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STATUS AND CHALLENGES OF PLASTIC MATERIAL RECYCLING PRACTICES AND ENVIRONMENT PROTECTION IN RWANDA: A CASE STUDY OF ECO-PLASTIC RECYCLING PLANT IN KIGALI MAGERAGERE SECTOR

Author NYIRAMUNINI MUKIZA Soleil
Advisor Dr. Abias MANIRAGABA PhD

University of Lay Adventists of Kigali (UNILAK)

Abstract

This research was assessed the status and challenges of plastic material recycling practices on environment protection in Rwanda. The specific objectives: to examine operation activities relating to plastic recycling as provided by Eco- Plastic recycling plant in Mageragere sector, to evaluate the status of plastic material recycling on environment protection provided by Eco- Plastic recycling plant, to analyse the variation of plastic emission on environment degradation in Rwanda and to establish relationship between plastic material recycling practices and environment protection in Rwanda. This study was designed as a case study of Eco- Plastic recycling plant Mageragere Sector using the survey method, questionnaires and interviews to the people of Eco-Plastic recycling plant Mageragere Sector; a case study was described as analysis of the study that help the researcher acquired knowledge and skills regarding the research study. The researcher used different methods to collect data, As far as this study was concerned, the population was comprised with population of Eco- Plastic recycling plant Mageragere Sector target population was 174 people who are working in different departments: waste collection department, production department, finance &accountants, technicians & experts, administrators and sorting department and sample size of 174 respondents were considered representative of the total population. The methods were based on the descriptive research design with Eco- Plastic recycling plant Mageragere Sector was selected as the study area for the data collection on the status and challenges of plastic material recycling practices on environment protection in Rwanda. The effects to the plastic material recycling practices on environment protection in Rwanda. The findings show the informal sector has a role in plastic waste management for facilitating for recycling of plastics practices of Eco- Plastic recycling plant. None of the respondents neither disagreed nor strongly disagreed to the informal sector has a role in plastic waste management for facilitating for recycling of plastics practices of Eco-Plastic recycling plant. The neutral responses comprised of 12(6.4%), 78(44.8%) respondents agreed to the informal sector has a role in plastic waste management for facilitating for recycling of plastics practices of Eco- Plastic recycling plant while 84(48.2%) strongly agreed that informal sector has a role in plastic waste management for facilitating for recycling of plastics practices of Eco- Plastic recycling plant, with a mean of 4.67 and standard deviation of 0.543 as shown. It was found that informal sector has a role in plastic waste management for facilitating for recycling of plastics practices of Eco- Plastic recycling plant. The level of public participation in solid waste management at present in Rwanda is still low. There is no structure that allows for a more synergistic relationship

between the public and the local authority. Apart from involving the people is taking the initial decisions, the government of Rwanda should strategically plan for sensitization of the people. Several solutions may be brought at table and agreed upon. But just like the findings show, the people feel that the first step should be to sensitise the public about the whole issue of solid waste management. Although there is agreement that sensitisation should come prior to implementation of the solid waste management program, in actual sense, effective and meaningful sensitisation is planned when the whole program package is complete. That is when one can know what exactly to sensitise about and how. It is my suggestion therefore that sensitisation should not be done for the sake of it and basing on mere thought but after a common agreement on the program of solid waste management for purposes of being systematic and thorough.

Keywords: Status, challenges, plastic material recycling practices and environment protection

1. Introduction

The world is facing a great problem of plastic residues that are increasing day by day (Aboti, 2012) and Rwanda included while a sizeable portion of their wastes disposal is very limit and disposed improperly resulting in environment degradation. Plastics are materials which include materials composed of chemical element such us carbon, hydrogen, oxygen, and are macromolecules, formed by polymerization which has capacity to be reformed by application of reasonable amount of heat and pressure or another kind of forces (El-Newely, 2016). Plastics are polymers materials which are composed by large joining numbers of thousands molecules.

Europeans countries, in 1991, Germany instituted an aggressive program intended to collect substantial quantities of recyclable packaging materials and promote the recycling and reuse of those materials. While normal operation of the market economy is responding to this situation, many observers consider the speed of progress inadequate (George C. 2018). This impression is, in part, driven by an anti-growth, anti-free enterprise bias on the part of many environmental advocates. Many environmentalists view new packaging materials as wasteful excess promoted by a greed-driven industry, rather than innovative and beneficial responses to consumer needs and demands. For many years, the cost of waste disposal has been minimal and almost entirely financed by tax dollars. This has not encouraged manufacturers to consider the issues of recycling and disposal of their products and packaging, (Steven E. 2018)

Many commentators believe that government must intervene to minimize the amount of waste created. The most viable option may be to promote recycling. The German program additionally sought to eliminate the use of landfills and incinerators. This Article examines the German recycling system, discusses the consequential effects of that system and reviews possible alternatives for policymakers to consider (Uppsala, 2017). Germany faced a similar situation and responded by enacting legislation which led to the creation of a government-industry system for collecting, sorting and recycling packaging waste materials. An industrial and scientific power since the late 1800's, Germany has also been innovative in blending government initiatives with a largely free market economic system (Steven P. 2019).

Rwanda experienced environmental problems caused by plastics used and throw away everywhere and these contaminate plants, soil and underground water and from burning plastics the air pollution comes; researchers at the Rwanda Environment Management Authority (REMA) have warned that recycling plastic bottles will make a sustainable solution (Tumwebaze, 2013) and a great efforts at conservation of environment and because Rwanda is facing problem with plastic recycling this mostly appear during the collection and sorting stages of recycling flexible packaging, it gets really very problematic. It is also less economically viable to invest in the necessary collection and sorting facilities for plastic bags and films. Most material recovery facilities and local authorities do not actively collect post-consumer flexible packaging due to the deficiencies in the equipment that can efficiently and easily separate them. Post-consumer film wastes manifest a very poor ratio of surface area to contamination and thus it requires extensive treatment (Leblanc, 2016).

The Government of Rwanda through the Ministry in charge of environment, the technical study was leading on the impact of plastic bags on the Rwandan environment, as well as the plastic bags involvement to the economy of our country. The study showed an uncontrollable negative impact of plastic bags on the environment which lead the Government of Rwanda to remove the use of plastic bags as they Rwandan government introduced the new policy of stopping the use of non-biodegradable plastic bags, this comes with a great and good impact on environment especially on soil productivity, where it increases crop products as the plastics bags were blocking the water flow by creating gutters and drains and this also could create flooding as it rains, from those floods the

stagnation comes providing a good habitat of mosquitoes which finally spread malaria (Abota, 2012) so the other positive impact is to reduce the rate of malaria in Rwandan community.

The UNEP study (2005) provides background information on recycling practices in Kigali. First, it makes the observation that recycling of items like paper, metals, plastics, tyres, and used clothes is becoming increasingly popular. At the Mageragere dumpsite, the study notes, scavengers salvage more than 30 different types of materials, the major ones being metals, especially aluminum and copper. It, in addition, observes that industry operators support the setting up of recycling schemes (importantly for aluminium cans, bottles, and polyethylene plastics) for environmental, social and economic reasons. On the recycling of plastic waste including bags, the following observations were made by the plastic sector group of Eco-plastic (Kantaria, 2015).

