Challenges associated with household solid waste management (SWM) during COVID-19 lockdown period: a case of ward 12 Gweru City, Zimbabwe

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Abstract The research assessed the challenges associated with household solid waste management during COVID-19 lockdown period. A mixed method approach was used triangulating both quantitative and qualitative methods. Ten-percent sample size of 1690 households (target population) participated in the research. Stratified random and purposive sampling methods were used to select the participants. Statistical Package for Social Science (SPSS) version 16 and content analysis were used to analyze the data. Chi-square test was used to test whether education level determines the disposal strategy used during the COVID-19 lockdown period. Research findings demonstrates that compulsive use of personal protection equipment such as masks, spending more time at home, bulk buying, and storage of food has skewed the trend of waste generation resulting in the increase in quantity of waste produced daily. COVID-19 lockdown period resulted in reduced waste collection since waste refuse collectors were not operating during lockdown period leading to illegal dumping and burning of waste. On average amount of waste produced weekly per household level was 73 kg (organic waste 35.2 kg, toxic waste 10 kg, and recyclable waste 26.8 kg). A chi-square p value of 0.35 was obtained, showing that there is a relationship between waste disposal strategy used during COVID-19 lockdown period and level of education of the respondents. The research concludes that COVID-19 has greatly affected waste management strategies from generation, collection, transportation, and disposal. It is recommended that the responsible authorities must prioritize collection of waste during the lockdown period as well as ensuring that waste recyclers and collectors are among the essential service providers during the pandemic.

Keywords Household waste · Solid waste management · Gweru City · COVID-19 pandemic

Introduction

Household solid waste is the residue generated daily by the people as a result of consuming goods and services (Ouhsine et al., 2020). The quantitative and qualitative aspects depend on the lifestyle and standard of living of citizens. Management of solid waste is usually a responsibility of the municipalities of the cities and towns across the world. However, the municipalities often face problems beyond the ability of the municipal authority to tackle (Baroi et al., 2020) mainly due to lack of organization, financial resources, complexity, and system multidimensionality (Jilani & Rashid,
Coronavirus disease of 2019 (COVID-19) pandemic has increased the challenges that were being faced by municipalities in managing household solid waste. One of the major contributing factors is the issue of lockdown period that was adopted by nearly all the countries worldwide as a way to manage the spread of the pandemic. During lockdown period people were allowed to buy food and other basics while observing WHO guidelines which are social distancing, sanitizing, and wearing face masks (Jribi et al., 2020). This also means that the responsible authorities for waste management in the countries, cities, and towns under lockdown were also affected as they were not operating.

In America, during lockdown period people were being supplied food items at their doorsteps and they were ordering for waste collection service online (Bene, 2020). According to Kulkarni and Anatharama (2020), online waste management services had a little effect on the waste disposal strategies as the online platform was efficiently used by the households in most of American cities. According to Onoda (2020), Japan recorded a number of waste management companies that had registered in terms of offering online waste management service during the period of January 2020–January 2021, and this indicated that a need was recognized by the people and addressed it through offering waste collection services. However, China faced challenges on disposing clinical waste such as masks, gloves, and sanitizer containers which were being generated at an accelerated rate (Van Fan et al., 2021).

According to Ikiz et al. (2021), when the COVID-19 lockdown restrictions were relaxed some of municipalities in Canada resumed their operations and it has been recorded that more workers were recruited so as to cover the gaps that were created during COVID-19 lockdown and one of the challenges was of waste management. Since physical collection of waste was banned in Italy, the government encouraged the households to maximize on composting solid waste and in worst scenarios burning waste at household level (Mehran et al., 2021). Some of the strategies being adopted as a result of COVID-19 lockdown are not environmentally friendly despite how developed a nation is. In as much as the COVID-19 pandemic affected waste management in the developed countries listed above, their management strategies were better and advanced to an extent that the effect was low (Valizadeh et al., 2021). For example, in Italy composting of waste was highly utilized as a waste management strategy during the pandemic period (Mehran et al., 2021).

Lockdown strategy was also adopted by developing countries as a way to reduce the spread of the pandemic. However, unlike the developed countries which were less affected, COVID-19 lockdown period greatly affected waste management strategies of the developed countries. In Kenya, when COVID-19 lockdown period was imposed in April 2020 the municipality workers were not allowed to go to work and even residents were not allowed to move from their residential areas to places that are 5 km away from their homes (Vanapalli et al., 2021). This led to accumulation of solid waste in households, and according to Lissah et al. (2021), households adopted burning of waste and disposal of waste in backyards. In South Africa, the city of Tembisa has faced a similar problem as indicated by Mukumbang et al. (2020), who mentioned that the number of illegal disposal sites increased rapidly as a result of lockdown period. Perteghella et al. (2020) indicated that in Mozambique the issue of waste segregation was no longer considered as clinical wastes such as gloves, masks, and sanitizer containers being mixed with food waste in a way which also increased the rate of contamination.

Zimbabwe was not spared from waste management challenges which resulted from the lockdown period as COVID-19 was declared a national disaster in March 2020 and lockdown period imposed to the residents (Chingwenya & Wadzanai, 2020). According to Dzobo et al. (2020), in Harare COVID-19 essential service providers were the only ones allowed to walk in the streets during lockdown period and municipality workers were not part of the essential service providers which resulted in solid waste accumulation at household level without being managed by responsible authorities.

