describing the evolution of environmental strategies, Macedo (2016) operationalizes reactive, preventive and proactive strategies using certain environmental practices. Similar to, Chrun, Dolˇ and Prakash (2016), Macedo (2016) describes compliance to environmental regulation, avoiding end-of-pipe technology, use of lifecycle assessment, energy and material efficiency as environmental practices and categorises them into reactive, preventive and proactive strategies as they evolve, but maintains that the evolution of environmental

strategies may not be consecutive but certain practices of one strategy may be employed simultaneously with practices of other strategies.

Proactivity in the use of environmental strategy therefore involves envisaging the environmental impacts of business operations, addressing them and going further to take advantage of the problem (Berry and Rondinelli, 1998). For example, enterprises can solve waste problem by recycling which provides an added advantage of reusing the waste as a resource.

2.1.4.3 Life cycle assessment (LCA)/ Cradle to Cradle (C2C)

Life Cycle Assessment "involves the evaluation of the environmental impacts of a product system through all stages of its life cycle. It is about going beyond the traditional focus on production site and manufacturing processes, in order to include the environmental, social, and economic impact of a product over its entire life cycle" (Koroneos *et al., 2013*). Hertwich (2005) maintains that LCA is important for sustainable consumption and production. Life cycle assessment starts from extraction of raw materials, manufacturing, transportation and distribution, product use and end of life. The end of life of a product can either be disposal or recycling/reuse which gives rise to the terms "cradle to grave" and "cradle to cradle". Koroneos et al., (2013) relates that the "*terms of "life cycle analysis", "life cycle approach", "cradle to grave analysis" or "Eco balance", stand for a rapidly emerging family of tools and techniques designed to help in environmental management and, longer term, in sustainable development".*

Cradle to cradle manufacturing takes the whole lifecycle of an item into account, including source and end-of-life disposal, emphasizing reintegration of products into the manufacturing processes. It suggests that industry must protect and enrich ecosystems and nature's biological metabolism. Describing it as the next industrial revolution, McDonough

& Braungart (2002) and Braungart et al., (2007) suggest that industry needs a new model that effectively and flawlessly addresses issues associated with over-consumption and waste.

Aiming at zero-emission and zero environmental impacts, and guided by three principles, the concept helps to manage waste in order to close the loop by using waste as a resource. C2C advocates total biological design or total technical design so that waste can either be total biological nutrients that can be fed back into ecological systems, (Bjørn & Strandesen 2011), or technical products that are incorporated into industrial or mechanical recycling. Hence, to achieve an effective closed loop, biological nutrients and technical nutrients should not be mixed when designing a product so as to ensure total recycling; biologically or technically (Bjørn & Strandesen, 2011). Cradle to cradle design also advocates the use of renewable energy. Since mechanical recycling processes consume lots of energy, the use of renewable energies such as solar and wind is encouraged as they have less environmental impacts. The third principle of cradle to cradle; the celebration of diversity considers how products are made and also how they are used over time, as such there is the need to design products using local materials and in accordance to local conditions and diversifying the energy production.

Therefore Life Cycle Assessment (LCA) and cradle to cradle are environmental practices industries use to assess the environmental impacts of their products at the end of its life so as to find measures to tackle these impacts.

2.1.4.5 Biodegradable materials and recycling

The use of biodegradable materials and recycling can be considered as environmental practices. In relation to plastics, Akinlabi *et al* (2018) defines biodegradable plastics as "plastics that degrade into methane (CH_4), carbon dioxide (CO_2), water (H_2O), and biomass

in a defined timescale and in defined environments – soil and marine environments, anaerobic digestion, and composting – through biological action". Clark (2015) maintains that landfills are and will continue to provide the main avenue for plastic disposal as such designing it for environment in the form of biodegradable plastics provides a viable option to tackle waste plastic waste, as its by-products of methane can be taken advantage of and used to generate clean energy. Adding that landfills need to be properly managed between a 2-50 year period and biodegradable should also be designed as such to be able to collect by-products of methane within this period. However, Akinlabi *et al* (2018), notes that landfilling is the least desirable option for plastic disposal, placing Municipal and domestic composting as the most preferred choice for end-of-life disposal.

The production and use of biodegradable plastics is however still at its lowest stage but is however growing at rapid rate. Based on their market data, European Bio plastics (2016) projected a 50% increase in the medium term in the amount of bio plastics produced to about 6.1 million tonnes in 2021 from about 4.2 million tonnes in 2016.

Clark (2015) suggests that manufacturers whose products usually ends up in landfills at the end of their lifecycles should integrate landfill biodegradable plastics products in their product design. This will provide the maximum environmental benefit upon disposal rather than environmental damage derived from the use of traditional synthetic plastics. Also recycling provides an environmentally friendly option for keeping materials out of landfills.

Recycling: an environmental practice that industries can adopt, involves making materials new and putting them back to use (Al-shuaibi, 2014). According to Al-shuaibi (2014), recycling provides environmental benefit in the form of reduction of greenhouse gases which is a positive impact on climate change. Plastic recycling has gained prominence as the most viable option to the management of plastic waste. "In any conversation related to

plastics and sustainability, recycling is an inevitable topic" (Clark 2015). Recycling offers the benefit of reducing energy consumption, oil usage and emissions of greenhouse gases associated with production from virgin raw materials. Hopewell *et al*., (2009) finds that recycling brings a net environmental benefit in terms of reduced energy consumption and landfill disposal. In an LCA study on Polyethylene Terephthalate (PET) bottle (WRAP 2008), it was found that a 100 per cent use of recycled PET instead of 100 per cent use of virgin PET would reduce the full life-cycle emissions to 327 g CO_2 per bottle from 446 g CO_2. Recycling also provides economic benefits in the form of job creation.

Conversely, Clark (2015) asserts that recycling has negative economic and environmental impacts as it is more costly in terms of time, money, and energy than discarding waste into landfills. These resources are spent during collecting and processing recycled goods, educational and marketing costs, and subsidies. Adding that plastics, are more expensive and time consuming to recycle than to produce from raw materials. Clark (2015) further mentions that plastics recycling has by-products containing contaminated wastewater and air emissions which if not managed properly may affect humans health, and can also damage nearby biomes and percolate into groundwater when mixed with rain water as many additives such as colorants, flame retardants, lubricants, and ultraviolet stabilizers are used in processing and manufacturing plastics

In addition, D'Ambrières (2019) opines that there are various impediments to the practice of recycling at various stages of a plastic lifecycle as such to achieve a sustainable recycling sector there should be a comprehensive approach to tackling these impediments. Hence all stakeholders from manufacturers that produce plastic products, petrochemical companies that produce raw plastic, retailers, consumers, waste managers, city authorities, governments, regulators and NGOs should be involved. Adding that during various stages

of a plastic life cycle; from product design, waste management and consumption of plastic products, there exist barriers to the realisation of recycling.

Essentially, firms may practice environmentalism by designing their products for the environment through the use of biodegradable materials for production in order to reduce the presence of synthetic materials in the environment. For example, the production of biodegradable plastics are being encouraged to confront the problem of plastic waste in the environment. Also recycling is an environmental practice that helps to reduce the environmental impacts of production which otherwise would have occurred if virgin input materials are used. This notwithstanding recycling has some challenges. Plastic recycling for example has challenges at its various stages and therefore needs a comprehensive approach to resolve it.

2.1.4.6 Sustainable technology

Fu et al., (2018) recognises the adoption of sustainable technology as an environmental practice and further distinguish it as an "effective means to achieve sustainable development". Fu et al., (2018), finds that, market pressures, price, coercive pressure, technology capability, internal support, adoption experience, certified systems, and cooperation are regarded as vital in the adoption of sustainable technology.

Huang *et al.*, (2009) establish that pressure from market stakeholders, shows a positive effect on the sustainable technology adoption degree. Triguero et al., (2015), and Triguero et al., (2013), show that customer demand for green products has a positive effect on sustainable technology adoption, measured by whether the company introduced clean technology or recycling technology. However, Arvanitis and Ley, (2013) found no significant impact of customer demand on the adoption of energy-saving technologies, material/fuel substitution or recycling technologies (Leenders and Chandra, 2013).

In essence, plastic producing enterprises may be motivated internally or externally to engage in corporate environmental practices in the forms of compliance with legal/regulatory requirement, adoption of environmental management system (EMS), and ensuring material and energy efficiency. These practices may be reactive or proactive and can lead to certain benefits such as reducing environmental and legal risks which could come as costs to the enterprises, improving their financial performance and offer them competitive advantage. Competitive advantage can come in the form of cost advantage where the use of by-products will reduce cost of production or differentiation advantage where enterprises can sell themselves to the public as caring for the environment.

2.2 Industrial Ecology

According to White (1994), "Industrial ecology is the study of the flows of materials and energy in industrial and consumer activities, of the effects of those flows on the environment, and of the influences of economic, political, regulatory, and social factors on the flow, use, and transformation of resources". Industrial ecology (IE) can also be defined as "*an approach to the design of industrial products and processes that evaluates such activities through the dual perspectives of product competitiveness and environmental interactions*" (Graedel & Allenby, 2010). Munholfen *et al.*, (2004) enlists five (5) components of industrial ecology as "dematerialisation, industrial metabolism, life cycle assessment, eco-design and eco-industrial parks". The component of eco-industrial parks brings to fore the idea of industrial symbiosis which is described by *Chertow et al. (2004) "as the exchange of material and energy streams among industries in relative proximity to one another"*. However, Ehrenfeld (1994) lists seven components of Industrial Ecology *as "improving metabolic pathways for materials use and industrial processes, creating loop-closing industrial practices, dematerializing industrial output, systematizing patterns of*

energy use, balancing industrial input and output to natural ecosystem capacity, aligning policy to conform with long term industrial system evolution and creating new action-coordinating structures, communicative linkages, and information". Though the components of industrial ecology as described by both authors slightly differ, both emphasize dematerialization and industrial metabolism or closing the loop, thus both look at how industrial processes can mimic nature. Industrial ecology therefore aims at achieving both economic and environmental benefits. National Academy of Engineering (1994) views industrial ecology as the integration of environmental concerns into economic issues. The need for sustainability can therefore be achieved through industrial ecology, which can be operated at three levels; firm-level, between firm and regional/global level as described by Graedel and Lifset (2002) in figure 1.

According to Korhonen (2001), industrial ecology can provide a model for which industrial systems can imitate natural ecosystems using four ecosystem principles of roundput, diversity, locality and gradual change.

The roundput principle of ecosystems involves the utilisation of residual energy (recycling), which occurs through flows in food chains with the only driver of the system being the input from the (infinite) solar energy. The roundput ecosystem principle can therefore be translated into recycling of waste and energy efficiency or use of use of renewable resources in industrial systems which falls within the components of IE described by Munholfen et al., (2004) and Ehrenfeld (1994) as dematerialisation.

Also the principle of diversity involves variety in species and organisms which provides basis of survival of species. This principle when applied to industrial systems by the presence various cooperation systems can expedite symbiotic co-dependence and aid the development of systems where the industrial bodies can use each other's waste materials

and energy. This emphasises industrial symbiosis as described by Chertow et al., (2004) and the industrial metabolism enlisted by Munholfen *et al.*, (2004).

The locality principle of ecosystems involves adapting to and interacting with the local environments. This principle when applied to industrial systems will involve the use local renewables and local waste material and energy sources. This can be observed in industrial symbiosis component of industrial ecology where corporation is amongst industries in close proximity.

The principle of gradual change can manifest in industrial ecosystem by the gradual development of the system diversity; as seen in how evolution takes place in ecosystems through reproduction. Reproduction is important in natural ecosystems to avoid extinction of species. Hence the use of renewable natural resources in industrial systems is important to ensure the sustainability of such resources. Gradual development of system diversity in industrial systems is express expressed by Ehrenfeld (1994) as creating loop-closing industrial practices component of industrial ecology.

In essence, industrial ecology involves mimicking of ecosystems with industrial systems, which can be expressed in four ecosystem principles of roundput, diversity, locality, and gradual change. These principles when applied in industrial systems means industries will have to recycle waste, use renewable energy, corporate and use by-products from one another and use local renewable resources.

2.3 Environmental Related Regulatory and Policy Framework on Industrial Activities

Environmental policy can be said to be procedures put in place by government to assess, evaluate and control hazards related to humans or ecosystems through regulations, economic incentives and/or training, education and awareness of existing environmental standards Ayee (1998). The Ghana environmental protection agency (EPA) is mandated by law under

Act 490 to regulate and implement government`s policies on the environment and also seek solutions to global environmental issues (Gemadzie & Agyekum, 2016). Therefore the environmental aspect of industrial activities in Ghana is regulated by the environmental protection agency. The Ghana National Environmental action plan (NEAP) set up in 1988, implemented in 1991 and revised in 2013, seeks to achieve sustainable development in Ghana by addressing concerns in various sectors including manufacturing/industry through the provision of sectorial environmental policies and strategies (EPA, 2017)

A number of policy and regulatory frameworks exist that can initiate and advance the idea of sustainable industrial development in Ghana. The 2010 industrial policy and the industrial Sector Support Programme (GoG, 2011) outlines several provisions government promise to put in place for sustainable industrial development in Ghana. Governments pledge towards sustainable industrial development includes the provision of land for industrial development only, put in place measures to ensure energy and water efficiency, encourage the development of voluntary standards through liaison between Ghana Standards Authority (GSA) and industry actors, strengthen capacity of regulatory bodies to enforce environmental regulations as well as effectively monitor manufacturing processes, and encourage the development and implementation of self -regulatory measures on environmental management by industries (PAGE 2015). PAGE (2015) further outlines government's pledge to cleaner production as supporting the efficient use of raw materials, energy and water in industry, aiding the adoption of cleaner production technologies and processes.

These provisions intend to support sustainable industrial development by supporting cleaner production, energy and material efficiency and accelerating the adoption of voluntary international environmental standards such as ISO. However the extent of implementation of these provisions is yet to be ascertained.

In 2019, government launched the national plastic management policy (NPMP) as part of its partnership with the global plastic action partnership (GPAP) to address the overwhelming plastic pollution in the country (MESTI, 2019).The ministry of environment, technology and innovation (MESTI) emphasizes that " the policy lays a foundation to enable the creation of an entirely new industry for redesigning, recovering, and recycling plastics, preventing pollution, of our environment, and communities and creating many new jobs in the green economy" (MESTI, 2019). The policy aims at achieving a circular plastic economy through education and awareness towards a behavioural change of plastic management amongst individuals and businesses as well as providing resources for sustainable plastic management within communities and corporations (MESTI, 2019).

In essence, government over the years have developed policies and made commitments to protecting the environment and minimize the environmental impacts of industrial activities; giving EPA the mandate. However, the level of implementation of the objectives of these policies is unreliable. One of the latest action of government on protecting the environment from plastic pollution is the adoption of national plastic management policy (NPMP) as part of the global plastic action partnership (GPAP); which aims at solving plastic pollution through circular economy principles. The adoption of industrial ecology by enterprises can facilitate the implementation of this policy as their tenets are similar.

2.4 Plastic Waste in Ghana

The convenience in usage and low cost of plastic has made the material the mainstay in recent years (Ellen MacArthur Foundation, 2017). With an advantage in functionality and cost, the product has revolutionized activities in various sectors of the economy from food storage, health, and energy production (Harris, 2018). This advantage has resulted in a rapid increase in plastic use and an ensuing increased plastic waste generated in the last 60 years. Geyer et al., (2017), alludes to the fact that the component of plastic waste in municipal

solid waste increased by approximately 10% between 1960 and 2005, while Lebreton and Andrady (2019) project an increase from 155 to 265 million Mt per year globally, by 2060 if the current trends remain unchanged. Plastic waste generation in Ghana has shown an increasing trend. According to Fobil (2000), plastic waste constituted 8% of solid waste in Ghana in 1999/2000 an increment from 1.4% in 1979 and 5% in 1996/97 analysed by Schweizer & Annoh (1996) and Archer et al., (1997) respectively and reached about 501,875 tons of plastic waste generated in the country annually by 2016 (Kortei and Quansah, 2016).

Most plastic manufacturing enterprises in Ghana are producers of packaging, single –use and multiple use plastic products from the use of virgin raw materials imported into the country, though a few enterprises use recycled material. Injection moulding and blowing technologies are usually used for production.

