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EFFECTS OF COVID-19 PANDEMIC ON SOLID WASTE COMPOSITION AND MUNICIPAL CAPACITY IN OL-KALOU TOWN, KENYA

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ABSTRACT

The COVID-19 pandemic outbreak has presented a threat to the global health sector, with many governments, healthcare, and waste management sectors being caught unprepared and unaware. With the outbreak of the infectious COVID -19 disease, many resources have been allocated to hospitals to help prevent the disease spread, leaving other crucial sectors such a waste management department with fewer resources to finance their waste management activities. The changes in quantity and composition of the wastes reaching the municipal waste stream have far-reaching effects on the waste collectors' health and the waste scavengers due to contamination by the COVID-19 virus. The households' failure to separate contaminated wastes and store the waste in safe containers for more than 72 hours can also facilitate disease spread. Despite the challenges posed by the pandemic, the waste management sector will have to experience some opportunities in the aftermath of the disease. Therefore, the study aimed to assess the COVID-19 pandemic's effects on waste composition and municipal capacity Ol-Kalou municipal council. Purposive sampling was used to select a sample of three officials in the waste management department in the Ol-Kalou municipal council. Primary data was collected through carrying out a waste composition analysis to determine the proportion of covid-19 related wastes in three Ol-Kalou town market curbsides, while data on municipal capacity was collected through an interview to waste management officials. The study's findings indicated that the proportion of covid-19 related wastes comprises 1.05%, a high number, plastics 19.24%, metals 11.86%, glass 5.84%, papers 4.12%, food wastes 46.05%, 3.09% leather, 1.19% Rubber and others 7.56%. Similarly, the results of the interview indicated that the municipal council could not sustainably handle the waste amid the pandemic due to decreased budget allocations, a limited number of workers, lack of worker training to manage contaminated wastes, and limited vehicles to transport cover large areas per day. The study recommended that waste management sectors require additional budget allocations to finance their activities, develop disaster waste management plans, and create public awareness of the importance of waste separation.

Keywords: COVID-19 related wastes, Disaster Waste Management Plan, and Resources Allocation.

INTRODUCTION

Every pandemic outbreak or a disaster in the environment bring in challenges and opportunities (Kulkarni & Anantharama, 2020). The COVID-19 outbreak has caused global emergency with many countries battling to contain the spread of the disease among the citizens. As countries around the world continue to fight and minimize the COVID-19 spread, one hidden challenge that the pandemic poses is the waste disposal. In response to containing the COVID-19 spread, many healthcare facilities and home-based nursing centres are now generating additional volumes of medical wastes that are contaminated and infectious than usual (Naughton, 2020). The new COVID-19 related wastes that are now produced in healthcare facilities, households and market places in large quantities include the single use plastics, gloves, masks, contaminated fabrics, packaging containers, that are likely to be infected with the virus. Both the developed and the developing countries across the world have adhered to use of protective measures to minimize contracting of the disease through the use of masks with nearly all citizens making them a basic requirement. However, the increased use of the

disposable masks and gloves by the citizens and the physicians have erupted a new crisis in the environment where these wastes are poorly disposed in the streets and dumpsites without disinfecting and sterilizing them (Yu et al., 2020).

Solid waste management remains a big challenge with developing countries facing many inadequacies such as poor collection methods, waste handling and safe disposals. The changes in quantity of wastes generated, density and proportions of wastes generated by households during the COVID-19 outbreak that is characterized by limited waste sorting and segregation increases the burden to municipal waste management systems. Given the size of population infected and inadequate resources to control and treat waste in municipal councils, there is high possibility of people becoming infected indirectly after coming into contact with the contaminated wastes. One major challenge that the COVID-19 outbreak poses to municipal waste collectors is the safe handling and disposal of the potentially infected materials from households nursing COVID-19 patients on home based care as well as the contaminated wastes from markets and healthcare. Given that COVID-19 transmissions results from direct contact with infected surfaces and

survival time for the virus outside the hosts being 72 hours many waste collectors without proper trainings and protective wears are likely to get infected leaving municipal councils with less personnel to handle the wastes .