First, out of the 45 plastic bag manufacturers operating in the country, about conduct recycling of postconsumer plastic waste. Second, in order for the recycling of plastic waste to succeed, the Eco-plastic should assume a pivotal role by facilitating source-separation and collection of recyclables. It should also set-aside appropriate locations where people could bring their postconsumer plastic wastes. Third, there is a potential market for recycling of post-consumer plastic waste though it has to be yet developed. Plastic waste is that of black plastic sheeting for use in building construction (Kantaria, 2015).

Recycling plastic waste is environmental friendly as compared to the other ways to dispose of plastic waste. In case, 2004, the government started to raise awareness about plastic materials recycling through a nation-wide campaign in media, In order to teach people about the maleficent of plastics to the environment and with those campaigns in 2008, a total achievement of non-using non-biodegradable plastic bags became immeasurable majority of this life cycle is useless in the end-of-life phase, either in a landfill or as rubbish in the environment cause expansive of natural within plastic's protection ,and Plastic recycling meet with much challenge, array from mixed plastics too hard to remove residues and mixed plastic stream is maybe the biggest challenge in recycling industry therefore designing plastic packaging and other plastic products with recycling in mind can play a significant role in facing this challenges and the recuperation and recycling of post-consumer flexible packaging is a problem. Most material recovery facilities and local authorities do not actively collect it due to the shortage in the equipment that can efficiently and easily separate them (Leblanc, 2018).

Plastics use has become popular and it is widely used materials in people's daily work because they are found in used items like toys, packaging bags and bottles, carpets .their lager quantity has resulted in spreading throughout agriculture soil, public places and because it is not biodegradable thus harming animal and human health ,even when it broken down, direct it produce micro plastics they pass into river, lakes and oceans and at the same times it pass in food chain upon ingestion by marine organisms (Mukankomeje, 2014) therefore the best choice to overcome with various challenges caused by plastic materials use in Rwanda is plastic recycling as the process of renewing plastics wastes into other useful materials Processes, Stages, and Benefits of Plastic Recycling **(**Cherie, 2002) so with those process of producing new materials will be more productive to Rwanda and improve the policy of introducing new industries with new products from recycled plastics and this goes with promoting made in Rwanda.

In case, Rwanda has inadequate proper areas to dispose plastics material residue in different urban and rural areas that handle large amounts of waste, human mud is generally disposed in volume at different local landfills around households (Change, 2017). Inadequate people awareness reflect to waste management, insufficiency number of modern landfills, lack of skilled technicians in field of recycling and highly expenses of recycling industry plants are among challenges of plastic waste management in Rwanda. Plastics recycling materials are used to save energy, landfill universe and used in new construction (Jefferson, 2008) In addition, recycling plastics materials are used to save amount of virgin plastics used in industries processing it can be mixed with virgin plastic to reduce cost without losing appearance and use in making polymeric woods for use in from picnic tables, fences, (Makers, 2018). Recycling is one of the most capable waste management choices we have; to deal with the environment safety. It is a process of transforming waste or row plastics into useable products. It reduces high charges of plastic (Rwanda Environment management Authority). After all in Rwanda they are some industries which make a recycling especially in Mageragere sector particularly Eco plastic recycling plant as a case study to be used to measure the status and challenges of recycling plastics practices because they do recycling of plastics materials trough receiving used plastic from a number of suppliers, including waste collection companies, individual, airports and hospitals, and becomes new raw materials. As current researcher, Researcher created awareness on importance of plastic material

recycling practices and environment protection as well as to maintain safe environment for their lives.
The objectives of the paper are:

i. To examine operation activities relating to plastic recycling as provided by Eco- Plastic recycling plant in Mageragere sector;
ii. To evaluate the status of plastic material recycling on environment protection provided by Eco- Plastic recycling plant;
iii. To evaluate measure established by government to keep environment protection in RWanda;
iv. To establish relationship between plastic material recycling practices and environment protection in Rwanda.

Review of Literature

Waste management hierarchy Theory

Priorities of good waste management are expressed by reduce, reuse, recycle, recover and redesign (Memon, 2018). Waste reduction normally forms the top of the waste management hierarchy theory. However, since there will still be some waste generated even with source reduction, an effective system to manage this waste is also needed (McDogall, et al. 2019). Plastic is collected from the waste stream and recycled into a durable application that when thrown away can be recovered for energy, (McDonough and Braungart 2018).

It is estimated that 10,000 tons of waste, if used for recycling, can create 250 jobs, as compared with 20 to 40 jobs if incinerated and only about 10 jobs when disposed off in a landfill (Arvanitis, 2017). Using recycled plastic to produce useful new products requires less energy and fewer resources. In addition, recycling also supports the economy. Over 90 per cent of the material collected for recycling is sold to companies that produce goods ranging from vehicle parts to coffee cups (SPi, 2020). Resource recovery in less developed countries is managed predominantly by informal sector entrepreneurs and is a major source of employment as Arnold & Inge (2015) note. For example in Kampala Uganda, as in other developing countries, urban waste has traditionally remained for municipal councils to manage, however, due to noticeable inefficiencies at municipal level, there is a manifest of low-income groups that take the initiative to extract and add value to materials from the waste stream (Kareem & Lwasa, 2019). In many low-income countries, the fraction of material that is won for resource recovery is very high. The work is done in a very labour-intensive way and for very low incomes. The situation in industrialized countries is different since resource recovery is undertaken by the formal sector driven by law and a general public concern for the environment often at considerable expense (Visvanathan & Ananth, 2017). Today, Tang & Luo (2018) argue that in the absence of direct financial incentives to recycle or penalties for non-recycling for example, it is a challenge for local government to reinforce a positive attitude and to change attitude of entrepreneurs who view recycling negatively.

Economics of Plastic Recovery Theory

The costs associated with plastics recovery can be divided into three main categories, raw material costs, production costs and transportation costs. The costs of raw materials for reprocessing differ according to the source, the quality and the type of waste plastics that will be used. The end product of one reprocessing stage, such as shredded material, can be used as the input material of the next stage, such as pelletizing. Arnold and Inge (2015) continue to explain that for each stage or activity in the recycling process, a separate cost/benefit analysis should be done. Improving the quality of the end product, such as by adding virgin plastics to the waste material will also add to the material costs. The most important production costs are labour, electricity, water, equipment and rent. Generally it is difficult to obtain reliable data on production costs, since re-processors usually do not keep records. One way to reduce the costs of transporting such waste plastics is size reduction, by cutting or shredding. Also consider the distance to the reprocessing plant, the sources of plastic waste and customers, as well as the frequency of collection.