The same issue was noted in most cities of Zimbabwe such as Bulawayo, Masvingo, Gweru, and Mutare. In Gweru, challenges of waste management existed way back before COVID-19 but however, were exacerbated by lockdown period. The situation also affected ward 12 of Gweru city which already had challenges of waste management before. COVID-19 worsened the situation as the priority was shifted from waste management to COVID-19 management and the lockdown period resulted in waste refuse collectors not working. This resulted in accumulation of waste in residential
areas and caused the residents to end up resorting to illegal dumping and mismanagement of waste. The ward is located in high-density suburb where space for waste disposal is limited; however, people ended up burning the waste behind their backyards and some burying waste in the pits during lockdown period. Unsustainable waste management practices are at an increase since 2020 when the COVID-19 was declared a national disaster. These management practices pose risk to the health of the people and this is a cause for concern. The responsible authority on waste collection, transportation, and disposal, that is, Gweru City Council, seem to be overwhelmed with work. Their schedule for waste collection has totally changed and the waste collectors are no longer collecting waste due to lockdown movement restrictions. This is posing a challenge as the aesthetic value of Gweru City ward 12 area is reduced as different types of waste can be found everywhere. This challenge has also led to more waste dumpsites emerging during lockdown as people were not able to transport waste to the nearby MacFeden disposal site. Some people were also digging waste disposal pits behind their backyards creating breeding grounds for mosquitoes and flies which can eventually cause cholera. Burning of waste became the order of the day which could be observed during the evening propounding smelling odor and smoke around the suburb. It was also noted that the water drains are blocked as dumping of waste in drains is now prominent. If these poor management practices continue it will be very difficult for the country to achieve some of the Sustainable Development Goals (SDGs) by 2030, which includes SDG 3 of good health and well-being and 11 of sustainable cities and communities. It is against this background that this research seeks to.

- To identify the types of solid waste generated at household level during the COVID-19 lockdown period in ward 12 of Gweru City.
- To establish the amount of solid waste generated at household level during the COVID-19 lockdown period in ward 12 of Gweru City.
- To examine the practices used to manage the household solid waste during COVID-19 lockdown period in ward 12 of Gweru City.
- To assess the challenges associated with solid waste management practices during COVID-19 lockdown period in ward 12 of Gweru City.

Materials and methods

The area under study is ward 12, Gweru City in Midlands Province (Fig. 1). The ward is comprised of locations such as Mkoba 6, Mkoba 7, and Mkoba 8 (Mkoba Teachers College). Mkoba 6 comprises of mostly residential areas, a shopping center (Muyambo Shopping Center), and a school (Chikumbiro Primary School). Mkoba 7 is comprised of partly residential area, a stadium (Mkoba Stadium), and a Swimming Pool. Mkoba 8 on the other side is comprised of Mkoba Teachers College. Mkoba 6 and 7 were hotspots for increased household solid waste as they are comprised of residential areas as well as shopping centers.

Study area

Hydrologically, ward 12 of Gweru City falls within Sanyati catchment. The ward has small streams that are resulted from the water drain system within the residential suburbs. Elevation ranges from about 1300 to 1400 m that makes it a highland. Due to this elevation, temperatures are generally low throughout the year and the COVID-19 virus thrives in such weather conditions. Generally, the geology of ward 12 of Gweru City is dominated by Fersiallitic soils (Nyamapfeni, 1991). These soils range from the sandy soil to clay in other regions. They are susceptible to erosion due to poor particle grading and weak consolidation. They, therefore, require high input use and good conservation in establishment of landfill sites.

Ward 12 of Gweru City has an estimated population of 6200 people as of the year 2012 (ZimStats, 2012). The proportion of male and female population is 3500 and 2700, respectively. The ward is characterized by retail activities and informal trading which are contributing to the increase in solid waste.

Research design

A descriptive case study research design was adopted on grounds that it allows for data triangulation through use of the mixed method study approach. The mixed method approach integrated qualitative (interviews, open-ended questionnaires, and direct-field observations) and quantitative data (closed-ended questionnaires) collection methods to provide a better and vivid
understanding of the research objectives combined rather than of each one individually (Creswell, 2003).

Target population

This research targeted 1690 households in both Mkoba 6, 7, and 8, which makes up ward 12 of Gweru City. Ward 12 was targeted due to accessibility since the data was collected during lockdown period so it helped the researchers to speed up data collection process and get access to the information without wasting time. More so, the population of interest was large with numerous clusters and strata; hence, selecting this ward gave the researchers a chance to complete the systematic investigation in a short time frame. From the 1690 households, 723 were households from Mkoba 6 and 967 were households from Mkoba 7. At household level, the researchers targeted household heads for questionnaire administration who were above the age of 18 years. This age group was targeted because it is the age group that is not regarded as minor, hence can give own consent to participate in the study. During the total national lockdown period (from March 30 2020 to September 2020), Mkoba 8 (Mkoba Teachers College) was an isolation center; hence, the researcher interviewed the head of department of works as a key informant. Other key informants who constituted the target population were the ward councilor, the Gweru City Council Department of Health (Environmental Health Technician), Environmental Management Agency, and the ward councilor.

Sample size determination and sampling procedure

This research adopted 10% of the target population as sample size and this translated to 169 households from Gweru City ward 12 participating in the study. This sample size was chosen as the most appropriate one because according to Creswell (2016), a sample of around 10–20% of the target population is an acceptable sample size which can be used during a research to generalize
the findings of the study with low error margin. Questionnaires were then randomly administered to 10% of the households in each residential area for the sake of ensuring proportional representation of all residential areas within the ward (72 households from Mkoba 6 and 97 households from Mkoba 7) as shown in Table 1.