Plastic waste impacts both terrestrial and marine or aquatic ecosystems. According to De Souza Machado et al., (2017), plastics sometimes disintegrates into microplastics and that interact with microorganisms, affecting their health and functioning. This consequently leads to effects on flora and fauna. Microplastics are also carried into food which is toxic to human and animal health. Adding that hormonal effects in vertebrates and invertebrates could be realized from chemicals released from plastic breakdown.

Plastic littering in Ghana has been a major cause of concern for public sanitation situation in the country. The cause of major floods in Ghana has been attributed to plastic littering which blocks drains and obstruct the flow of water during rainfall. Fisher folks in areas such as Ga King Shorna and Mensah Guinea have complained about low harvest due to increased plastic waste at sea which destroy their nets (www.myjoyonline.com, 2016).

In Ghana however, a ban on single-use plastics was proposed by the government to take effect in November, 2015 but was met with stiff opposition from plastic producers and importers. A major section of the populace also opposed it due to their reliance on plastic packaging. Kwadzo (2020) reports that the Minister of Environment, Science, Technology and innovation; Professor Kwabena Frimpong-Boateng has stated the contribution of plastics to the economy and the reliance of Ghanaians on packaged water are factors that hinders the ban of plastics in Ghana currently. Plastic recycling is therefore being encouraged to manage the plastic waste situation in the country. However, recycling is still on the lower side as Linnenkoper reports that 6% of the 1.7 million tons of plastic waste generated in the country annually is recycled (Linnenkoper, 2019).

The 3Rs (reduce, reuse and recycle) approach to waste management has been encouraged worldwide. Defined by United States Environmental Protection Agency (USEPA, 2017) as "the separation and collection of materials that otherwise would be considered waste, the processing and remanufacturing of these items into new products to complete the cycle". By this definition recycling is an approach to incorporating waste into the circular economy which is in line with cradle to cradle principle of using waste as resource. Bio- plastics and bio-degradable plastics provides prospects for sustainable plastic production.

In essence though plastics are convenient and cheaper to acquire, indiscriminate production, use and disposal could be harmful to the terrestrial, aquatic and human health and there is a need for a sustainable approach to managing plastic waste, which could be achieved using industrial ecology principles such as recycling.

2.5 Industrial Ecology and Sustainable Development Goals

The global social, economic, and ecological systems are interconnected such that they requires an integrated approach to managing them. The sustainable development goals is

based on a triple (3) bottom line; social, economic and environmental, providing a benchmark to which businesses, private and public institutions can adopt into their developmental strategies. Industrial ecology provides a holistic approach to managing economic systems such that it has rippling effects on social and ecological systems. Huber (2000) classifies recommendations of various institutions including the United Nations (UN) towards achieving sustainability into three broad categories, namely; sufficiency, efficiency and consistency. He explains that the sufficiency strategy emphasizes conservation, whereas efficiency strategy seeks to achieve maximum value with minimum resources through technological and infrastructural improvement. Adding that the consistency strategy of sustainable development renders a leeway for true industrial ecology through the "innovation of new technologies, products, and material flows in order to change the qualities of the industrial metabolism". Loop closing strategies have therefore been looked upon to provide prospects for sustainable development, hence approaches such as zero waste, circular economy and industrial ecology have been linked to sustainable development. Schroeder et al., (2018) identifies potential contribution of circular economy (CE) practices to achieving a significant number of sustainable development goals (SDG) targets; showing significant relationships between circular economy practices and the targets of SDG 6 (Clean Water and Sanitation), SDG 7 (Affordable and Clean Energy), SDG8 (Decent Work and Economic Growth), SDG12 (Responsible Consumption and Production), and SDG 15 (Life on Land). As circular economy practices aims at closing the loop, so does industrial ecology practices as seen in the components enlisted by Ehrenfeld (1994) and Munholfen et al., (2004) in section 2.2, and the principles of ecosystem that can be adopted by industrial systems indicated by Korhonen (2001), as such IE can contribute to the achievement of a number of the sustainable development goals (SDG). Also Sullivan et al., (2018), finds significant relationship between industrial ecology and SDG 7

(Affordable and Clean Energy), SDG 9 (innovation and infrastructure), SDG12 (Responsible Consumption and Production) and SDG13 (climate action). Inference can therefore be made that SDG12 (Responsible Consumption and Production), has a higher probability of being achieved through circularity practices whether circular economy or industrial ecology. Therefore enterprises aiming to achieve SDG 12 can aid in achieving certain aspects of other goals of the SDGs.

The concept of "sustainable consumption and production" (SCP) has been critical for policy –makers in solving the challenges of sustainable development since the early 1990s (Pogutz & Micale 2011). It has been the focus of governments, businesses and civil societies towards the achievement of sustainable development. In 2005, a group of academics explained that "sustainable consumption focuses on formulating equitable strategies that foster the highest quality of life, the efficient use of natural resources, and the effective satisfaction of human needs while simultaneously promoting equitable social development, economic competitiveness, and technological innovation" (Tukker et al. 2006). Whereas sustainable production focuses on innovation in the design of products and its processes while considering the full life cycle of products or processes (UNEP 2009). In an effort to achieve sustainable development the European Union endorsed the Sustainable Consumption and Production Action Plan, in 2008. Some scholars maintain that increased resource productivity through cleaner technological innovations can be beneficial to both the firms and the environment (Lovins *et al.*, 1999). In relating sustainable consumption and production to the widely held IPAT (impact = population * affluence* technology) equation, Pogutz and Micale (2011) establish that sustainable consumption and production can and has been widely achieved through technological advancement which is the option that can be controlled by governments and businesses as population and affluence can hardly be managed by policy makers. Sustainable production and consumption has been a critical part

of policy making in for years and therefore targeting problems of plastic pollution through sustainable production and consumption of the material can help solve the plastic pollution problem.

Nonetheless, the challenges of sustainable development persist till date, indicating that both production and consumption patterns should be totally closed rather than shifting to green consumption which is basically a shift in the type of products being consumed and not necessarily a loop closing feature. Loop closing strategies such as industrial ecology can be explored to solve the major challenge of sustainable development; sustainable production and consumption. As such the adoption of industrial ecology; a loop-closing strategy in the production and consumption of plastic will be essential for sustainability.

2.6 Theoretical Frameworks Underpinning the Study

2.6.1 Institutional Theory

The institutional theory and the natural resource-based view are ideal in explaining the factors that influence the adoption of corporate environmental practices and its benefits, though this study does not emphasize between firm exchanges. The institutional theory has evolved over time; from realist institutionalism to social institutionalism and attempts to explain a balanced combination of legitimacy with the principles of institutional modification. The theory posits "that an organization does not choose an alternative action based on the rational calculation, but rather is a passive being who accepts what is defined as desirable and legitimate in a given institutional environment" (Jo et al., 2020) and essentially, tries to explain the factors that causes an institution to adopt certain practices. One of its major proponents, Scott; outlines three (3) pillars on which the theory is premised. Scott (2001), suggests that the three pillars on which the institutional theory is based on, are regulatory, normative and cognitive.

The regulative pillar of the institutional theory has to do with external bodies of power such as the national legal actions (Meyer, 2006), who have the ability to set rules, ensure compliance and reward or punish compliers and perpetrators of the set rules or laws (Oh & Ryu, 2019). These bodies of power therefore compel institutions to adopt certain practices they deem appropriate. Saeed *et al.*, (2018) finds that institutions adopt environmental practices to derive rewards or to offset punishment for non-compliance to government laws and regulations; as such coercive pressures have a significant direct impact on firms` environmental behaviours.

The normative pillar leans towards acceptance from society or interest groups such as pressure groups and nongovernmental organizations and in recent times, clients (local and international). Thus firms that have international clients or markets may adopt environmental practices due to high demand and willingness to pay for environmentally friendly goods which may even transcend demanding environmentally- friendly products from their supply chain (Earnhart, *et al.*, 2014).

The third pillar which is the cognitive pillar has to do with the institutions belief system born out of its association and interaction with other organisations within its domain which guides its decision to adopt certain practices. As such industries may adopt environmental practices only because their compatriots and/or competitors are adopting these strategies. Alexiou & Wiggins (2019) recognises that the cognitive pillar is necessary in determining the regulatory and normative pillars to work with. Similarly, Debroux (2010) states that "When normative expectations and attitudes are largely diffused in society, they are gradually internalized by individuals and become accepted as the norms to which everybody is encouraged to conform".

The institutional theory; with its tenets have been found useful in a number of studies in the fields of sustainability science, business, agriculture, etc. In business, Debroux (2010) adopted the theory in his book, *"Female Entrepreneurship in East and South-East Asia: Opportunities and challenges"*, where the institutional theory was used to study the legitimacy of entrepreneurship in Asia in the section, "*the rising tide of entrepreneurship*". Juárez-Luis *et al.*, (2018) used the theory in their study, "*Institutional Pressures and Green Practices in Small Agricultural Businesses in Mexico: The Mediating Effect of Farmers' Environmental Concern".* In this study, the institutional theory was used to "explore the intervening role of farmers' environmental concern in the relationship between institutional pressures and green practices" (Juárez-Luis et al., 2018). And in sustainability studies the institutional theory was used "as a lens to understand the factors that legitimize the adoption of renewable energy activities in an oil and gas company" by Jaber & Oftedal (2020), in their article titled *"Legitimacy for Sustainability: A Case of a Strategy Change for An Oil and Gas Company".*

It is therefore expected that plastic producing enterprises will adopt corporate environmental practices due to either regulative forces, normative forces or cognitive forces. This may be due to the nature of regulative regimes within the country, the growing agitation on environmental plastic pollution by the citizens and civil society groups and demand from international markets or the increasing sophistication of the plastic producing enterprises as well as keen competition within the plastic industry.

2.6.2 Natural Resource-Based Theory

The natural resource-based theory is another theory that will be used in this study. The natural resource-based theory was developed by Hart (1995), following his realisation of an omission in the resource- based theory which is the natural environment. To address this omission, Hart developed the natural resource-based theory in his book, '*a natural resource-*

based view of the firm' to incorporate the biophysical environment into business strategy arguing that capabilities rooted in environmentally sustainable economic activities will enable the realisation of a sustainable competitive advantage.

The resource-based theory is grounded on the premise that there exists a relationship among a firm`s resources, capabilities, and competitive advantage. Hart and Dowell (2011) describe the resource of a firm as its asset including physical, social and financial asset, while the firms` capability refers to the forte of the firm to perform its functions drawing strength from its resources and experience. A combination of the firms' resources and capability gives rise to a competitive advantage. The theory maintains that the resources have to be unique devoid of possibility of being imitated by other competitors in order to create a sustained competitive advantage. In this regard, the resource of the firm should be tacit, scarce and non-substitutable in order to create value (Hart & Dowell 2011) either through cost advantage or differentiation advantage. It is not conclusive that the availability of resources will result in competitive advantage but that the effective utilization of the right resources is crucial to achieving competitive benefit, as pointed by Yu, *et al.*, (2017), and Hitt, *et al.*, (2016).

Hart (1995) therefore situates the natural resource-based theory within three strategic capabilities namely; pollution prevention, product stewardship and sustainable development which act together with the firms resources to attain competitive advantage and sustainability benefit.

With Pollution prevention, environmental sustainability is sought through the prevention of waste and emission at the initial stages. This leads to environmental sustainability in terms of reduced waste and emission to the environment and also results in a competitive

advantage in terms of reduced or no cost of disposal of waste, simplified internal operations and reduced cost of compliance and liability (Hart & Dowell, 2011; Christmann, 2000).

Product stewardship has to do with the integration of environmental sustainability in the design and production process of products. This therefore leads to sustainability benefit in terms of conservation, recyclability and avoidance of waste throughout a products' lifecycle (Mcdougall *et al.*, 2019, Miemczyk, Johnsen, & Howard, 2016). Competitive advantage is achieved through product differentiation and strategic pre-emption (Hart & Dowell, 2011).

The third strategy, which is sustainable development is where the firm tries to achieve a triple bottom line in terms of economic, social and environmental sustainability, by being environmentally sustainable while providing economic benefits to societies affected by its activities. According to Hart (1995), "commitment to sustainable development might raise a firm's expectations for future performance relative to competitors, reflected by such measures as price earnings or market-to-book ratio" Competitive advantage is therefore achieved through exposure to new markets and price advantage.

The natural resource based view (NRBV) theory has been applied in a number of studies in the fields of sports, business management and corporate environmental studies. McDougall *et al.*, (2014), studied the relationship between NRBV and sustainable supply chain management and innovation within UK food companies in their article "*A Dynamic Natural-Resource-Based Framework for Innovative Sustainable Operations*". This study found a relationship between the NRBV, sustainable supply chain management and innovation.

Applying the NRBV theory to the present study, it is expected that the incorporation of environmental concerns into firms` strategy either through capability of the firm to practice pollution prevention, product stewardship or sustainable development will have some impact on the firm in terms of resulting in some form of competitive advantage such as

improved efficiency and reduced cost of production, differentiation benefit and access to international markets. This could be achieved due to increased awareness on the effects of the consumption of plastic products and the concerns raised on plastic pollution to the environment. In essence concerns raised about plastic pollution can lead to firms practicing environmental responsibility which will eventually result in some form of competitive advantage.

2.7 Conceptual Framework of Corporate Environmental Practices of Plastic Producing Enterprises Towards Industrial Ecology and Plastic Waste Reduction In Relation To SDG 12

Figure 2 shows the motivating factors for the adoption of corporate environmental practices by plastic producing enterprises, its benefits and how it aligns with industrial ecology and plastic waste management while contributing to SDG12

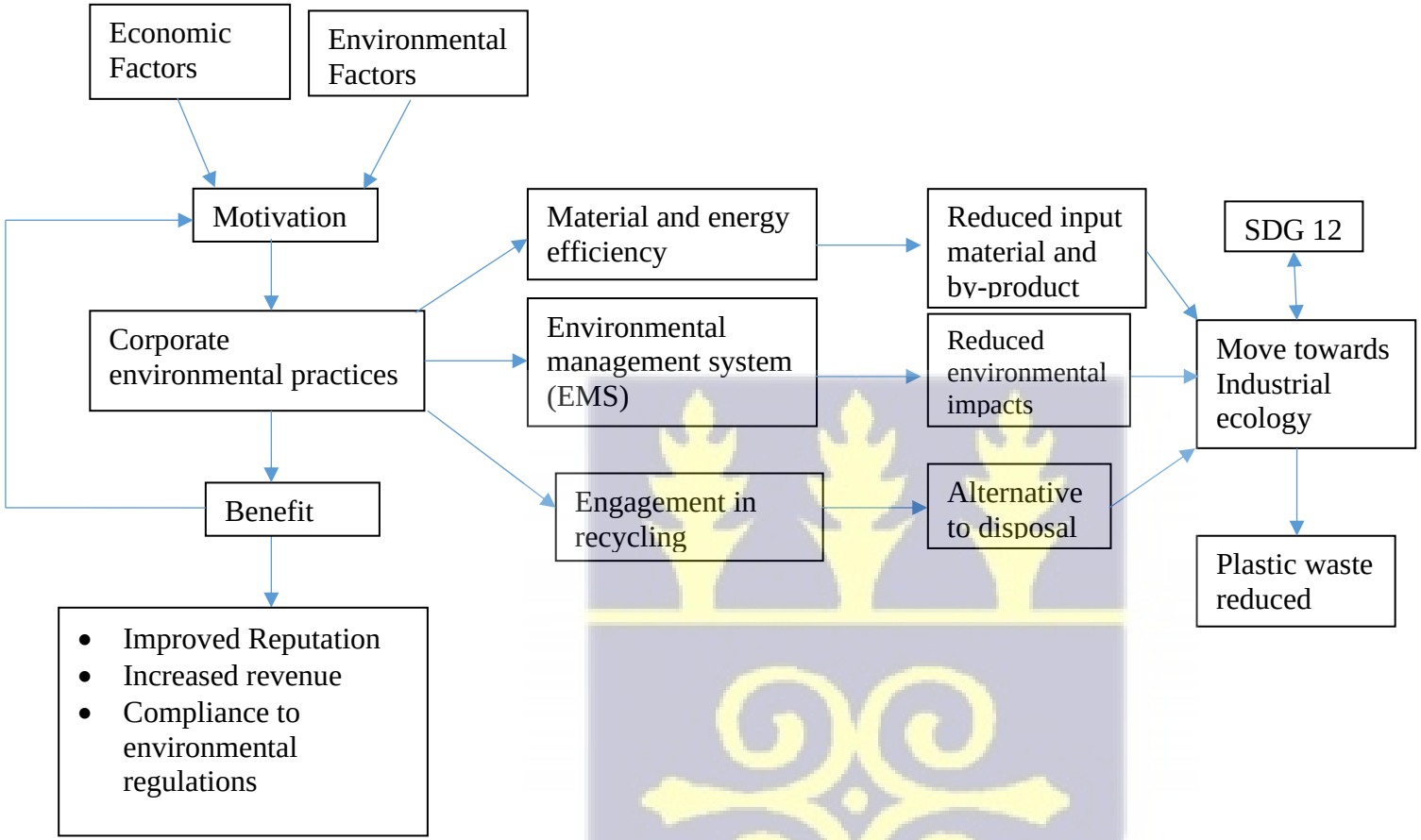

Figure 2: Conceptual framework showing the motivation and benefits of corporate environmental practices of plastic manufacturing enterprises towards industrial ecology and plastic waste reduction in relation to SDG 12

Source: Authors Own Construct.