When very thin it is transparent; when thick it is milky white, unless a pigment is added. Polypropylene (PP) is more rigid than PE but can be bent sharply without breaking. It is used for stools and chairs, high-quality home ware, strong mouldings such as car battery housings and domestic appliances and so on. Polystyrene (PS) is brittle and usually transparent. It is often blended (copolymerized) with other materials to obtain the desired properties. PS is used for cheap, transparent kitchen ware, light fittings, bottles, toys, food containers, amongst others. Polyvinyl chloride (PVC) is a hard rigid material, unless plasticizers are added. Common applications for PVC include bottles, thin sheeting, transparent packaging materials, water and irrigation pipes, gutters, window frames, building panels, etc.

Primary waste plastics are generated within the plastics producing and manufacturing industries themselves. The waste is pure and suitable for reprocessing. The term 'secondary waste' refers to waste plastics from sources other than the industrial ones. Under the influence of light, heat or mechanical pressure plastics can decompose and release hazardous substances. Most types of plastics are not biodegradable and the majority of polymers manufactured today will persist for at least decades and probably for centuries if not millennia (Barnes et al. 2019). Open burning of plastic waste releases considerable quantities of polluting substances such as carbon monoxide, a major contributor to the global warming problem, dioxins and furans which are released into the air (Wienaah, 2017). Whilst carbon monoxide is widely known, dioxins and furans are not and yet they are linked to respiratory diseases and cancer.

Waste Management Stakeholders theory

As with any new theory, one should start with defining the scope of the theory, and define the core of its concepts. Waste management has to be planned within restrictive limits, where the choice of options is generally pre-specified. It is expected that the insight that the theory of waste management would give to the domain would greatly contribute to achieving the goals of waste management: resources conservation and environment protection. The practical values of Waste Management Theory thus are Giving answers to conceptual questions by explaining waste and concepts. Providing a guide for choosing waste management options. Providing a foundation for how and when to select and integrate waste management options. Predicting the outcomes of the use of waste management actions. Aiding legislation in how to prescribe activity for/upon waste.

Sustainable waste management is fundamental in environmental protection, highlighting the invaluable link between the built environment and the natural environment. 100 per cent waste diversion would lead to zero waste. Segregation attests to a good waste management plan and good practice. This plan should expressly contain and monitor the amount of waste being generated, how much of it is recovered and how much leaves the system or home in this case. This monitoring in itself would provide a record of waste generated (which would give insight into the consumption patterns of generators) and the characteristics of the waste, this would in turn give a good sense of the amount of plastic waste accumulating in the terrestrial habitat if widely adopted. The aforementioned indicators demonstrate that a healthy ecosystem is predicated to the residents being motivated to participate in sustainable waste management From the literature review it is clear to see that the variables that affect sustainable waste management are essential in the holistic management of plastic waste. These are, motivation and participation of public to segregate waste at source and having interaction with waste management companies and other stakeholders who support the sustainability agenda. It has been emphasized that most of the destruction the environment is facing is due to human behavior, meaning that by changing our behaviour we can change their future (and ours) for the better.

Zero plastic waste is much like the concept of zero waste where all the waste is repurposed and not disposed off in the environment irresponsibly. While this is difficult to actualize, the idea being proposed is that all waste has value, thus worth recovery. The circular economy/metabolism is much like the closed loop system that involves a comprehensive chain of events, integrated to avoid any waste leaving the system. LEED (U.S), GreenStar (Australia) amongst other rating systems enlist minimum requirements for a sustainable building and give credit to a sustainable waste.

Environmental Protection

Environment can be defined as is a set of physical, chemical and biological elements as well as socio-economic, cultural, aesthetic and intellectual factors likely to have a direct or indirect, immediate or long term impact on the development of environment, human beings and human activities. It is a cross-cutting field and must be integrated in economic growth and social development with which it constitutes the three pillars of sustainable development. The fight against poverty, long term planning and protection and management of natural resources constitute the essential objectives of the national environment policy for sustainable development. In 1987, the Brunt land Commission published its report, Our Common Future, in an effort to link the issues of economic development and environmental stability. However, the degradation of environment continued to worsen as a result of the population pressure, serious erosion, pressure on natural resources, massive deforestation, pollution in its various forms, and lack of a strong and coherent political, institutional and legal framework. The pursuit of environmental sustainability is an essential part of the global effort to reduce poverty. This was confirmed at the turn of the millennium in two important declarations: In December 2000, world leaders agreed to eight

Millennium Development Goals associated with 18targets at the United Nations Millennium Summit; at the 2002 World Summit on Sustainable Development world leaders adopted the Johannesburg Declaration on Sustainable Development and Plan of implementation (Jerome, 2019).

The concept of Environmental Sustainability arose out of the growing recognition that human activity is affecting many of the critical resources not only locally but now also at global scale, and with potential effects on human as well as ecological health. Among the many problems, there has been depletion of ocean fisheries, over-exploitation of the great aquifers, an unprecedented rate of species loss, increasing problems of waste disposal, and changes to the gaseous composition of the lower and middle atmosphere. Recognition of such problems led to the notion of sustainability, which implies development that meets the needs of the present without compromising the ability of future generations to meet their own needs. In the 1980s a major initiative was established under the aegis of the United Nations to address issues of environmental sustainability. Its Agenda 21 is a comprehensive plan of action to be taken globally, nationally and locally. Principles of sustainable development are now intrinsic to the Millennium Development Goals (UN, 2016).

Environmental Requirements and Voluntary Initiatives

Voluntary environmental initiatives are private or public efforts to improve corporate environmental performance beyond existing legal requirements. Voluntary initiatives have become an important element in the mix of public policies and corporate strategies for managing industrial impacts on the environment, but considerable uncertainty exists concerning the effectiveness, efficiency and fairness of voluntary programs relative to other policy instruments. This paper considers the potential role for voluntary initiatives in the transition toward more sustainable industrial systems, in light of these criteria. Several pervasive problems have hindered evaluation of their environmental effectiveness so far including poorly specified objectives, inadequate data on results and poorly specified baselines for comparison. Economic models indicate that in different circumstances, voluntary approaches may increase or decrease economic efficiency. However, these conditions remain poorly understood. Little if any analysis so far has focused on the intergenerational and intergenerational equity of voluntary approaches. Evaluations of negotiated agreements indicate that they often reduce the ability of outside parties to observe both the process and the outcomes of a policy relative to regulations. These considerations suggest that while voluntary initiatives can help us move toward more sustainable industrial systems, considerable advances in the design and analysis of voluntary initiatives will be required to harness their full potential (Tsutsumi, 2019).

Voluntary environmental initiatives are private or public efforts to improve corporate environmental performance beyond existing legal requirements. Over the last decade, voluntary initiatives have become an important element in the mix of public policies and corporate strategies for managing industrial impacts on the environment. In Europe, for example, national governments have negotiated more than 300 voluntary agreements with industry associations (European Environment Agency, 2017). Japan has more than 30 000 voluntary agreements between single firms and local agencies in place (Imura, 2019; Tsutsumi, 2019; Sugiyama, 2018). The US has based its global climate change policy almost entirely on voluntary programs such as Green Lights, Energy STAR and Climate Wise (US Department of State, 1997). More recently, the US EPA announced its National Environmental Performance Track Program aimed at pollution prevention through voluntary negotiated agreements with firms (United States Environmental Protection Agency, 2015). Despite the growing interest in implementing voluntary initiatives, the research community has, until recently, devoted relatively little attention to them. Debate on industry's role in addressing global environmental issues has shifted over the last decade from a focus on 'greening' to a new vision for more sustainable industrial systems (see, for example, Roome, 2018). This dialogue has raised the expectations for corporate environmental performance (Hart, 2017), while generating a range of prescriptions for action. Allenby (2017) for example, points out that some arguments in favour of extensive voluntary action imply a fundamental, and inappropriate, shift in the theory of the firm from profit seeking to social welfare maximizing behaviour.