Stratified sampling was employed in this study; stratas of the residential areas were created. Stratified random sampling was used in order to represent all groups (stratas) in the ward since it constituted 3 residential areas (Mkoba 6, 7, and 8). Two stratas which were created in this study were Mkoba 6 and Mkoba 7 residential areas since Mkoba 8 was an isolation center during the lockdown period. Within each strata simple random sampling technique was used. Purposive sampling was used during selection of key informants for interviews.

Questionnaire survey and administration

The researchers personally administered the questionnaires to household heads to ensure that the sample size was reached within 2 weeks. During questionnaire administration period, explanation on some sections of the questionnaire was sought and the researcher and the assistant researcher were there to explain further some gray areas so that the respondent will be aware of information sought, henceforth ensuring reliability and validity of the data obtained. The researcher first sought consent of the ward councilor to administer the questionnaires to the households and also sought verbal consent of participants to participate in the research. Since data was collected during the COVID-19 pandemic the researchers observed COVID-19 regulations by wearing masks, sanitizing hands, and practicing social distance during data collection process.

Online interviews

Semi-structured interviews were adopted in this study and the interviews were conducted online through the use of phone calls. Online interviews were done because the researcher was not able to visit offices physically because of COVID-19 restrictions. Purposive sampling technique was adopted for selection of key informants who had better knowledge on the topic under consideration. Key informant interviewees for this research encompassed the Environmental management agency (District Environmental Officer), the city of Gweru (Environmental Heath Technician), The Ward Councilor (Gweru City ward 12), and Mkoba Teachers College (Department of Works). To get access to the telephone numbers the researchers first visited the City of Gweru municipality offices and they requested contact details of the EHT and Ward councilor. The EHT is the one who provided contact details for the District Environmental Officer and the Ward councilor provided contact details for the Department of Works (Mkoba Teachers College) under his jurisdiction.

Direct-field observations

Direct-field observations were conducted to supplement data that was collected through the questionnaire survey and the online interviews. The researchers observed waste disposal facilities at household level and also visited some of the illegal disposal sites within Gweru City ward 12 to observe types of waste that is being disposed at those facilities.

Data presentation and analysis

Both qualitative and quantitative data was presented in form of descriptive words, pictures, graphs, and tables. The data that was obtained from closed ended questionnaires was presented in form of tables and graphs (quantitatively). Data that was obtained from open-ended questionnaires, interviews, and direct observations was presented and analyzed using content analysis. Quantitative data gathered from the questionnaire survey through the closed-ended questions was coded and entered into a computer through the Statistical Package for Social Science (SPSS) version 16, for analysis. Non-parametric test was used, whereby the chi-square test was performed to determine the relationship between education level of the respondent and the disposal strategy used during the COVID-19 lockdown period. Through the SPSS software, descriptive statistics were generated whereby

| Residential area | Number of households | Sample size at 10% |
|------------------|----------------------|--------------------|
| Mkoba 6          | 723                  | 72                 |
| Mkoba 7          | 967                  | 97                 |
| Total            | 1690                 | 169                |
the quantitative data was converted into percentages, arithmetic means, and frequencies through numerical coding.

Results and discussion

Socio-demographic characteristic of respondents

The majority of respondents were females (64%) and males constituted 36% of the respondents. According to Zimstats (2018), Mkoba residential area, in general, is a female-dominated residential area. Among the respondents 57% were from Mkoba 7 while the remaining 43% were from Mkoba 6 residential area. Age group of 21–30 years dominated the research by 34% of the respondents; the median age of 31–40 and 41–50 also constituted 40% of the respondents and lastly the aged population of 51+ constituted 26% of the respondents. Generally, ward 12 of Gweru City is characterized by educated people, which was indicated by the findings of this research. Majority of the respondents (72%) attained secondary education, 14% of the respondents completed their tertiary education, and 7% of the respondents only reached primary education level while 6% only attained standard education. On average, the household size of the respondents was 4–6 people per house, which was indicated by 86% of the respondents.

Types of solid waste generated in ward 12 of Gweru City at household level during the COVID-19 lockdown period

Respondents indicated that the solid waste they generate consists largely of organic waste such as food leftovers, yard waste, and wood while inorganic waste contributed a small percentage of the total waste as shown in Table 2. Mkoba Teachers College Department of Works director also indicated that Mkoba Teachers College which was used as an isolation center produced more of medical waste in form of masks and sanitizer containers as well as food remains which were given to the people in isolation. Gweru City Council Health Department officer indicated that wastes that were generated during COVID-19 period were largely food remains as well as medical waste. A study conducted by Jerie and Mandevere (2018) before the pandemic revealed that households produced less medical waste and more of food remains and garden waste. When compared to the findings in this research which was conducted during the COVID-19 pandemic, it shows that people were frequently using medical gadgets or stuffs to treat sick people at home and also wearing of personal protective clothing (masks) which increased the generation of medical wastes. This was also attributed to the fact that people were spending most of their time at home.

