



(RESEARCH ARTICLE)



Efficiency of solid waste management methods in Karu Local Government Area, Nasarawa State, North Central, Nigeria

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Publication history: Received on 17 November 2020; revised on 24 November 2020; accepted on 27 November 2020

Article DOI: <https://doi.org/10.30574/wjarr.2020.8.2.0428>

Abstract

The efficiency of solid waste management in Karu Local Government Area, Nasarawa State was studied through the administration of questionnaires to heads of household using systematic sampling methods. The study covered a wide range of socio-economic and demographic variables from the households, such that income of household heads, household size, educational status of household heads, methods and frequency/efficiency of waste collection; waste bins by households and disposals facilities used as well as the role played by government in waste management in the study area were investigated. The study area was divided into Masaka, Karu and Mararaba communities. The results were largely based on the data generated through the administration of questionnaires. 300 copies of questionnaires were administered to household heads in the three areas selected, where Masaka area had 75; Karu area had 108 while Mararaba area had 117. It was deduced that solid waste generated in all the areas remained for days or weeks without been evacuated and containers used for waste collection are not adequate, majority of household heads in the three areas use either plastic or metal buckets to collect and disposed their waste at the locations designated containers for such are placed and also that the socio-economic characteristics varied in all the three areas. Furthermore, at 5% level of significance, H-calculated (as against H_0 , efficient waste management) for the three communities were $0.178 < 5.99 < 9.21$, and are all higher than 0.05 with the implication that solid waste management is not efficient in all the areas. It is therefore, recommended that Nasarawa State should as a matter of priority release more funds to the body that is responsible for management of wastes through Nasarawa State Berau of waste management, a unit under Nasarawa Urban Development Board to cope with the increasing volumes of wastes in the study area. This will help to reduce the high rate of the likelihood of outbreak of epidemic.

Keywords: Waste; Management; Efficiency; Household; Pollution

1. Introduction

Solid waste is any material which comes from domestic, commercial and industrial sources arising from human activities which has more or less no value to the people who possess it and is discarded as an unwanted material at a particular period of time and which could be useful at some other points [1]. Solid waste management relates to all the strategies involved in handling wastes from generation to final disposal. It also refers to source separation, storage, collection, transportation and final disposal of waste in an environmentally sustainable and friendly manner. In the light of the above, solid waste management is regarded as an important environmental health service, and an integral part of urban services. The implications of poor waste management can be very hazardous to the people exposed to these unsanitary conditions. Diseases such as cholera, dysentery and malaria are all related to the practice of poor waste management which can results to loss of human resources needed in the development process.

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The responsibility of collection, transfer and disposal of waste has been generally assumed by metropolitan governments in both developed and developing world, this constitutes the basic and expected government function. This practice varies in most urban areas where solid wastes are collected either by government agencies or private contractors. Despite the fact that developing countries do spend about 20 to 40 per cent of metropolitan budgets on waste management, they are unable to keep pace with the scope of the problem [2]. The governments of African countries were required by the World Health Organisation (WHO) to prioritize their environmental health concerns, the results of which revealed that solid waste was identified as the second most important problem after water quality [3].

Since 1991 when the seat of the Federal Government of Nigeria was officially moved from Lagos to Abuja, the Federal Capital City of Abuja has been and is still witnessing tremendous influx of people. By the year 2010, it was estimated that the city is home to about 3.5 million people and that more than eighty per cent of this population live in the surrounding satellite towns. Furthermore, it is estimated that out of the over two million people residing in the satellite towns, about forty per cent reside in Masaka, Karu and Mararaba areas of Karu Local Government Area of Nasarawa State. With this influx of people outstripping the provision of basic infrastructures, one of which is solid waste management, it is believed that the intractable problem of solid waste collection and disposal is already being experienced in these satellite towns. Data concerning frequency of collection, size of collection equipment, are among others reliable information that can assist waste managers to optimize waste management strategies. It is therefore, the concern and the need to provide reliable information as a management strategy for Nasarawa State Urban Development Board (NUDB), the agency statutorily responsible for waste management in Nasarawa State that informed this research work. This Study focuses on efficiency of solid waste management in Karu Local Government Area of Nasarawa State. This study covers Masaka, Karu, and Mararaba satellite towns in Karu Local Government Area of Nasarawa State which are the closest of all the satellite towns to the Federal Capital City, Abuja.