He suggests that a more appropriate challenge is to incorporate the goals of sustainability without abandoning the profit motive in the theory of the firm. Hart (2015), on the other hand, argues that the goal of sustainability is entirely consistent with the profit motive. He suggests that a 'sustainable' corporation may achieve significant competitive advantage by exerting leadership in meeting environmental and social needs. Sustainable development holds the potential to create enduring competitive advantage for firms that create

solutions to urgent social and environmental problems. The transition from 'greening' to 'sustainability' as corporate and social goals compounds the dilemma over the role of the firm. Greening of industry focuses on a perceived obligation to reduce pollution and resource consumption, which relate specifically to the activities of the firm, its suppliers and its customers. Greening requires the firm to internalize the externalities it creates to the extent possible within the constraint of achieving positive profits. The concept of sustainable industry implies, in addition to greening, an involvement in improving social welfare, and over longer time horizons. The concept of sustainability is considerably more difficult than greening to frame analytically. Actions in pursuit of sustainability are intended to remedy both sins of commission by industry (such as environmental pollution, or disruption of traditional social systems) and sins of omission by society as a whole (such as under-investment in developing countries).

Many of the social needs that must be addressed are geographically remote from and not closely related to the core activities of the firms that will be called upon to act. This disconnection creates ambiguity concerning the nature of the industries' and firms' obligations and casts uncertainty over the role of government regulations as policy instruments. This study critically evaluates the strengths and limitations of four types of voluntary approach, and the state of knowledge about them, based on the accumulated theoretical and empirical experience. These are: unilateral initiatives, private codes, voluntary challenges, and negotiated agreements. Unilateral initiatives are actions to improve environmental performance within a single firm. Private codes include initiatives by industry associations, non-government organizations and standards organizations (Nash and Ehrenfeld, 2017). Voluntary challenges are government sponsored programs that encourage firms to improve environmental performance and receive public recognition for their efforts (Harrison, 2019). Negotiated agreements involve contracts reached between government and industry. Research has been uneven across the four categories of voluntary initiatives, but all of them appear to have potential for contributing to sustainability.

Pollution Control and Remediation

Environmental monitoring is becoming increasingly critical to protect the public and the environment from toxic contaminants and pathogens released into air, soil and water from toxic chemical wastes, spills, manufacturing waste and even underground storage tanks. The US Environmental Protection Agency (EPA) has imposed strict regulations on the maximum allowable concentrations of many environmental contaminants in air and water and is reported to have been monitoring over two million underground storage tanks containing hazardous (and often volatile) contaminants from as early as 2012. Nanotechnology has the potential to bring in solutions to minimize or eliminate the use of toxic materials and the generation of undesirable by-products, and also sensitively detect (and monitor) specific polluting agents well before any major environmental catastrophes occur. Research related to improved industrial processes and starting material requirements, development of new chemical and industrial procedures and materials to replace current hazardous constituents and processes, resulting in reductions in energy, materials and waste generation are being supplemented by the application of nanotechnology to control and predict the potential damage to the environment (Kantaria, 2015).

Futuristic examples of types of nanotechnology applications that may lead to reduction or elimination of pollutants of concern include atomic-level synthesis of new and improved catalysts for industrial processes; adding information into molecules that senses toxic molecules; self-assembling molecules as the foundation for new chemicals and materials for toxic waste detection and prevention; and building molecules just in time in microscale reactors and on-line sensitive sensors for monitoring and catastrophe prediction and prevention. More contemporary possibilities include facile and accurate detection/monitoring of common airborne pollutants such as NOx and CO, waterborne harmful agents such as pathogens and metal ions, amongst others. Monitoring hazardous materials with current methods is costly and time intensive and several limitations in sampling and testing with analytical techniques have been identified. The time and expense involved in the detection of environmental pollutants (Birchall, 2016).

Research Gap

The government has established structures for building sustainable environmental protection as foundation with plastic material recycling practices. And it has created a well done, long-term reform strategy that informs all of the country's short-term development goals. The government has worked to meet the effective team for protecting environment by streamlining regulatory processes involved in starting every step in all districts. Beyond undertaking legal and administrative reforms, the government has invested in training for professionals in ecosystem to ensure proper environmental protection. Recognizing the benefits

of a diverse knowledge base, Rwanda need also imported technical experts from other countries, to replicate good practices and build capacity in ecosystem. And the government has involved the public sector and private sector in the reform process and maintained an open line of communication to keep citizens, civil society and other (MINIFRA Report 2012).

All these efforts are showing results in Rwanda's sustainable environmental protection and Rwanda's dedication to REMA, in triggering sustainable environmental, has contributed substantially to its overarching goal of promoting the plastic material recycling practices and environmental protection with prosperity. This study aims to fill that gap. This chapter provides information from previous literatures regarding criteria of plastic material recycling practices and environmental protection. This includes review of perspective on plastic material recycling practices and environmental protection.

3. Materials and Methods

The descriptive research design was used in this study as a way to facilitate a researcher to have a mixture of both qualitative and quantitative approaches. This is considered as a way to investigate how it was utilized to depict characteristics of a wonder to be examined Kumar (2011). The analyst was portrayed the circumstance or preparing detail. Thus, this study was used descriptive research design.

The total target masses was considered and expected to give out the information related to the objectives of the explore think approximately was based on participations of differing individuals in Eco-Plastic Recycling Plant in Kigali who was composed of 174 employees in different departments and 174 respondents as sample size. As all population was sample size; therefore, be made of number the staff and employees of Eco-Plastic Recycling Plant in Kigali respondents who was involved in interaction with researcher. Data collected was analyzed using descriptive statistics because the data obtained in this study was quantitative. According to (Quang and Hong, 2009), quantitative data are observations measured on a numerical scale. Results collect also entered into the statistical analysis. This analysis indicated variations of the response in the sample, response to the various questions and variations among different groups. Presentation of the results and findings were in terms of tables and graphs. Qualitative analysis techniques were used. The Qualitative analysis techniques were complemented with some statistics that was mainly obtained from the secondary data that was obtained through documentary analysis from the case study organization.

