Solid waste management

Business, Management

SOLID WASTE MANAGEMENT PRACTICES WITHIN INFORMAL SETTLEMENTS IN NAIROBI: ACASE STUDYOF MATHARE BY Rosemary Kwamboka TABLE OF CONTENTSii LIST OF TABLESiii DEDICATIONiv ACKNOWLEDGEMENTSv ABSTRACTvi 1. 0 INTRODUCTION. 1 1. 2 Background of the Study4 1. 3 Problem Statement. 5 1. 4 Justification6 1. 5 The purpose of the study6 1. 6 Hypothesis6 1. 7 Specific objectives6 2. 0 LITERATURE REVIEW7 3. 0 METHODOLOGY11 3. 1 Area and population of Study12 4. 0 RESULTS14 5. 0 DISCUSSION17 5. 1 Statistical Analysis19 5. 2 Conclusions and Recommendations20 7. 0 REFERENCES23 6. 0 APPENDIX25

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Table 11: ANOVA F- Ratio Table for HoI16 ABSTRACT A solid waste management appraisal was undertaken in Mathare, an area affected by poor solid waste management strategy as evidenced by many informal dumping sites. Questionnaires were administered seeking data on demographic and waste management in four zones of the area. The rate of waste generation was determined by sorting and weighing of solid wastes produced by people living in the same house. The weighing was done every Friday of the week

for one month. The weights obtained were subjected to ANOVA to determine variation across the four zones.

Chi-Square test was used to investigate whether there was relationship between waste produced and family size. It was also used to test relationship between waste disposal methods, level ofeducationand income levels. F-calculated = 3. 34(2. 55), while the value of F from table is 2. 49 hence there was significant variation in the composition of waste generated. Chi-square showed that there was significant relationship between solid waste produced and family size. The critical value of X2 of 2 at 0. 05 level was 5. 99 from table (less than 164 calculated).

Hence waste disposal methods also depended on income and education level. In general management of solid waste in Mathare calls for more concerted efforts in the areas of public enlightenment campaigns, regular collection and disposal of generated wastes and extension of services to cover more inhabitants of the area. 1. 0 INTRODUCTION. Wastes are inevitable part of human activity. The problems associated with waste can be traced back to the very beginning of civilization, when humans gathered in communities (Priestly, 1968).

Wastes generated then were contained and disposed off by natural processes. However, as population increased and villages grew into towns and then into cities, the amount of waste generated increased. Consequently, wastes were dumped indiscriminately into waterways, empty lands and access roads. The appalling conditions gave rise to epidemics like the ‘‘ Black Plague’’ that destroyed large population of Europe in the 14th

century (Priestly, 1968). Similar conditions were also experienced in the other continents.

The industrial revolution that took place in Europe in the 19th century marked a turning point in waste management. It brought with it, among other things, migration of people from rural areas to towns and cities in search of jobs. The resulting concentration of people in towns and cities gave rise to alarming proportion of wastes being dumped in the streets and waterways. Legislations were passed by the governments of the day in order to curb the indiscriminate dumping of waste. Progress was slow until a positive link was established between vermin infested wastes and the spread of disease.

The discovery of pathogens as the agents of diseases that for centuries had been the scourge of mankind, paved the way to the modern sanitary practice. Waste is more easily recognised than defined. Something can become waste when it is no longer useful to the owner or it is used and fails to fulfill its purpose. Solid waste according to Miller (1988) is any useless, unwanted, or discarded material that is not liquid or gas. A great mixture of substances including fine dust, metal, glass, paper and cardboard, textiles, putrescible vegetable materials and plastic characterise solid waste.

The term municipal solid waste refers to solid wastes from houses, streets, public places, shops, offices, and hospitals, which are veryoften theresponsibilityof municipal or othergovernmental authorities. Solid waste from industrial processes are generally not considered" municipal" however they need to be taken intoaccount when dealing with solid waste as theyoften end up in the municipal solid waste stream. While urbanisationin

developing countries has contributed to wealth accumulation, it has also been accompanied by an alarming growth in the incidence ofpoverty.