1.1. Waste management

A critical concept worth mentioning is waste Management. Wastes, once generated, must be collected, processed and disposed. In view of the serious adverse environmental consequences of the practice of wastes dumping and disposal, there has been a progressive shift in the last quarter of the last century to waste management [4, 5, 6, 7]. Waste Management by definition, means the collection, transport, storage, treatment and disposal of wastes including the after care of the disposal site [8].

The management of waste is made up of processes. A step by step execution of these processes is required to satisfy the best management practice and thus schemes should be developed and run with at least, a considerable level of organisation for this activity to be efficient within any given territory or locality. If it must be treated or reused as a resource, it has to be manipulated. Finally, for any waste to be gotten rid of, it has to be disposed in the efficient/appropriate way or manner. The process of waste collection involves the initial movement of wastes from their origin to positions or locations that are more appropriate. Waste collection can be done with crews manually loading refuse into special vehicles, where the material is compacted to increase collection efficiency. In some cases, a mechanized collection system is used; where a driver uses a machine to automatically grab and place refuse into the compacting truck. Collection activities can be done either by public or private collection methods [7].

2. Study area

The study area is made up of Masaka, Karu and Mararaba, areas in Karu Local Government area of Nasarawa State. The study area lies between latitudes 8° 30' and 9° 30' N and between longitudes 7° 30' and 8° 10' E of Greenwich meridian (Figure 1). Karu Local Government Area is situated at the eastern part of the Federal Capital Territory, Abuja. It occupies a land area of about 27,116.8 square kilometres. The area is located in the North-Central geo-political zone of Nigeria and bounded to the west by Federal Capital Territory, Abuja, to the north by Kaduna State, to the east by Keffi and Kokona Local Government Areas and to the south by Nasarawa Local Government Area. The population of the entire Karu Local Government Area was two hundred and five thousand, four hundred and forty-five (205,445) people, according to National Population Census [9]. The major ethnic group are Gbagi and Nyankpa and other settlers.

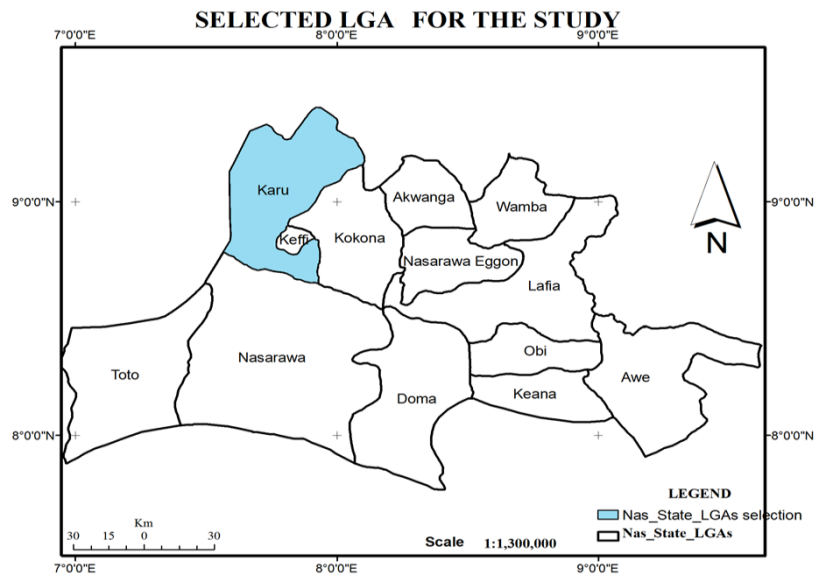


Figure 1 Map of Nasarawa State showing Karu LGA, the study area.

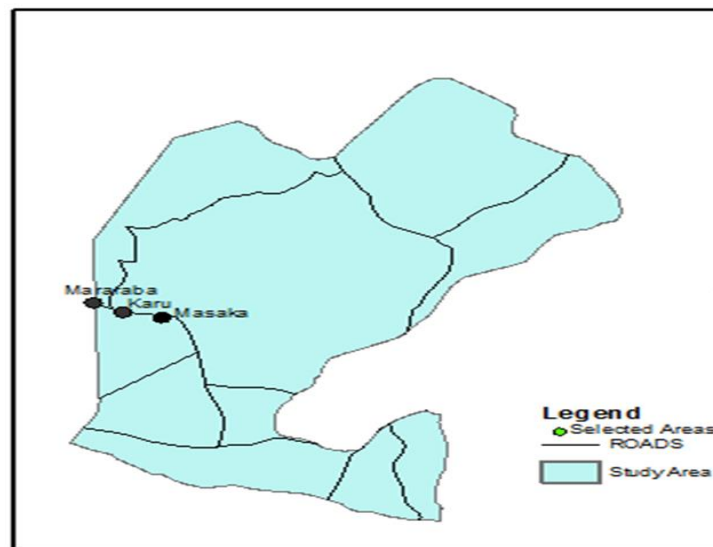


Figure 2 Selected communities in study area Masaka, Karu and Mararaba.

