International Research Journal of Multidisciplinary Scope (IRJMS), 2020; 1(SI-2): 9-17
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ORIGINAL ARTICLE | ISSN (O): 2582–631X **DOI:** 10.47857/irjms.2020.v01si02.027

Environmental and Health Impacts of and Challenges on Rappie Koshe Waste-to-Energy Facility, Addis Ababa

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ABSTRACT

Rappie/Koshe waste-to-energy facility, the first waste-to-energy facility in Africa, is challenged by several factors including poor solid waste management, poor waste collection system and amount of waste, etc. The main purpose of this study is to assess the challenges and environmental impact of the Rappie/Koshe waste-to-energy facility in Addis Ababa. The study also aimed to give suggestions on how the current challenges and environmental issues can be improved; focusing on the current situation and future improvements. The primary work of this thesis was to study the current challenge of waste to energy facility, environmental impact, and stakeholder involvement. Data were gathered through interviews supplemented by field observation, self-administered questionnaires, and focus group discussion. Then, the data were analyzed descriptively. In addition, secondary data were gathered from documents. Findings revealed that the current Solid Waste Management practice could not cope with the waste-to-energy technology. About 25% of waste sorted out from the entire this activity strongly affects the efficiency of the waste to energy facility by 85% by reducing the calorific the worth of waste. Besides, major challenges, environmental issues, and the level of stakeholder activity were identified. The study would provide practical insights to decision-makers in solving the problem of the Rappie/ Koshe waste-to-energy facility.

Keywords: Rappie/Koshe, Waste to Energy Facility, Challenges, Environmental Impact, And Solid Waste Management.

1. INTRODUCTION

A waste-to-energy facility capability the facility that burns municipal strong waste to get better strength in the structure of electricity. Waste to energy makes use of a stable waste as a key and deliberate to deal with residual municipal and industrial stable waste, and different comparable waste kind the use of testing excessive-efficiency, waste combustion with energy restoration via thinking about the full variety of environmental and social issues.

The high rate of population growth, the rapid pace of global urbanization, and the economic expansion of developing countries are leading to increased and accelerating rates of municipal solid waste production. With proper solid waste management and the right control of its polluting effects on the environment and climate change, municipal solid waste has the opportunity to become a precious resource However, an increasingly demanding set of environmental, economic, and technical factors represents a challenge to the development of these technologies. In the past environment has not featured on the development agenda in

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(Received 17 October 2020; Revised 28 October 2020; Accepted 02 November 2020)

Ethiopia project evaluation and decision-making mechanisms have focused only on short-term technical feasibility and economic benefit (1). the global municipal solid waste generation is approximately 1.3 billion tons per year or an average of 1.2 kg/capita/day. Many Africa cities do not have access to energy from municipal solid waste because of the poor management of solid waste. Waste to energy involves the recovery of heat and electricity from waste, especially non-recyclable waste (2-3).

In 2010, there were more than 600 wastes to energy facilities around the world, most of them planted out of Africa. But there is a high level of waste generated in most African cities if there are well proper use and good solid waste management. Africa cities have converted more than a thousand million tons of municipal solid waste into more than a hundred billion kilowatts electrical power in Each day generate and enough electrical power deliver to 80% of cities home (4). a spectacular city boom that continue in East Africa Today, according to World Bank of the 2014 document between 2010 and 2035, the city's population is expected to more than double. By the middle of the century, it is estimated that more than a billion people will remain in the city. a major concern is that there are no satisfactory infrastructural facilities in Ethiopia. However, their development is too slow to meet the demand of the increasing population due to both natural growth and rural-urban migration. In particular, the inadequacy of solid waste management is a major environmental (5).

The Rappie Waste-to-Energy project is the first of its kind in Ethiopia and East Africa as it produces green energy within the city limits from municipal solid waste. It will also be the first bracelet power in the country, providing electricity 24 hours a day for over 330 days a year. The facility will be a modern waste disposal system, eliminating over 1.4 million kilograms of waste every day and producing 50 MWh per day. Addis Ababa municipal administrations are responsible for collecting and delivering municipal solid waste to the structure every day (6). This article will be organized into six sections: Section one deals with the background of the study or introduction, section two presents, the review of related literature. The third, the fourth, the fiveth, and the sixth sections present the research design, the methodology and the data collection process, the result, the discussion, the Conclusion and Future Scope.