Economic factors such as reduced cost of input material and revenue from the sale of by-product can motivate plastic manufacturing enterprises to adopt corporate environmental practices (CEP). Plastic manufacturing enterprises can adopt CEP in order to avoid legal and regulatory penalties which comes as cost to them. Also plastic manufacturers can adopt CEP due to environmental factors such as their commitment to contribute to resolving plastic pollution. The adoption of CEP by plastic manufacturing enterprises can bring about benefits in the form of increased revenue, improved corporate reputation and avoidance of punishment or gaining rewards from regulatory bodies. These benefits will further serve as motivating factors for the adoption of CEP.

Corporate environmental practices can manifest in the form of material and energy efficiency, adoption of environmental management systems (EMS), and engagement in recycling. Material and energy efficiency practices which are eco-efficiency components of industrial ecology (IE) at the firm level can lead to a reduction in the amount of input materials needed for production and reduce energy consumption; hence reduction in emission and move towards target 2 of SDG12 i.e. efficient use of natural resources. In essence material and energy efficiency can contribute to IE and SDG12. Material efficiency will therefore mean reduced plastic waste. Also the adoption of EMS by plastic manufacturing enterprises can help them monitor the environmental impacts of their operations and mitigate them. This will contribute to the pollution prevention component of industrial ecology which SDG12 seeks to address. Further, engagement in recycling by plastic manufacturing enterprises can provide an alternative to disposal into the environment such as landfilling. Plastic waste are therefore given a new life. This will boost the recycling target imbibed in SDG12 and also create a loop-closing industrial system which industrial ecology seeks to achieve.

Industrial ecology principles can therefore contribute towards the achievement of SDG12 through its components of eco-efficiency, pollution prevention and recycling/reuse. These principles can also lead to plastic waste reduction as plastic waste is recycled and input materials are used in an efficient manner.

CHAPTER THREE

METHODOLOGY

3.1 Description of the Study Area

Figure 3 shows a map of the Greater Accra Region in Ghana highlighting Accra and Tema Metropolis within which the study was carried out.

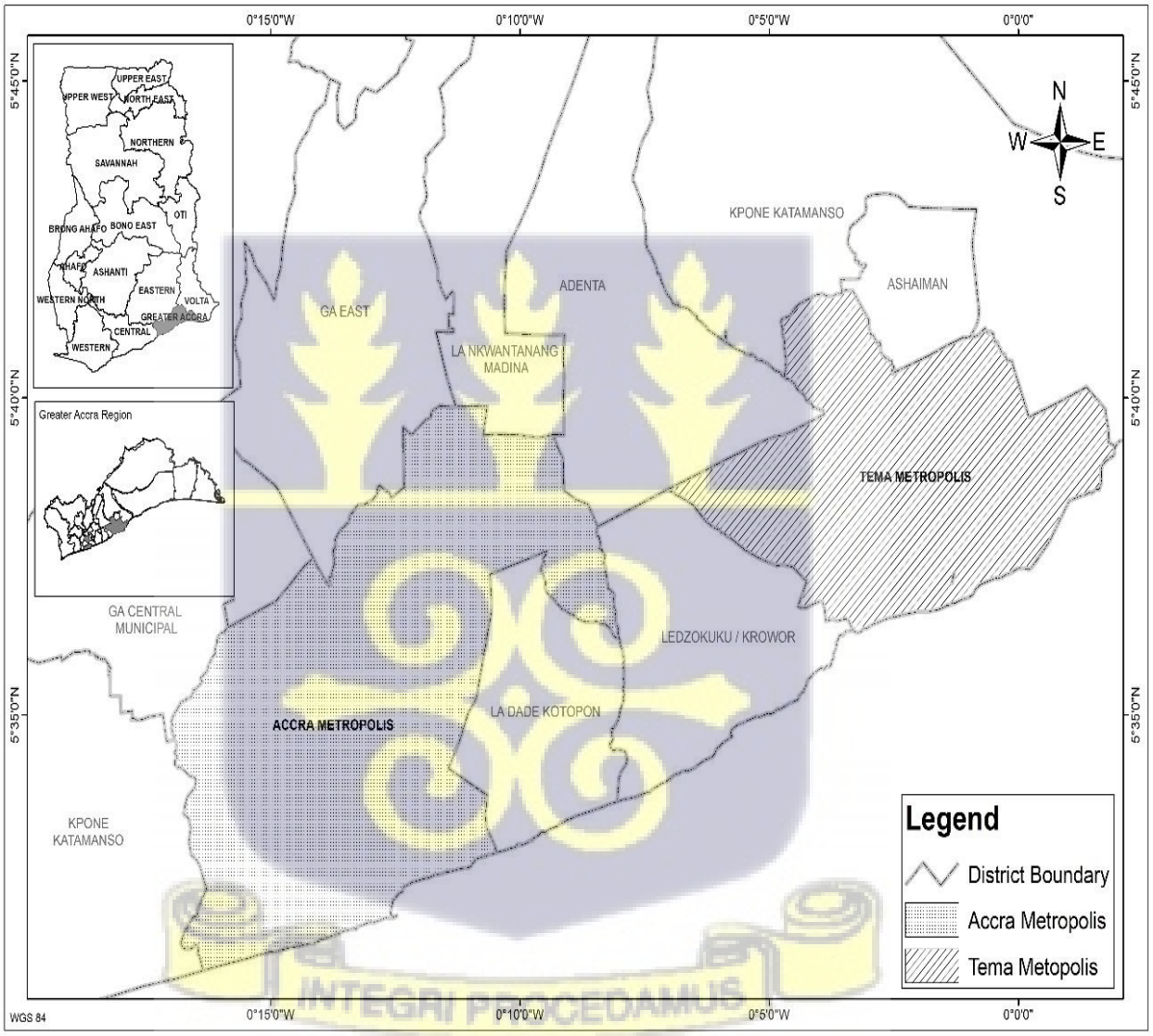

Figure 3: **Map of Greater Accra Region showing Accra Metropolis and Tema Metropolis**

Source: Authors own construct.

Ghana is a country in West Africa with 16 administrative regions and 261 metropolitan, municipal and district assemblies (MMDAs). Ghana has a total land area of 238,533 square kilometres and a coastal line of 550 km (Miezah *et al.*, 2015) and an estimated population of 31,072944 (www.populationpyramid.com, 2020). The Greater Accra region is the capital of Ghana, located along its coast line; covering an area of 3,245 square kilometres and a population of 4,402,688 (Krakah & Bessah, 2016) and 29 MMDAs.

The study focussed on the Accra Metropolis and the Tema Metropolis in the Greater Accra Region of Ghana, since these areas have the highest number of business establishments in the Greater Accra Region, according to Krakah and Bessah (2016). The Accra Metropolis is located in the Greater Accra Metropolitan Assembly (GAMA) of the Greater Accra Region of Ghana. It covers a total land area of 139.674 square kilometre and has a population of 1,665,086 representing 42% of the region's total population (Ghana Statistical Service, 2014b). The Accra Metropolis is characterised by a high number of economic activities taking place within it; hosting a number of manufacturing and service businesses. It is considered as the economic hub of the Greater Accra Region and the rest of the country (Ghana Statistical Service, 2014b), as it constitutes about 45.5% of the total number of business establishments in the Greater Accra region though it has the smallest land area within the region (Krakah & Bessah, 2016). Tema Metropolis has the highest number of business establishments in the Greater Accra region after the Accra Metropolis (Krakah & Bessah, 2016).

The Tema Metropolis is located on the east of Accra, within the coastal savannah zone; having Tema as its capital. It is characterised by flat topography and erratic rainfall pattern. Tema Metropolis is an industrial hub, thus greenbelts have been demarcated to help mitigate the environmental effects of industrialisation within the area by controlling the micro climate as a result of the absence of forest reserves (Ghana Statistical Service, 2014a).

However, increasing industrial activities without corresponding mitigative measures of environmental pollution has resulted in changes in the climatic conditions of the area and a resultant loss of biodiversity. Ghana Statistical Service (2014a) adds that solid waste is collected from most households, however, 21.8% of households dump solid waste in public container. The economic characteristics of the Accra and Tema Metropolis make them a viable option for a study area.

The target population for the study was plastic manufacturing enterprises in the study area due to the growing social activism on plastic pollution. Plastic manufacturing enterprises were therefore targeted to find out whether they are contributing to solving the plastic pollution problem, what they are doing to reduce plastic pollution and what they can do to reduce plastic pollution. The two Metropolis were therefore used as strata while using the stratified sampling method.

3.2 Sampling Procedure

List of plastic manufacturing enterprises in Accra and Tema Metropolis were sourced from online business directory of Ghana Yello similar to the work of Banerjee (2002) on corporate environmentalism where the membership directory of the American Marketing Association was used as the sampling frame. Ghana Yello online business directory was used as the sampling frame because it had the largest number of list of plastic manufacturing companies online. 50 companies were identified in the online business directory as plastic businesses operating in the Accra and Tema Metropolis; 17 located in Tema Metropolis, and 33 located in Accra Metropolis.

Gill et al., (2010) table of sample size based on desired accuracy with confidence level of 95%, was used to arrive at a sample size of 44 at a 95% confidence level, as shown in table 1.

Table 1: Sample size based on desired accuracy with confidence level of 95%.

	Variance of the Population P=5%		
	Confidence Level = 95% Margin of error		
Population Size	5	3	1
50	44	48	50
75	63	70	74
100	79	91	99
150	108	132	148
200	132	168	196
250	151	203	244
300	168	234	291
400	196	291	384
500	217	340	475

Source: Gill et al., (2010)

With the two Metropolis serving as strata, proportional stratified sampling was be used to select firms from each stratum adopting the formula of Bour, et al., (2019):

ni= (Ni/N).n

where Ni is the total population of each Metropolis.

N is the total population of the two (2) Metropolis. = 50

n is the sample size, = 44

ni is the sample allocation for each stratum Metropolis).

Using the above formula, a sample size of 15 for Tema Metropolis and 29 for Accra Metropolis was obtained. Letters requesting to administer questionnaire to enterprises was obtained from Institute for Environment and Sanitation Studies (IESS) and sent out to randomly sampled enterprises from each stratum. Systematic random sampling was used to reach plastic manufacturing enterprises. This was done by alphabetically listing all 50 manufacturing enterprises. First 10 were selected, ensuing 2 were exempted; this was done till the list was exhausted. Purposive sampling was then used during questionnaire administration.

44 questionnaires were administered and 18 were received giving a response rate of 40.9%. Purposive sampling was used during questionnaire administration, The questionnaire survey targeted environmental managers. However, in the absence of environmental managers, Human Resources Managers or General Managers referred staff who handled environmental aspects of the company and were thus eligible to fill the questionnaire to ensure the reliability of the data collected. Respondents included Safety Officers, Human Resources Managers and Factory Supervisors, among others, who were involved in key decision making for the enterprises.

3.3 Description of Sample

The enterprises were categorised based on Poku et al., (2015) classification of business establishments as shown in table 2.

Table 2: Categorisation of enterprise size by number of employees based on Poku et al., (2015)

Number of staff	Business size
less than six people	micro-size
6 to 30	small-size
30 to 100	medium-size
More than 100	large-size

Based on the classification in table 2, fourteen (14) were large size enterprises, three (3) were medium size enterprises 1 small size enterprises. 12 enterprises were within the Accra Metropolis while 6 enterprises were from the Tema Metropolis. Enterprises were producers of multiple use plastic products, single use and packaging products using injection moulding and blowing technologies. Plastic waste was the main by-products realised after production.

3.4 Instrument of Study

The instrument of study was a questionnaire containing both closed-ended and open-ended questions as well as Likert scale type questions. The closed-ended parts entailed a list of options for respondents to choose from. The open-ended questions allowed flexibility in

answering them to supplement responses from the closed-ended questions. Seven (7) point likert scale type questions were also used ranging from strongly agree, somewhat agree, slightly agree, neutral, slightly disagree, somewhat disagree, strongly disagree. This was to enable data to be measured at the interval level, as Dawes (2008) affirms that a 7 likert point scale allows ordinal data to be treated as interval level data in which case means could be found and parametric analysis could be performed.. The questionnaire was sectioned into five parts; sections A, B, C, D, and E. Section A, sought general information about the firms such as its total number of staff, its production capacity and the position of the questionnaire respondent. The second part; Section B of the questionnaire also focussed on the perception of the respondents on the subject matter; that is corporate environmental practices and industrial ecology. The third part of the questionnaire; Section C, concentrated on existing environmental practices being practiced by the firm while the fourth and the fifth parts, Sections D and E of the questionnaire looked at regulatory practices and environmental policy and the impact of environmental concerns on the firm, respectively.

3.5 Ethical Consideration

Given that the study involved human participants whose rights and values need to be respected, Ethical clearance was sought for from the University of Ghana ethics committee of College of basic and applied sciences (ECBAS) to safeguard respondent's information and ensure adequate ethical standards were followed throughout the research. This was particularly important to assure participants of confidentiality.

After ethical clearance was granted, introductory letters from the institute for environment and sanitation studies (IESS) were obtained to request questionnaire administration to respondents and assure them of being a student from the institute. This was necessary as the research would inquire company information which is regarded valuable. Also the use of

qualitative methods was involved which Perera and Emmerich (2018) find to be important to have ethical consideration to carryout.

The goal and scope of the study as well as its benefit to the respondents and the nation were spelt out to respondents to seek their consent which they did verbally. Respondents were also assured that their responses were going to be kept confidential and used purposely for academic work.

3.6 Data Collection Methods

Primary data was collected through Questionnaire personally administered by the researcher. In some cases, the researcher read the questions and selected options chosen by the respondents. In other cases the respondents were allowed to answer the questions on their own if they felt they could, or wanted to attend to it and return it later. Informal interviews were also conducted by striking conversations with respondents seeking further details about their responses and the overall activities of the enterprises to provide more details. Further, interview with respondents were transcribed either verbatim or intelligent transcript. This provided further explanation on the environmental practices of enterprises.

Secondary data sources included relevant materials sourced from reports, journals, articles, internet sources and books that were reviewed. Data was also collected from enterprises` websites.

3.7 Data Analysis Procedure

Completed questionnaires were numbered, edited and examined to clear errors, rule out inconsistencies and increase validity as put forward by Statistics Netherlands (2011). Methodological triangulation was employed in the analysis of data, where the qualitative data was used to support the quantitative data in order to supply the strengths of each method as well as offset the weaknesses of each method (Bryman, 2006). Aspects of the

questionnaire that were close-ended were quantitatively analysed while open-ended questions were qualitatively analysed, or content analysis conducted.

Quantitative data was analysed with descriptive statistics such as frequencies and percentages as well as inferential statistics such as correlation coefficient. This was done by utilizing the Statistical Package for Social Sciences (SPSS) software version 24. Results were presented in tables and charts. All results were interpreted at alpha 0.05 or a 95% confidence level.

For qualitative analysis, qualitative content analysis was used. "Content analysis is a widely used qualitative research method which includes screening printed or visual materials systematically and analysing them based on identified categories thematically" (Demirok et al., 2015). Open- ended questions from my questionnaire were selected, coded and categorised under respective objectives and then analysed quantitatively using descriptive statistics of frequencies and percentages with the aid of The Statistical Package for Social Sciences (SPSS) software. Codes developed were therefore keyed in the SPSS software programme for analysis.

To analyse objective 1, enterprise-level environmental management practices were defined based of material efficiency, energy efficiency and the adoption of sustainable technology or possession of EMS or environmental policy. Determinants of material efficiency such as the type of input material used, engagement in recycling, and environmental issues considered in developing products were used in the analysis. In terms of technology, adoption of environmental management system (EMS), adoption of an environmental policy statement, and factors considered in adopting a new technology were considered. Also, measures put in place to ensure energy efficiency was sought and analysed.