4. Results

4.1 Perceptions of the Respondents on operation activities relating to plastic recycling as provided by Eco- Plastic recycling plant in Mageragere sector

Table 1: Shows perceptions of respondents on operation activities relating to plastic recycling as provided by Eco- Plastic recycling plant in Mageragere sector

Indicators		SD	D	N	A	SA	Total	Frequency	
								Mean	SD
The informal sector has a role in plastic waste managemen t for facilitating for recycling of plastics	Frequency Percentage	0 0%	0 0%	12 6.4%	78 44.8%	84 48.2%	174 100%	4.67	0.543

practices of Eco- Plastic recycling plant									
Kigali city provide dumps which has two sides and Residents are willing to participate in recycling programmes for improved plastic waste management	Frequency Percentage	0 0%	6 3.4%	20 11.4%	78 48.8%	70 40.2%	174 100%	4.43	0.725
Residents segregate waste with or without separate bags for facilitating for recycling of plastics practices of Eco- Plastic recycling plant	Frequency Percentage	0 0%	2 1.1%	19 10.9%	81 46.5%	72 41.3%	174 100%	4.21	0.966

SD = strongly disagree, D= disagree, N= Not sure, A= agree, SA= strongly agree.

Source: Primary Data (2023)

Table 1 for each indicator shows the percentage and frequency shows the mean and standard deviation of the responses elicited from the respondents. The findings show the informal sector has a role in plastic waste management for facilitating for recycling of plastics practices of Eco- Plastic recycling plant. None of the respondents neither disagreed nor strongly disagreed to the informal sector has a role in plastic waste management for facilitating for recycling of plastics practices of Eco-Plastic recycling plant. The neutral responses comprised of 12(6.4%), 78(44.8%) respondents agreed to the informal sector has a role in plastic waste management for facilitating for recycling of plastics practices of Eco- Plastic recycling plant while 84(48.2%) strongly agreed that informal sector has a role in plastic waste management for facilitating for recycling of plastics practices of Eco- Plastic recycling plant, with a mean of 4.67 and standard deviation of 0.543 as shown. It was found that informal sector has a role in plastic waste management for facilitating for recycling of plastics practices of Eco- Plastic recycling plant.

It further depicts that 6(3.4%) of the respondents disagreed and were 20 (11.4%) neutral with the statement that Kigali city provide dumps which has two sides and Residents are willing to participate in recycling programmes for improved plastic waste management, 78(48.8%) agreed while 70(40.2%) strongly agreed, with a strong mean and standard deviation of 4.43 and 0.725 respectively. From the tables, 2(1.1%) of the respondents disagree to the Kigali city provide dumps which has two sides and Residents are willing to participate in recycling programmes for improved plastic waste management, 19(10.9%) are neutral, 81(46.5%) of

the respondents each agreed and 72(41.3%) strongly agreed that Kigali city provide dumps which has two sides and Residents are willing to participate in recycling programmes for improved plastic waste management as shown in the table with a strong mean of 4.21 and standard deviation of 0.966 showing that they all have heterogeneous responses or varying perceptions and there is a very significant level of assessment by Kigali city provide dumps which has two sides and Residents are willing to participate in recycling programmes for improved plastic waste management.

Furthermore, none of the respondents strongly disagreed that there is not residents segregate waste with or without separate bags for facilitating for recycling of plastics practices of Eco- Plastic recycling plant, while 6(3.4%) disagree that there is not residents segregate waste with or without separate bags for facilitating for recycling of plastics practices of Eco- Plastic recycling plant. 14(8%) are neutral with the statement, 63(36.2%) agree and 01(52.2%) strongly agreed that there is a residents segregate waste with or without separate bags for facilitating for recycling of plastics practices of Eco-Plastic recycling plant, with a mean of 4.28 and standard deviation of 0.872 which shows that there is a residents segregate waste with or without separate bags for facilitating for recycling of plastics practices of Eco- Plastic recycling plant.

4.2 Perceptions of the Respondents on variation of plastic emission on environment degradation in Rwanda

Table 2: Shows **perceptions of respondents on variation of plastic emission on environment degradation in Rwanda**

Indicators		**SD**	**D**	**N**	**A**	**SA**	**Total**	**Frequency**	
								Mean	**SD**
Recycling p revents the emissions of many greenhous e gases and water pollutants, and saves energy	Frequency Percentage	0 0%	0 0%	0 0%	76 43.6%	98 56.3%	174 100%	4.41	0.815
Using recovered material generates less solid waste	Frequency Percentage	0 0%	9 1%	9 5.1%	75 43.1%	81 46.5%	174 100%	4.26	0.958
Recycling helps to reduce the pollution caused by the extraction and processing of virgin materials	Frequency Percentage	0 0%	0 0%	7 4%	78 44.8%	89 51.1%	174 100%	4.01	.040

SD = strongly disagree, D= disagree, N= Not sure, A= agree, SA= strongly agree.

Table 2 for each indicator shows the percentage and frequency shows the mean and standard deviation of the responses elicited from the respondents. The findings shows that the 174 respondents, table 4.7 show that 98(56.3%) strongly agreed and 76(43.6%) agreed that the recycling prevents the emissions of many greenhouse gases and water pollutants, and saves energy. None were neither neutral nor strongly disagreed to this fact and disagreed with the statement. Most of the respondents witnessed that there is a recycling prevents the emissions of many greenhouse gases and water pollutants, and saves energy with strong mean and standard deviation of 4.41 and 0.815 respectively, implies that there is recycling prevents the emissions of many greenhouse gases and water pollutants, and saves energy.

Most of the respondents also confirmed that using recovered material generates less solid waste as it can be seen from table 4.7 where 9 of respondents with (5.1%) are disagreed and neutral with the statements, 75 (43.1%) agreed and 81(46.5%) strongly agreed that using recovered material generates less solid waste with strong mean and standard deviation of 4.26 and 0.958 respectively.
Recycling helps to reduce the pollution caused by the extraction and processing of virgin materials 89(51.1%) are strongly agreed and agree 78(44.8%) all show that some of the respondents are neutral 7(4%) respectively. The strong mean and standard deviation of 4.01 and 1.040 respectively, further shows that recycling helps to reduce the pollution caused by the extraction and processing of virgin materials.

Perceptions of the Respondents on status of plastic material recycling on environment protection provided by Eco- Plastic recycling plant

Table 3. Shows perceptions of respondents on status of plastic material recycling on environment protection provided by Eco- Plastic recycling plant

Indicators		SD	D	N	A	SA	Total	Frequency	
								Mean	SD
Drop the plastic waste into the recycling bin, it most likely makes its way around the world	Frequency Percentage	0 0%	0 %	18 10.3%	64 36.7%	92 52.8%	174 100%	4.26	0.855
It can pose a health and security risk to developing countries	Frequency Percentage	0 %	10 5.7%	16 9.1%	60 34.4%	88 50.5%	174 100%	4.22	0.039
Plastic sticks around in the environment for ages, threatening wildlife and spreading toxins	Frequency Percentage	0 %	5 2.8%	14 8%	80 45.9%	75 43.1%	174 100%	4.01	0.126

Source: Primary data (2023)

Table 3 for each indicator shows the percentage and frequency shows the mean and standard deviation of the responses elicited from the respondents.

The findings shows that the 174 respondents, that 92(52.8%) strongly agreed and 64(36.7%) agreed that drop the plastic waste into the recycling bin, it most likely makes its way around the world, 18(10.3%) neutral and none of strongly disagreed to this fact and disagreed with the statement. The strong mean and standard deviation of 4.26 and 0.855 respectively, implies that drop the plastic waste into the recycling bin, it most likely makes its way around the world.