2. RELATED WORK

2.1 Waste to Energy (WTE)

Recent studies show that this level of landfill disposal of municipal solid waste is not any longer a sustainable option due to the issues regarding the limited landfill sites and high cost (7). There's a requirement to seek out an alternate thanks to overcome the solid waste disposal and waste to energy (WTE) is preferred to be the simplest option. WTE is that the process of recovering the energy from the waste through either direct combustion or production of combustible fuels within the sorts of methane, hydrogen, and other synthetic fuels (8). WTE that gives clean and reliable energy within the sort of heat and power contributes to primary savings in conventional utility systems (9). WTE is an environmentally sound process and proven to supply reliable electricity (10-12).

2.2 Waste recycling challenge

Sorting is an important component of solid waste management (13). It's a sort of activity which is separated differing types of wastes in their respective nature. It makes waste management easy and straightforward. However, it shouldn't be a one-time activity, rather should be a habit for correct and sustainable solid waste management (14). Waste-to-energy supporters contend that the recycle versus incinerate comparison represents a false choice that the 2 can coexist. One among the foremost common arguments against WTE, as waste is that the staple for the WTE facilities, the establishment of more and more WTE facilities will necessitate more waste generation, thereby, will discourage recycling (15).

2.3 Social challenges

The purpose of any waste management activity is to enhance conditions for people during a community by minimizing the negative impacts of waste. Impacts include public health, environmental protection, and also a financial cost. WTE should therefore be viewed consistent with its overall impact on the population and weighed against other approaches to waste management (16).

2.4 Local capacities and political context

Implementing a WTE project involves many steps: the initial concept stage; pre-feasibility and feasibility assessments; technology selection; public tendering; permitting and contractual agreements, including selecting an appropriate tipping fee; project finance; project implementation; operations; and eventually decommissioning (17). Most of those require a point of government capacity. In waste management, an environment that has only been hospitable commercial participation since 2008, and during which waste management competes with many other municipal issues for the eye of government , WTE is rapidly growing everywhere the planet because it can reduce the demand for landfill, prevent dependence on fossil fuels (18).

2.5 The complex nature of the wastes

Municipal solid waste is more heterogeneous than that within the housing and infrastructures. These excavated wastes aren't only aged and vary during a wide selection of contents, but can also be mixed with intractable waste that would be hazardous. Therefore, proper sorting and complete separation of the excavated waste mixture is required before the waste is often delivered to waste to energy plants for disposal.

2.6 Environmental and health impacts of waste to energy facility

The incineration process produces two sorts of ash. Bottom ash comes from the furnace and is mixed with slag, while ash comes from the stack and contains components that are more hazardous. In municipal waste incinerators, bottom ash is approximately 15% by volume and approximately 20 to 30% by weight of the solid waste input. Ash quantities are much lower, generally only a couple of percent of input. Emissions from incinerators can include heavy metals, dioxins, and furans, which can be present within the waste gases, water, or ash. Plastic and metals are the main sources of the calorific value of the waste. The combustion of plastics, like PVC, gives rise to those highly toxic pollutants. It is often a change within the average weather or a change within the distribution of weather events around a mean (19).

3. MATERIALS AND METHODS

3.1 Location of the Study Area

Ethiopia is situated at 3 degrees and 14.8-degrees latitude, 33 degrees and 48-degree longitude in the Eastern part of Africa lying between the Equator and the Tropic of Cancer. Rappie Koshe Waste to Energy Facility is found in both Kolfea and Nifas Silk Sub-City of Addis Ababa.

3.2 Socioeconomic Environment

Rappie Open-air landfill: The Open-air landfill at Rappie has created various nuisances and a health hazard for people living nearby, due to the unsanitary form of the current disposal systems. More out of 5,000 recyclers per day work continuously on the site, live there and interfere with operations to collect recoverable materials such as plastics, wood, scrap metal, and discarded food. There there is no fence or odor and vermin control in the area. The site is within Addis Ababa's largest garbage site.

3.3 Physical Environment

The once-remote site is now surrounded by commercial and residential districts With with an area of 37 hectares and a depth of 40 meters, it is one of the largest concentrations of waste in the

country. The current method of disposal is surface dumping: transporting waste by truck, spreading, and leveling by the bulldozer and compaction by the compactor.