According to Clemens & Heinemann (2020), various urban centres have experienced drastic changes in the sources and volumes of solid waste generation due to the effects of lockdown by the ministry of health's trying to contain the COVID-19 disease spread. Notably, country such as China where the COVID-19 outbreak was first discovered recorded a high volume of medical waste within a span of three months as a result of lockdown with Hubei province showing a sharp increase in the medical waste of over 370.00% (Yu et al., 2020). The poor disposal of used masks, gloves and protective equipment's have steadily become eyesore in many roadsides alongside the plastics wastes. Similarly, UK has also faced enormous impacts of the COVID -19 lockdown and other restrictive measures on waste management (You et al., 2020). With the enforcement of lockdowns throughout UK, many households spent about £ 1.9 billion worth of groceries that were panic-bought and stockpiled and are likely to be disposed in the waste bins. Almost all household waste recycling centres and charity shops in UK got closed up on the onset of the pandemic, increasing the likelihood of these recyclable waste being sent to landfill or getting incinerated which result to negative environmental impacts (Kulkarni & Anantharama, 2020).

The increased disposal of the COVID-19 related wastes fall in a category of medical waste which are now filling the dumpsites thus exposing thousands of waste collectors and waste scavengers at risk. Sadeghian (2020) reported that the corona virus is spread by the tiny droplets from infected person's coughs, sneezes or speaks which survives for up to 72 hours. While touching the contaminated surfaces by the COVID-19 virus is not thought to be the main way the disease is being spread, it does pose a risk in East African countries where the households, waste scavengers and business operators cannot access disinfectants, waste management services and lack of adequate sanitary equipment's (Nakkazi, 2020). In the sub-Saharan African countries, environmentally sound management of household, hazardous, construction and medical wastes is the key challenge during the normal times.

Many developing countries grapple with the large quantities of municipal waste which is quite expensive comprising nearly 20 percent of the municipal budgets which is always inadequate (Hettiarachchi et al., 2018). Waste management is a costly and a complex operation that many developing countries have not been able to meet as the sector compete for funding's with other priorities such as safe and clean water for drinking, health, hunger, education and poverty reduction. To exacerbate the problem, during a pandemic outbreak such as the COVID-19 disease, waste management challenges get magnified because of the increased generation of medical wastes that are highly infectious as well as the consumer wastes (Ranjan et al., 2020). While the health facilities are equipped to dispose and get rid of their waste, the home based care for patients suffering from covid-19 and other diseases as a result of hospital getting full to capacity have resulted to increased medical waste disposal in households. Many households are ignorant or not aware of proper handling and disposing of the contaminated medical wastes especially for the COVID-19 related wastes.

In Kenya, waste management is an expensive operation with waste generation rates surpassing sustainable collection and management of the wastes at municipal levels (Wanza Mutua, 2019). The municipal authorities are characterized by limited capacity and resources to hire adequate waste workers, vehicles and utilization of the best available technology (BAT) and best environmental practices (BEP). Despite having recyclable masks in the market, many Kenyans are opting the single-use disposable masks which are much cheaper increasing the possibility of dumping after use in the environment worsening the situation by poor disposal and waste management habits. The tonnage of waste has surged with the addition of disposable mask, gloves, sanitizers containers and plastics used in packaging these products which is likely to overwhelm the waste collectors (Sarkodie & Owusu, 2020). As the COVID-19 pandemic continue to spread and negative impact upon the Kenyan economy, human and environment intensify on a daily basis, the government as well as the municipal waste management systems will have to treat waste management as an essential and urgent public service to prevent the unforeseen knock-on effects on both human and environmental health.

The current waste management systems in Ol-kalou municipal council will have to evolve to become resilient to the impacts of the unplanned extreme pandemics and disasters events to create a more successful circular economy. The Ol-kalou municipal council is characterized by limited capacity for planning a result of low budget allocations which makes the waste management a complicated operation with the town struggling to address the challenge holistically. The impacts of poor waste management are dire falling proportionally to the poor residents who in most case often get unserved by the municipal council due to failure of paying fees for facilitating waste collection

services (Henry et al., 2006). Understanding how much waste is generated, types of wastes and the capacity of the local authority to manage waste effectively will help the local government to design new systems that has adequate municipal workers, number of vehicles, safety handling of the infected wastes, establish efficient routes, track progress, set targets for diversion of waste as well as adapt waste generation patterns change. With the data collected from this research, the Ol-kalou municipal council will realistically allocate adequate resources for managing wastes effectively, training the waste collectors as well as households to handle COVID-19 related wastes in a safer manner through assessing relevant technologies and consider strategic partners for efficient service provision.