2.1. Socio-economic setting and land uses

Due to the agrarian nature of the area's economy, it guarantees a fast-ready market for various agricultural crops and products, which include maize, yams, beans, millet, cassava, oranges, and rice, among others. Fishing is also one of the major sources of income for the people within the riverine areas. The predominant land uses in the study area include, residential, commercial, educational, agricultural, and parks. Others include open space and green areas. Due to the influx of people into the study area as a result of movement of Federal Capital from Lagos to Abuja in 1992, there has been an increase in the demand for land for residential and other human activities. The dominant land use types are residential and commercial which are due to rapid urbanization and high population growth rates in the study area selected. Karu is one of the largest towns that make up the greater Karu urban centre in Nasarawa State as a conurbation consisting of towns and villages along the Keffi-Abuja expressway making up the Nyanya, Masaka, Karu, and Mararaba urban centres.

3. Materials and method

Various data required to achieve the objectives of this study were discussed including the data collection procedure, population and sample frame, reconnaissance survey of the areas selected, fieldwork and techniques employed for the

analysis of data were also looked into. Primary data were collected through the use of copies of structured questionnaire designed and administered to heads of sampled households. The questionnaire administered to heads of household covered a wide range of socio-economic and demographic variables from the households, such as income of household heads, household size, educational status of household head, methods and frequency/efficiency of waste collection; waste bins by households and disposals facilities used were investigated. The role played by government in waste management within the study area, among others were also studied. Based on the 2006 National population census, the estimated population of the study sites was 100,000, out of which Masaka has 25,000 (25%), Karu 36,000 (36%), and Mararraba 39,000 (39%) respectively.

Table 1 Sample frame for Questionnaire Administration

Communities Studied	Land Plots	Total Percentage	No Questionnaires	of	Sample Interval
Masaka	6,250	25	75		83
Karu	9,000	36	108		83
Mararraba	9,700	39	117		83
Total	24,950	100	300		-

Source: Reconnaissance Survey, 2019

Within a systematically sampled plot of land, one household was randomly sampled. The household within a sampled plot of land was numbered and the household numbered one (1) was sampled to be representative of all the households within the sampled plot of land (Table 1). Furthermore, the household sampled within a sampled plot was administered with a copy of questionnaire each. If a sampled land plot was found to be empty, or the residents of sampled land plot were not present for interview, the plot after the sampled land plot was selected as a replacement. Similarly, when it was also discovered that the sampled plot was an uncompleted building, a plot after the sampled plot was also selected as a replacement.

4. Results and discussion

4.1. Gender of Respondents

Figure 3 shows that 83% of respondents are male while only about 17% are female. This shows that majority of household heads interviewed are males who are married with children and this conforms to the cultural settings of the study area where societies are largely patrilineal. However, the 17% that are females represents widows, housewives separated from their husbands or divorcees who now head households.

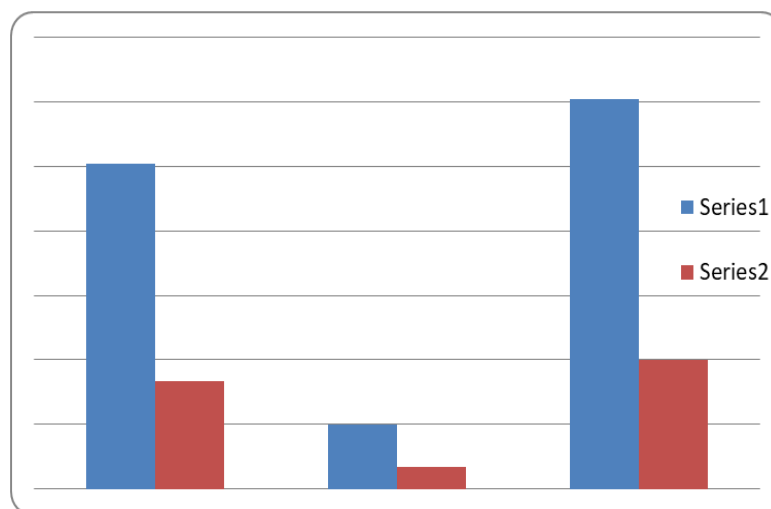


Figure 3 Gender of respondents

4.2. Marital Status of Respondents

Based on the data on Figure 4, about 71% of household heads are married and only 29% are single. This implies that household sizes would be significant, which will directly influence the volume and amount of waste generation in the study area.

