A Stakeholder analysis of PET wastes management in Kigali, Rwanda.

Mycline UMUHOZA * Somila KAKSHAPATI, Zineb Guendouz** Bruce MUGISHA**

Tongji University, College of Environmental Science and Engineering, P.R. China. ** Institute of Environment and Sustainable Development (IESD), P.R. China.

Abstract- PET Plastic containers are the most used way of packaging beverages and other liquids in Kigali due to they are inexpensive, lightweight, strong, durable, corrosion-resistant materials, with high thermal and electrical insulation properties, their diversity of polymers and the versatility of their properties results in many societal benefits. However, their current ways of usage and disposal in Kigali are not sustainable. They can result to a multitude of health and environmental problems such us accumulation in landfills and in natural habitats, they can cause physical problems for wildlife resulting from ingestion or entanglement in plastic and also the leaching of chemicals from plastic products. The durability of plastic wastes in the environment and their potentials to transfer chemicals to wildlife and humans are dangerous. Generally, the system of Solid waste management in Kigali, especially PET waste management is a procedure that involves and affects numerous stakeholders. It requires an effective communication and collaboration among stakeholders if an improvement is to be made in the system. Throughout this study, the main stakeholders were identified with their roles, power and interest as a result of Stakeholder Analysis (SA)application. In additional to that, by using Social Network Analysis (SNA) the researcher was able to map the existing connections concerning partnerships, collaborations and the sharing of information among identified stakeholders. The findings show that though there are some well-functioning relations gaps were found in the communication and collaboration network system since some of the relations are weak, dormant or non-existing, therefore the researcher suggest a development of an extensive communication strategy that will engender effective communication and collaboration in the PET management system in Kigali. It was found that this system also luck strategic directions and innovations which limits its ability to attract and retain strategic partnerships. The Researcher recommend the formulation of strategic plan (1-3 years) and suggest of yearly themes to further enable the formation of strategic and targeted partnership to improve the current PET waste management system.

Index Terms: PET wastes management, Social network Analysis (SNA), Solid waste management. Stake holder Analysis (SA).

Introduction

1.1 Background:

Polyethylene was discovered in March 1933 by Reginald Gibson and Eric Fawcett, two research chemists at ICI's Winning-ton Laboratory in the UK, and it was first synthesized as a low-density resin (LDPE) in 1935. Polyethylene manufacturing processes have since become more sophisticated and cost-effective. Currently, there are about 25 different processes for manufacturing the range of PEs and metallocene-catalyzed polyethylene (mPE). The latter has superior toughness and is one of the most recent and the fastest growing processes. Polyethylene is presently the second most widely used class of resin globally. There are several different grades of

PE classified according to the average density of the resin linear LDPE (LLDPE), 0.925 g cm^{-3}; LDPE, 0.930–0.935 g cm^{-3}; medium density polyethylene (MDPE), 0.93–0.945 g cm^{-3}; HDPE, 0.945–0.965 g cm^{-3})[1].

Rwanda is an African country located in the east central part of Africa, which capital city is Kigali. Geographically Kigali is situated on latitude 1^0 57'S and on longitude 30^{0}04'E, with population density of 1600 per km². it covers an area of 730 km² and serves about 1,223,000 people and Kigali's. Currently GDP per capita is 724$, a 3 fold increase from 2000 and the GDP target is $1,240 by 2017 [2].Kigali is currently facing problems of solid waste management due to lack of proper amenities ways of recycling processes and proper ways of waste disposal which is affecting both the environment and human health for nowadays as well as the future. Currently the majority of all generated solid waste are collected and taken to Nduba dumpsite which receives about 400 tons per day of unsorted waste or 140,000 tons per year[3].

About 70 %, of waste generated are mainly made by organic waste, approximately 13% of non-recyclable /inert wastes, approximately 5% PLASTIC (plastic bottles), approximately 5% of cartons, 1% of metals, approx.1% electronic waste and

Approximately 1% of hazardous waste. The average waste generation is between 1800 and 2000 t per day [4].

Plastic containers in Kigali are mainly made from PET and they are the most used way for packaging beverages and other liquids due to they are inexpensive, lightweight, strong, durable, corrosion-resistant materials, with high thermal and electrical insulation properties. Their diversity of polymers and the versatility of their properties results in many societal benefits [1]. However, their current ways of usage and disposal in Kigali are diverse and not sustainable it can result in accumulation of waste in landfills and in natural habitats, physical problems for wildlife resulting from ingestion or entanglement in plastic, the leaching of chemicals from plastic products and the potential for plastics to transfer chemicals to wildlife and humans.

Although many studies have been done regarding solid waste management systems in Kigali City ([3],[5] , [2], [6],and [7] ,there is no reported study which was focused on a stakeholder analysis of the management of plastic waste in Kigali.