METHODOLOGY

Study area

The study was carried out in Ol-kalou municipal council, in Nyandarua County, Kenya between the months of June- July 2020. Ol-kalou town pans between $0^{\circ} 14'59''$ S- $0^{\circ} 17' 59''$ S, and $36^{\circ} 20'59''$ E- $36^{\circ} 24'0''$ E. Ol-kalou township covers an area of 371 km² consisting of urban, peri-urban and rural areas. The Ol-kalou town is the largest wholesale agricultural products market in Ol-kalou sub-county. The town is located at the center of various wards making it a trading point for farmers, buyers, sellers for farm products and other products. Nyandarua County being an agriculturally based region, the Ol-kalou town therefore attracts many sellers in the market thus generating high wastes volumes from the farm products. The population during market day is approximately 2,355 persons who come to trade and buy the products from Ol-kalou market.

Research Deign

The study applied a descriptive research. The descriptive research design was effective in the study which involved observing and describing the behavior of various research variables used in the study without influencing their states in any way. The descriptive research design help determine, reporting of the variables as they exist in the study area and presentation of the outcomes in form of tables, frequency distributions, figures, percentages and average scores. The unit of analysis was the municipal waste management and the waste collectors was the respondents. Random sampling technique was used to select the respondents in the study. The municipal waste service providers in Ol- kalou municipal council were selected to participate in the survey to determine the challenges and opportunities that the municipal council has faced due the COVID-19 outbreak.

Research Instruments

Data on municipal capacity was collected using structured interviews. During waste composition analysis, heavy duty gloves, gumboots, facial mask, dust coats were used to protect the researcher from coming into contact with contaminated wastes while sorting and separation of wastes. Shovel was also used to thoroughly mix the wastes while a weighing balance was used to measure the weights of the various waste type in the curbsides. Plastics sacks were then used to pack sort waste for measuring and data recorded in a weight recording sheet.

Sample Size and Sampling

The target population of this study comprised of the six municipal council officials and waste collectors in the department of waste management in Ol-Kalou municipality. A total population of 2,355 comprising of traders and buyers during the market day will be used to determine the mass of wastes generated as well as calculating the waste composition in the market place. The population was obtained from the Ol-kalou town council data base. A purposive sampling technique was used to select the respondents from the municipal authority as the population was mutually homogenous and they held ready information on waste management. Ol-kalou municipal council was selected to provide information on municipal capacity in handling solid waste management during the ongoing COVID-19 outbreak because they are responsible for waste collection, transportation and safe disposal of waste in Ol-kalou town. Three curbsides were also selected purposively in three different locations in Ol-kalou Town where waste composition analysis was carried out. The three skip containers have different quantities and waste composition despite their wastes being collected and disposed in a common dumpsite.

Data Collection

Both primary and secondary data sources were used. The municipal capacity of Ol-kalou municipal council in terms of available trained waste collectors, waste transporting vehicles, number of skips provided in market place and dumping sites was collected through interviewing waste collectors. Municipal solid waste composition was collected using a waste composition recording worksheet. Various types of Solid waste were subjected to physical analysis through sorting based on categories, separated, weighed with a weighing balance and their respective weights expressed as % of the total weight. The percentage (%) weight of the different waste types were then recorded in a

waste composition recording sheet. Average weight of various solid wastes categories was carried for every two market days in the evening for a period of three weeks in the month of June 2020 to observe the changes in waste proportions in the three market curbsides. Secondary data was obtained from the limited literatures on MSW managements during infectious diseases outbreak, scientific research papers, journals and government publications.