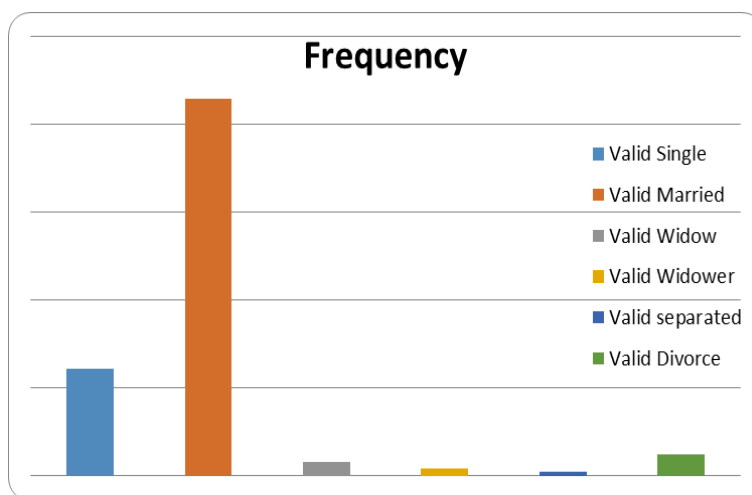


Figure 4 Marital Status of respondents

4.3. Household Size of Respondents

Household size of between 10 persons and above dominates the study area, constituting about 60% (Figure 5). However, the percentage of the family size of 1 to 9 is also significant and this represents 40% of those interviewed. This is in accordance with the national average family size of between 8 to 10 persons per household. Thus, those households with more than 10 persons may be those household with low level of educational attainment with culture and religion also playing important roles in the life of people. Those that married more than one wives also have a larger family size. Given the differential family sizes, it is expected that the amount of waste generated in the study area will be significant.

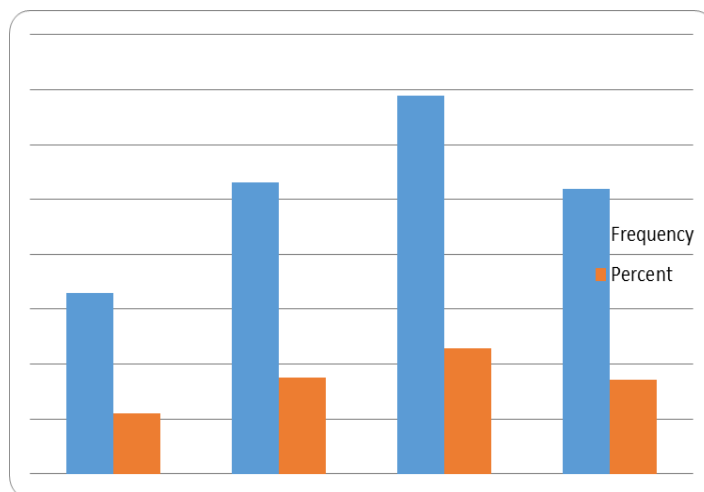


Figure 5 Household size of respondents

4.4. Educational Status of Respondents

The data on Figure 6 shows that 47% of household heads interviewed have tertiary education in the study area. While only about 20% did not attend school at all. However, about 12%, 15% and 5% have attended primary, secondary and vocational education in the study area respectively. These household heads are civil servants or private sector employees who possessed varying certificates. The implication is that there should be high level of environmental

awareness and consciousness in the study area and this has implications on waste and environmental management generally.