Stakeholder analysis is the process of identifying individuals or groups that are likely to affect or be affected by a proposed action, and determining their potential impact on the action or what impact the action could have on them[8]. This information is used to assess how the interests of those stakeholders should be addressed in a project, policy, program, or other action. A stakeholder is any person or organization, who can be positively or negatively impacted by, or cause an impact on a process [9]. For this particular study we have divided out stakeholders into the following roles: Government as policy makers and regulators, Transportation and PET wastes management companies, manufacturing and PET packaging companies, private sectors and others.

1.2 **Problem statement**

Rwanda is a country located in the east central part of Africa, which capital city is Kigali. Geographically Kigali is situated on latitude 10 57'S and on longitude 30004'E, with population density of 1600 per km².It covers an area of 730 km² and serves about 1,223,000 people. And Kigali's Currently GDP per capita is 724$, a 3 fold increase from 2000 and the GDP target is $1,240 by 2017 [2].

Kigali is currently facing problems of solid waste management especially PET wastes due to lack of proper amenities ways of recycling processes and proper ways of waste disposal which is affecting both the environment and human health for nowadays as well as the future [7].

Currently the majority of all generated solid waste are collected and taken to Nduba dumpsite which receives about 400 tons per day of unsorted waste or 140,000 tons per year [3]. About 70 %, of waste generated are mainly made by organic waste, approximately 13% of non-recyclable /inert wastes, approximately 5% PLASTIC (plastic bottles), approximately 5% of cartons, 1% of metals,

approx.1% electronic waste and approximately 1% of hazardous waste. The average waste generation is between 1800 and 2000 t per day [10].

Plastic containers in Kigali are mainly made from PET, and they are the most used way for packaging beverages and other liquids. This is due to their inexpensive, lightweight, strong, durable, corrosion-resistant materials, with high thermal and electrical insulation properties. The diversity of polymers and the versatility of their properties results in many societal benefits. However, their current way of usage and disposal in Kigali are diverse, alarming and are not sustainable[10]. PET bottles can result in accumulation of waste in landfills and in natural habitats, they can cause physical problems for wildlife resulting from ingestion or entanglement in plastic. It's also evident that the leaching of chemicals from plastic products and the potential for plastics to transfer chemicals to wildlife and humans is a serious problem to consider[11].

Generally, the system of Solid waste management in Kigali, especially PET waste management is a procedure that involves and affects numerous stakeholders. It requires an effective communication and collaboration among stakeholders if an improvement is to be made in the system. Poor communication between stake holders and inaccessibility to information, lack of follow up to the implementations of laws and strategies, unawareness of the impacts of PET Bottles to the environment and health at large are one of the main causes to poor management of PET wastes management and failing to know whose responsibilities are is the big problems in regard to PET waste management in Kigali.

It's on this context that the researcher would like to assess and analyze every person or organization, who can be positively or negatively impacted by, or cause a change in regard to PET bottles waste management process in Kigali.

1.3 Research objectives:

    i.   To identify various stakeholders in PET waste management system in Kigali.

    ii.   To determine their roles and interest in the process of PET management.

    iii.   To assess the power of stakeholders and their relationship

    iv.   Assess the Information access and sharing of stakeholders.

    v.   Determine the gap and Identify a strategy to be used to close the gap in regard to PET waste management.

1.4. Theoretical significance and Practical significance

Practically the study will be of great importance to government and local authorities in decision making considering management of plastic waste. This will enable us to identify the key stake holders in regard to the issue of plastic waste management who can play a major role to improve the MSW management especially PET waste in terms of policy making, implementation and follow up.

Theoretically, The Study will serve as a guidance and reference point for academics and other researchers, as mentioned above for stakeholder analysis.

2. Literature review

2.1 Stakeholder analysis

Stakeholder analysis determines whose interests are relevant in the process of setting up and implementing a given policy or program[12] .it delineates aspects of social and natural phenomenon affected by a decision or action, identifies individuals, groups and

organizations who are affected by, or can affect those parts of the phenomenon, and prioritizes these individuals and groups for involvement in the decision-making process [13].

According to [14] ,this analysis is also used in project development from different sectors of activity. SA as a tool for policy analysis has its roots in the early work of policy scientists, who were concerned with the power distribution and the role of interest groups in the decision-making and policy process [15]. Given that participatory methods are broadly seen as essential to address the difficulties of environmental policy and decision-making, SA is one of the most common approaches for better understanding of the interests of the main parties [16] . For instance, SA can be used to understand the environmental systems by defining the aspects of the system under study, to identify who has a stake in those areas of the system, and to prioritize which stakeholders must be involved in the decisions[17] . As global and environmental change has come to the forefront in recent times, particularly in relation to waste management, stakeholders can now include several other stakeholders apart from the conventional investors and shareholders. Thus, the importance of being aware of who the relevant stakeholders are, and how they might be managed appropriately in the waste and environmental management fields[18].