To analyse objective 2, certification by the EPA was used as a proxy measure of compliance to regulatory requirement. This was because, the EPA is mandated by law through ACT 490 ENVIRONMENTAL PROTECTION AGENCY ACT, 1994, to regulate the generation, treatment, and disposal of industrial waste, control and prevent the release of waste and improve the quality of the environment as well as give permits and pollution reduction warnings to offending bodies. Therefore certification from the EPA provides a convincing stance to measure regulatory compliance. Further the relationship between the adoption of environmental practices and compliance to environmental regulation was analysed using correlation analysis between selected variables that depict environmental practices, in this regard, engaging in recycling, having an environmental policy statement, and having an EMS were correlated to being certified by the environmental protection agency (EPA).

To analyse objective 3, Likert scale questions were analysed using means and standard deviation. According to Dawes (2008), a 7 point likert scale allows ordinal data to be treated as interval level data in which case means could be found and parametric analysis could be performed. Likert scale data was therefore keyed into SPSS coding them as strongly disagree = 1, somewhat disagree = 2, slightly disagree = 3, neutral = 4, slightly agree = 5, somewhat agree = 6, strongly agree = 7.

Means of items used were then ranked and interpreted, using a maximum mean score of 7. Further, means of data for each strata that is Accra Metropolis and Tema Metropolis was computed by item in a clustered graph and a comparative analysis was made.

To identify opportunities and challenges of industrial ecology in achieving sustainable plastic production and consumption, relative to SDG 12; and what has been achieved so far, SDG 12 indicators that relates with components of industrial ecology were used as variables for analysis. As such the following SDG 12 indicators were used for analysis.

- Number of countries with sustainable consumption and production (SCP) national action plans or SCP mainstreamed as a priority or a target into national policies
- By 2030, achieve the sustainable management and efficient use of natural resources
- National recycling rate, tons of material recycled
- Number of companies publishing sustainability reports
- Education and awareness

3.8 Limitations of the Study and Measures to Mitigate Them

The major limitation of the study was in getting participants to fill the questionnaire and returning them. Many enterprises rejected to participate in the study due to their busy work schedules. Others collected the questionnaire but returning it took several months. The difficulty in getting participants was further compounded by the outbreak of COVID 19 which immensely affected the plastic industry, as such they were reluctant to participate in the study.

To mitigate these challenges, enterprise` management were assured of confidentiality of their information. Further, all COVID 19 protocols such as wearing of nose masks, keeping adequate distance, washing of hands and use of alcohol- based hand sanitizers were observed. Respondents that were taking long to return questionnaire were followed up with phone calls and messages. Some were visited at their offices several times before making themselves available to fill the questionnaire with the researcher. This favourably, provided the opportunity to engage respondents in an informal interview to give further insights into the responses given.

CHAPTER FOUR

RESULTS

4.1 Demographic Analysis of Sample Population

The valid return rate of companies sampled was 40.9%.

All respondents (100%) had tertiary education, with the highest percentage of respondents aged between 44 and 52 as shown in table 3. Also 15 of the respondents representing 83.3% were part of key management members in decision making of their enterprises as shown in table 4. Three (3) respondents however, were not part of key decision making of their enterprise but had good knowledge on the environmental activities of their enterprise and could give informed details.

Table 3: Education and Age Characteristics of Respondents

	Age (yrs.)				Total
	26 to 34	35 to 43	44 to 52	above 60	
Education tertiary	6	4	7	1	18
Total	6	4	7	1	18

Table 4: Cross Tabulation between Position of Respondents and their Involvement or not in Key Decision Making

Position	Part of key decision making		Total
	Yes	No	
Human resource manager	1	1	2
Safety	3	1	4
Sales	1	0	1
Accountant	2	0	2
Manager	5	0	5
Director	1	0	1
Supervisor	2	1	3
Total	15	3	18

From figure 4, 14 of the enterprises, representing 77.8 % were classified as large-scale enterprises, as they had more than 100 staff members. In terms of type of plastic products produced, enterprises produced a combination of products, being single use plastics, multiple use plastics, and plastic packaging products. Accra Metropolis had more (10) large sized enterprises located within it, and the remaining 4 large enterprises were located in the Tema Metropolis. Also 2 medium sized enterprises were in Accra Metropolis, while Tema Metropolis had 1 medium sized enterprise and 1 small sized enterprise (figure 5).

Figure 4 Number of Enterprises and their Size

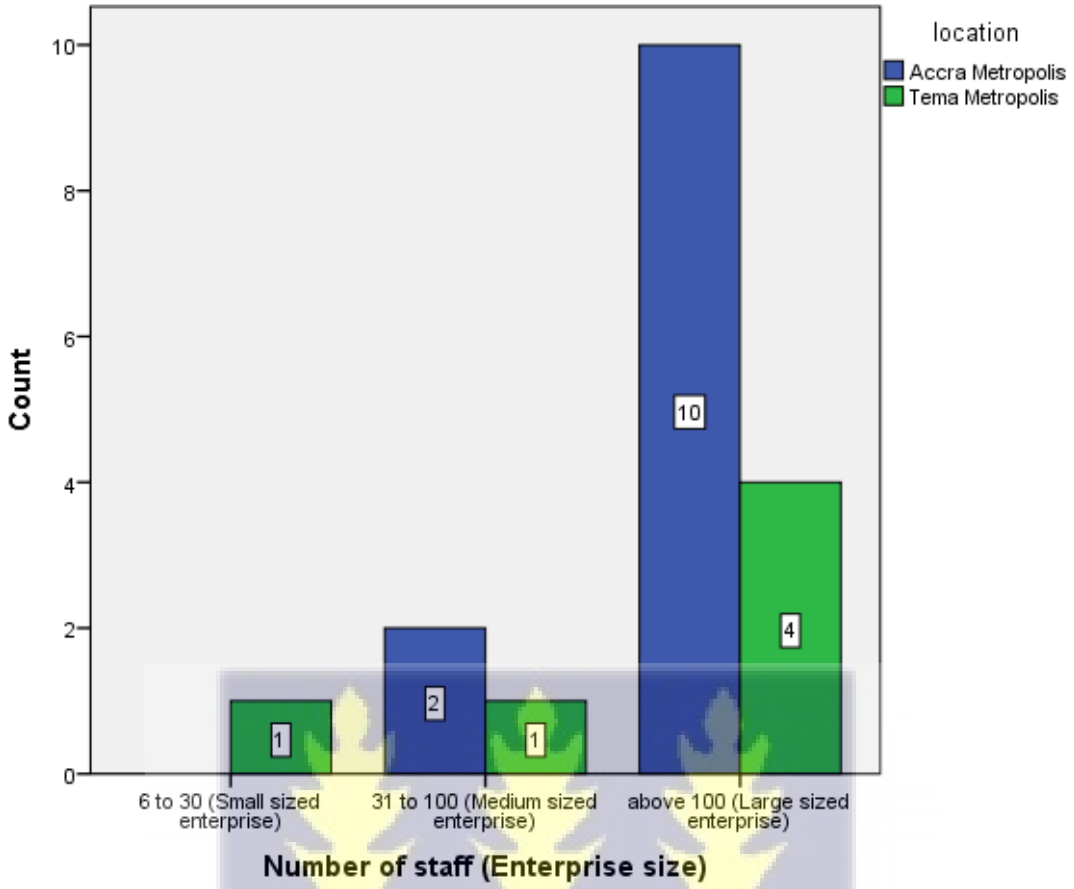

Figure 5: Enterprises size by location

A cross tabulation between enterprise size and products produced, from table 5, showed that, 8 out of the 18 enterprises representing 44.4% were producers of multiple use plastics; all being large sized enterprises. 3 enterprises ranging from small sized enterprises to large sized enterprises were producers of single use plastics, while 4 enterprises were producers of both single use and multiple use plastics. This shows that majority of plastic manufacturers in the study area were producers of multiple use plastic products.

Table 5: Cross Tabulation between Enterprise Size and Type of Plastic Products they produce

Number of staff (enterprise size)	Type of plastic product					Total
	single use	Multiple use	single use and multiple use	single use and packaging	Multiple use and packaging	
6 to 30 (small size enterprise)	0	0	1	0	0	1
31 to 100 (medium size enterprise)	2	0	1	0	0	3
above 100 (large size enterprise)	1	8	2	1	2	14
Total	3	8	4	1	2	18

A few number of respondents representing 27.8% had heard of the term industrial ecology while the other 72.22 representing 13 respondents (Appendix 1) had not heard of the term industrial ecology.

A cross tabulation between respondents that had heard of the term IE and whether or not environmental practices of their enterprises align with industrial ecology showed majority of them representing 4 (80%) as shown in table 6 answering that practices of their enterprise aligned with industrial ecology, while 1 was in disparity. A content analysis of the understanding of respondents that said they had heard of industrial ecology showed varied responses as to their understanding of industrial ecology. Two (2) of the respondents (figure 6), understood it to mean the interaction or interdependence amongst industries from. Figure 6 also shows 1 respondent understood industrial ecology as material and energy exchanges amongst industries. Also, one (1) respondent said IE is the study of the effect of material and energy use by industries on the environment, while 1 respondent understood IE as the relationship between production and the environment.

Table 6 : Respondents that have Heard of Industrial Ecology and their Engagement or Not in IE Practices

Heard the term Industrial ecology	IE practices		Total
	Yes	No	
Yes	4	1	5
Total	4	1	5

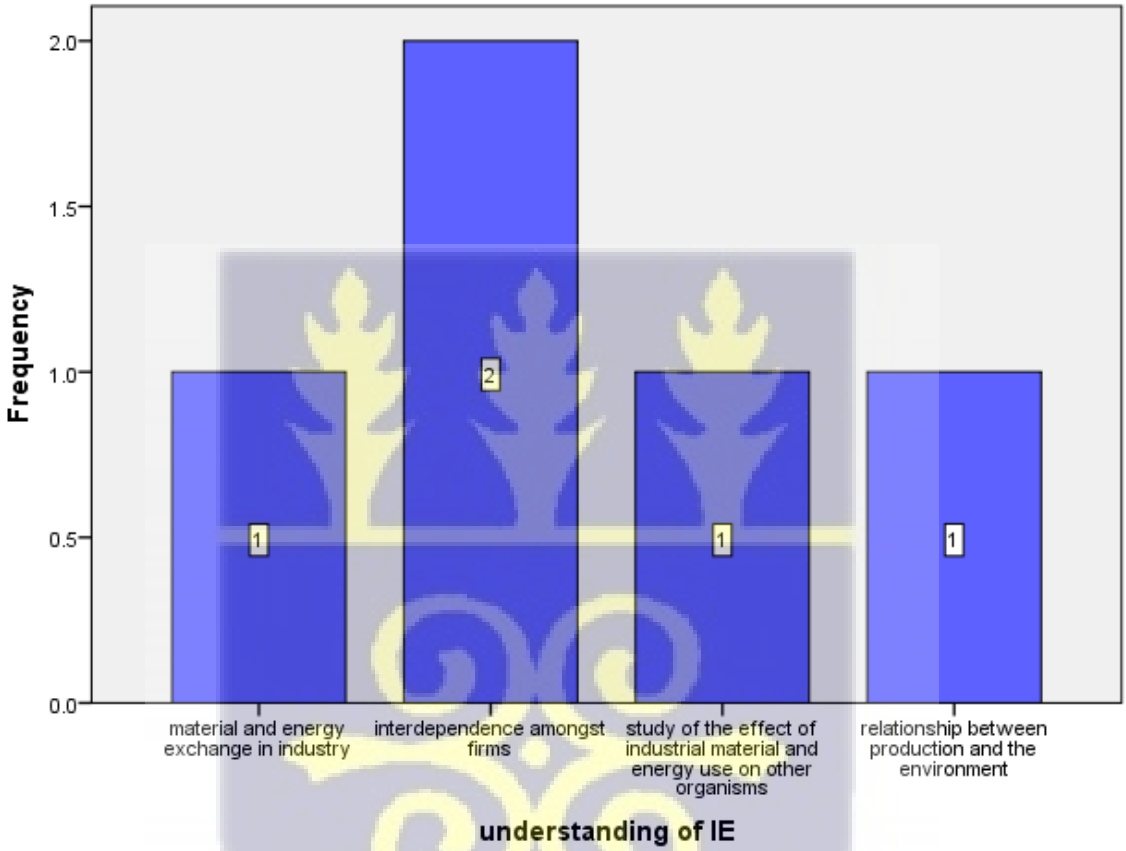

Figure 6 : Respondents understanding of industrial ecology.

Table 7, shows that all respondents that had heard of the term IE were from large sized enterprises, showing that large sized enterprises were more informed of IE than smaller sized enterprises.

Table 7: Enterprise Size and their knowledge or not of IE

		Heard of industrial ecology		Total
		yes	No	
Number of staff (enterprise size)	below 25 (micro enterprise)	0	1	1
	25 to 50 (small size enterprise)	0	1	1
	50 to 100 (medium size enterprise)	0	2	2
	above 100 (large size enterprise)	5	9	14
	Total	5	13	18

4.2 Environmental Practices among Plastic Producing Enterprises.

4.2.1 Enterprise practices on material efficiency

Figure 7 shows the type of input materials used for production by the enterprises, showing that majority of enterprises (55.6%) used a mixture of both raw materials and recycled materials in production, hence each of their products contains a percentage of virgin raw materials and recycled material. This was closely followed by a 38.9% (figure 7) of respondents indicating that they used totally virgin raw materials for production, while 5.6% of respondents had separate products that were produced mainly from raw virgin materials and other products mainly produced from recycled materials. Results (Appendix 2) also indicated that majority of respondents (44.4%) were aware they could use biodegradable plastics and considered it as an environmentally viable option to their current input material, however, further interview with respondents indicated most respondents saying that they

could not adopt it due to its relatively high cost. However, 38.9% (Appendix 2) of respondents were not aware of biodegradable plastics.

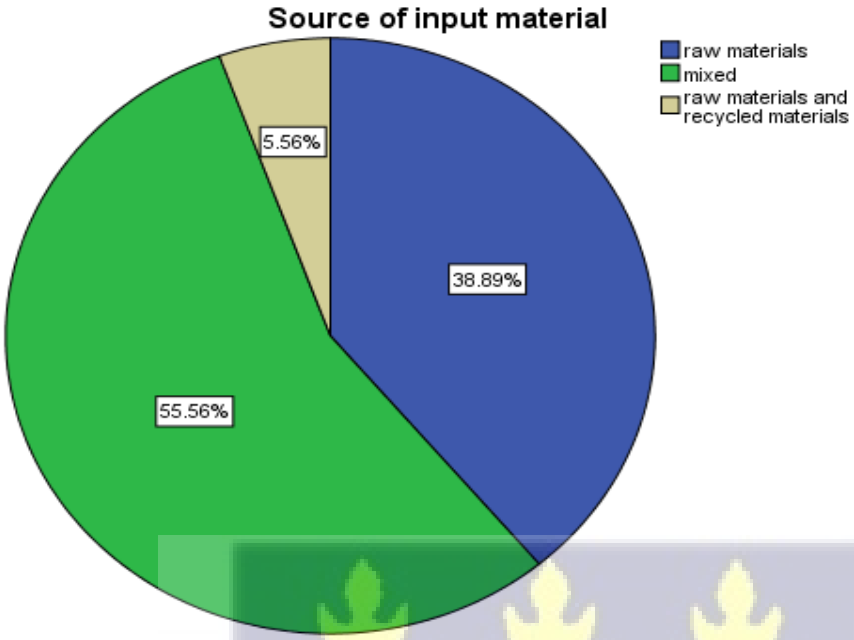

Figure 7: Source of input material

Five (5) out of the 10 enterprises (table 8) that used alternate source of input material aside virgin raw materials sourced such input material from other plastic manufacturing enterprises. Informal interviews with respondents showed that most of the enterprises that used only virgin raw materials for production saying they did not use recycled products for production since it could affect the desired quality of their final product. In addition to the use of by-products, 7 enterprises mentioned that they were willing to pay for by-products from other industries, while 11 enterprises (appendix 3) were not ready to purchase by-products from other enterprises for production.