Organic waste

The respondents (72%) indicated that during COVID-19 lockdown period, much of their waste was kitchen organic waste as shown in Table 2. This was because people were spending most of their time at home during the lockdown period and some respondents even indicated that their eating habits increased. Environmental Health technician of Gweru City council confirmed this by indicating that spending more time at home directly affects the eating habits and ultimately generates more household solid waste. According to Filimonau (2021), in a research that was done in Swede, the results indicated that people were stacking food stuffs in their houses in a fear that COVID-19 may prolong which may result in hunger. In a research that was done by Laguna et al. (2020), they also indicated that during lockdown period perishable food waste increased as a result of stockpiling. This is in line with results of this research where the majority of the respondents indicated that the most prevalent type of

| Table 2 | Types of household solid waste generated during COVID-19 lockdown period |
|---------|---------------------------------------------------------|
|         | Frequency | Percent (%) | Average amount produced weekly per household level (kg) |
| Organic waste | 122      | 72         | 35.2 kg                  |
| Toxic waste    | 19       | 11         | 10 kg                    |
| Recyclable     | 28       | 17         | 27.8 kg                  |
| Total          | 169      | 100.0      | 73 kg                    |

*Source: Field survey 2021*
waste produced during COVID-19 lockdown period in Gweru City ward 12 is organic food in form of kitchen waste. Fruit peelings and food remains were major types of kitchen waste observed on disposal sites. Garden waste also forms part of organic waste produced by households during COVID-19 lockdown period. Some respondents indicated that they also produced waste in form of animal waste. Some of the respondents indicated that they started projects such as poultry breeding as they lost their jobs due to COVID-19 lockdown.

Wood is also another recyclable waste that was produced during COVID-19 lockdown period. Wood cardboards were also identified on the disposal sites near Mkoba 6 shopping center; this indicated that cardboards were part of solid waste generated during COVID-19 lockdown period. At the shopping center some business operators were violating lockdown regulations and conducting business in order to survive during the pandemic, thereby producing this type of waste. Mkoba Teachers College director also indicated that since the facility was used as an isolation center, more furniture breakages occurred and the majority of the breakages were in form of wood waste.

Recyclable

Respondents (17%) indicated that they also produce plastics as another form of waste as shown in Table 2. Plastic waste was also identified to be one of the major types of waste produced during COVID-19 lockdown period. Some of the types of plastic waste observed in the waste bins as well as disposal sites include drink bottles, bottle caps, grocery bags, drink lids, and straws. Environmental Management Agency officer indicated that drink plastic bottles were most prevalent type of plastic waste that can be observed within the ward. In a research that was done by Mandevere and Jerie (2018) before the pandemic, they also confirmed that plastic waste was one of the most definite wastes found in high-density areas. In a research that was done by Vanapali et al. (2021), they also indicated that COVID-19 resulted in the increased use of plastics as metal was also identified as a possible COVID-19 contaminant source. This means that plastics have always been a form of waste produced by households before and during the pandemic.

Metal waste in terms of ferrous and non-ferrous metals also constituted part of waste that was generated during COVID-19 lockdown period in Gweru City ward 12. The metal wastes that were observed were bed mattresses, steel rods, car parts, and metal wire and brushes. This was mostly because small-scale businesses (carpenters, steel makers, and vendors) were operating at home trying to make a living during the lockdown period. In a research that was done by Sakodie and Owusu (2021), they also indicated that metal waste was associated with household solid waste produced in high-density suburbs during COVID-19 lockdown period.

Toxic waste

The respondents indicated that medical waste was a major waste produced during COVID-19 lockdown period. Since the government emphasized on mask up when one is in public, face masks were predominantly becoming toxic medical waste generated from households during COVID-19 lockdown period. Because most of the masks used were not recyclable, the face masks were visible across the streets and even identified in the disposal sites. These masks posed a great threat to the people as they are spreaders of COVID-19. Environmental Health technician pointed out that medical waste is an order of the day as people use it to fight against the spread of COVID-19.

Amount of solid waste generated at household level during the COVID-19 lockdown period

The majority of respondents (64%) indicated that they did not have refuse bins at their homes while 36% indicated that they had refuse bins at their houses. This was a challenge in terms of waste quantification as some ended up estimating the amount of waste they produced per day. From those who indicated that they had refuse bins at their houses, 80% used plastic containers, 12% metal containers, and 8% used plastic paper bins. Environmental Health technician of Gweru City Council testified that they provided the residents with plastic containers to use as refuse bins. The researchers also observed that these plastic containers were being used as water storage containers by most of the residents in Gweru City ward 12 which was the reason why majority of respondents (64%) indicated that they do not have refuse bins at their households.

Waste generated per day

COVID-19 has significantly affected Gweru City ward 12 people’s food purchasing and consumption habits.
Majority of the respondents (80%) indicated that they used plastic containers as refuse bins with a net mass of 31–75 kg and they disposed them once a week while others (20%) indicated that they disposed them 2 times a month. Fourteen percent indicated that they used plastic paper bins with a net mass of 1–30 kg and they disposed them once a day and some also indicated that they disposed them twice and thrice a week. The remaining 6% indicated that they used large metal containers with net mass of 75 kg and they only disposed them when council refuse collectors come to collect waste which was once per week.

The councilor explained that the amount of waste being produced per household level reduced to some level by indicating that before COVID-19 pandemic waste generated per household level, on average, would range between 75 and 100 kg whereas during the lockdown period it ranged between 50 and 7 kg per week. Respondents also indicated that shopping habits were also affected by the COVID-19 lockdown period as people were restricted movements to and from shopping centers. An analysis on the amount of waste produced and household size (number of people at each household) was done to see if household size affects the amount of waste being produced as shown in Table 3.

A correlation between the amount of waste produced and household size was statistically tested in this research. The result of 0.921 was observed, which indicated the strong positive correlation as indicated in Table 3. This means that as the household size increases, household solid waste generated also increased. This was also attested by the interviewed respondents who indicated that they had tenants renting at their houses who also contributed in household waste generation. An analysis on the quantity of waste produced and standard of living was done to see if standard of living affects the amount of waste produced as shown in Table 4.

The type and strength of relationship between standard of living and quantity of waste produced was statistically tested in this research. The result of 0.564 was observed, which indicates a moderate positive correlation as indicated in Table 4. This means that those with better standard of living produced more waste that those with poor standard of living.