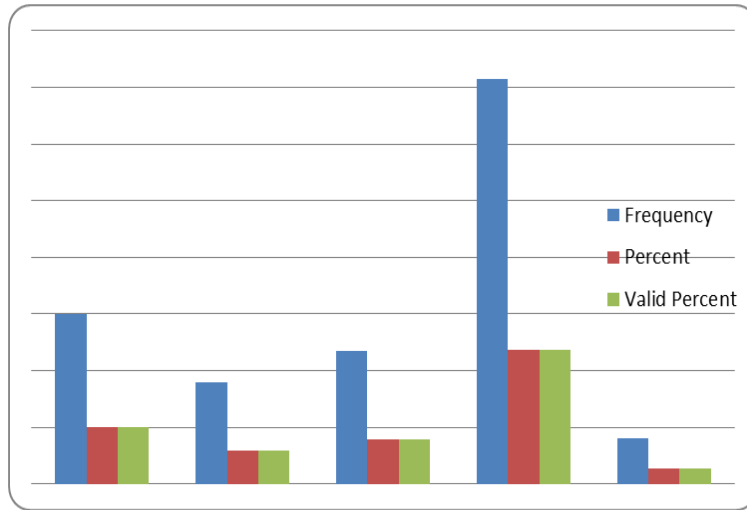


Figure 6 Educational Status of Respondents

4.5. Income rates of Respondents

Based on the data on Figure 7, most residents in the study area fall within the income rate of N20, 000 per month before the minimum wage of N18, 000 per month was introduced. While only 32% fall within the income range of N20, 000 – N100, 000. However, there are also people within the income range of N100, 000 and above who are residents in the area.

Furthermore, 60% of residents of Masaka, Karu and Mararraba are low income earners, and about 40% are medium income earners. Thus, there may be high income earners residents in the study area. This is clearly shown on the Figure 7. The implication is that the rate of waste generation should be significant in the study area. This is in accordance the results of the research work sponsored by World Bank on improving solid municipal waste management in India which revealed that income level, economic growth and lifestyle have strong influence on waste generation [10]

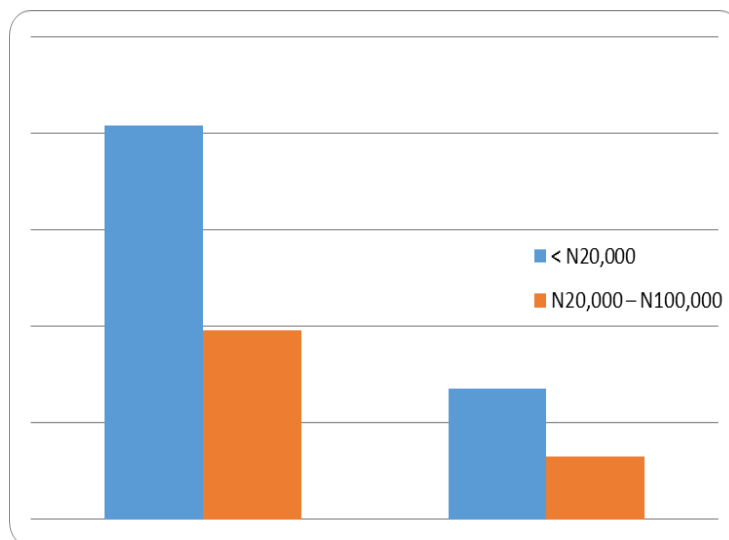


Figure 7 Income rates of Respondents

4.6. Method of Waste Disposal

Majority of household heads have their waste disposed of by Nasarawa State Urban Development Board (NUDB) (Figure 8). This is the most acceptable means of waste disposal, although most of the waste disposed at the depots remained at the dump sites for a long time before being cleared. However, only 18.2% and 10.3% dispose their waste at open dump and burning sites, these heads of household may be those who did not attend formal education or with less qualification, thus they are less aware of the environmental implications of indiscriminate dumping of waste and its serious implications on the environment.

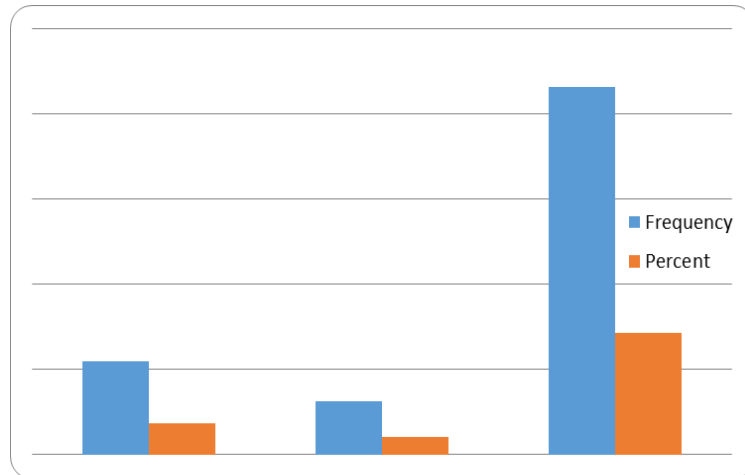


Figure 8A Method of Waste Disposal



Figure 8B Waste dumpsite at Mararraba



Figure 8C Waste dumpsite at Masaka

4.7. Payment for Waste Collection

As shown on Figure 9, 81.1% of respondents pay less than N1000 for waste disposal annually. While 10.9% and 7.9% pay between N1000-N2500 and N3000-N4500 for the disposal of waste on annual basis. The implication is that majority of respondents are not willing to contribute in solving waste management problems in the study area, which is in contrast with what is obtainable in Khurra Mahboob Bangladesh called Community Based Initiative to deal with solid waste management problems where households are motivated to pay for a door to door waste collection service which resulted to cleaner environment [11].