Social network analysis (SNA)

According to [19], he described SNA as an approach that focuses its attention on how the relationships among stakeholders constitute to a framework or structure that can be studied and analyzed in its own rights. Furthermore, the network perspective assumes that: (a) relationships among stakeholders are important; (b) stakeholders are interdependent rather than autonomous; (c) a relationship between two stakeholders accounts for a flow of material or non-material resources; and lastly, (d) network structures enhance or inhibit stakeholders' ability to act [20]. SNA uses a network model and graph theory, and the role of the analyst is to examine the stakeholders and the patterns characterizing their relationships within the network [21] . United States of America; [22],proposed a network model that can be used to select the sustainable technology from patent documents; in a study focused on bio-plastics production; [23] Ghali et al.(2016) analyses the potential role of online social networking to stimulate social connections and enable the material flow's compatibilities, to foster the formation of industrial synergies; and [24] (Kreakie et al.2016) suggested internet-based social networks as effective approaches for building stakeholder networks among conservation and natural resource management professionals.

Stakeholder Analysis (SA) and Social Network Analysis (SNA)

Overall on one hand SA deals with stakeholder's attributes, and on the other hand, SNA clarifies the structure of relationships between those stakeholders, which render those methodologies complementary and its combination a significant contribution [25] . The combination of SA and SNA is not a new approach and has been applied in several study fields such as, institutional, political and social analysis, organization, human resources and business planning, natural resources, urban and project management, among others [9]. Additionally, there is evidence showing environmental benefits in applying stakeholder approaches to environmental or waste management systems .this approach are used to investigate how stakeholders' networks function [18].

3. Research methodologies

A literature survey on stakeholders of PET waste management systems was conducted, to categorize the stakeholders within Kigali. As a result, six groups, according to different sectors of intervention, were selected to be analyzed in the study: Government, Private Waste Management Companies, Operation management of Nduba dumpsite, Plastic waste generators, Plastic Packaging and

importing companies**,** Private sector. Afterward, constituents of each group were identified, and a list of 22 potential stakeholders was produced.

3.1 Data collection

After identifying the six groups of stakeholders and the 22 corresponding constituents, a series of self-administered questionnaires and through email, using a structured questionnaire were conducted. 250 questionnaires were distributed in total and got back 167 respondents from all groups in total. 6 from the Government, 4 respondents from Private Waste Management Companies, 1 from Operation management of Nduba dumpsite, 149 Plastic waste generators (including Household and commercial waste generators), 5 from Plastic Packaging and importing companies**,** 2 Private sectors.

Questionnaires Generally focused on the assessment of the respondents' knowledge about PET wastes effects on the environment, PET management system in Kigali and the stakeholder's involvement in it. it also focused on stakeholders' power and interest, their views in regard to the access to information, the existing partnerships and collaborations, and sharing of information among other stake holders.

3.2 Data analysis

Microsoft Excel was used to structure and organize the data and then construct the power versus interest grid, and the diagrams representing sharing and access to information as outputs of the Stakeholder analysis[19] .

Stakeholders in the upper two quadrants are those with higher power to influence or affect the system players but with varying levels of interest. those on the right-side bear significant interest in the system. Stakeholders in the two lower quadrants are those with lower but with different interest level. On the left side they have less interest while in the right side they have significant interest in the management system of PET management in Kigali.

4. Results and discussion

4.1 Stake holder identification

 This part focus on the Introduction of different stakeholders, their missions, Functions, policies and laws regarding the issue of plastic bottles wastes management in Kigali**.** Stakeholder analysis have become increasingly a popular tool to analyze the relationship among users, managers, policy makers and researchers who have a stake and the ability to influence or change the actions and aims of an organization, project or policy directions. the main aim of stakeholder analysis is to gauge the relevance of stakeholders to a particular project or policy[15].

While conducting the analysis, the position, interest, influence, interrelations, networks and other characteristics of stakeholders are taken into consideration with reference to their past, present positions and future potential. This process comprises of methods for: i) identification of stakeholders; ii) Classifying stakeholders based on their roles and interest and iii) investigating relationships between stakeholders [8].

Identification and classification of stake holders

Classification	Stakeholder identification
	MINIRENA

Government/ policy makers	REMA
	MINEACOM
	RURA
	RSB
	CITY OF KIGALI
	COPED
Private Waste Management Companies	UBUMWE
	AGRUNI
	COCEN
Operation management of Nduba dumpsite	RWANDA RESERVE FORCE
Plastic waste generators	LOCAL DISTRIBUTORS AND SELLERS
	HOUSEHOLD AND COMMERCIAL WASTE GENERATORS
Plastic Packaging and importing companies	INYANGE
	JIBU
	COCA COLA
	SULFO
	AMAZI YA HUYE
	UNDPR
Private sector	PSF
	FONERWA

The above list of stakeholders is divided into three main groups which are the Government that are mostly described as decision makers regarding plastic waste management in Kigali, those includes Rwanda Ministry of Environment and Natural Resources (MINIRENA), Rwanda Environment Management Authority (REMA), Rwanda Utilities Regulatory Authority (RURA). The second group is composed of companies and NGO'S in charge of collection, transportation and management of solid waste in Kigali, and this includes COPED which is in charge of collection and transportation of solid waste from different municipalities in Kigali and dispose them at Nduba dumpsite. Currently, Reserve force is in charge of the management of Nduba dumpsite. The third part is composed of producers of plastic bottle wastes, those includes companies that imports Plastic bottled beverages in Kigali, the local distributors and sellers, it includes also consumers of plastic bottled beverages who finally generate plastic bottles them as wastes. In additional to that, there are other companies and NGO's that are associated to plastic waste management issue in Kigali and they can be interested or affected in one way or another by any change of policy regarding plastic waste management, those includes Rwanda's Green Fund (FONERWA) which funds environmental and climate change projects.