The practices used to manage the household solid waste during COVID-19 lockdown period

**Collection and transportation of household solid waste in Gweru City ward 12 during COVID-19 lockdown period**

All respondents (100%) attested that they used plastic receptacles as their refuse bins. The Gweru City Council Environmental Health technician confirmed that they provided these receptacles to their residents but for financial reasons the authorities did not provide more than one receptacle to enable separation of waste.

### Table 3 Correlation between household size and quantity of waste produced

| Household size | Pearson correlation | Significance (2-tailed) | N | Quantity of waste produced | Pearson correlation | Significance (2-tailed) | N |
|----------------|---------------------|-------------------------|---|----------------------------|---------------------|-------------------------|---|
| Household size | 1                   | 0.921**                 | 146|                           | 1                   | 0.921**                 | 146|
| Quantity of waste produced | 1 | 0.921** | 146|

**Source:** Field survey 2021 **Correlation is significant at the 0.01 level (2-tailed)**

### Table 4 Correlation between standard of living and quantity of waste produced

| Standard of living | Pearson correlation | Significance (2-tailed) | N | Quantity of waste produced | Pearson correlation | Significance (2-tailed) | N |
|--------------------|---------------------|-------------------------|---|----------------------------|---------------------|-------------------------|---|
| Standard of living | 1                   | 0.564**                 | 146|                           | 1                   | 0.564**                 | 146|
| Quantity of waste produced | 0.564** | 1 | 146| 146|

**Source:** Field survey 2021 **Correlation is significant at the 0.01 level (2-tailed)**
at source. These receptacles and plastic containers were placed by the gate by residents once a week for collection on the designated day for each particular area, and residents from both Mkoba 6 and 7 indicated that waste was usually collected in the morning. The Environmental Health technician, however, indicated that during COVID-19 lockdown period they faced challenges of being understaffed which then resulted in the changes of timetables for waste collection. The other problem indicated was of vehicle breakdown, which also affected the collection of waste in Gweru City wards including the ward under study. Sharma et al. (2020) also indicated that, during COVID-19 lockdown period, small municipalities, especially those in developing countries, were heavily affected in collection of waste. Van Fan et al. (2021) also indicated that developing countries were incapacitated to a point that they were channeling resources to economy rather than to waste management practices. The councilor indicated that before COVID-19 pandemic, waste within the ward was collected once a week, Mondays in Mkoba 6 and Fridays in Mkoba 7. He further indicated that waste is supposed to be collected frequently; however, during lockdown period the waste collectors were not allowed to work as they were not regarded as essential service providers. The Councilor was quoted saying:

...the waste management department is greatly affected by COVID-19 as it is not safe for the workers to patrol across the streets collecting waste.

Respondents also indicated that due to erratic collection of waste by the city council they hired private waste collectors to dispose waste during the night at illegal dumpsites. This shows that waste dumping was therefore a result of poor waste collection and transportation strategies during COVID-19 lockdown period.

Household solid waste disposal in Gweru City ward 12 during lockdown period

Disposal forms the last and least expected phase of the waste management hierarchy and need to be avoided since an efficient system ensures that minimal solid waste reaches the landfill. Disposal of solid waste in Gweru City ward 12 before COVID-19 lockdown period was done mainly by council which collects household solid waste from households. However, respondents indicated that during the lockdown period disposal of waste was mainly being done by households at individual level on illegal dumpsites. Council is also expected to clear illegal dumps in various places in residential areas under normal circumstance. Respondents also indicated that the front-end loaders were not clearing the waste but however they would mix the waste with gravel and leave it on the sides of the roads. The findings revealed that waste generation in Gweru City ward 12 exceeded the frequency of waste collection, henceforth the presence of more disposal sites during COVID-19 lockdown period. The respondents also attested that they did not wait for council to come and collect waste as it was rare to see the council waste collection vehicles during COVID-19 lockdown period; hence, the cheapest and easiest way to dispose waste was to dump it illegally across the streets.

It was also observed that open burning of waste was common along roads and open spaces where residents dumped their household solid waste. This is against EMA Act which indicates that open waste burning practices contribute to ground level ozone pollution (smog) which can worsen respiratory, heart, and other health problems. This can also lead to eye, nose, and throat irritation as well as damage of the central nervous system (EMA, 2014).

In an interview with the women who was observed dumping waste along the road, she mentioned that:

We have no option but do our mini-waste management of burning the waste or carrying it at night to the dumps outside the houses because the council is not collecting waste since the commencement of COVID-19 pandemic.

The director of Mkoba Teachers College also attested that medical waste was a challenge in terms of its disposal. Medical waste requires professional treatment and technologies which are sometimes costly to the waste producers (Hantoko et al., 2021). The respondent indicated that since the facility was used as an isolation center, medical waste, in form of masks and sanitizers, was difficult to dispose. Figure 2 shows some of the reasons that were brought forward by the respondents as to why they were illegally dumping waste during COVID-19 lockdown period.

The relationship between waste management strategies and level of education

Figure 3 shows the waste management strategies being used by the households in relation to their level of
education. Respondents who indicated that they only attained primary and standard education were mostly those who were practicing burning of waste, throwing waste in the drains, and disposing waste illegally. The reason behind this cause was that they did not have enough knowledge on the implications of these unsustainable ways of waste management. Those who attained secondary and tertiary education in contrary were the ones who mostly mentioned used composting and recycling as shown in Fig. 3. These ones have a know-how on how waste can be managed and understand how vital sustainability is. The results are in line with the findings by Ragazi et al. (2020) and You et al. (2020), who also indicated that those who are educated know the effects of waste mismanagement unlike those who are not educated.