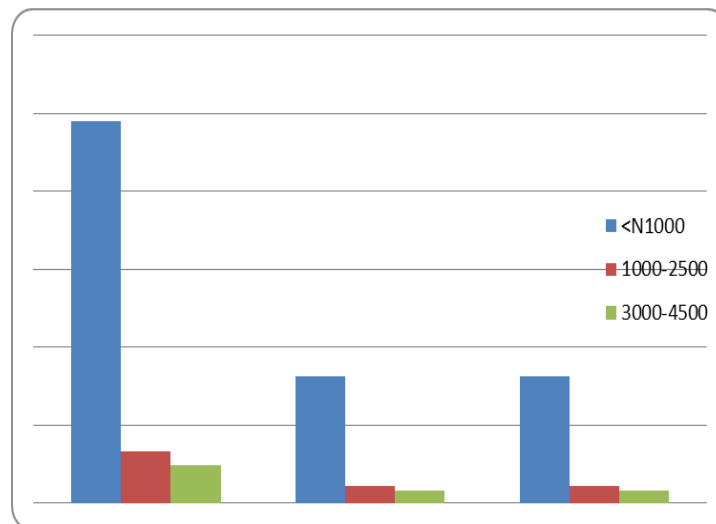


Figure 9 Payment for Waste Collection

4.8. Appropriateness of Charges for Waste Collection

The data on Figure 10 shows that 89.7% of respondents considered the charges for waste disposal in the areas as inappropriate and only 10.3% considered the charges as appropriate. However, those respondents that consider the charges to be appropriate could be among those that are not willing to contribute much in solving waste management problems, as waste is considered by most residents as the sole responsibility of government or Nasarawa State Urban Development Board (NUDB) to handle in the study area.

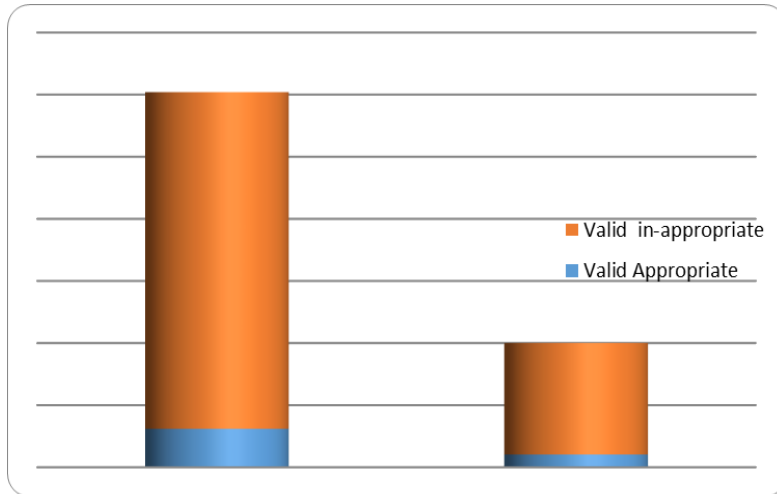


Figure 10 Charges for Waste Collection

4.9. Services Rendered by NUDB

The data on Figure 11 shows that 70.9% of heads of households observed the services rendered by Nasarawa State Urban Development board as inefficient. While 18.2% observed the services as highly efficient and 10.9% sees the services rendered as efficient. However, sometimes heaps of waste remains for several days or weeks before been cleared by the board may be the reason. In addition, those respondents that considered the services to be either highly efficient or efficient could be those with low level of education and environmental awareness in terms of waste management. This is in contrast with a survey carried out by Nigerian Institute of Social and Economic Research [12], where majority of residents of Ibadan were satisfied with refuse collection services.