Government and decision makers

Rwanda Ministry of Environment and Natural Resources (MINIRENA)

The ministry of environment and natural resources has a mission to ensure protection and conservation of the environment, specifically they are responsible of regulating the sector and related sub-sectors through the development of laws and regulations to ensure rational utilization of natural resources and ensure protection of the environment and conservation of natural ecosystems.

MINIRENA is also responsible of Monitoring and evaluating the implementation of sector and sub-sectors policies, strategies and programs through:

a) Setting up and implementation of appropriate mechanisms and systems for monitoring and evaluation of environment and climate change situation in the country as well as in the region;

b) Monitoring and assessing the implementation and mainstreaming of policies and laws that enhance the protection of environment and the rational utilization of natural resources in all cross-cutting sectors in the country;

c) Monitoring the sector performance indicators and consolidating the data from decentralized institutions;

d) Submitting to the government periodic and annual reports on the impact of the sector policies, strategies, programs and projects on sustainable national social economic development.

Rwanda Environment Management Authority (REMA)

The alarming rate of environmental destruction as a result of population pressure, serious erosion, pressure on natural resources, massive deforestation, pollution in its various forms etc. necessitated the Government, to form REMA to coordinate, supervise and regulate environmental management for sustainable development in Rwanda.

Rwanda Environment Management Authority (REMA) is non-sectorial institution mandated to facilitate coordination and oversight of the implementation of national environmental policy and the subsequent legislation. And it has a key role to play towards the achievement of the national goal of sustainable development as set in out in the National Development Vision 2020.

It works with and through public, private sector and civil societies to achieve its objectives. Thus, the structure of REMA accommodates operational links at these levels in order to enhance services delivery to its stakeholders. REMA structure is flexible enough in order to cope with various challenges at central, decentralized and international levels. Two types of environmental management functions below, have to be given thorough consideration in the process of preparing the structure of REMA:

- Sectorial Environmental Management Functions relating to specific natural resources or environmental services such as agriculture, water, mining, forestry, waste management etc.

- Coordination and integration of environmental management functions in relation to cross-cutting issues such as monitoring and evaluation of environmental policy and implementation of environmental legislation, these are a prelude of REMA.

Mandates, roles and functions of REMA are clearly stipulated in the Law No 16/2006 of 03/04/2006 .

REMA operates under the Ministry of Environment and Lands (MINELA), and is headed by the Director General who is responsible for the implementation of policy and framework legislation relating to environment.

Rwanda Utilities Regulatory Authority (RURA)

Rwanda Utilities Regulatory Authority (RURA) was initially established by the Law n° 39/2001 of 13 September 2001 with the mission to regulate certain public Utilities, namely: telecommunications network and/or Telecommunications services, electricity, water, removal of waste products from residential or business premises, extraction and distribution of gas and transport of goods and persons. It has been established with a mandate to regulate sanitation services. Therefore, it is responsible for improvement in the delivery of sanitation services including waste disposal and management. RURA is the only body that gives consent to any city or town, company, sector cell, public/private to acquire and operate a dump site. [6] Since RURA sets standards for all goods made and imported inside the country, this implies that they can also play an important role in the implementation of any policy in guard of plastic waste management in Rwanda.

RSB

The Rwanda Standards Board (RSB) is a public National Standards Body established by the Government of Rwanda, whose mandate is to develop and publish National Standards, carry out research in the areas of standardization, and to disseminate information on standards, technical regulations related to standards and conformity assessment, metrology for the setting up of measurement standards, among others. The Organizational Structure of RSB therefore comprises four Divisions: National Standards Division, National Quality Testing Laboratories, National Metrology Services and National Certification Division. RSB is committed to providing standardization, conformity assessment and metrology services that improve competitiveness of Rwanda products and services within the region and internationally.

MINEACOM

Following a Cabinet Decision on October 7th, 2016, the Ministry of Trade and Industry together with the Ministry of East African Community was merged to form the Ministry of Trade, Industry and East African Community Affairs (MINEACOM). The goal of MINEACOM is to achieve Rwanda's 2020 vision through civil society and private sector engagement. This means facilitating business through regional integration and ensuring the growth of a productive, middle class of entrepreneurs as part of a service and knowledge-based economy

the Ministry of Trade and Industry together with the Ministry of East African Community is in charge of all imports and trades inside of the country. It was established by the government of Rwanda with an ambition to become a lower middle-income country, in order to operate as a service-based hub by the year 2020. To achieve this goal implies that there should be exploitation of the opportunities that are available together with creating a dynamic and competitive private sector for which institutional capacity can flourish.