Most of the respondents also confirmed that it can pose a health and security risk to developing countries as it can be seen where 60 (34.4%) agreed and 88(50.5%) strongly agreed that it can pose a health and security risk to developing countries, 10 of respondents with 9.1% are neutral the statement while 10 of respondents with 5.7% are desagree. The strong mean and standard deviation of 4.22 and 0.039 respectively, implies that it can pose a health and security risk to developing countries.

Plastic sticks around in the environment for ages, threatening wildlife and spreading toxins 75(43.1%) are strongly agreed and agree 80(45.9%) all show that some of the respondents are neutral on 14 (8%) and 5(2.8%) are disagreed respectively. The strong mean with standard deviation 4.01 and 0.126, further shows that plastic sticks around in the environment for ages, threatening wildlife and spreading toxins.

4.4 Perceptions of the Respondents on plastic material recycling practices and environment protection in Rwanda

Table 4. Shows **Perceptions of Respondents on plastic material recycling practices and environment protection in Rwanda**

Indicators		**SD**	**D**	**N**	**A**	**SA**	**Total**	**Frequency**	
								Mean	**SD**
Carrying out national bans to reduce the consumption and manufacturing of single-use plastic in the country	Frequency Percentage	0 %	6 3.4%	0 %	89 51.1%	79 45.4%	174 100%	4.71	0.526
Turning fossil fuels into plastics pollutes the water. The tiny pellets produced by these facilities often	Frequency Percentage	0 %	5 2.8%	5 2.8%	73 41.9%	91 52.2%	174 100%	4.54	0.696

spill into waterways to be eaten by birds and fish									
Plastics help us protect the environment by reducing waste, lowering greenhouse gas emissions, and saving energy at home, at work, and on the road.	Frequency Percentage	0 %	2 1.1%	10 5.7%	72 41.3%	90 51.7%	174 100%	3.77	1.264

Source: Primary data (2023)

Going by table 4 none of the respondents strongly disagreed or were neutral on Carrying out national bans to reduce the consumption and manufacturing of single-use plastic in the country, 6(3.4%) of the respondents disagree, 89(51.1%) agree while 79(45.4%) strongly agreed that Carrying out national bans to reduce the consumption and manufacturing of single-use plastic in the country. The mean and standard deviation from the table is 4.71 and 0.526 respectively showing that the responses are heterogeneous and strong. This goes further to show that the respondents are adequately.

From table 4.9, none of the respondents strongly disagreed with the statement, but 5(2.8%) disagreed, 5(2.8%) is neutral with the statement, 73(41.9%) agreed that Turning fossil fuels into plastics pollutes the water. The tiny pellets produced by these facilities often spill into waterways to be eaten by birds and fish while 91(52.2%) strongly agreed with a strong mean of 4.54 and standard deviation of 0.696 as seen from table 4.9.

None of the respondents strongly disagreed with the statement. Out of the 174 respondents, from tables 4.8, 2(1.1%) are disagreed with the statement, 10(5.7%) are neutral with the statement, 72(41.3%) agreed to this and 90(51.7%) strongly agreed that plastics help us protect the environment by reducing waste, lowering greenhouse gas emissions, and saving energy at home, at work, and on the road with a strong mean of 3.77and standard deviation of 1.264 which implies that a small percentage of the respondents confirm the statement.

4.Correlations analysis between plastic material recycling practices and environment protection

Correlation was conducted between independent and dependent variables. The aim was to establish the nature and strength of relation between the independent and dependent variables. Correlation refers to a technique used to measure the relationship between two or more variables. When two variables are correlated, it means that they vary together. Positive correlation means that high values on one variable are associated with high values on the other and that low values on one are associated with low values scores on the other (Kavale, 2017). In the interpretation of correlation the sign of the correlation coefficient means either a positive or negative correlation coefficient. The positive correlation coefficient means that the

variables move in the same direction, while negative correlation means variables move in opposite directions. The correlation significance is indicated by a probability value of less than 0.05 or 0.01.This means that the probability of obtaining such a correlation coefficient by chance is less than five times out of 100 or is less than one times out of 100, so the result indicates the presence of a relationship.

Table 5. Correlations between plastic material recycling practices and environment protection

			Plastic material recycling practices	**Environment protection**
Spearman's rho	**Plastic material recycling practices**	Correlation Coefficient	1.000	.993*
		Sig. (2-tailed)	.	.000
		N	174	174
	Environment protection	Correlation Coefficient	.993*	1.000
		Sig. (2-tailed)	.000	.
		N	174	174

*. Correlation is significant at the 0.05 level (2tailed).

Legend:

[-1.00 - 0.00 [: Negative correlation;

[0.00 - 0.25 [: Positive and very low correlation;

[0.25 - 0.50 [: Positive and low correlation;

[0.50 - 0.75 [: Positive and high correlation and

[0.75 - 1.00] : Positive and strong correlation.

The variation of Spearman Coefficient correlation is between -1 and 1. Spearman Coefficient correlation has significance when it is equal or greater than 0.01. According to the research, the correlation of 0.993 (91.4%) is located in the interval [0.75 - 1.00] categorized as positive and strong correlation. As the significant level is at 0.01 (1%), the p-value of 0.000 (i.e. 0.0%) is less than 1%. This leads to confirm that there is significant relationship between plastic material recycling practices and environment protection.

Multiple linear regression analysis

Multiple linear regression analysis was carried out to found out the effect of the independent variables (plastic material recycling practices) on the dependent variable (environment protection). Multiple Linear regressions were computed at 95 percent confidence interval to establish the relationship between independent variables and dependent variables. Based on the model summary, the coefficient of determination (R squared) shows the overall measure of strength of association between independent and dependent variables.

Table 6: Model Summary on plastic material recycling practices

Model	**R**	**R Square**	**Adjusted R Square**	**Std. Error of the Estimate**
1	.782[a]	.612	.603	.748

a. Predictors: (Constant), Plastic material recycling practices

The study results in table 6 show that plastic material recycling practices have statistically significant effect on environment protection with a positive coefficient of determination of 0.782 indicate that there is a positive correlation between independent values and dependent value.

Table 7: ANOVA Test on plastic material recycling practices

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	116.600	2	38.867	69.480	.000[b]
	Residual	73.841	171	.559		
	Total	**190.441**	**173**			

a. Dependent Variable: Environment protection
b. Predictors: (Constant), Plastic material recycling practices

As indicated in the table above the F-test value was 69.480 with significance value of .000 at 5% level of significance. Since the p-value obtained was less than 0.05, the F-test was significant hence the conclusion that the regression model was good.