A chi-square test was performed to analyze the relationship between the level of education and waste management strategy used within Gweru City ward 12. A $p$ value of 0.35 was obtained, which is less than 0.5 significance level as shown in Table 5. This shows that we accept the H1 hypothesis and reject the H0 hypothesis concluding that there is a relationship between waste disposal strategy used during COVID-19 lockdown period and level of education of the respondents.

![Fig. 2 Reasons why people were dumping waste at illegal disposal sites (source: Field survey 2021)](image)

![Fig. 3 A graph showing the waste management strategy in relation to level of education (source: Field survey 2021)](image)
Challenges associated with solid waste management practices during COVID-19 lockdown period

The challenges faced by Gweru City ward 12 households ranged from household challenges to institutional challenges. Figure 4 shows the challenges that were indicated by the respondents which are hindering effective waste management in Gweru City ward 12.

Environmental policies lack clear strategy

As indicated in Fig. 4, 12% of the respondents strongly agreed to the point that environmental policies lacked clear strategy on waste management. Respondents said that they were not aware of the policies that are set aside by the regulatory authorities on how waste can be managed during COVID-19 lockdown period. EMA officer indicated that trainings were done prior to the outbreak but it was difficult to conduct trainings during the lockdown period as people were not permitted to assemble in large numbers. Nzeadibe and Ejike-Alieji (2020) is also of the view that during COVID-19 lockdown period more attention was given to medical treatment facilities and isolation centers and little was being done in waste management sector. This is also in line with

| Table 5 | Chi-square test on the relationship between education level and waste disposal strategy used |
|---------|--------------------------------------------------------------------------------------------|
|         | Value | df | Asymptotic significance (2-sided) |
| Pearson chi-square | 1.025E2* | 9  | 0.035 |
| Likelihood ratio    | 106.272 | 9  | 0.034 |
| N of valid cases    | 146   | | |

Source: Field survey 2021

*Nine cells (56.3%) have expected count less than 5. The minimum expected count is 0.25

Fig. 4 Challenges associated with household solid waste management (source: Field survey 2021)
the findings of this research, where a clear indication has been drawn that refuse waste collectors were not regarded as essential service providers during COVID-19 lockdown period. The perpetrators who dumped waste on illegal disposal sites were not arrested; henceforth, waste management practices lack clear strategies.

Inadequate law dealing with solid waste

As shown in Fig. 4, 70% of the respondents agreed to the point that the law which deals with solid waste is not adequate. In an informal discussion with the lady who was observed dumping waste along Mambo road, she indicated that most of the people were dumping waste without any punishment for that. The councilor indicated that people usually dump waste at night fearing to be arrested, which therefore shows that the law dealing with solid waste exists. The councilor also stressed a point that the law exists but enforcement is a challenge. Sarkodie and Owusu (2021) also indicated that in most cities law enforcers are reluctant and some are corrupt. Enforcement of law and regulation is something that must be taken seriously if the Zimbabwe is to achieve sustainable waste management. Before COVID-19 illegal disposal of waste has always been rampant and this was also observed in this research during the pandemic period yet the country is on a mission to achieve SDGs by 2030. It will be very difficult to achieve SDG 3 of good health and well-being poor waste management practices have their own repercussion to the health of people and environment in general.

Waste management institutions are not working because of lockdown

The majority of respondents (70%) strongly agreed that waste management institutions were not operating during the lockdown period as shown in Fig. 4. The institutions such as EMA, City Council, and non-governmental organizations were not working at full capacity during lockdown period. The Environmental Health technician indicated that during lockdown period they were working at 40% capacity as a way of limiting the spread of the COVID-19 virus. This was a challenge in a way that even waste truck drivers were not coming to work, which therefore affected waste collection services. The households also indicated that before COVID-19 pandemic, they used to see waste recyclers collecting plastic and metal waste for recycling but they were no longer doing this because of restrictions on movement during the lockdown period. The director of Mkoba Teachers College pointed out that they have resorted to burning of waste since it was not being collected by responsible institutions as they were not working during lockdown period.

Limited funds are sometimes misused

The majority of respondents (90%) strongly agreed that misuse of funds was one of the challenges which affected solid waste management as shown in Fig. 4. The respondents indicated that they pay money for waste to be collected in their respective wards. However, they indicated that they were not aware of how the money was being used since the waste was not being collected. The ward councilor emphasized that the little funds available were sometimes misused and resulted in the council not able to collect waste and dispose it responsibly. Ganguly et al. (2021) indicated that COVID-19 funds were also supposed to be used in waste management but in the case of Nigeria, they were just used for health services. Hantoko et al. (2021) also support this suggestion by saying that waste management is also part of the health system which is supposed to be catered for during COVID-19 lockdown period.

Lack of public education on waste management

EMA officer indicated that during COVID-19 lockdown period, they were not carrying out waste management campaigns. The respondents (60%) strongly agreed that lack of public education was one of the challenges that affected household management strategies during lockdown period. The respondents also indicated that since people were not allowed to gather in large numbers, environmental campaigns were going to be regarded as breach of COVID-19 regulations. He also alluded to the fact that COVID-19 brought with it a new wave of waste mismanagement as medical waste was not properly disposed. In a research done in Italy, Ragazzi et al. (2020) also noted that those who were educated were at low risk of posing environmental pollution than the uneducated one.
Operational equipment is obsolete and insufficient

Operational equipment that is being used to ferry waste from households to MacFeden disposal site was reported by the EHT of city of Gweru to be obsolete and insufficient. The city of Gweru Department of Works indicated that they only had 8 functional waste trucks which were being used across the city and in most cases they were affected by breakdowns to a point that maybe 2 or 3 will be functioning at a time. Mandevere and Jerie (2018) also indicated that shortage of operational equipment is also another reason why Harare has poor waste management strategies in place. The respondents also supported this point by indicating that the waste collection trucks did not collect waste frequently and they agreed that the equipment was insufficient and obsolete. If this situation continues to occur it will be very difficult to achieve SDG number 11 of sustainable communities since mismanagement of waste has greater negative impacts on the environment.