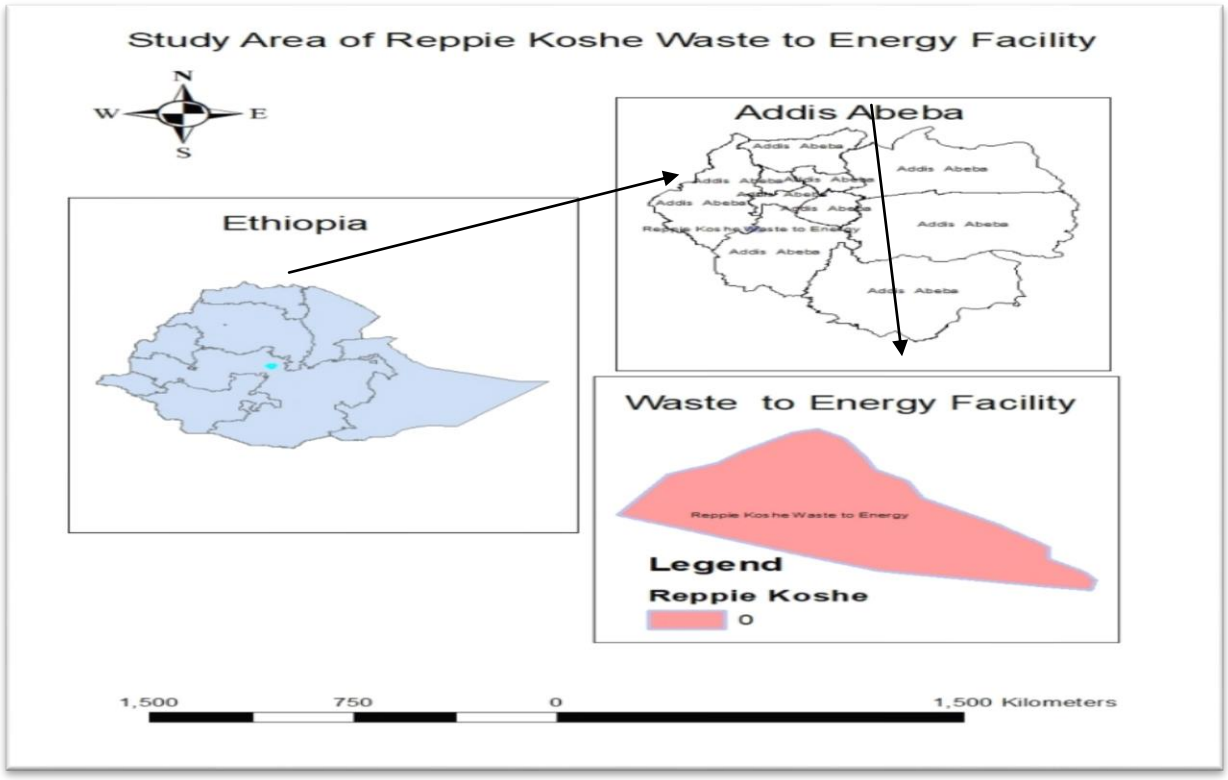

Figure 1: Map of the Study Area

3.4 Biological Environment

Flora and Funa: There is no vegetation and animals site as it is currently being used as an open dumpsite. There are no protected area and it is an environmentally hazardous area.

3.5 Data Analysis and Interpretation

The researcher The was collected from qualitative and quantitative data from a sample of respondents. Regarding To make the calculation accurate, reliable and time-saving, the raw data obtained through the questionnaires will be organized using the latest version of Statistical Package. In an analysis of the data collected, plus - scheduling processes, average and ratio Percentage, and various different tests will be to compare the statistical significance of the response difference between the different sample groups.

4. RESULTS AND DISCUSSION

4.1 Challenges of waste to energy facility

4.1.1 Waste Sorting and recycling activity

The direct measurement results From total waste is collected from Hotels, Private Company, Government Offices, and Households the food has been mixed with the type of waste which is complicated to isolate such waste in waste to the power plant, the type of waste they take to different sites such as food, plastic, paper, metal, glass and other different types of textile waste.