Table 8: Regression coefficients on plastic material recycling practices

Model	Unstandardized Coefficients		Standardized Coefficients	T	Sig.
	B	Std. Error	Beta		
(Constant)	.849	.612		1.388	.166
Operation activities relating to plastic recycling	.307	.051	.438	5.970	.000
Variation of plastic emission	.117	.053	.124	2.204	.028
Status of plastic material recycling	.236	.062	.234	3.813	.000
Plastic material recycling practices	.176	.041	.228	4.261	.000

a. Dependent Variable: Environment protection

The results from Table 8 indicated that operation activities relating to plastic recycling has a positive and significant effect on environment protection by Eco- Plastic recycling plant (β1= 0.438; t=5.970; p-value < 0.05). This means that 1% change in variation of plastic emission leads to an increase of 0.438% change in environment protection by Eco- Plastic recycling plant. The results again indicated that there is a positive and significant effect of status of plastic material recycling on environment protection by Eco- Plastic recycling plant (β2= 0.124; t=2.204; p-value < 0.05). This means that 1% change in project design system; it leads to at least 0.124% increase change in environment protection by Eco- Plastic recycling plant.

The results again indicated that plastic material recycling practices has positive and significant effect on environment protection by Eco- Plastic recycling plant (β3= 0.234; t=3.813; p-value <0.05). This means that 1% change in status of plastic material recycling leads to at least 0.234% change in environment protection by Eco-Plastic recycling plant. Findings revealed that plastic material recycling practices and significant effect on environment protection by Eco- Plastic recycling plant (β4= 0.228; t= 4.261; p-value < 0.05). This means that 1% change in plastic material recycling practices leads to at least increase of 0.228% in environment protection by Eco- Plastic recycling plant.

5. Discussion

The level of public participation in solid waste management at present in Rwanda is still low. There is no structure that allows for a more synergistic relationship between the public and the local authority. Eco- Plastic recycling plant, being less than a decade old is more preoccupied with infrastructural projects at the moment leaving the solid waste management issue less attended to and with fewer resources for the venture. This has consequently given room for people to dispose of waste carelessly since the issue has not been practically adopted as a priority in the Kigali as yet. Everyone has the discretion to decide what best

suits them as far as solid waste management is concerned for environment protection.

Waste reduction through waste reuse is a primary function of the public at the stage of waste generation. Eco- Plastic recycling plant, there has been effort towards waste reduction for plastic material recycling. The people do not possess knowledge on the benefits to the environment and consequently sustainable development when the volume of waste is reduced. There is no appreciation of the fact that solid waste affects sustainable development. The required circumstances for effective solid waste reduction are not prevalent in Eco- Plastic recycling plant given the low level of social capital established among the people. The characteristic capitalistic and individualistic life style makes it harder for solid waste reduction to be collectively achieved. It leaves the Eco- Plastic recycling plant with fewer alternatives for sustainable solid waste management, albeit waste reduction can also still be provoked.

Knowledge about the importance and benefits of sorting waste is one thing, and having knowledge on the recyclable waste material is another. People do realise that it is a good thing to sort solid waste so that not all of it is dumped together. The intention is to easy the management of the waste by having some of the waste items recycled. The knowledge base about recyclable items among the people of Rwanda is minor and very low. The people know little about recyclable items and this in itself forms a barrier to waste sorting. For one to embrace waste sorting, one needs to know which items to particularly sort-out, without this knowledge, it becomes useless and unlikely so to happen. From the attitudes of the people, it is very clear that not all is lost. The future of sustainable solid waste management in the towns is bright but only so if the potentials of the people to participate are delicately and purposively tapped. There is willingness by the public to participate. They are ready to play their role in solid waste management, but as they unanimously agreed that they cannot manage on their own, they need the technical guidance of the authorities.

Collaboration is thus very important for success of any project and solid waste management is not an exception. The willingness among the people to work together with one another and with the authorities for a common good is a starting point for a synergy which will move from just mere complementarity through embeddedness to a co-productive relationship which is the epitome of participation. The time to act is now because if nothing is done immediately, the more time passes, the more complicated the solid waste management problem will get. The population is without doubt increasing day in day out and the impact on the environment is also becoming enormous. The damage on the environment is already noticeable in all districts of Rwanda as a result of the careless waste disposal practices. The situation calls for an immediate arrest as the only way to reverse the effects in future.

6. Recommendations

There are fertile prospects for public participation in solid waste management in Rwanda. The best way to do is by showing the people that they are worth by involving them in the initial planning stages. The people's ideas should be included in the initial deliberations and discussions so that they can see themselves as part of the decision-making structure. This is important because the people themselves have been responsible for both the good and bad practices at present and therefore for any change to be concrete there is need to involve the people right from the start by way of consultations. This will also help in taking the relationship between the public and the authorities to another level of mutual understanding and interdependence. With this, the operations will most likely be smooth and less costly both politically and financially.

Apart from involving the people is taking the initial decisions, the government of Rwanda should strategically plan for sensitization of the people. Several solutions may be brought at table and agreed upon. But just like the findings show, the people feel that the first step should be to sensitise the public about the whole issue of solid waste management. Although there is agreement that sensitisation should come prior to implementation of the solid waste management program, in actual sense, effective and meaningful sensitisation is planned when the whole program package is complete. That is when one can know what exactly to sensitise about and how. It is my suggestion therefore that sensitisation should not be done for the sake of it and basing on mere thought but after a common agreement on the program of solid waste management for purposes of being systematic and thorough.

The imminent bye-law by Eco- Plastic recycling plant on solid waste management with a specific focus on waste collection fees structure is one of those items that need to feature in the sensitization. This the Eco- Plastic recycling plant may be already planning but the concern should also be on the basis for determination of the fees structure. This is a critical issue and the fact that it will come in form of a law

that will demand conformity; it requires utmost care on the side of the law makers. To be able to come out with an acceptable fees structure the Eco-Plastic recycling plant should do a well-planned and empirically supported consultation or survey that will ensure determination of a win win financial legislation for solid waste collection and management.

The Eco- Plastic recycling plant has been doing social networking with a few good-willed individuals. This is a good thing and thus a good base on which to launch a fully fledged campaign on networking. The potential for scaling up this venture should be explored and given attention because the Eco-Plastic recycling plant administration will need the members of the public and vice versa. There are people who posses or at least have access and control over useful resources that can be used for better solid waste management. Therefore social networking should be seriously considered as it will help in reaching cost effective ways of dealing with solid waste in the area. Since there are potential economic benefits that the Kigali city is aware of that can be attained from business in solid waste, a plan to give elementary training to interested members of the public may be worthwhile with time. It will be a positive investment for future solid waste management which is community led other than led by the administration because in that way, it will be cheaper and yet sustainable. Just like the city revealed that they have seen it successfully work in Districts of Rwanda, I think it could even work better in Eco- Plastic recycling plant which is near Kigali city with all the necessary socio-economic advantages.

It is understandable that all local government units operate under meagre financial resources and thus have to set their priorities right. In most cases, solid waste management misses out in the strategic plans and consequently in the budget. The defence for this omission may be that waste management is not an economically rewarding investment and therefore not very much a priority.