Model specification

The variation in waste composition generated in a given region is inevitable. According to Azadi and karimi-Jashni (2016), waste generated in a given period of time has been useful in estimating the waste quantities in many municipalities. Waste composition analysis helps yield the trend in waste generation on a given population. A reliable estimate can only be achieved by selecting an unbiased model for long-term forecast as the characteristics of the solid waste generation keeps on changing over time due to socioeconomic characteristics of a population. However, getting accurate prediction of the waste composition and generation rates is highly affected by the changes in income, inadequate data, environmental factors such as diseases outbreaks and other economic activities.

Despite the challenges experienced in waste composition and generation analysis, time series or factors models such as regression models have been statistically proven to provide effective prediction of waste generation rates. Although the time series or factor models are widely used, Oribe- Garcia et al. (2015) reported that the models are not 100% effective in prediction as they are prone to being influenced by the predictor variables thus providing inaccurate predictions. Although regression model can be influenced by the predictor variables, the model variables has the capability to resist certain changes such as population dynamics and socio-economic changes. The model tends to be effective in analyzing effects of the changes brought about by the predictor variables, account for the experienced changes as well as establishing the relationship that occurs between the outcome and the predictor variables. The study applied a simple linear regression model technique to help forecast the composition of waste to be generated during the Covid-19 pandemic using the model shown below:

$$Y = \beta_0 + \beta_1 X + \varepsilon \quad \text{Eqn 1}$$

Where, Y is the predicted value of the dependent variable (y) for any independent variable (X), β_0 is the Y intercept, β_1 is the regression coefficient, x is the independent variable and ε is the estimated error.

The model will be re-expressed as follows;

$$Y = \beta_0 + \beta_1 X_{\text{Inc}} + \beta_2 X_{\text{edc}} + \beta_3 X_{\text{Pop size}} + \varepsilon \quad \text{Eqn 2}$$

The quantities of contaminated Covid-19 waste disposed in the three town skips will be calculated as follows; $W_{\text{day}} = (W_{\text{mrkt}} + W_{\text{H/H}}) / N_{\text{pop}}$

Where, W_{day} is the waste generation rates

W_{mrkt} is the total waste produced in the Ol-kalou Town during market day

$W_{\text{H/H}}$ is the total waste generated by urban households in Ol-kalou Town and N_{pop} is the total number of traders during the market day

Data Analysis

The data collected from interviewing the waste service providers was first checked for its consistency, accuracy, and level of completeness and then coded. The Coded data was then analyzed using the statistical package for Social Science (SPSS.version 25). Descriptive statistics and correlation matrix were used in the data analysis. The variations in waste composition of the waste generated in three curbsides was measured using the model of goodness of fit using the t-statistics and R-square. The cross-tabulation tables generated after the analysis was to enable the comparison and percentile relationship between the income levels and the population size of the town.

RESULTS AND DISCUSSIONS

Quantification of waste in Ol-kalou Marketplace

The average waste generated in Ol-kalou marketplace in three consecutive weeks formed a representative sample of the waste composition generated in market place per market day. The study findings indicated that the average waste generation rate in Ol-kalou market is 0.247 Kg per person per day.

The average waste per capita generated in the marketplace per week is 0.494 kg which is approximately 23.73kg per person in one year. The study found that the total wastes approximates to 55.88 tonnes of solid waste collected by the Ol-kalou municipal council annually.

Waste composition analysis

The composition and generation rate of wastes in the Ol-kalou market during the Covid-19 period have continue to change over time. The solid wastes disposed in the skip containers in the Ol-kalou market can be categorized into nine main categories: covid-19 related wastes comprise of 1.05%, a high number, plastics 19.24%, metals 11.86%, glass 5.84%, papers 4.12%, food wastes 46.05%, 3.09% leather, 1.19% Rubber and others 7.56%. The results from sampling and analysis of the composition and mass of wastes disposed in the three skips in the Ol-kalou market are indicated in the Figure 1 below.