COLLECTION TRANSPORTATION AND MANAGEMENT OF PLASTIC WASTE.

In 1999, orderly waste collection and transportation started in Rwanda by one company called COPED (Company for Environment Protection and Development) which was the only company dealing with solid waste collection and transportation at that time and it was operating only in the city of Kigali. but currently, waste collection companies and cooperatives are present in different areas and orderly waste collection system has expanded in most districts of the country. After the collection of wastes they are all transported at Nduba dumpsite located in Nyanza district of which Rwanda reserve force **(RDF)** is currently managing its operations.

Beside COPED which has recently started to recycle plastic waste materials, there is COCEN which is the only recycling company in the whole city. It handles community household waste converting it to Biomass fuel briquettes to be used in households and compost of organic fertilizer useful in crop production.

PET manufacturing and packaging companies

Plastic manufacturing and packaging companies are one of the main stakeholders. Their profit is very much affected by any decision taken on plastics and they also have the potential to influence policy implementation on either way. Their consultation will be key to finding appropriate means of dealing with plastic waste. The consumers are the main generators of plastic waste; they are most often not involved in decision making and their role in waste management has been overlooked. Separation at source is key to MSWM and this can only be achieved if consumers are properly informed, their involvement will be key to achieving waste separation and the use of alternatives identified.

Others

Since the country has not implemented a proper full and systematic waste management framework, Kigali city has partnered with UNDPR project for support in the areas of technical, financial and maintenance techniques regarding waste management. UNDPR have been developed with the aim of: developing a socially, sustainable and environmentally friendly waste management framework, it is supposed to conduct a feasibility study on Fukuoka Method for the current Kigali landfill facility, to provide support to IRST in the production of high quality of combustible briquette, to create an institutional framework that brings all stakeholder in working together to fulfil the waste management actions plans at both national and local level.in additional to that UNDPR is supposed to organize stakeholders meetings, workshops and sensitization in regard to proper waste management in order to provide and improve public awareness about waste management, they are in charge of daily maintenance of Nduba landfill , they have in their duty to design and construct a new sanitary landfill with recycling facilities.[26]

https://books.google.com/books?id=dLckCwAAQBAJ&printsec=frontcover&dq=subject:%22Environmental+policy%22&hl=en&sa=X&ved=0ahUKEwiJv7_m-NXeAhXaJDQIHZi7C2wQ6wEIUzAH#v=onepage&q&f=false

Rwanda's Green Fund (FONERWA) is a groundbreaking environment and climate change fund. Its purpose is to be the engine for the next 50 years of green growth in Rwanda, while serving as a touchstone for Africa and the rest of the world. Its strategy is to provide unheralded technical and financial support to the best public and private projects that align with Rwanda's commitment to a green economy in order to accelerate goals of national sustainable economic development.

PSF

The Private Sector Federation – Rwanda (PSF) is a professional organization, dedicated to promote and represent the interests of the Rwandan business community. It is an umbrella organization that groups 10 professional chambers. It was established in December

1999, replacing the former Rwanda Chamber of Commerce and Industry. PSF is a key role player enabling the private sector to respond to Rwanda's vision for its future. As the country's flagship business institution, private enterprises look to PSF to address or facilitate solutions to business constraints that they face and represent their interests during dialogues with the government.

Stake holder name   potential roles, Influence/power and interest

No.	Stake holder	Major role	Example of stake holders	Power/ Influence	Interest
1.	**Ministry of Environment and Natural Resources**	They play an important role in policy formulation, implementation, monitoring and evaluation they also provide action plans on a national level in regard to environment protection and sustainable development.	MINIRENA	Very High	Very High
2.	**Environment Management Authority**	Coordination, supervision and regulation of environmental management for sustainable development in Rwanda.	REMA	Very High	Very High
3.	**Rwanda Standards Board**	Develop and publish National Standards, carry out research in the areas of standardization, and to disseminate information on standards, technical regulations related to standards and conformity assessment, metrology for the setting up of measurement standards, among others.	RSB	High	medium
4.	**Rwanda Utilities Regulatory Authority**	1.Regulate certain public Utilities including removal of waste products from residential or business premises. they regulate sanitation services; therefore, they are responsible for improvement in the delivery of sanitation services including waste disposal and management. 3.Responsible to give consent to any city or town, company, sector cell, public/private to acquire and operate a dump site.	RURA	High	Low

5.	Ministry of Trade, Industry and East African Community Affairs	Regulates, approve, and monitor all imports and trades inside of the country. Issues permitting conditions of PET virgin bottles imported from outside of the country and all plastic bottled beverages trades inside of the country.	MINEACOM	High	
6.	Rwanda reserve force	Control all operations and activities of Nduba dumpsite			
7.	Private Waste Management Companies	1.They collect and transport waste from homes and office places to the dumpsite. 2.They sort out wastes at dumpsite level. 3.Responsible for recycling wastes. 4. Responsible for converting waste into energy.	COPED, COCEN, UBUMWE, AGUNI	High	Low
8.	Packaging Companies	Bottling and packing of water and other drinks for sale. Import virgin PET from outside of the country	INYANGE, NIL, AMAZI YA HUYE, AKANDI, Jibu	Medium	Low
9.	Local distributors and sellers	They buy and sell PET bottled beverages. They comply with the waste management rules.		Low	Low
10.	Household and commercial waste generators	Consumers of plastic bottled water and beverages. Pay the monthly waste fees and comply with Waste Management rules.		Low	Low
11.	City of Kigali	Responsible for general Waste Management in Kigali through Administrative and Legal Responsibilities		Medium	High