Recommendations

The results of this research indicated that the challenges faced by the households in managing solid waste during COVID-19 lockdown period are attributed to several factors. Therefore, the following recommendations may be very useful in improving household solid waste management during lockdown period:

- The government of Zimbabwe must prioritize waste management practices by considering the waste collectors as essential service providers during lockdown period. Those responsible in waste collection, disposal, and recycling must be regarded as essential service providers and must be allowed to operate even in the times of lockdown period with guidelines. This is very important as it will allow collection of waste during the lockdown periods and reduce cases of illegal dumping of wastes on undesignated areas, thereby helping in the achievement of SDG 11 of sustainable cities and communities.
- The Environmental Management Agency and Gweru City council must collaborate to intensify awareness campaigns on the risk of mismanagement and illegal dumping of waste during COVID-19 lockdown period as it can be a source of contamination and infection to the people. Since physical contact is limited during COVID-19 lockdown period, there should be educative programs on all social media platforms in all languages on how best waste can be managed in the case of an outbreak of a pandemic or during lockdown periods.
- Environmental Management Agency and Zimbabwe Republic Police must enforce waste management laws that will see perpetrators getting arrested if they are found guilty of disposing waste illegally. This will help in reducing illegal dumping of waste and improve the aesthetic value of the environment in the process achieving SDG 11.
- If the Gweru City council is incapacitated, the council should also source some private organization to collect and dispose waste on their behalf. This is important as it will reduce cases of poor management of waste by households and help in promoting good health and well-being through living in a clean environment in the process achieving SDG 3.
- Alternatively, it is also recommended that the city of Gweru should introduce skip bins in areas that are dominated by illegal dumps.
- The residents of ward 12 and general public are recommended to practice waste management practices such as composting, recycling, and reusing products in order to reduce generation and accumulation of waste. Composting can be practiced with organic waste while recycling and reusing can be employed when dealing with plastics, paper, and tin products. This is very important if undertaken at household level at it will in the achievement of SDGs 3 and 11.

Conclusions

In conclusion during COVID-19 lockdown period there was a gross mismanagement of household solid waste by residents as the responsible authorities were not collecting waste. Gweru City council was incapacitated, therefore weakening their household solid waste management strategies. Although the council was providing poor services prior to the pandemic the situation worsened due to lockdown movement restrictions which resulted in waste refuse collectors not operating as they were not regarded as essential service providers. Lack of knowledge and information on how to reduce waste production at household level is prevalent within the study area and this contributed greatly to poor household waste management strategies as...
shown by chi-square test results. Without proper waste management it will be difficult to achieve some of the SDGs by 2030 which includes SDGs 3 and 11. Waste management practices also faced threats from the COVID-19 pandemic, because lockdown period limited movement of waste collection workers, resulted in lack of funds, poor environmental education among the residents, limited expertise, and shortage of suitable machinery among other factors. Medical waste such as face masks was identified at the disposal sites which also imposed a risk of contamination from the deadly COVID-19 pandemic. The majority of the residents of Gweru City ward 12 did not have receptacles; hence, they illegally dumped waste across the roads. This scenario was worsened by the fact that during COVID-19 lockdown period, the council was not collecting waste from the residents. Conclusively, COVID-19 lockdown period affected waste management practices at household level from the amount generated to disposal strategies. It also affected the responsible authorities who were responsible for managing waste.

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Declarations

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Consent to participate Research participants signed consent forms and this is explained under methodology section.

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References

Baroi, A. R., Chowdhury, R. B., Roy, B. B., & Sujauddin, M. (2020). Sustainability assessment of phosphorus in the waste management system of Bangladesh using substance flow analysis. Journal of Cleaner Production, 273, 122865.

Béné, C. (2020). Resilience of local food systems and links to food security—A review of some important concepts in the context of COVID-19 and other shocks. Food Security, 1–18.

Chigwenya, A., & Wadzanai, P. (2020). The intersectionality between right to the city, inferiority and waste management in Masvingo City, Zimbabwe. Journal of Urban Systems and Innovations for Resilience in Zimbabwe-JUSIRZ, 2(2), 26–52.

Creswell, J. (2016). Research in Education: Design, Conduct and Evaluation of Quantitative and Qualitative Research (Translated by Kouvarakou, N). Ion (Year of Publication of the Original 2005), Athens.

Creswell, J. W (2003). Research design: Qualitative, quantitative and mixed methods approaches (2nd ed.) Thousand Oaks, CA: Sage.

Dzobo, M., Chitungo, I., & Dzinamarira, T. (2020). COVID-19: A perspective for lifting lockdown in Zimbabwe. The Pan African Medical Journal, 35 (Suppl 2).

EMA ACT. (2014). Environmental Management Act. United Nations Environment Programme.

Filimonau, V. (2021). The prospects of waste management in the hospitality sector post COVID-19. Resources, Conservation and Recycling, 168, 105272.

Ganguly, R. K., & Chakraborty, S. K. (2021). Integrated approach in municipal solid waste management in COVID-19 pandemic: Perspectives of a developing country like India in a global scenario. Case Studies in Chemical and Environmental Engineering, 3, 100087.