Skip container	Waste category	Total waste disposed market day (Fri)	Total waste before collected market day (Sat)	Total waste during marketplace	Total wastes in W _{day} (kg/d)
Skip container A	Covid related wastes	0.9	1.1	2.0	139
	Plastics	19	21	40	6.4
	Metals	10	12	22	10.8
	Glass	5	7	12	21.8
	Papers	3	5	8	33.9
	Food wastes	38	44	82	3.4
	Leather	2	4	6	39.3
	Rubber	1	1.3	2.3	114.8
	Others	7	9	16	16.8
	Totals	85.9	104.4	190.3	
	Average	0.036	0.044		0.081
Skip container B	Covid –related wastes	1.1	1.0	2.1	132.4
	Plastics	11	21	32	8
	Metals	13	12	25	9.5
	Glass	7	6	13	20.2
	Papers	3	5	8	33.9
	Food wastes	40	46	86	3.3
	Leather	2	4	6	39.3
	Rubber	1	1.6	2.6	101.5
	Others	6	9	15	17.9
	Totals	84.1	105.6	189.7	
	Average	0.036	0.045		0.081
Skip container C	Covid –related wastes	0.9	1.1	2.0	139
	Plastics	19	21	40	6.4
	Metals	8	14	22	10.8
	Glass	5	4	9	29.1
	Papers	3	5	8	33.9
	Food wastes	48	52	100	2.8
	Leather	2	4	6	39.3
	Rubber	1	1	2	132
	Others	4	9	13	20.6
	Totals	90.9	111.1	202	
	Average	0.039	0.047		0.087
Totals	260.9	321.1	582		

Figure 1: Waste composition and mass of wastes generated in Ol-kalou Town Municipal

Waste Management Capacity

The results of the interview of the three municipal waste management authority workers (two top management officers and one waste collector) indicated that the municipal council does not have adequate capacity to provide effective waste management in the township. The main factors cited to impede effective an efficient waste collection in Ol-kalou township results from financial constraints.

The financial constraints are said to result from low budget allocations from the county government and failure to remit and evade waste management services fees by the town residents. Inadequate finances in the municipal council

has posed a challenge of hiring enough waste management services providers, offering trainings on safety measures to the waste collectors, purchasing of safety garments and vehicles, and repairing of the available infrastructures.

Despite the challenges posed by the Covid-19 pandemic, the waste management service provider's reported that they have tried their level best to offer waste management services to all areas in the township. The municipal council has managed to control and avoid waste heaps in town through increasing vehicles trips to collection sites and training their workers on effective methods of handling the suspected contaminated wastes in the residential and, market areas.

Opportunities in Aftermath of Covid-19 Pandemic

The Covid-19 pandemic outbreak in the world has brought both positive and negative impacts in the environment. Despite the negative impacts associated with the Covid-19 outbreak such as high death rates and financial depletions, many countries have learnt that waste management is as crucial as other sectors such as health in prevention of secondary transmissions that results from coming into contact with contaminated wastes. Many households have learnt in a hard way the importance of waste separation and safe disposal of wastes to avoid diseases spread.

Similarly, the Municipal councils have learnt the importance of prior training of waste collectors about safety measures in handling contaminated wastes. The pandemic outbreak is a mind opening experience to many governments especially on lower income countries to give priority in waste management through allocating adequate finances to the waste management systems. One positive impact that has been brought about by the Covid- 19 pandemic outbreak is the establishment of safe disposal points, new dumpsites allocated which are highly monitored and awareness creation to the households on importance of waste separation and disposals in their areas.

CONCLUSION

Waste management is a crucial activity that needs to be given a higher priority irrespective of whether there is a pandemic or not. Market wastes in many urban centers in Kenya are experiencing high waste generations that is mixed of variety of waste categories due to lack of waste separations. Lack of prior sustainable waste management strategies poses a challenge to waste management systems during a disaster occurrence due to lack of capacity to handle the wastes exacerbated by inadequate finances and infrastructures required to provide the services. The developing countries are far behind in attaining the sustainable waste management strategies which becomes worsened by the pandemics due to increased loads of wastes which is beyond the waste management systems to handle with the limited resources they have.

RECOMMENDATIONS

A clean environment free from wastes is very human desire. For many countries especially the developing and lower income earning countries to achieve a level of sustainable waste management, restructuring the waste management systems is crucial. Municipal waste management authorities need to be allocated higher budget to finance their services and waste collection fees be automated to ensure the finances are channeled to the right paths for effective use of financing waste management's activities.

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