12.	Scavengers			
13.	Private sector	They sponsor and provide for environmental activities.		Medium	Low
		They provide training for environmental teachers, Set-up activities for public education and raising awareness.			

4.2 Stake holder power and influence map
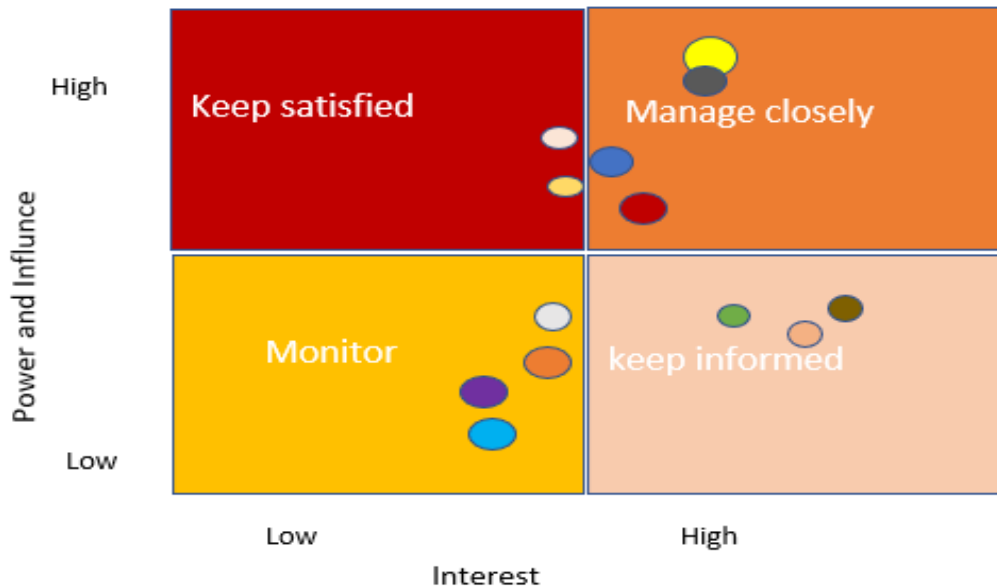
List of stake holders	Influence/pow	Interest(1-5)
1 Ministry of Environment and Natural Resources	4	2
2 Environment Management Authority	4	2
3 Rwanda Standards Board	2	1
4 Rwanda Utilities Regulatory Authority	3	-2
5 Ministry of Trade, Industry and East African Community Affairs	3	1
6 Rwanda reserve force	-2	3
7 Private Waste Management Companies	-2	4
8 Packaging Companies	-3	3
9 Local distributors and sellers	-3	-2
10 Household and commercial waste generators	-2	-1
11 City of Kigali	3	-1
12 Scavengers	-1	-2
13 Private sector	-3	-3

Power /Influence: the capacity of stakeholder to influence the PET management system in Kigali city.

Interest: the interest the stakeholder has on the PET management system in Kigali.

(-5: very little power /No interest) – (+5: very significant power/ Strong interest)

Gap analysis and recommendation

In the essence of PET waste management in Kigali Stakeholders with High influence/power and high interest should be managed closely and they must have good relations with the project itself or with any policy to be introduced or implemented if it is to be a success. Stakeholders must collaborate together and have a good communication at all stage of PET management project or policy implementation. In this particular research Government as policy makers and regulators were found to be of high influence, while packaging companies were found to be of high interest but the influence is low. Local distributors, house hold and companies waste generators were found to be of low interest and low influence but still they can be affected by any change in management practice or policy in regard to PET management.