Table 8: Source Of Input Material and Use of By-Product From Other Enterprises or not

Source of input material	use of by product from other enterprises		Total
	Yes	No	
raw materials	0	7	7
Mixed	5	5	10
raw materials and recycled materials	0	1	1
Total	5	13	18

Majority (94.4%) of enterprises were involved in recycling of their own plastic waste with 7 of them (38.89%) giving their reason for recycling to be, to reduce their cost of production (Figure 8). Further, other enterprises indicated that they recycled their waste to yield economic benefits through the sale of waste, reduced cost of waste collection, as well as avoid wastages which could end up in the environment. Hence 4 (22.22%) enterprises, had both economic and environmental reasons for recycling their waste, while 6 (33.3%) enterprises claim to recycle in order to contribute to reducing plastic pollution in the environment.

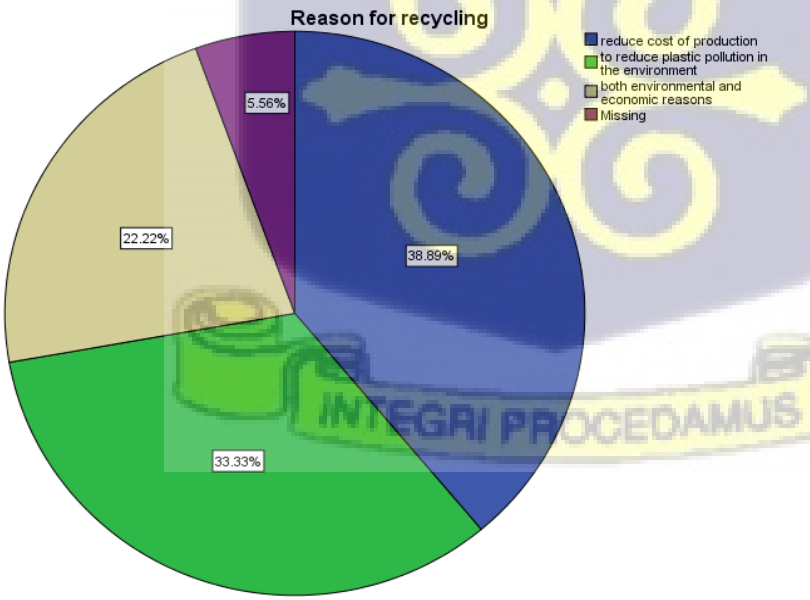

Figure 8: Reasons for recycling plastic waste

Also most of the enterprises did the recycling within their enterprises. From figure 9, 83.3% (15) of enterprises did the recycling within their enterprises, while 1 enterprise had the recycling of their waste done by other recycling companies because they did not have a recycling plant. One (1) enterprise recycles some of its by-products and send others they couldn't recycle to a recycling company.

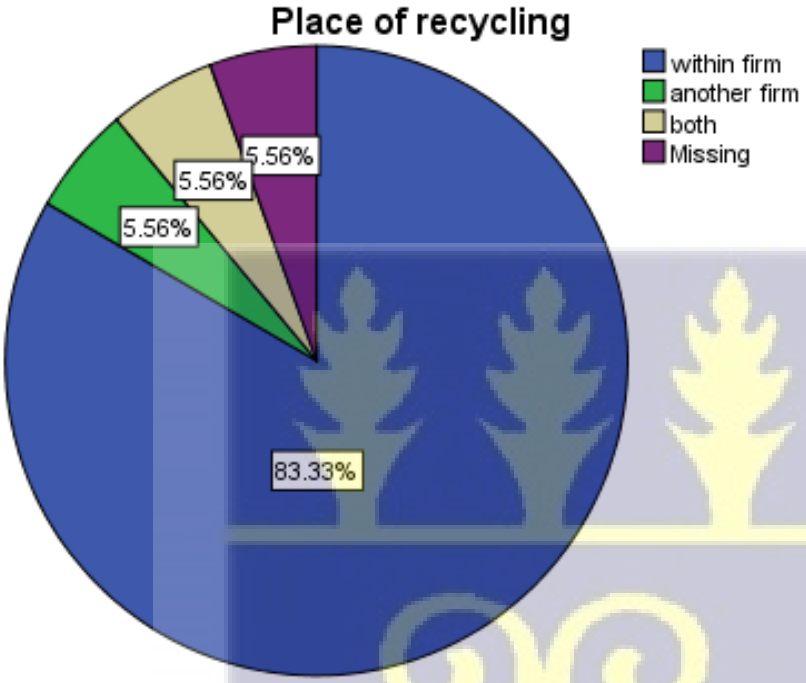

Figure 9: Place of recycling

Most (94.4%) of the enterprises affirmed that they considered environmental issues when developing or designing their products, of which 55.6% (figure 10) of the enterprises prioritized the recyclability of the products when designing them. Figure 10 further shows 1(5.56%,), of the enterprises prioritized pollution control, thus, they designed their products such that it produced less pollution during the manufacturing process, while 27.78% (figure 10) of the enterprises considered both recyclability and pollution control.

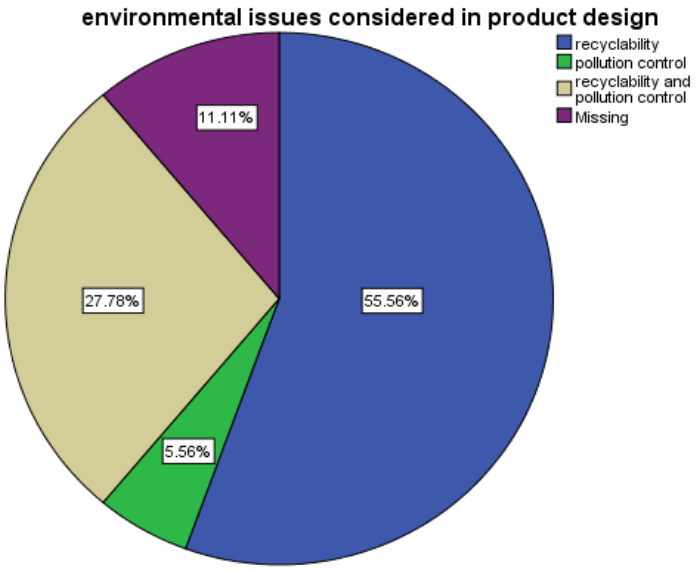

Figure 10: Environmental issues considered in product design by the Enterprises.

4.2.2 Possession of environmental policy and EMS implementation

An environmental policy statement is one that is voluntary and stipulates the environmental effects of the operations of an enterprise on the environment and how to tackle such effects. Of the 18 enterprises participating in the study, 13 industries had an environmental policy statement guiding their operations. Eleven (11) out of the 13 that have an environmental policy statement were able to abide by their environmental policy statement. Ten (10) were large scale enterprises and 1 being a small sized enterprise. During informal interviews, most enterprises that had an environmental policy statement said they needed it in order to acquire or start processing an ISO 14001 certification, while others also mentioned that having an environmental policy helped them to stay within the law.

The adoption of an environmental management system (EMS) was also analysed. From table 9, 8 enterprises stated that they have an environmental management system all of which were large scale enterprises. Table 10 shows enterprises that have an EMS adopting it mainly to monitor their activities, especially pollution levels while a few (2) enterprises adopted an EMS to help them monitor their employees adherence to their environmental

policy. The lack of EMS adoption amongst most of the enterprises, was mainly attributed to inadequate finances to fund the use of an EMS. It is also important to note that all small and medium sized enterprises did not have an EMS and stated financial constraints as their reason for not having one as indicated in table 11.

Table 9: Enterprises` size and their adoption or not adopting an EMS

		Number of staff (Enterprise size)			Total
		6 to 30 (small size enterprise)	30 to 100 (medium size enterprise)	above 100 (large size enterprise)	
Ems	Yes	0	0	8	8
	No	1	3	6	10
Total		1	3	14	18

Table 10: Adopting or not adopting EMS and reasons by Enterprises sampled

		Reason For EMS		reason for not adopting EMS		Total
		to monitor our pollution	to ensure employees adhere to environmental policy	we do not have the resources	it is being discussed	
EMS	Yes	6	2	0	0	8
	No	0	0	8	2	10
Total		6	2	8	2	18

Table 11: Enterprise size and their reason for adopting or not adopting an EMS

	Number of staff (Enterprise size)			Total
	6 to 30 (small scale industry)	30 to 100 (medium scale industry)	above 100 (large scale industry)	
to monitor our pollution	0	0	6	6
to ensure employees adhere to environmental policy	0	0	2	2
we do not have the resources	1	3	4	8
it is being discussed	0	0	2	2
Total	1	3	14	18

Table 12 shows that five (5) enterprises had international certifications out of which 4 were large sized enterprises while 1 was a medium sized enterprise. Most of the certifications were ISO 9001 and ISO 14001.

Table 12: Acquiring of international certification (ISO) by enterprises based on their sizes

		Number Of Staff (Enterprise Size)			Total
		6 to 30 (small sized enterprise)	30 to 100 (medium sized enterprise)	above 100 (large sized enterprise)	
International certification (ISO)	yes	0	1	4	5
	no	1	2	10	13
Total		1	3	14	18

4.2.3 Practices on energy efficiency

In terms of energy efficiency measures being practiced by enterprises, enterprises` priority when it came to the adoption of new technology was sought. Analysis from figure 11 shows that majority (33.3%) of enterprises considered a combination of various factors when it came to the adoption of a new technology. These enterprises considered price, innovativeness, energy efficiency and pollution control among others before making a decision on the kind of technological innovation to adopt.

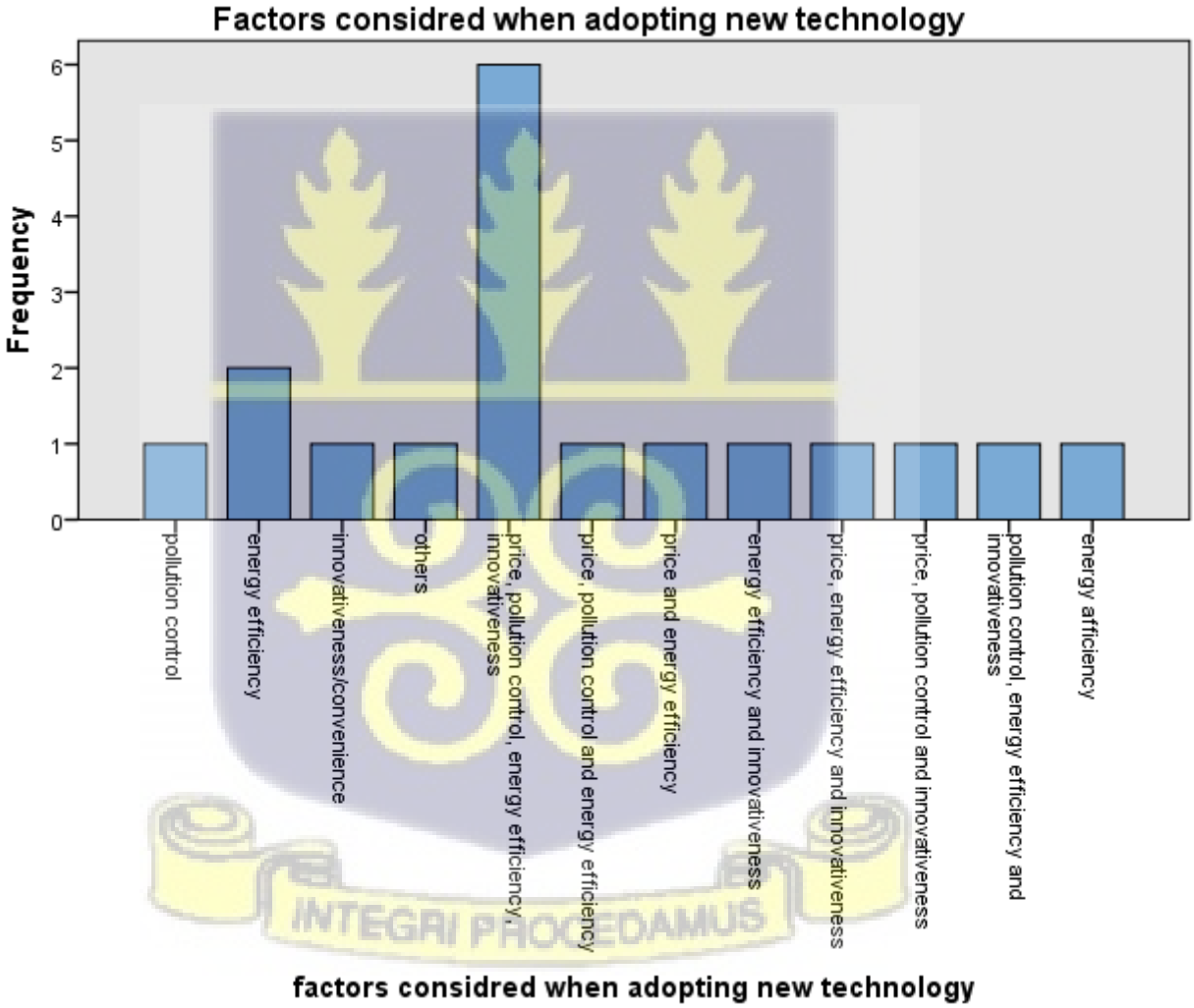

Figure 11: Factors Considered When Adopting a New Technology.

The main source of energy for enterprises visited was from the national grid, which was complemented with diesel generator by about 50% of the enterprises and11.1% (2) enterprises supporting with solar energy. Only 1 enterprise produced energy internally, using their by-products. To ensure energy efficiency, most (44.4%, table 13) enterprises put off all their machinery at the end of day when there is no production and they are not in use. Also, those that were into 24hr production ensured they had a power factor corrector to minimize their energy consumption and also replaced obsolete technology with energy efficient ones.

Table 13: Measures put in place to ensure energy efficiency

Measures	Frequency	Percent
put off machines when not in use	8	44.4
replace obsolete technology for energy efficient ones	3	16.7
power factor corrector	1	5.6
put off machines when not in use and replace obsolete technology for energy efficient ones	4	22.2
power corrector and put off machines	2	11.1
Total	18	100.0

4.3 Regulatory Compliance of Enterprises

Almost all enterprises (17), had certification from EPA, showing that they complied with their regulatory requirement.

The correlation analysis between having an EPA certification and having an environmental policy (Table 14), revealed a positive correlation of 0.391 between having an environmental policy and compliance to EPA regulatory requirement ($p=0.109$; $p>0.05$) suggesting an insignificant relationship and therefore low association.

Table 14: Correlations matrix of compliance with environmental regulation and some environmental practices.

Variable		Environmental policy statement	Comply with EPA regulation	EMS	Engage in recycling
Environmental Policy statement	Pearson Correlation	1	.391	.305	.391
	Sig. (2-tailed)		(.109)	(.218)	(.109)
	N	18	18	18	18
Comply with EPA regulation	Pearson Correlation	.391	1	.217	-.059
	Sig. (2-tailed)	(.109)		(.387)	(.817)
	N	18	18	18	18
Have EMS	Pearson Correlation	.305	.217	1	.217
	Sig. (2-tailed)	(.218)	(.387)		(.387)
	N	18	18	18	18
Engage in recycling	Pearson Correlation	.391	-.059	.217	1
	Sig. (2-tailed)	(.109)	(.817)	(.387)	
	N	18	18	18	18

Significance levels are in parentheses

Content analysis of qualitative data on enterprises reason for having an environmental policy shows majority (53.8%, table 15) of the respondents that had an environmental policy statement indicated that they did so in order to be able to adhere to regulatory requirements, while 5 (38.5%) of respondents that had an environmental policy statement did so because they wanted to meet both local and international standards in terms of their obligation towards the environment and thereby have access to a wider market. One enterprise mentioned that they adopted an environmental policy statement mainly to ensure that best environmental practices are followed.

In terms of relationship between having and an EMS compliance to environmental regulation, the correlation matrix table 14 shows a positive correlation of 0.217 between having an EMS and compliance with environmental regulation ($p=0.387$; $p>0.05$).

Also results from qualitative data on why enterprises adopt an EMS showed most of the enterprises mentioning that they obtained an EMS in order to be able to monitor their pollution levels (table 10). Quantifying the results from interviews showed 6 of respondents that had an EMS gravitating towards the need to monitor their pollution levels and impact of their activities on the environment. While 2 of the respondents that had an EMS did so in order to monitor their staff and ensure that their activities did not go beyond their environmental targets.

On the other hand, results from the correlation matrix of table 14 demonstrates a negative correlation of -0.59 between engagement in recycling and compliance to environmental regulation ($p=0.817$; $p>0.05$).