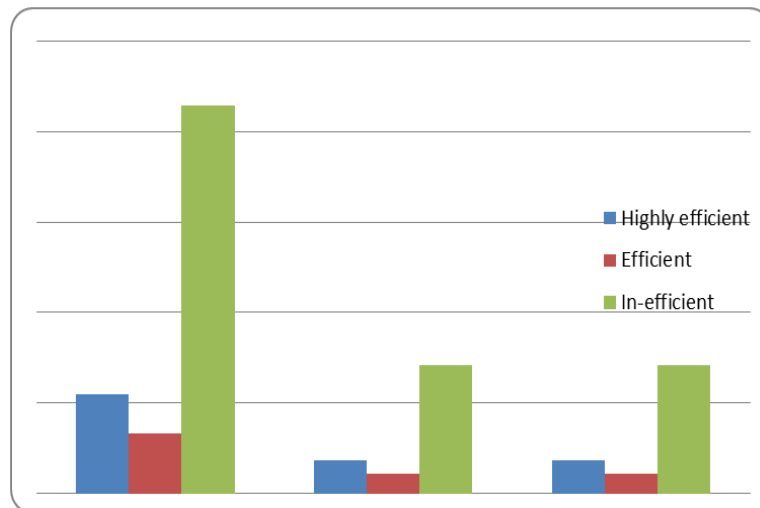


Figure 11 Services Rendered by NUDB

4.10. Frequency of Waste Collection by NUDB

The frequency of waste collection in the area as shown in Figure 12 where 62.3% of households waste is collected twice in a week, while 29.8% have their waste collected daily and only 7.9% have their waste collected forth nightly. With these results, it is expected that the environmental conditions in terms of solid waste management should either be good or fair, but the reverse is the case. The reasons for this may have to do with the method of disposal and the financial capability to handle such waste, where a lot of waste is never carried to the final waste disposal sites or properly treated or managed in the study area.

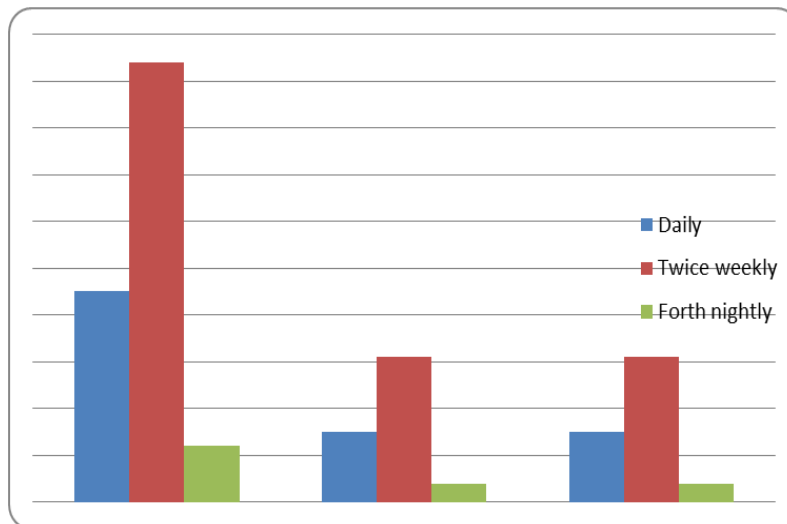


Figure 12 Frequency of Waste Collection by NUDB

4.11. Appropriateness of Waste Disposal by NUDB

Looking at the results in Figure 13, 59.9% of households considered waste disposal method in the area as inappropriate, 21.2% considered it to be appropriate, 10.9% observed the methods as highly inappropriate, while 7.9% considered the methods as highly appropriate. Those respondents that considered the methods as appropriate or highly appropriate could be those that dispose their waste directly into the waste collection tank provided in scattered locations by Nasarawa State Urban Development Board and also because of their level of environmental awareness.