Today, one out of four people in cities lives in " absolute poverty," while another one in four is classified as " relatively poor". Throughout the developing world it is these urban poor, often in the peri-urban areas, that suffer most from the life-threatening conditions deriving from deficient Municipal solid waste management(Zerbock2003). Municipal authorities tend to allocate their limited financial resources to the richer areas of higher tax yields where citizens with more political pressure reside.

Usually as income of the residents' increases, part of the wealth is used to avoid exposure to the environmental problems close to home, but as waste generation also increases with increasing wealth, the problems are simply shifted elsewhere. Thus even as environmental problems at the household or neighbourhoodlevel may recede in higher income areas, city wide and regional environmental degradation due to a deficient solid waste management remains or increases. Hudson and David (1977) observed thatin every human settlement, the microscopic unit of waste generation is the household.

The rate ofgeneration in the household is related to its size, lifestyle, type and quality of housing among othersocio-economic characteristics. In developing countries, an urban generated solid waste crisis is highly attributedto three factors: rapid increase in population, heavy consumption pattern of urban dwellers andinefficiency of the authorities whose statutoryroles include efficient refuse management. As time passes the only certainty is that accumulation of waste will outstrip its control. Throughout

the western world, there are no longer enough convenient holes in the grounds into which to tip unwanted matter.

The third world, having refused to become the “ dustbin” of the western world, also lacks appropriate storage facilities, treatment technologies, and good methods of disposal for its waste. Nairobi like many cities in the world suffers from poor waste management. Waste management is not an isolated phenomenon that can be easily classified and solved with one strategy. It is particularly an urban problem that is closely related, directly or indirectly, to a number of issues such as urban lifestyles, resource consumption patterns, jobs and income levels, and other socio-economic and cultural issues.

All these issues have to be brought together on a common platform in order to ensure a long-term solution to urban waste (JICA 1998). Rapidly growing, informally constructed low-income residential areas present a particular challenge to Municipal Solid Waste Management (MSWM). Besides the physical constraints of dense, low-income settlement, the inadequacies of other infrastructure services such as roads, drains and sanitary facilities often exacerbate waste management problems. The access of collection vehicles or push carts may be difficult where roads and foot-paths are npaved, for example. Existing drains are often clogged with waste materials, and solid waste itself may be contaminated with faecal matter. These conditions lead to a proliferation of vermin and disease vectors, and increase environmentalhealthrisks. The interrelated nature of service problems and the active role of residents- who are often owner-builders of their house call for adapted, sectorally integrated development approaches which depend, to a considerable degree, on the cooperation and participation of residents .

There is no single solution to the challenge of waste management. The waste management process is usually framed in terms of generation, storage, treatment, and disposal, with transportation inserted between stages as required. Hence, a combination of source reduction, recycling, incineration, and burring in landfills and conversion is currently the optimal way to manage solid waste. 1. 2 Background of the Study In Kenya like in many other developing countries, typically one to two thirds of the waste generated is not collected.

As a result, the uncollected waste, which is often also mixed with human and animal excreta, is dumped indiscriminately in the streets/wards and in drains, contributing to flooding, breeding of insect and rodent vectors and the spread of diseases such as cholera. Poverty Eradication Plan recognizes that waste management is almost non-existent in Kenya. It denotes that for instance in Nairobi, refuse is collected from only 20% of the population and only half of it is disposed in a proper way with the rest being dumped indiscriminately (Senkoro 2004/2005). Furthermore, little attention has been given to waste water disposal and storm drainage.

Drainage is poor and limited to major roads and pathways. Most local governments and urban agencies have, time and again, identified solid waste as a major problem and this has been attributed to poor institutional arrangements, poor technologies used and lack of the capacity to handle wastes. This has reached proportions requiring drastic measures. We can observe three key trends withrespectto waste - increase in sheer volume of waste generated by urban residents; change in the quality or make-up of

waste generated; and the disposal method of waste collected, by land-fill, incineration among others.