There were varied responses to the reason for engaging in recycling. Enterprises engagement in recycling was mainly for economic reasons, as shown in figure 8. However a significant amount of enterprises also engaged in recycling to reduce plastic pollution, while other enterprises had both economic and environmental reasons for engaging in recycling.

Table 15: Reason for having an environmental policy statement

Response	Frequency	Percent	Valid Percent	Cumulative Percent
To meet both local and international standards	5	27.8	38.5	38.5
To ensure best environmental standards are followed	1	5.6	7.7	46.2
To meet regulatory requirement	7	38.9	53.8	100.0
Total	13	72.2	100.0	
Not applicable	5	27.8		
Total	18	100.0		

4.4 Perception of Plastic Producing Enterprises on the Influence of Activisms around Plastic Pollution on their Activities.

It is observed from table 16 that plastic producing enterprises perceived certain actions and influences of theirs to be due to growing public activisms on plastic pollution. Results from the study indicated that reduction in sales and profits over the last 10 years scored an average of 3.06, receiving the lowest rank, while firms professed that raw materials have become more expensive due to scarcity of resources from the natural environment, was a main influence of activism against plastic pollution on their operations, as this item ranked highest an average score of 6.17. The results showed that enterprises rank high in highlighting the environmental features of their products and services in their packaging and advertisements (6.06), putting in effort towards substantially reducing plastic waste in the environment (5.50), adopting technologies that move towards sustainable production and consumption (5.39), and changing their marketing strategies (5.17).

However, enterprises claimed that economic aspects of their enterprises of showing more responsibility toward their customers, shareholders, and employees than the environment (3.67) and a reduction in sales and profits over the last 10 years (3.06) received the lowest ranks. Enterprises therefore maintain that they have responsibility towards the environment, as a rank of 3.67 showed a slight disagreement to prioritizing their stakeholders over the environment, but then also, their sales over the years has not been affected by social action against plastic pollution.

Table 16: Descriptive Statistics of the perception of enterprises on the effects of activism on plastic pollution on their activities.

	N	Minimum	Maximum	Mean	Std. Deviation
Raw materials have become more expensive due to scarcity of resources from the natural environment	18	5.00	7.00	6.17	.78
We highlight the environmental features of our products and services in our packaging and advertisements	18	3.00	7.00	6.06	1.30
Our enterprise puts in effort towards substantially reducing plastic waste in the environment	18	1.00	7.00	5.50	1.97
Our enterprise develop/adopt technologies that move towards sustainable production and consumption	18	1.00	7.00	5.39	2.19
Environmental concerns have influenced our marketing strategies	18	1.00	7.00	5.17	1.97
Our enterprise advocates public education/awareness on the effects of plastic pollution.	18	1.00	7.00	4.83	2.50
Our enterprise ensures sustainability reporting	18	1.00	7.00	4.39	2.40
Environmental concerns have influenced the kind of products we develop	18	1.00	7.00	4.17	2.53
Our enterprise has more responsibility toward its customers, shareholders, and employees than the environment	18	1.00	7.00	3.67	2.40
Environmental concerns has led to a reduction in sales and profits over the last 10 years	18	1.00	7.00	3.06	1.95
Valid N (list wise)	18				

Grand mean =4.8333

Interviews with some participants however revealed other factors that may be affecting the price hikes of raw materials. One respondent stated that:

> "*Import duties keep increasing all the time*".

Another respondent mentioned that

> "*Not only environmental concern about the scarcity of raw materials have made raw materials expensive. Sometimes, trade wars amongst countries affect prices. Also, political wars or political instability in some of the countries we import from also brings about artificial shortage which results in increase in prices of goods."*

In addition, a respondent pointed out that,

> *"Another thing that has caused resources to become expensive aside concern for the environment is increased competition amongst plastic manufacturing companies and demand for quality by customers.*

Generally, there was no clear categorisation of whether social activism were perceived to be affecting reputation of enterprises more than its profits. However, more items related to reputation of enterprises received higher ranking than economic related items.

A comparative analysis of item means by location between Accra and Tema Metropolis, showed Accra Metropolis receiving the highest rank of environmental impact with the item "raw material have become expensive due to scarcity of resources from the natural environment" with a mean score of 6.25 (figure 12), while Tema Metropolis had "Our enterprise develop/adopt technologies that move towards sustainable production and consumption" receiving the highest rank with a mean score of 6.17 (figure 12). Plastic manufacturing enterprises in Tema Metropolis showed the highest level of agreement that environmental concerns about their activities has pushed them to adopt sustainable technology than enterprises in Accra Metropolis.

Reduction in sales and profits over the last 10 years ranked lowest in both areas with mean scores of 3.33 and 2.50 for Accra Metropolis and Tema Metropolis respectively. This shows enterprises in both locations showed lowest level of agreement about a negative impact of plastic activism on their enterprises in terms of sales.

Additionally, items that were related to reputation of enterprises particularly highlighting the environmental features of products and services in packaging and advertisements, putting in effort towards reducing plastic waste in the environment, adopting technologies that move towards sustainable production and consumption, and marketing strategies received pretty high ranking above 4 in both areas, being that 7 is the maximum mean to be received.

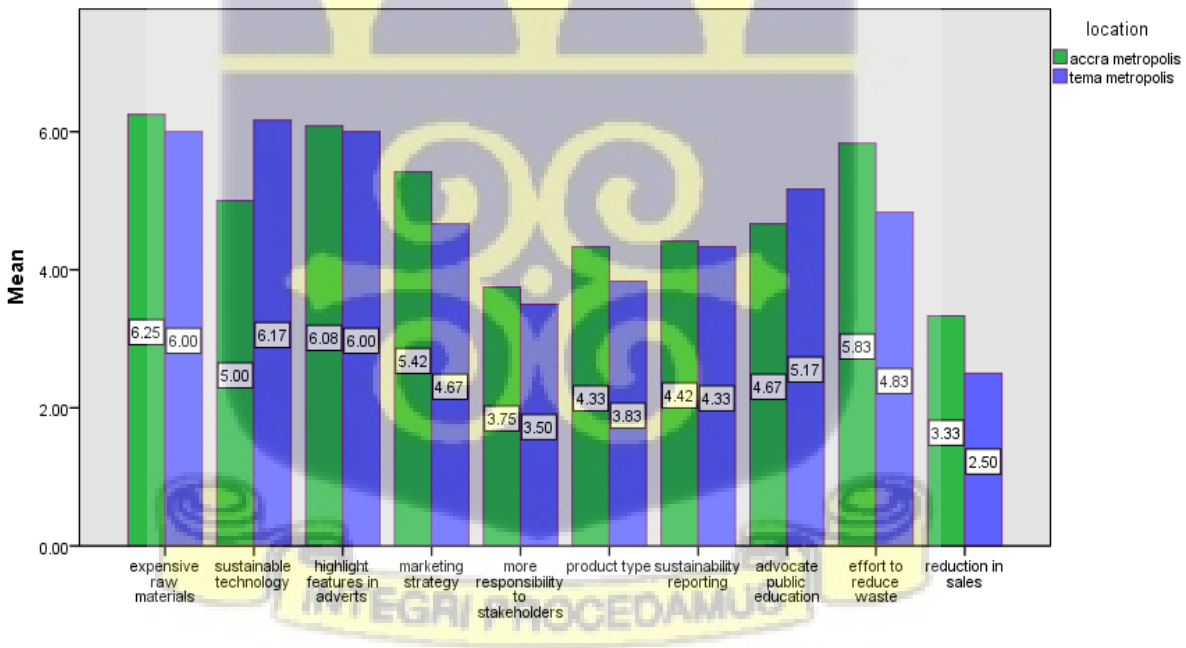

Figure 12: Mean of Effects of Environmental Concerns on Enterprises by Location.

From figure 13, enterprises showed a 4.83 mean on the influence of activism on plastic pollution on their operations, which shows an above average level of agreement. Enterprises

in the Accra Metropolis (4.83) perceived that activism on plastic pollution influenced their operations more than enterprises in the Tema Metropolis (4.7).

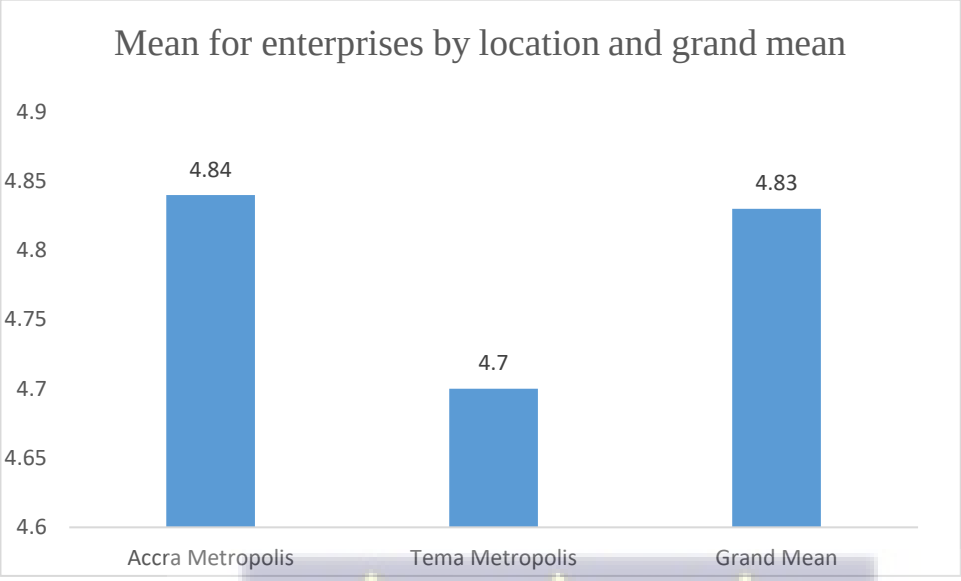

Figure 13: Mean perception of Enterprises on the influence of activism on plastic pollution on their operation by Location and in general

4.5 Opportunities and Challenges of Using Industrial Ecology to Achieve Sustainable Plastic Production And Consumption in Relation to Sustainable Development Goal 12 (Responsible Production and Consumption).

4.5.1 SDG 12 indicator on National Policy

National action plans in terms of sustainable plastic production and consumption was identified as the national plastic management policy (NPMP). Though the policy is relatively new, most of the respondents 77.8%, had heard about it, with 50%, of total respondents or 64.3 % of respondents that had heard of NPMP responding to understanding its details (table 17).

Table 17: Respondents who understand or do not the details of NPMP

	Frequency	Percent	Valid Percent	Cumulative Percent
Yes	9	50.0	64.3	64.3
No	5	27.8	35.7	100.0
Total	14	77.8	100.0	
not applicable	4	22.2		
Total	18	100.0		

4.5.2 Material Efficiency

The study found most of the enterprises practicing the 3Rs of sustainability, i.e. reduce, reuse and recycle. Half (50%) of the enterprises shown in figure 14 ensured judicious use of materials through measuring of their input materials to avoid wastage. Others also reuse and recycle materials that did not come out well. From figure 14, 27.78% of enterprises indicated that they recycle outputs that did not come out right and 22.22% of enterprises indicated that they measure their input materials as well as recycle outputs that did not come out well.

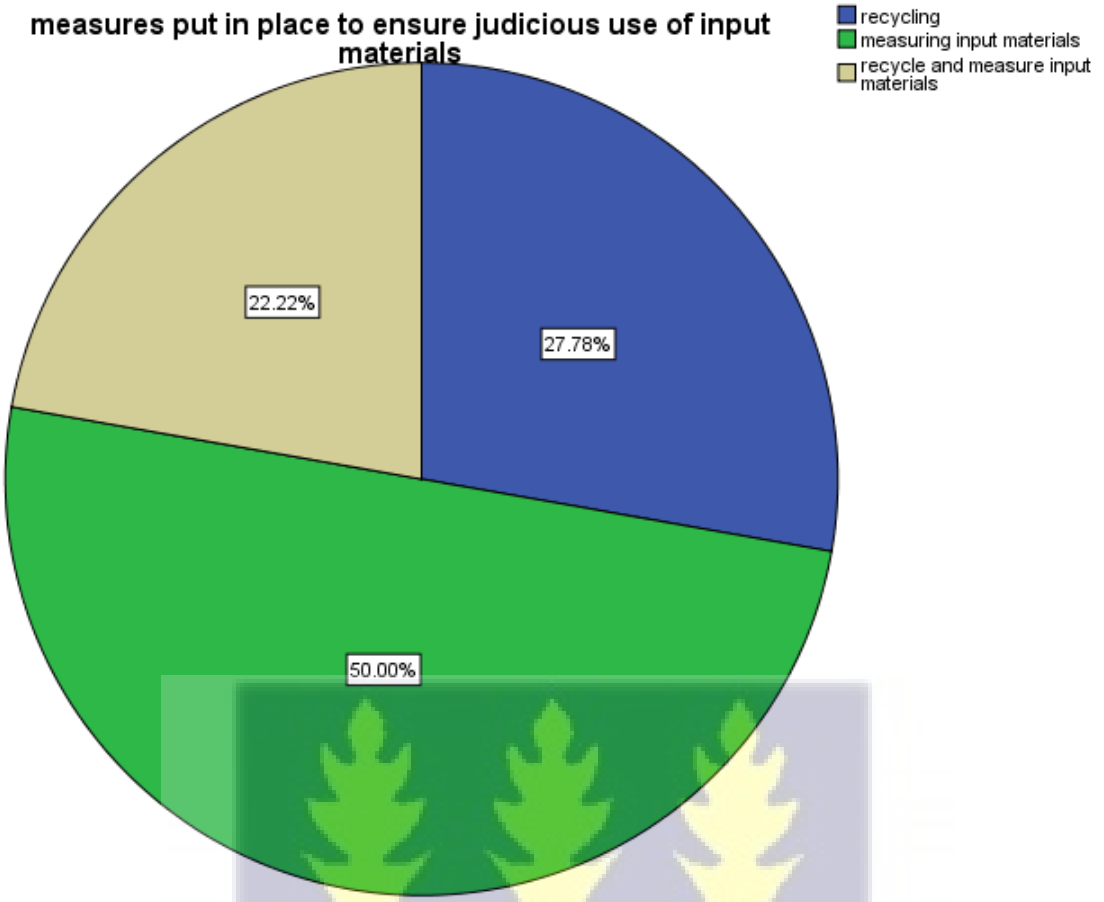

Figure 14: Measures put in place to ensure judicious use of input materials

In an interview with some of the respondents partaking in the study, one of the respondents stated that,

> "*Every job is quantified to determine the amount of material needed before production is done".*

Another respondent mentioned that,

> "We *measure materials before we start production*".

Most (61.12%) used some level of by-products as input materials for production as shown in figure 7, while 5 enterprises used by-products from other enterprises.

With IE, enterprises can access by-products from other enterprises to reduce their consumption of raw materials. Results from the study shown in table 18, shows that 5

enterprises representing 27.8% had identified by-products of other industries that can be useful to them, 4 of which were willing to pay for such by-products and 1 enterprise was not willing to buy by-product for production. Three (3) other enterprises had not identified any by-product from other enterprises that could be useful to them but were however willing to pay for such by-product if they identified some. In total, a few (7) enterprises were willing to pay for by-products. Table 19 further shows that all enterprises that had identified useful by-products from other enterprises were already engaged in the use of by-products from other enterprises for production.

Table 18: Identification of useful waste/by-product from other enterprises or not and whether enterprises were willing to pay for or not pay for waste/by-product

		Willingness to pay for waste/by-product		Total
		Yes	No	
Identified useful waste/by-product from other enterprises.	yes	4	1	5
	no	3	10	13
Total		7	11	18

Table 19: Cross tabulation between enterprises that have identified useful waste/by-product from other enterprises and those already engaged in the use by-product from other enterprises

		Use by-product from other enterprises		Total
		Yes	No	
Identified useful waste/by-product from other enterprises	yes	5	0	5
	No	0	13	13
Total		5	13	18

4.5.3 Recycling

Most (94.4%) of enterprises were engaged in recycling of their by-products either within their enterprise or by another plastic manufacturing enterprise or a recycling company. This provides the opportunity in terms of expertise and technology for plastic recycling. However, most of the recycling done were industrial waste. Only a few enterprises recycle post- consumer waste.

The capacity in terms of machinery and expertise to recycle post-consumer waste was said to be limited and involved lots of processes that enterprises were not willing to go through. In an interview with one of the respondents, he stated that,

> "*The use of waste from the environment affects the quality of the products we produce*".