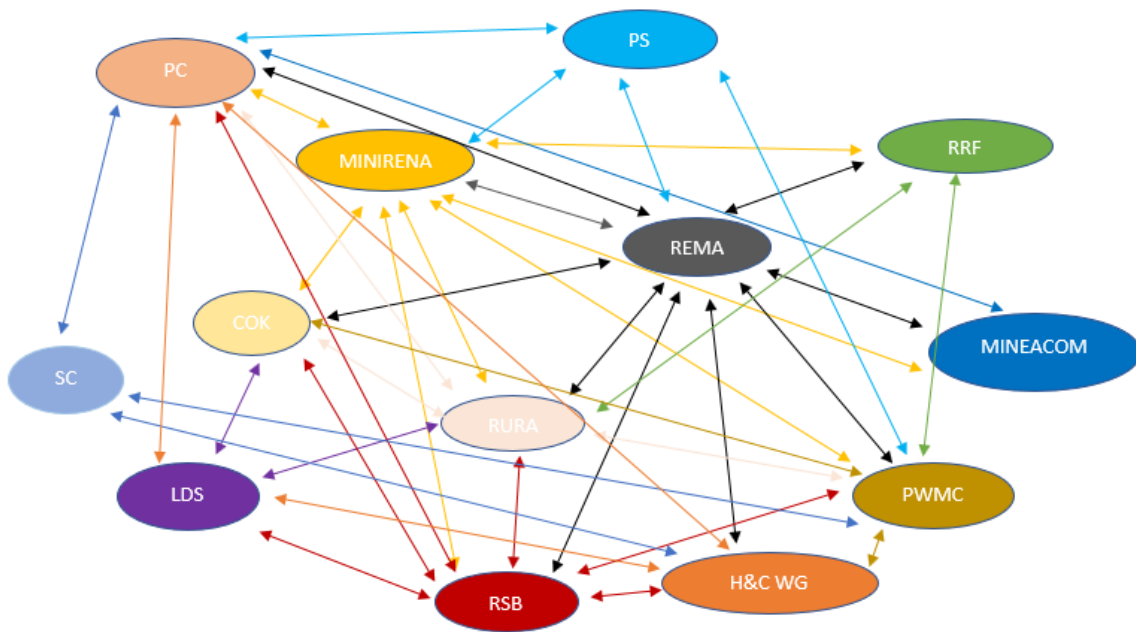Stakeholder intercommunication and information sharing network map

	Table of abbreviations		
REMA	Environment Management Authority	**RSB**	Rwanda Standards Board
RURA	Rwanda Utilities Regulatory Authority	**LDS**	Local distributors and sellers
RRF	Rwanda reserve force	**SC**	Scavengers
MINEACOM	Ministry of Trade, Industry and East African Community Affairs	**COK**	City of Kigali
PWMC	Private Waste Management Companies	**PS**	Private sector
H&C WG	Household and commercial waste generators	**MINIRENA**	Ministry of Environment and Natural Resources
PC	Packaging Companies		

A gap was found that however relationships and networks exist among most institutions, the communication level between stakeholders is still ineffective due to some of the links in the stakeholder network were weak or not functioning at all.

Therefore, to optimize communication between the government, waste management companies and household generators, the researcher recommend developing an extensive stakeholder communication strategy that will include establishment of a Joint Forum

for Observer-Member communication, a periodic evaluation of stakeholder outreach efforts, and the dedication of resources to stakeholder outreach through the creation of a designated Stakeholder Outreach Officer position within Kigali.

The second Gap that was determined was that the PET management system in Kigali lack of strategic directions and innovations, which limits its ability to attract and retain strategic partnerships. The Researcher recommend the formulation of strategic plan (1-3 years) and suggest of yearly themes to further enable the formation of strategic and targeted partnership and also to adapt quickly with digital innovations.

For improvement of PET waste management in Kigali system, the importance of stakeholder participation should be recognized in specific aspects of project preparation addressing the interest of stakeholders both to enhance the environmental, economic and social development identifying relations between stakeholders that can be built upon to improve success in policy implementation or project execution. assessing the most appropriate way that different stakeholders should participate at different stages of the project's system.

Stakeholders are "key persons, groups or institutions with an interest in a project or policy". And they can be affected rather directly or Indirectly, either positively or negatively, by the implementation of a project or policy.

An effective relationship between the various stakeholders within a stakeholder framework is very important and stakeholders are likely to be successful when they are interdependent instead of autonomous.

Reference:

1. Andrady, A.L. and M.A. Neal, *Applications and societal benefits of plastics.* Philosophical Transactions of the Royal Society B: Biological Sciences, 2009. **364**(1526): p. 1977-1984.
2. REMA, *Kigali State of Environment and Outlook Report 2013.* 2013.
3. J BAZIMENYERA, Q.F., and K. Antoine,, *Solid waste management in Kigali City, Rwanda. .* East African Journal of Science and Technology, 2012. **2**.
4. Specht, D.K.a.N., *Report on the New landfil site Construction and recycling centre, Kigali, Rwanda* 2012. **1**: p. 59.
5. Innocent, K., *Selection and implementation of an optimal system to handle garbage in Kigali, Rwanda. .* 2011.
6. RURA, *Guidelines on Minimum Requirements for Collection, Transportation, Recycling/Treatment and Disposal of Solid Wastes and on Management of Dumping Sites. .* 2009.
7. Josephine Isugi, D.N., *Research on Landfill and Composting Guidelines in Kigali City,*