Hantoko, D., Li, X., Pariatamby, A., Yoshikawa, K., Horttanainen, M., & Yan, M. (2021). Challenges and practices on waste management and disposal during COVID-19 pandemic. Journal of Environmental Management, 286, 112140.

Ikiz, E., Maclaren, V. W., Alfred, E., & Sivanesan, S. (2021). Impact of COVID-19 on household waste flows, diversion and reuse: The case of multi-residential buildings in Toronto, Canada. Resources, Conservation and Recycling, 164, 105111.

Jilani, S., & Rashid, R. (2020). Municipal solid waste dumping and its impact on soil quality in Karachi. EQA-International Journal of Environmental Quality, 36, 9–14.

Jribi, S., Ismail, H. B., Doggui, D., & Debbabi, H. (2020). COVID-19 virus outbreak lockdown: What impacts on household food wastage? Environment, Development and Sustainability, 22(5), 3939–3955.

Kulkarni, B. N., & Anantharama, V. (2020). Repercussions of COVID-19 pandemic on municipal solid waste management: Challenges and opportunities. Science of the Total Environment, 743, 140693.

Laguna, L., Fisman, S., Puerta, P., Chaya, C., & Tárrega, A. (2020). The impact of COVID-19 lockdown on food priorities. Results from a preliminary study using social media and an online survey with Spanish consumers. Food Quality and Preference, 86, 104028.

Lissah, S. Y., Ayanore, M. A., Krugu, J. K., Aberese-Ako, M., & Ruiiter, R. A. (2021). Managing urban solid waste in Ghana: Perspectives and experiences of municipal waste company managers and supervisors in an urban municipality. PLoS ONE, 16(3), e0248392.
Mandevere, B., Jerie, S. (2018). Household solid waste management: How effective are the strategies used in Harare Zimbabwe. *Journal of Environmental Waste Management and Recycling, 2*(1), 1622.

Mehran, M. T., Raza Naqvi, S., Ali Haider, M., Saeed, M., Shahbaz, M., & Al-Ansari, T. (2021). *Global plastic waste management strategies (Technical and behavioral) during and after COVID-19 pandemic for cleaner global urban life.* Energy Sources, Part A: Recovery, Utilization, and Environmental Effects, pp.1–10.

Mukumbang, F. C., Ambe, A. N., & Adebiyi, B. O. (2020). Unspoken inequality: How COVID-19 has exacerbated existing vulnerabilities of asylum-seekers, refugees, and undocumented migrants in South Africa. *International Journal for Equity in Health, 19*(1), 1–7.

Nyamapfeni, K. (1991). Soils in Zimbabwe. Nehanda Publishing House, Harare.

Nzeadibe, T. C., & Ejike-Alieji, A. U. (2020). Solid waste management during Covid-19 pandemic: Policy gaps and prospects for inclusive waste governance in Nigeria. *Local Environment, 25*(7), 527–535.

Onoda, H. (2020). Smart approaches to waste management for post-COVID-19 smart cities in Japan. *IET Smart Cities, 2*(2), 89–94.

Ouhsine, O., Ouigmane, A., Layati, E., Aba, B., Isaifan, R., & Berkani, M. (2020). Impact of COVID-19 on the qualitative and quantitative aspect of household solid waste. *Global Journal of Environmental Science and Management, 6* (Special Issue (Covid-19)), 41–52.

Perteghella, A., Gilioli, G., Tudor, T., & Vaccari, M. (2020). Utilizing an integrated assessment scheme for sustainable waste management in low and middle-income countries: Case studies from Bosnia-Herzegovina and Mozambique. *Waste Management, 113*, 176–185.

Ragazzi, M., Rada, E. C., & Schiavon, M. (2020). Municipal solid waste management during the SARS-COV-2 outbreak and lockdown ease: Lessons from Italy. *Science of the Total Environment, 745*, 141159.

Sarkodie, S. A., & Owusu, P. A. (2021). Impact of COVID-19 pandemic on waste management. *Environment, Development and Sustainability, 23*(5), 7951–7960.

Sharma, H. B., Vanapalli, K. R., Cheela, V. S., Ranjan, V. P., Jaglan, A. K., Dubey, B., Goel, S., & Bhattacharya, J. (2020). Challenges, opportunities, and innovations for effective solid waste management during and post COVID-19 pandemic. *Resources, Conservation and Recycling, 162*, 105052.

Valizadeh, J., Hafezalkotob, A., Alizadeh, S. M. S., & Mozafari, P. (2021). Hazardous infectious waste collection and government aid distribution during COVID-19: A robust mathematical leader-follower model approach. *Sustainable Cities and Society, 69*, 102814.

Van Fan, Y., Jiang, P., Hemzal, M., & Klemeš, J. J. (2021). An update of COVID-19 influence on waste management. *Science of the Total Environment, 754*, 142014.

Vanapalli, K. R., Sharma, H. B., Ranjan, V. P., Samal, B., Bhattacharya, J., Dubey, B. K., & Goel, S. (2021). Challenges and strategies for effective plastic waste management during and post COVID-19 pandemic. *Science of the Total Environment, 750*, 141514.

You, S., Sonne, C., & Ok, Y. S. (2020). COVID-19’s unsustainable waste management. *Science, 368*(6498), 1438.

Zimstats. (2012). Census 2012 National Report. Population Census Office, Causeway, Harare.

Zimstats. (2018). Quarterly Digest of Statistics: Third Quarter 2018. Causeway, Harare.

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