While another respondent stated that

> "*We do not have the financial capacity to employ waste pickers, however, we encourage our customers to return products when they are broken so that we can recycle them".*

4.5.4 Sustainability Reporting

Results showed 22% of enterprises reporting on sustainability of their operations annually, all of which were large scale enterprises, and another 44.4% were not consistent with sustainability reporting. Enterprises therefore had some experience in sustainability reporting. However, few enterprises (33.6) recognise the importance of sustainability reporting.

> "*It only remains here when we do it"* –HR manager of one enterprise.
> *"We do not have the time for it*", said one respondent
> "*We usually feature environmental aspects of our operations in our yearly magazine*", said another respondent.

And few enterprises (22.2%) had the financial capacity to do so.

4.5.5 Education and Awareness.

A few (33.33%) of enterprises mentioned that they engaged in public education and awareness on the impact of plastic pollution. While the majority of respondents representing 66.67% did not engage the public in education and awareness of plastic pollution.

In an interview, one respondent mentioned that,

> *"We sponsor advertisement in the media, against plastic littering".*

Another respondent mentioned that,

> "*We usually collaborate with NADMO* (National Disaster Management Organisation*) to provide education to the public".*

Enterprises that engage in environmental management initiative can provide education to their customers.

> "*We usually educate our customers on the effects of plastic pollution when they come here to buy. We also encourage them to bring back broken plastic products for recycling by giving them free products in return."*

However, some enterprises did not feel obliged to engage in public education on plastic pollution as indicated by some respondents.

> *"It is the responsibility of the AMA* (Accra Metropolitan Assembly), *since we pay environmental tax",* said one respondent.

Another respondents mentioned that,

> "*Our association does that".*

Opportunities and challenges of industrial ecology exist in achieving sustainable plastic production and consumption in relation to various indicators of SDG 12 and these are outlined in table 20.

Table 20: Summary table of achievements, opportunities and challenges of Industrial Ecology in Relation To Selected SDG Indicators

SDG indicator	Achievement	Opportunities	Challenges
12.1.1: Number of countries with sustainable consumption and production (SCP) national action plans or SCP mainstreamed as a priority or a target into national policies	Ghana adopted the national action plan to manage plastic waste through the NPMP. Most of the respondents (77.8%) know about it, with 64.3%, understanding its details.	Based on circular economy which embodies tenets of IE	Inadequate stakeholder involvement Poor flow of information
12.2: By 2030, achieve the sustainable management and efficient use of natural resources	All enterprises put in measures to efficient in material use. Recycling and reuse of industrial by-products. 61.12% used some level of by-products as input materials for production 5 enterprises used by-products from other enterprises.	Five (5) enterprises had identified by-products that can be useful to them. Few (7) enterprises were willing to pay for by-products.	Majority of enterprises are not willing to pay for by-products from other enterprises.
12.5.1: National recycling rate, tons of material recycled	Majority (94.4%) of respondents engage in recycling	Opportunities in terms of expertise and technology are available.	Inadequate financial and technological capacity.
12.6.1: Number of companies publishing sustainability reports	Few (22.2%) of enterprises confirmed sustainability reporting yearly, while another 44.4% were not consistent with their sustainability reports	Majority of enterprises have an experience on sustainability reporting which provides the opportunity for SDG12. IE provides the opportunity to achieve sustainability reporting since it is required to track the flow of resources amongst industries	Few enterprises recognise the importance of sustainability reporting. The resources for sustainability reporting was said to be limited
12.8: By 2030, ensure that people everywhere have the relevant development and lifestyles in harmony with nature information and awareness for sustainable	Few (6) enterprises mentioned that they engaged in public education and awareness of plastic pollution	Enterprises can provide education to their customers.	Some enterprises are of the opinion that they are not obligated to educate the public on plastic pollution

CHAPTER FIVE

DISCUSSION

5.1 Demographic Characteristics of Sample Population.

The demographic characteristics of the sample population provides some useful information about enterprises as well as the individual respondents which has an impact on the results attained.

All respondents have tertiary education and have knowledge about their enterprises` environmental activities. Most respondents are also directly involved in decision making of their enterprise as such information given by these respondents was reliable. A higher percentage of respondents were part of key decision making of their enterprises, which means they can make contributions that drive the operations of their enterprises and can therefore make decisions on environmental practices of their enterprise

Enterprises that basically produced multiple use plastics are all large sized enterprises. From the study, most of the enterprises are large scale enterprises, and are involved in more environmental practices than medium, and small size enterprises. Further, the variation in company characteristics and respondents' characteristics added to the wealth of the study. The experience of respondents in their various positions and enterprises provides distinctive responses on their enterprises` practice of sustainable environmental practices.

5.2 Perception of Respondents on Industrial Ecology.

All respondents that have heard of the term industrial ecology were from large scale enterprises with majority of them asserting that their enterprises engaged in practices that are in line with industrial ecology, showing that large size enterprises were more knowledgeable about environmentalism or the subject matter of industrial ecology than smaller sized enterprises. Though respondents understanding of industrial ecology differ,

their responses given on their understanding of IE, still fell within the definition of White (1994), highlighting interdependence of firms in terms of materials and energy flows, and the effects of production on the environment. In addition, Ehrenfeld`s (1994), seven components of Industrial Ecology of improving metabolic pathways for materials use and industrial processes, creating loop-closing industrial practices, dematerializing industrial output, systematizing patterns of energy use, balancing industrial input and output to natural ecosystem capacity, aligning policy to conform with long term industrial system evolution and creating new action-coordinating structures, communicative linkages, and information, encapsulates the various understanding or definition of IE given by the respondents., The components of improving metabolic pathways for materials use and industrial processes, balancing industrial input and output to natural ecosystem capacity were observed.

5.3 Implications of Enterprise-Level Environmental Practices in the Plastic Industry

The type of environmental practices engaged by enterprises are determined by various factors. The study finds most of the enterprises engaging in environmental practices in terms of the input material used. Enterprises that use alternate source of input material aside raw materials source such input material from other plastic manufacturing enterprises, thus they were being material efficient and this shows that there is already some level of interaction taking place amongst the enterprises. This aligns with the roundput, locality and diversity principles of ecosystem described by Korhonen (2001), where there is recycling, use to local renewable materials and corporation amongst members of the ecosystem. In addition, some enterprises are willing to pay for by-product from other firms showing their proactivity. The use of biodegradable materials is rather almost absent, and therefore at par with Korhonen's (2001) roundput principle of ecosystem though most enterprises maintain that recyclability is a major factor they consider in their product design. Clark (2015) suggest that manufacturers whose products usually ends up in landfills at the end of their lifecycles

should integrate landfill biodegradable plastics products in their product design and this is observed in the study where recyclability of products was the major factor most enterprises considered in their product design though some enterprises are considering adopting biodegradable plastics.

Majority (94.4%) of enterprises engaged in recycling which is described by Macedo (2016), as being preventive. Many enterprises have an economic reason for recycling, and a good number of enterprises also have environmental reasons for engaging in recycling. Therefore enterprises may be motivated internally or externally to adopt environmental practices as described by Sindhi & Niraj (2012) who categorises factors that influence the adoption of corporate environmental practices into internal factors and external factors. External factors being self-regulation, market pressures, stakeholder pressure and regulatory framework and internal factors being the features of the organisation. Hence the adoption of environmental practices by enterprises due to their intent to contribute to resolving plastic pollution situation in the country is motivated externally in the form of self-regulation as described by Sindhi & Niraj (2012) as meeting regulatory compliance and as such a reactive strategy. Internal motivation is also manifested in the economic benefits enterprises derive from recycling in the form of sale of waste, reduced cost of waste collection, as well as efficient use of input material. This is also suggestive of competitive advantage that results in profit as described by Bansal and Roth (2000), who recognise competitive advantage, legitimation, and ecological responsibility as the three main motivation factors for the adoption of environmental practices.

Recyclability of material is one major factor enterprises consider in the development of their products. While recyclability along with pollution control is also highly considered in the product design. However the pollution level in terms of emissions is least considered. This shows that many industries take into consideration the lifecycle of their product, hence they

design such that their product can be useful at the end of its life cycle; fitting into the roundput principle of ecosystem and cradle to cradle. Cradle to cradle design of manufacturing takes into account the whole lifecycle of an item, including source and end-of-life disposal, emphasizing reintegration of products into the manufacturing process (Braungart et al., 2007). It suggests that industry must protect and enrich ecosystems and nature's biological metabolism. Walls et al. (2011), mentions that firms that are proactive incorporate environmental issues in their overall business strategy and invest in innovation for product design and processes. Enterprises are therefore proactive in terms of product design.

Another regulatory measure adopted by enterprises is the embracing of EMS. All enterprises that have an EMS are large scale enterprises, who mainly adopt the EMS to monitor their activities in terms of pollution levels, while smaller sized enterprises have financial challenges hindering their ability to adopt an EMS. This aligns with IEFE (2005) who report that well-known environmental management systems such as ISO 14001 and Eco-Management and Audit Scheme (EMAS) are typically designed for large business not small business as the implementation and maintenance of these systems are expensive. Walker et al., (2008) also reports a European study which shows that the limitation to the implementation and maintenance of EMS amongst SMEs was more of a problem of inadequate human resource rather than financial constraint.

Majority of enterprises consider various factors when adopting new technology. Eight (8) enterprises consider price, energy efficiency, innovativeness, and pollution control as the major combination of factors taken into consideration before a new technology is adopted because they did not find one factor to be more important than the other. In as much as they need convenience in the production process, they also have to be economically efficient while protecting the environment through pollution control and energy efficiency. Thus

enterprises have economic and environmental reasons for choosing their technology. This is in synchrony with Fu et al., (2018), who recognises that a combination of various factors such as price, coercive pressure, technology capability, internal support, adoption experience, certified systems, and cooperation are factors that influence the adoption of new technology. The study finds price play a major factor in the adoption of new technology as price is part of majority of combination of factors considered. And this is also recognised by Fu et al., (2018)

However, Huang et al., (2009), Triguero et al., (2015), and Triguero et al., (2013), all find pressure from market stakeholders, shows a positive effect on the degree of adoption of sustainable technology. Hence, the adoption of sustainable technology is important as it has been established by Pogutz & Micale (2011) that technological advancement can and has led to the achievement of sustainable consumption and production as choice of technology is largely controlled by businesses.

Energy efficiency is also an environmental factor that the study sought to find how enterprises ensure it since it has implication for the environment through its influence on climate change. Eight (8) enterprises put in effort to ensure energy efficiency by putting off their machines when not in use. Also 4 enterprises put off machines when not in use and replace obsolete technology for energy efficient ones, highlighting the reason energy efficiency ability of a technology is a major factor for which it is adopted. In their study on corporate environmental management initiatives in Ghana, Nukpezah, and odoom (2017) find that enterprises engage in pollution control and resource conservation, through conservation and efficiency of energy use, reuse and recycling of process water, meeting EPA standards, emission /effluent control and monitoring, waste separation at source, replacement of obsolete machinery and use of alternate source of technology. Their results suggests that enterprises in Ghana were more likely to make voluntary commitment to

replace obsolete technology having scored a 0.77 on a corporate environmental management initiative (CEMI) index scale of 0 to 1 range; even higher than their likelihood to meet regulatory requirement which scored 0.75 on their scale.

Essentially, CEP of recycling, energy efficiency and exchanges among industries being implemented amongst plastic producing enterprises align with ecosystem principles of roundput, locality and diversity. Also, enterprises are practicing firm level industrial ecology in terms of pollution prevention, design for environment and Eco-efficiency as described by Graedel and Lifset (2002). As such Industrial sector initiatives and Eco-industrial parks (industrial symbiosis) are needed to propel enterprises into practicing between firms industrial ecology.

5.4 Implications of Regulatory Compliance of Enterprises.

Using having an EPA certification as proxy indicator for compliance to environmental regulation, the study observe significant level of compliance to environmental regulations by the enterprises, with over 94.4% of enterprises being certified by the regulatory body.

Having an environmental policy statement have the highest correlation with compliance with environmental regulation with a coefficient of 39.1% showing a positive relationship between having an environmental policy statement and complying with environmental regulatory requirement. This is similar to findings of Karassin and Bar-Haim (2019) who find a positive relationship between having an environmental policy and meeting regulatory requirement and conclude that generally, regulation positively influences corporate environmental performance. Most of the enterprises that have an environmental policy also claim they did so in order to meet regulatory requirement.

Environmental practices such as having an environmental policy statement, having an EMS had positive correlations of 0.391 and 0.217 respectively with being certified by the

environmental protection agency (EPA) or compliance with environmental regulation. This goes to support the findings of Shen (2009) who finds that the engaging in environmental practices improved environmental performance and consequently compliance to regulatory regimes. However, recycling had a negative correlation with compliance with environmental regulation. Clark (2015) mentions that recycling has both economic and environmental impacts. Environmental impacts of recycling could be attributed to the negative correlation between recycling and regulatory compliance.

5.5 Implications of Perception of Plastic Producing Enterprises on the Influence of Their Strategies by Social Activism against Plastic Pollution

Enterprises prioritize their reputation, as such enterprises put in effort to redeem their reputation in the eyes of the public by highlighting environmental features of their products in their packaging and advertisements, putting in effort towards substantially reducing plastic waste in the environment, adopt technologies that move towards sustainable production and consumption and adapting marketing strategies to suit consumers. This supports the study of Shen (2009) who found that the biggest impact of environmental strategy on corporate performance is on its relation with stakeholders.

Though the results show that raw materials have become expensive. Some enterprises did not attribute the increasing cost of raw materials to environmental concerns but rather to other factors such as political instability, and economic factors such as trade wars and increasing import duties.

5.6 Implications of Identified Opportunities and Challenges of Using Industrial Ecology to Achieve Sustainable Plastic Production and Consumption in Relation to Sustainable Development Goal 12 (Responsible Production And Consumption).

The study finds that opportunities to practice industrial ecology exists in the areas of material efficiency, and possible exchanges of by-products amongst enterprises though some enterprises were already involved in the exchange of by-products. Also the willingness of some (7) enterprises to pay for waste provides opportunity for industrial ecology to be practiced. In addition the existing national policy on plastic management serves as an opportunity to practice industrial ecology as it hinges on circular economy which has similarities with IE. This will further lead to working towards the achievement of indicator 12.1 of the SDG goals, as Schroeder et al., (2018) identifies potential contribution of circular economy (CE) practices to achieving a significant number of sustainable development goals (SDG) targets including SDG 12. Also Sullivan et al., (2018), finds significant relationship between industrial ecology and SDG12 (Responsible Consumption and Production). Pogutz & Micale (2011) finds that the efficient use of natural resources is a vital part of sustainable consumption and production.

The study shows a high rate of recycling of industrial waste amongst enterprises with minimum recycling of post-consumer waste. This is similar to the assertion by Hopewell *et al.*, (2008), that "pre-consumer plastic waste such as industrial packaging is currently recycled to a greater extent than post-consumer packaging, as it is relatively pure and available from a smaller number of sources of relatively higher volume". Hopewell Dvorak & Kosior (2008) references that the amount of post-consumer wastes are, nonetheless, up to five times larger than those generated in commerce and industry and therefore both waste streams need to be collected and recycled in order to achieve high overall recycling rates.

Opportunities for recycling therefore exist since enterprises are already recycling their own waste, however this need to be expanded to cover post- consumer waste in order to achieve SDG 12 target on recycling.

Hopewell *et al.*, (2008) outline processes of recycling to be from collection, sorting, size reduction and cleaning, further separation and current advances in plastic recycling. These processes are seen to be reasons for low level of recycling of post-consumer waste, as the study also reveals the challenge of recycling post-consumer as discovered in interviews with respondents.

Existing national plastic management policy is a step forward, though more education and awareness on the policy is needed for stakeholders to fully appreciate its usefulness and importance.

5.7 Theoretical Implications of the Study.

The findings of the study found plastic producing firms, adopting corporate environmental practices either due to regulatory forces or normative forces. Plastic producing enterprises have direct relationship with consumers as their products are physical and used by all, making them available for public scrutiny especially in the face growing concerns on plastic pollution. The study therefore finds that enterprises adopt environmental practices mainly due to normative forces by highlighting environmental features of their products in their packaging and advertisements, putting in effort towards substantially reducing plastic waste in the environment, adopt technologies that move towards sustainable production and consumption and adapting marketing strategies to suit consumers. This enhance their reputation and gain legitimacy among consumers. Enterprises that acquired international certification also did so due to normative pressures in order to gain access to international markets. The main reasons for recycling by enterprises was to reduce cost of production and

also to reduce the plastic pollution problem in the environment, these reasons fall under the cognitive pillar where enterprises recognise the need to handle plastic pollution in the environment. This cognitive behaviour however stems from normative pressures from the society and civil society groups on the effect of plastic pollution. Thus concordant to the assertion by Alexiou & Wiggins (2019) that the cognitive pillar is necessary in determining the regulatory and normative pillars to work with. As Debroux (2010) also states that "When normative expectations and attitudes are largely diffused in society, they are gradually internalized by individuals and become accepted as the norms to which everybody is encouraged to conform". Thus the internalisation of the effects of plastic pollution in the society has made enterprises find the need to tackle plastic pollution problems in the country.