Rwanda Based on China's Experience. International Proceedings of Chemical, Biological and Environmental Engineering, 2016. **94**.
8. Reed MS, G.A., Dandy N, Posthumus H, Hubacek K, Morris J, et al. .;90(5):1933-49., *Who's in and why? A typology of stakeholder analysis methods for natural resource management.* Journal of Environmental Management, 5, April 2009. **Volume 90, Issue** (5): p. 1933-1949.
9. Rădulescu, C., Ştefan, O., Rădulescu, G., Rădulescu, A., Rădulescu, M.,, *Management of stakeholders in urban regeneration projects. Case study: Baia-Mare,Transylvania.* Sustainability, 2016. **8**: p. 238.
10. Specht, D.K.a.N., , , *Report on the New landfil site Construction and recycling centre, Kigali, Rwanda*. 2012. p. 59.
11. Richard C. Thompson, C.J.M., Frederick S. vom Saal and Shanna H. Swan, *Plastics, the environment and human health: current consensus and future trends.* Phil. Trans. R. Soc. B, 2009. **364**: p. 2153-2166.
12. dos Muchangos, L.S., Tokai, A., Hanashima, A., *Analyzing the structure of barriers to municipal solid waste management policy planning in Maputo city,Mozambique.* Environ. Dev., 2015. **16**: p. 76-89.
13. Reed, M.S., Graves, A., Dandy, N., Posthumus, H., Hubacek, K., Morris, J., Prell, C., Quinn, C.H., Stringer, L.C.,, *Who's in and why? A typology of stakeholder analysis methods for natural resource management.* J. Environ. Manag., 2009. **90**.
14. Zurbrügg, C., Caniato, M., Vaccari, M., , *How assessment methods can support solid waste management in developing countries.* Sustainability, 2014. **6**: p. 545–570.

15.   Brugha, R., Varvasovszky, Z.,, *Stakeholder analysis: a review. .* Health Policy Plans, 2000. **15**: p. 239-246.
16.   Lienert, J., Schnetzer, F., Ingold, K.,. *Stakeholder analysis combined with social network analysis provides fine-grained insights into water infrastructure planning processes.* J. Environ. Manag., 2013. **125**: p. 134-148.
17.   Prell, C., Hubacek, K., Reed, M., . Soc. Nat.,, *Stakeholder analysis and social network analysis in natural resource management.* Resour. Int. J., 2009. **22**: p. 501-518.
18.   Heidrich, O., Harvey, J., Tollin, N.,, *Stakeholder analysis for industrial waste management systems.* Waste Manag, 2009. . **29**: p. 965-973.
19.   Ackermann, F., Eden, C., . , *Strategic management of stakeholders: theory and practice.* Long Range Plann, 2011. **44**: p. 179-196.
20.   Vance-Borland, K., Holley, J., , *Conservation stakeholder network mapping, analysis, and weaving. .* Conserv., 2011. **4**: p. 278-288.
21.   Otte, E., Rousseau, R.,. *Social network analysis: a powerful strategy, also for the information sciences.* J. Inf. Sci., 2002. **28**: p. 441-453.
22.   Park, S., Lee, S.-J., Jun, S.,, *A network analysis model for selecting sustainable technology.* Sustainability, 2015. **7**: p.,13126-13141.
23.   Ghali, M.R., Frayret, J.-M., Robert, J.-M., , *Green social networking: concept and potential applications to initiate industrial synergies.* Clean. Prod, 2016. **115**: p. 23-35.
24.   Kreakie, B.J., Hychka, K.C., Belaire, J.A., Minor, E., Walker, H.A.,. *Internet-based approaches to building stakeholder networks for conservation and natural*

resource management. Environ. Manag, 2016. **57**: p. 345-354.
25.   Holland, *Tools for Institutional, Political and Social Analysis of Policy Reform: A Sourcebook for Development Practitioners, Social Analysis. The International*

Bank for Reconstruction and Development/The World Bank, Washington, DC, United States of America. (*http://dx.doi.org/10.1596/978-0-8213-6890-9*). 2007.
26.

https://books.google.com/books?id=dLckCwAAQBAJ&printsec=frontcover&dq=subject:%22Environmental+policy%22&hl=en&sa=X&ved=0ahUKEwiJv7_m-NXeAhXaJDQIHZi7C2wQ6wEIUzAH#v=onepage&q&f=false.

Authors:

First Author- Mycline UMUHOZA, Mater Degree Candidate, Tongji University, College of Environment al Science and Engineering, Institute of Environment and Sustainable Development (IESD), Shanghai, China, umuhozamyc@gmail.com .

 Second Author –Somila KAKSHAPATI, Mater Degree Candidate, Tongji University, College of Environment al Science and Engineering, Institute of Environment and Sustainable Development (IESD), Shanghai, China, Kakshapatisomila@gmail.com .

Third Author – Zineb Guendouz, Mater Degree Candidate, Tongji University, College of Environment al Science and Engineering, Institute of Environment and Sustainable Development (IESD), Shanghai, China,

Fourth Author: kallon christian samuel, Suzhou university of science and technology, kallonchristiansamuel@gmail.com .

Fifth Author: Bruce MUGISHA, Bachelor Degree in Finance, Independent Institute of Lay Adventists of Kigali, mugishabruce01@gmail.com

Correspondence Author – UMUHOZA Mycline, umuhozamyc@gmail.com, 1793181@tongji.edu.cn , +86 152 1667 3212