Table 1: Sorted Waste Amount

No.	***Waste Sorting Organization***	***Amount Of Waste (Kg)***	***Highest Waste Type***
1.	Hotels	15161	Food
2.	Private Company	11608	Food
3.	Government Offices	4858	Paper
4.	Small Scale Enterprises	1,273,184	Food
5.	Households	6584	Food and others
6.	***Total***	13,11,395	

4.2 Waste transport system and period of time

Waste is not collected door to door by small scale enterprises waste collectors (SSEWC) in every day. About 34 % of the respondents are response wastes are collected by SSEWC waste collectors weekly. 53% of the responder response waste is collected every 15 days and the rest 13% of respondents, SSEWC does not collect the waste properly For this reason the respondent says waste has carried away from them. Addis Ababa Cleansing Agency eliminates 172 trucks for secondary collection. But According to data from the cleaning agency, only 143 of these trucks are functional. Around 20 are in maintenance and 9 are not working, due to the average age of trucks over 12 years old, maintenance difficulties, neglect and frequent accidents during traffic jams.

Table 2: Number of skipping point and the number of trips of waste collector cars

Sub-city	Number of skipping Point	Amount of waste per skip point per week in tone	Number of trips per week per skip point in tone
Bole	195	4.3	1.2
Yeka	179	4.1	1
Lideta	55	10.4	2.7
Nifas silk	204	6	1.5
Akaki	55	8	2
Gulele	90	7.1	1.8
Arada	60	12	3.4
Adiss ketema	55	17	4.4
Kolfea	89	12.4	3.1
Kirkos	63	12.2	3
Total	1074	9.4	2

4.3 Institutional capacity

The Addis Ababa City Administration has set up the Cleansing Agency to manage the collection and disposal of solid waste in the city. But the coverage of Solid refusals was not proportional to the institutional capacity and to improve the range of coverage and the consistency of the service, the Agency established Sub-city and Woreda

Cleansing branches and outsourced services of waste collection to cooperatives to provide waste collection and disposal services.

4.4 Public awareness

The main challenge for the Solid waste collections from various sectors has been public awareness. Almost all waste producers did not have a good awareness of the disposal and disposal of solid waste.

Hazardous waste sorting

The hazardous waste disposal site

4.5 Environmental Issues

By field observation at Rappie waste to energy facility, the incineration process produces two sorts of ash. Bottom ash comes from the furnace and is mixed with slag, while ash comes from the stack and contains components that are more hazardous. Rock bottom ash is approximately 10% by volume and approximately 20 to 35% by weight of the solid waste input. Ash quantities are much lower, generally only a couple of percent of input. Emissions from incinerators can include heavy metals, dioxins, and furans, which can be present within the waste gases, water, or ash. Plastic and metals are the main sources of the calorific value of the waste. The combustion of plastics, like PVC (PVC), gives rise to those highly toxic pollutants.

The Emissions of leachate parameter reppie waste to energy can include Dioxins and furans heavy metals, dioxins and furans, which may be present in the waste gases but the researcher can find only PH, SS, TN, NH3, BOD and COD because the limitation of laboratory.

Table 3: quality of incilieration plant leahete

S.No.	**Politant**	**Unit**	**Actual emmission value**
1.	Total dust	Mg/Nm^3	50
2.	HCl	Mg/Nm^3	35
3.	SON_3	Mg/Nm^3	129
4.	NO	Mg/Nm^3	167
5	NOX_2	Mg/Nm^3	167
6	NOX_3	Mg/Nm^3	174
7	HF	Mg/Nm^3	4
8	CO	Mg/Nm^3	120
9	Hg	Mg/Nm^3	0.1
10	CD + Ti	Mg/Nm^3	0.1
11	Dioxins and furans	$(ngTEQ/Nm^3)$	0.05

I. Human Health Concerns

The waste-to-energy program aimed at maximizing energy recovery is technologically incompatible with the reduction of dioxin emissions. Dioxins are the deadliest Persistent Organic Pollutants (POPs) which have irreparable consequences on environmental health. The affected population includes people living near the incinerator as well as those living in the wider region are exposed to toxic compounds in several ways:

- By breathing air that affects both plant workers and those living nearby;
- By eating locally produced foods or water that has been contaminated with air pollutants from the incinerator; and
- By eating fish or wildlife contaminated by air emissions. Dioxin is a highly toxic

compound that can cause cancer and neurological damage and disrupt the reproductive, thyroid, respiratory, etc. systems.

II. Financial Impacts

The government required to build the waste-to-energy plant was $ 120 million (£ 76.8 million) for EU emission standards, which will incinerate the city's waste to generate MW electricity. But now the amount of money has been significantly increased and the ability to generate electricity has been reduced to 25 MW.