The main reason enterprises that have EMS gave for adopting EMS was to monitor their pollution levels, which can also be recognised as a cognitive pillar as it stems from enterprises main aim to handle their pollution levels. Most enterprises however had a regulatory reason for adopting an environmental policy thus regulatory pressures influenced the adoption of this environmental practice.

The study also finds that the incorporation of environmental concerns into enterprises` strategy either through capability of the firm to practice pollution prevention, product stewardship or sustainable development have some impact on the firm in terms of resulting in competitive advantage such as improved efficiency and reduced cost of production, differentiation benefit and access to international markets. Enterprises were found to engage prevent pollution or waste and emission through recycling and reuse of materials and adoption of EMS which results in material efficiency as juxtaposed by the NRBV. Also energy efficiency is practiced by enterprises in terms of replacing obsolete technology and putting off machines when not in use, thus reducing emissions.

The study also finds enterprises exhibiting product stewardship in the design of their products. Recyclability was a major factor that is considered in the design of products leading to sustainability benefit in terms of recyclability and avoidance of waste at the end of the products' lifecycle.

Further, enterprises engagement in education and awareness of plastic pollution falls in place with the social aspect of sustainable development strategy. Also environmental aspect of sustainable development is reflected in enterprises adoption of sustainable technology, EMS and compliance with regulatory requirements as well as seeking international certifications. This is found to result in the opening of new markets at the international level to enterprises that have international certification such as ISO 14001.

CHAPTER SIX

SUMMARY OF KEY FINDINGS, CONCLUSION AND RECOMMENDATIONS

6.1 Summary of Key Findings

Table 21: Summary of key findings to specific objectives

Table 21 shows a summary of the objectives of the study and key findings at the end of the study.

Objectives	Key findings
To determine firm-level environmental practices among plastic producing enterprises.	Enterprises were found to engage in environmental practices such as recycling, adoption of sustainable technology and environmental management systems (EMS), energy efficiency, which is imitative of the principles of ecosystems for industries, particularly, roundput, locality and diversity.
To assess level of compliance to environmental regulations by plastic producing enterprises	Compliance with environmental regulation was found to be high amongst enterprises with 17 of 18 enterprises having met regulatory requirements and therefore certified by the regulatory body (EPA). Also CEP influence regulatory compliance to some extent.
To examine the perception of plastic producing enterprises on the influence of activisms around plastic pollution on their activities.	Enterprises did not perceive reduced sales over the years; though raw materials were perceived to have become more expensive due to scarcity of resources from the natural environment. Results also implied that Enterprises were putting in measures to improve their reputation in the face of the public as a result of public activisms on plastic pollution
To identify opportunities and challenges of using industrial ecology to achieve sustainable plastic production and consumption in relation to sustainable development goal 12 (responsible production and consumption).	It was found that there exists a national plastic management policy which can help tackle plastic waste. Also, opportunities for using industrial ecology to tackle plastic waste relative to SDG 12 exist through recycling. Recycling, sustainability reporting and education and awareness provides opportunity for industrial ecology to be used to achieve sustainable plastic waste management, though there exist some challenges such as unwillingness to use plastic by-products/waste by many enterprises.

6.2 Conclusion

The study showed that all institutional pressures; normative cognitive and regulatory forces influenced enterprise behaviour and enterprise environmental strategies and also resulted in competitive advantage.

Plastic producing enterprises within the Accra and Tema Metropolis engage in environmental practices such as material efficiency through the use of recyclable material, engagement in recycling, and the adoption of an environmental policy statement. Energy efficiency and the adoption of sustainable technology and environmental management system (EMS) were environmental practices practiced by enterprises within the study area. These were imitative of the principles of roudput, locality and diversity of ecosystems.

Enterprises were also found to be more concerned about their reputation as such they perceived public concerns about plastic pollution resulted in they highlighting environmental features of their products in their packaging and advertisements, putting in effort towards substantially reducing plastic waste in the environment, adopt technologies that move towards sustainable production and consumption and adapting marketing strategies to suit consumers.

Further existing practices such as the existence of a national plastic management policy, material efficiency, recycling, sustainability reporting and education and awareness of plastic pollution provides opportunity for industrial ecology to be used to achieve sustainable plastic consumption and production in relation to SDG 12. However top-down approach to policy formulation and implementation, and inadequate technological and human resources as well as financial constraints for recycling poses challenges to achieving SDG 12 through industrial ecology.

The findings of the study therefore emphasise the importance of institutional pressures on the adoption of environmental practices and the resulting advantages accrued. Therefore the adoption of industrial ecology as an environmental practice will have competitive and differentiation advantage for enterprises and also contribute to solving the plastic waste problem in the country, and consequently contribute to sustainable development.

6.3 Recommendations

Environmental policy formulation and implementation should take a bottom-up approach rather than a top-down approach so as to gain inputs from employees, managers and stakeholders across board. This will keep them informed and have everyone keen in the implementation of such policies.

Enterprises need to be more intentional about advancing environmental practices as such employing environmental managers to handle environmental management practices of enterprises as all enterprises did not have environmental managers.

Plastic enterprises can also liaise with other industrial sectors who consume their products to return plastic waste from their industries either by introducing discounts for industries that do so or by simply encouraging them by spelling out its benefits to them such as to reduce their cost of waste management due to reduced waste volumes. This will help to increase the amount of useful by-product for the plastic enterprises.

Further studies can therefore be conducted on how various industries within the Accra and Tema industrial areas can interact with one another as a drive towards a full scale industrial ecology and achieve maximum benefits.

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APPENDICES

Appendix 1: Respondents that have Heard of Industrial Ecology

Response	Frequency	Percent
Yes	5	27.8
No	13	72.2
Total	18	100.0

Appendix 2: Respondents' consideration biodegradable material as an environmentally viable alternative to current non-biodegradable input materials.

Response	Frequency	Percent	Valid Percent	Cumulative Percent
Yes	8	44.4	44.4	44.4
No	3	16.7	16.7	61.1
I don`t know	7	38.9	38.9	100.0
Total	18	100.0	100.0	

Appendix 3: Enterprises Willingness to pay for by-products

Response	Frequency	Percent
Yes	7	38.9
No	11	61.1
Total	18	100.0

Appendix 4: Sample of Questionnaire

UNIVERSITY OF GHANA

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Questionnaire for plastic producing enterprises

My name is Salwah Omar Gyabo, an Mphil Sustainability Science student from the Institute for Environment and Sanitation Studies at University of Ghana. This instrument is to help gather data to aid in my research on the topic: "**TOWARDS INDUSTRIAL ECOLOGY: AN ASSESMENT OF ENVIRONMENTAL PRACTICES WITHIN THE PLASTIC INDUSTRY IN ACCRA, GHANA".** The purpose of this instrument is strictly for academic purposes in partial fulfilment of requirement for an MPhil degree in sustainability science. Please be assured any information provided shall be kept confidential. Thank you for your permission.

Please tick where appropriate

SECTION A: Demographic Data

1) Gender: male ( ) female ( )
2) Age 18-25( ) 26-34( ) 35-43( ) 44-52( ) 53-60( ) >60( )
3) What is your level of education?
   None ( ) Primary ( ) JHS ( ) SHS ( ) Tertiary ( )
4) What is the name of your firm?
   ……
5) List the type and quantities of products produced on monthly basis.

Product	**Quantities (tonnes)**
Single- use plastics	
multiple use plastics	
Plastic Packaging products	

6) How many people are employed by your firm? **Permanent staff** ……**Casual Staff** ……
7) How many branches do you have in Ghana? ……..
8) Are you a formal or an informal staff member?
   Formal ( ) informal ( )
9) Which department do you belong to?
   ……
10) What position do you hold in your firm?
……

11) Are you part of the key decision making body of your firm?
   Yes ( ) No ( )

12) How are you involved in decision making in your firm?
……
……
What is your knowledge about your firm's environmental activities?

……
……

SECTION B: General Perception about Corporate Environmental Practices and Industrial Ecology

13) Have you heard of the term **industrial ecology**?
   a) Yes (if yes, go to 15)
   b) No (if no, go to 18)

14) How do you understand **industrial ecology**?
……
……
……

Does your firm engage in environmental practices that align with **industrial ecology**?

   a) Yes b) No

15) What are the practices your firm engage in that align with **industrial ecology**?
……
……
……

What environmental practices does your firm engage in?
……
……
……

Does your firm engage in the reuse or recycling of by-products or waste within the firm for production?

   a) Yes
   b) No

16) For each answer given in (19), give reason(s).
……
……
……

Does the by-products/waste of your firm serve as raw materials for other industries?

   a) Yes b) No c) I don't know

17) Give reason(s) for answer given in (21)
……
……

18) Does your firm use waste or by-products from other industries for production?
   a) Yes b) No c) I don't know

19) Give reason(s) for answer given in (23)
……
……

20) What methods do you put in place to ensure environmental preservation?
……
……
……

Please indicate how much you agree or disagree with each of the following statements by ticking in each row.							
Perception about corporate environmental practices	Strongly agree	Some what agree	Slightly agree	Neutral	Slightly disagree	Somewhat disagree	Strongly disagree
Our firm has a responsibility to preserve the environment							
Environmental preservation is vital to our firm's survival							
It is difficult for our firm to be successful and preserve the environment at the same time.							
We evaluate our environmental efforts by their economic benefits to our firm							
We have no use for							

our waste.							
We engage in re-use and recycling of waste mainly to reduce our cost of productio n.							
There is no advantag e for us in the use of by-products/ waste							
The use of by-products is detriment al to the quality of our final products.							
We have our own internal processes and do not interact with other industries .							
We prioritize energy conservat ion							
Energy efficiency							

is a paramount factor when adopting new technology.							
In our firm profits are more important than our environmental activities							
Preserving the environment is a vital corporate value in our firm							

SECTION C: FIRM-LEVEL ENVIRONMENTAL PRACTICES

21)What is your source of materials for production?

a) Recycled materials
b) Raw materials.
c) mixed

22)What are your main input materials for production? (kindly List them)

23)Is there any environmentally friendly option that could be considered?

a) Yes (if yes go to 29) b) No c) I don't know

24)What other material can be used, and why has this option not been used or explored yet?

……
……
……

25) Do you segregate your waste?

a) Yes

b) No

26) Are your by-products or waste recycled or re-used?
   a) Yes (If yes go to 34)
   b) No (If no go to 32)

27) Why are waste/by-products not re-used or recycled?

……

……

28) What are the types and quantities of by-products or waste realised from production and how are they managed within the industry?

Waste/by-product type	Quantity (tonnes)	Management Technique

29) List the type of waste, mode of recycling/reuse (within firm (1) or by another firm (2) or by both (3)) and the quantities involved i.e. list the type of waste that are recycled/reused within the firm, in another firm or both and the quantities involved.

Type of waste	Mode of recycling/reuse (select 1 or 2 or 3)	Quantity (Tonnes)

30) How are hazardous chemicals realised from production within the firm managed?

……

……

31) Is there use of by-products from other industries?
   a) Yes (if yes go to 37)
   b) No (If no go to 38)
   c) I don't know

32) State the industry and the by-product being used.

Name of Industry	Waste Generated

33) Indicate why there is no use of by-product(s) from other industries?

……

……

34) Has your firm identified any (other) by-product(s) from other industry that can be useful to your firm?
   a) Yes (if yes, go to 40)
   b) No
35) For each by-product that can be useful to your firm, list the industries that generate them.
   ……..
   ……..
   ……..
   ……..
36) Will you be willing to source/pay for such by-product from other businesses?
   a) Yes
   b) No
37) What does your firm do to ensure judicious use of materials for production?
   ……
   ……
   ……
38) Do you consider environmental issues when developing your products?
   a) Yes (If yes go to 44)
   b) No (if no go to 45)
39) What are the issues considered? (Example: recyclability, pollution reduction etc.)
   ……
   ……
40) Why are environmental issues not considered in developing products?
   ……
   ……
41) What environmental standards do you consider in developing your products?(tick as many as apply)
   a) Environmental protection agency (EPA)
   b) ISO
   c) Others (specify) ……
42) Why is/are the option(s) in (46) considered?
……
……

43) What factor(s) does your firm consider in adopting new technology? (Tick as many as apply).
   a) Price
   b) Pollution control
   c) Energy efficiency
   d) Innovativeness/ convenience
   e) Others (specify)……..
44) Why is/are the factor(s) in (48) considered?
   ……
   ……
   ……
45) What is/are your sources and monthly consumption of energy? (Kindly tick as many as may apply)

Energy Source	**Consumption**

National Grid alone	
National Grid and Diesel Generator	
Diesel generator alone	
Thermal	
Solar energy	
Others (specify)	

46) Do you generate energy internally?
   a) Yes (if yes, go to 52)
   b) No

47) What is/are your energy source(s) and generation capacity?
   ……..

48) Do you depend on other industry (ies) within the north industrial area for power?
   a) Yes (if yes go to 54)
   b) No

49) Mention the industry (ies) and their energy source.
   ……
   ……

50) How do you ensure energy efficiency at your firm?
   ……
   ……

51) Do you have an **Environmental Management System (EMS)**?
   a) Yes b) No

52) For answer given in (56), give reason(s).
   ……
   ……
   ……

53) Does your firm have any environmental policy statement advising environmental awareness amongst the staff?
   a) Yes (if yes go to 60) b) No (if no, go to 59) c) I don't know

54) Why don't you have an environmental policy?
   ……
   ……

55) Do you abide by your internal environmental policy?
   a) Yes b) No (If no, go to 61)

56) What impedes your abidance to your environmental policy?
   ……
   ……

57) Does your firm integrate environmental concerns from the public into its corporate strategy?
   a) Yes b) No

58) How are your environmental objectives or policy linked to your corporate strategy?
   ……
   ……
   ……

SECTION D: Regulatory Practices and Environmental Policy

59) Do you meet with environmental regulations set by the environmental protection agency (EPA)?
a) Yes b) No (If no, go to 65),

60) What are the challenges to complying with environmental regulations?
……
……

61) What measures are being put in place to ensure compliance with regulatory requirement?
……
……

62) Are you certified by any international environmental organisation?
a) Yes (If yes, go to 68) b) No (If no, go to 69),

63) State the certification you have and by which organisation
……
……

64) Why don't you have an environmental certification, and have you considered getting one?
……
……

5. SECTION E. Perception of plastic producing enterprises on the influence of activisms around plastic pollution on their activities.

Please indicate how much you agree or disagree with each of the following statements by ticking in each row.							
perception of environmental concerns on the firm	Strongly agree	Some what agree	Slightly agree	Neutral	Slightly disagree	Somewhat disagree	Strongly disagree
Raw materials have become more expensive due to scarcity of resources from the natural environment							
We highlight the environmental features of our products and services in our packaging and advertisements.							

Environmental concerns have influenced our marketing strategies							
Our firm has more responsibility toward its customers, shareholders, and employees than the environment.							
Environmental concerns has led to a reduction in sales and profits over the last 10 years.							
Environmental concerns have influenced the kind of products we develop							
Our firm ensures sustainability reporting							
Our firm advocates public education/awareness on the effects of plastic pollution.							
Our firm puts in effort towards substantially reducing plastic waste							

in the environment							
Our firm develop/adopt technologies that move towards sustainable production and consumption.							

65) How does your firm engage in public education and awareness on plastic pollution?

……

……

……

66) How does your firm contribute to managing the plastic pollution situation in the country?

……

……

……

67) How does your production activities affect communities around you?

……

……

……

68) What measures do you put in place to offset these effects?

……

……

……

69) Is there support or collaboration from district assembly and the EPA with your firm to solve environmental issues? .....

70) How do these institutions support you in achieving your environmental targets?

……

……

……

71) What more can the institutions do to support your environmental management strategy?

……

……

……

72) How does your firm ensure responsible production, and consumption of plastic among citizenry?

……

……

……