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Reference

1. Abota Charles, (2012). *Green Development: Environment & Sustainability in the Third World,* London and New York, Routledge.
2. Allenby (2017). What we buy, what we throw away and how we use our voice. Sustainable Household waste management in UK. *Sustainable Development,* 12**,** 32-44.
3. Alshenqeeti, (2014). *Qualitative Interview Design*: A Practical Guide for Novice Investigators. The Qualitative Report, Vol. 15(3), 754-760.
4. Andrady (2017). Beyond recycling: 'Commons-friendly' Waste reduction at new consumption communities. *Journal of Consumer Behaviour,* 6**,** 271-286.
5. Amin, (2012). *Research Methodology and Techniques* New Delhi New Age International (P) Limited Publishers.
6. Arena et al. (2018). Waste, recyclers and recycled. In *Planet in Peril: An Atlas of Current Threats to people and the Environment.* UNEP/GRID-Arendal and Le Monde diplomatique.
7. Arnold and Inge (2015). Accounting for the Shortage of solid waste disposal facilities in Southern China. *Environmental Conservation,* 28**,** 99-103.
8. Arvanitis, (2017). *Public Participation in Solid Waste Management: Challenges and Prospects (MSc. Development Management Thesis) By Mukisa Philemon Kirunda*
9. Barnes et al. (2019). Rethinking waste management in India. *Humanscape Magazine.* In UNEP(2007) *Global Environment Outlook-4. Environment for Development*, United Nations Environmental Programme
10. Birchall, (2016). Urban Residential Solid Waste Management in India. Issues Related to Institutional Arrangements. *Public Works Management and Policy,* 4**,** 319-330. Change makers, (2017). Lessons in Solid Waste Management. *For Teachers Grades K-3. A School Enrichment Program. Household Hazardous Waste.*
11. Cherie Lunghi,(2002). Beyond recycling: 'Commons-friendly' Waste reduction at new consumption communities. *Journal of Consumer Behaviour,* 6**,** 271-286.
12. De Vriend & Van Koningsveld, (2018). *Community guide to environmental issues and to the environmental management and co-ordination act, 1999: Nairobi city.* Nairobi: ELCI.

13. De Vriend et al., (2014). Breaking free from plastics. *Ecoforum environmental solutions.* Nairobi: ELCI.
14. Diana, (2018). Plastic recycling: A case study. Lund: Lund University.
15. Dvorak, (2009). *The study on solid waste management in Nairobi city in the Republic of Kenya*: Interim report. CTI Engineering
16. Drost (2011). *Social Research Methods*, Fourth Edition. Published in the United States by Oxford University Press Inc., New York Cambridge Scholars Publishing.
17. EcoShape, (2018). City Consultation on solid Waste Management and a Strategic Plan. A Case of Wakiso District, Uganda. Kampala, Kampala City Council.
18. El-Newely, (2016). *Approaches to participation in Rural Development,* Geneva, International Labor Organization.
19. Fisher, (2017). Plastic waste heading for oceans quantified: Science and environment.
20. 12 February, 2015. BBC news. 12 March, 2015.
21. Fletcher & Mackay, (2016). Waste Minimization as a Local Government Issue: Fact or Fiction? *Sustainable Development,* 6**,** 78-91.
22. Garforth et al. (2014). Applications and societal benefits of plastics. *Phil. Trans. R. Soc. B 364, 1977– 1984*, *retrieved: March 4, 2015*: *doi:10.1098/rstb.2008.0304*
23. George C. Lodge & Jeffrey F.(2018). Closed Loop Process: Plastic recycling comes full circle UK.http://news.bbc.co.uk/2/hi/uk_news/magazine/7470662.stm#text
24. Gregory (2019). Recycling of polymeric materials used for food packaging: Current status and perspectives. *Food Rev. Int. 17, 291–346.*, *retrieved: February 20, 2015: doi:10.1081/ FRI-100104703*
25. Harrison, (2019). Sustainable Management of Plastic Bag Waste: The Case of Nairobi, Kenya (Masters paper). Sweden.
26. Hart, (2017). Plastic problem in Africa. *Japanese Journal of Veterinary Research, 61(Supplement): S1- S11, retrieved: March 10, 2015.*
27. Jefferson, (2008). A case study of the relationship between the City Council of Nairobi and Community Based Waste Management Organizations
28. Jerome A. (2019). A World Current of Plastic Waste in the Marine Environment and Solutions to the Problem: Global Studies Capstone California State University Monterey Bay.
29. Julius, (1990). *Qualitative Interview Design*: A Practical Guide for Novice Investigators. The Qualitative Report, Vol. 15(3), 754-760.
30. Jonathan, (2010). *Research Methodology, a step-by-step guide for beginners*, Washington: SAGE Publications Ltd.
31. Kantaria, Bimal, (2015). 3R Practices for Municipal Solid Waste Management in Asia: The Second Baltic Symposium on Environmental Chemistry Kalmar, Sweden.
32. Kareem & Lwasa, (2019). Urban Solid Wastes, Recovery And Recycling, Bangkok: Enda Third World Document.
33. Kyrikou & Briassoulis (2017). An Introduction to Sustainable Development: Routledge Perspectives on Development Series. Third edition. London and New York: Taylor and Francis Group.
34. Makers, (2018). To Save Energy -Avoid and Reduce- waste in the first instance, only then -Recycling- what can't be –Reused, first burnie city council.
35. Mattia, (2014). Breaking free from plastics. Ecoforum environmental solutions. Nairobi: ELCI.
36. McDonough & Braungart (2018). Understanding Environmental Pollution. Second Edition. Formerly of the University of Maine. Cambridge university Press.
37. Memon, (2018). What A Waste A Global Review of Solid Waste Management. No. 15. Urban development series, knowledge papers. World Bank. Washington DC.
38. MINIFRA Report (2012). *Global Environment Outlook-4. Environment for Development*, Valletta, United Nations Environmental Programme.
39. Morris (2016). Plastics recycling: challenges and Opportunities. *Eco Products Agency, London*, *retrieved: 18 February, 2015: doi:10.1098/rstb.2008.0311*
40. Mukankomeje, (2014). Tackling industrial toxic waste through voluntary action – EPAs 33 /50 Program and preliminary findings of Inform' s research. *Toxics Watch* 1995. Inform: New York.
41. *doi:10.1016/j.wasman.2007.01.006*
42. Perugini et al. (2015). *Voluntary Approaches to Environmental Protection*: *the Role of Legislative Threats*, Nota di Lavoro 21.97. Fondazione Eni Enrico Mattei: Milan.
43. Rebeiz & Craft,(2015). Proactive corporate environmental strategy and the development of
44. Shaxson et al. (2019). From dependency to Interdependencies: The emergence of a socially rooted but commercial waste sector in Kampala City, Uganda.

45. waste management as if people matter. *Habitat International*. *Vol. 30(4): 863-871*
46. SPi, (2020). The Study of Solid Waste Management in Nairobi City, Final Report.
47. Steven E. Landsburg, (2018). Bruce Paton, Department of Environmental Studies, University of California, Santa Cruz, CA 95064, USA.
48. West (2007). As e-waste piles up, disposal issues grow." *USA Today*. 23 June 2011. Web. 02 February 2013.
49. WRAP (2014). Electronic Waste Management in the United States Through 2009." EPA 530-R-11-002. May 2011. Web. 28 December 2011.