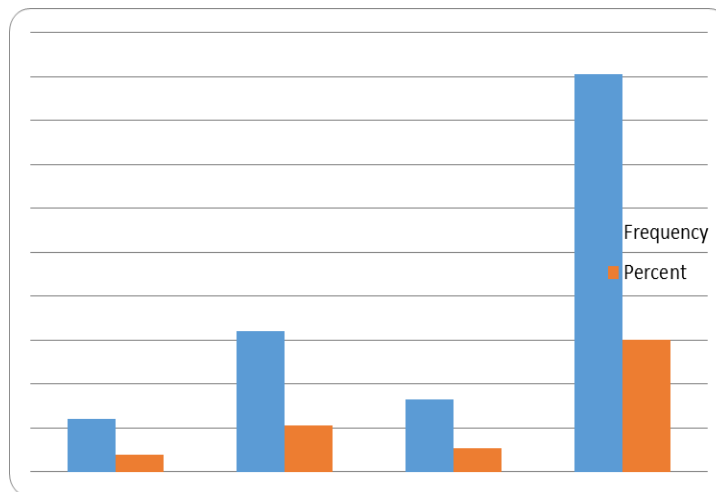


Figure 13 Appropriateness of Waste Disposal by NUDB

4.12. Waste Bins

Figure 14 is the statistics of the number of waste bins provided by Nasarawa Urban Development Board. The results show that the waste bins are inadequate, which formed 81.1% and 10.9% considered it to be very inadequate, while only 7.9% considered the number of waste bins to be very adequate. The Nasarawa State Urban Development Board has provided waste tanks in scattered locations, but because of constraints in terms of finance could be the reason which hinders adequate provision of waste bins in all the study sites. Majority of households provide these waste bins which clearly indicate their interest in managing solid waste at the source which is the most acceptable means of waste management at the source.

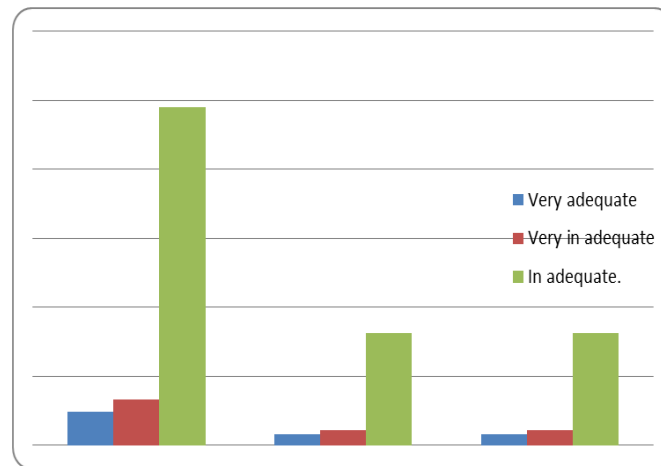


Figure 14 Waste Bins

4.12.1. Test of Hypothesis

Ho. The level of efficiency in solid waste management is high in all the three residential areas.

H1. The level of efficiency in solid waste management is low in all the three residential areas.

Result = H-test (equation (1) below)

$$H = \frac{12}{N(N+1)} \sum_{k=0}^K \frac{R^2}{n} - 3(N+1) \quad (1)$$

Where R = sum of the ranks in each sample, n = number of values in each samples, N = Total number of values and K = Number of samples.

H 0.05 = 0.178

H 0.05 = 5.99

H 0.05 = 9.21

Calculated H = 0.178 < 5.99 < 9.21 therefore, Ho is rejected, and the conclusion is that the level of efficiency in solid waste management is low in Masaka, Karu and Mararaba areas of Karu L.G.A of Nasarawa State.

5. Conclusion

The results of the research findings are in support of the following conclusions:

The results shows that majority of household heads interviewed are male who are married with children and dominated with household size of between 1-9 family size. This is concluded that, it is in line with the average family size of 8-10 per household. The implication is high population concentration and more waste generation.

Majority of heads of household interviewed attended tertiary education, but the results shows that significant number are not willing to contribute to waste management in the area, which makes it difficult for NUDB to handle waste efficiently in the study area.

The study showed that majority of household heads are low income earners, however, medium and high income earners also exist in the area. This has implications on waste generation and management in the area.

Majority of residents of the area have their waste disposed of by NUDB which is the most acceptable means of waste management, but waste remain at the depots for weeks before been cleared which has serious implications on the environment in the areas. This clearly showed that waste management by NUDB is not efficient. Furthermore, majority of household heads interviewed are of the opinion that waste management by NUDB is not efficient at all, because they are not frequently cleared by the Board. This was also confirmed from the results of hypothesis tested, which revealed that the level of efficiency in solid waste management to be low in all the three areas.

Compliance with ethical standards

Acknowledgments

Authors are grateful the Staff members, Nasarawa State Urban Development Board (NUDB) for their support by providing information related to waste management in the study area and for assisting in data collation.

Disclosure of conflict of interest

Authors declared that there is no conflict of interest in this research work.

Statement of informed consent

Informed consent of the household heads involved in the study was obtained through the collaboration the ward heads in the study area.

Author's contributions

ATO and ODO conceptualized the initial manuscript. ATO, ODO and MA contributed to the development of the initial manuscript. All authors critically reviewed the important intellectual content of the manuscript. All authors read and approved the manuscript at final stage

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