III. Contribution of CO2 emission to the atmosphere

During the incineration of the waste, some amount of CO2 released from the waste to energy facility into the atmosphere.

IV. Scaling down the volume of the wastes

According to SWM Addis Ababa- Final Strategy Report December 2013The contribution to the total generation of waste by the different sources is estimated to be around 76% for households, 18% for commercial, institutional and industrial sources, and 6% from streets and public areas and the characteristic of solid waste of Addis Ababa was 57% biodegradable, 8.8% of the waste plastic, 4.4% of the total waste is paper, 2.6% of waste is glass, 1.5% of waste is textile and other Percents are metal hygienic, medical care waste.

V. Lower the risk of spreading diseases

The accumulates garbage in landfills, sewers, and streets attract not only pests but also disease. Although landfills and sewers are isolated from residential areas, sewage and leachate can still invade groundwater and spread disease throughout the region. However, WTE systems could inhibit the production of pests and prevent them from spreading viruses, bacteria, and the like in the community.

VI. Gas emission contains toxic compounds

Incineration leads to producing gas that has a high content of toxic compounds such as nitrous oxide (N2O), Carbon dioxide (CO2), and heavy metals.

VII. Preserving the quality of groundwater resources

The waste and leach can be prevented from invading the groundwater resources through a well-organized WTE system and the evaporation of the leach by the heat produced.

5. DISCUSSION

The current mean calorific value of the collected waste ranges between 2000 and 5600 KJ / kg, and for heat treatment, according to the technology Guidance Report from World Bank ("Municipal Solid Incineration"- 1999): The average low calorific value of the waste should be at least 6 MJ/kg (i.e. 6000 KJ / kg) in all seasons. The annual average low calorific value should not be less For 7 MJ/kg (ie 7000 KJ / kg) ". Thus, Without pre-treatment (drying/earring), the waste currently collected is not recommended for heat treatment (20).

Project The Rappie Waste-to-Energy is the first of its kind in Ethiopia because it generates green energy within city limits from municipal solid waste (MSW). It also to be the first basic load capacity in the country, and provide electricity throughout 24 hours a day for more than 330 days a year. The facility will be a modern waste disposal system, eliminating more than 1,400 tons of waste per day and producing 185,000,000 kilos kWh per year. The energy is put into The grid without long transmission lines is required in remote wind and hydropower projects (21).

6. CONCLUSION AND FUTURE SCOPE

One of the main challenges of waste to energy facilities may be a waste sorting activity. In total, it's predicted that within the city

municipality alone over 5,552 people (542 associations) sleep in waste collection and sorting activities. Individual Small scale enterprises perfo-rm various pre-processing activities like gathering plastic materials, iron, etc. At disposal sites, it's common to seek out over 150 scavengers organized in teams working for dealers. About 25% of waste sorted out from the entire this activity strongly affects the efficiency of the waste to energy facility by 85% by reducing the calorific the worth of waste. By considering the quantity of plastic waste and paper waste collected during a city the study tray to define the calorific value of Addis Ababa waste, therefore the calorific value of Addis Ababa is 8,400J/kg by this case wastes that are currently collected are often advised to waste to energy facility.

Hazardous waste Sorting is an important component of waste to energy facilities. It's a sort of activity which is separated differing types of hazardous wastes in their respective nature. However, it shouldn't be a one-time activity, rather should be a habit for correct and sustainable solid waste management. All of the respondents said that they don't separate hazardous waste at the household level. On the contrary, there are domestics who replied that waste is divided at the household level: into organic and inorganic only. The unsorted municipal solid waste isn't an element in waste to energy facility, but hazardous wastes mixed with municipal waste make rock bottom ash hazardous this phenomenon crate bottom ash eliminate with none reuse purposes.

RECOMMENDATIONS

- To Increase the lower rate of payment of the solid waste cost above the present price of recycling material
- Revise policies on enforcement and Control actions help to stop the illegal sorting activity.
- Enforce the small scale enterprise to collect the waste door to door properly according to the schedule
- Distribute movable plastic bins, door to door that used to separate harmful waste from the other wastes.
- Give awareness among the city residents and Government staff of hazardous waste management through irregular seminars, workshops, posters, radio/ TV programmers and training.

ACKNOWLEDGEMENT

We would like to thank the "Almighty God" who helped and guided us in all aspects of our life especially to accomplish this work successfully.

CONFLICT OF INTEREST

We declare that there is no conflict of interest associated with this manuscript.

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