It is important that the right action be carried out at the right level. Thus, actions at the household level should be predominantly social, technologyand economic in nature. Similarly actions to be taken at the state and nation level should also be predominantly economic, political and administrative in nature. 1. 3 Problem Statement. Despite several efforts, legal and institutional frame works that are in place to enhance proper waste management, there is still persistent poor waste management.

It is estimated that Nairobi City Council (NCC) spends United States Dollars 1. 53 million per month to remove only 30% of the total waste generated (Simmens 2000). As amounts of solid waste increase, the cost of its removal increases too. Yet NCC does not have sufficient resources to completely and efficiently carry out this responsibility due to lack of proper institutional arrangements, poor technologies like modern trucks and the lack of the capacity by the council to handle the wastes generated. The result has been delays in disposing off this garbage.

Also the communities are ignorant of the best way to manage the waste, as there is a little community initiative to undertake collective action. The local people involved in this study area are considered to be poor. Therefore they are vulnerable to health hazards and environmental negative effects resulting from the delayed removal of solid wastes. Solid waste at informal disposal sites produces toxic gases, bad odour and createsair pollution. Given this situation there is need to promote complimentary alternatives such as community initiatives to remove garbage.

The microscopic unit of waste generation is the household. The rate ofgeneration in the household is related to its size, lifestyle, type and quality of housing among othersocio-economic characteristics. This problem of poor waste management requires innovative solutions and one of the solutions could be a participatory approach where the local people are involved to define the problem and then propose the solutions. Therefore, this study sought to explore the quantity of solid produced and possible measures which should be undertaken at household level to curb the same. . 4 Justification There are plenty of informal dumping sites due to the lack of collection of solid waste. These are mainly due to improper solid waste management at household level. Dumping sites pose a great health hazard to the inhabitants of the area. This has led to increased incidences of diseases such as coughs, diarrhea, fever among others, hence increasing public expenditure on drugs. There is consistent bad odour from the dumpsites. The aesthetic value of the area is also greatly reduced. 1. 5 The purpose of the study

The purpose of this study was to establish the quantity of solid waste produced and variation in the composition of household waste generated within Mathare. 1. 6 Hypothesis There is variation in the composition of household waste generated in Flats, Madoya and Ngei 2. There is no significant relationship between household size and amount of wastes generated. 1. 7Specific objectives ? To find out the means used to collect, transport and dispose off wastes. ? To establish the variation in composition of household waste generated. 2. 0 LITERATURE REVIEW

Waste is a man-made substance in a given time and places which in its actual structure and state is not useful to the owner or is an output without an owner and purpose. In other words, waste is anything that we no longer need. It is also commonly referred to as rubbish, trash, garbage, refuse, effluents and “ unwanted or unusable materials” (Zake 2007). It is important to note that wastes take two forms that is; solid or liquid wastes. Solid wastes refer to particles or materials which are no longer useful to their owners and which require to be discarded.

They are movable objects, which have no direct use and or no ‘ current’ market value or no use to the individual that they require to be disposed off. They are both organic/biodegradable for instance the waste generated from animal and plant remains; it may be broken down by living organisms such as bacteria, protozoa and fungi. This form of waste occurs as green plant tissue waste, foodremains, paper, animal and waste (faeces and urine), and non-organic/non bio- degradable wastes, is that form of waste that cannot be broken down by living organisms. It includes metals, polyethylene, most plastics and rubber.

Most non biodegradable wastes are produced from manufacturing industries. (Thomas-Hope 1998). On the other hand, Liquid wastes refer to waste materials that contain full liquids. These include waste water from industries, households; sewerage and leachates from land fill or garbage heaps. This is equally harmful to the water sources hence endangering both human beings who depend on such water sources and the aquatic life. It also destroys the land and its level of productivity since some of these wastes like grease,

paints will deepen into the soils hence affecting the soil alkalinity (Simmens, 2008).

The term ‘ Waste Management’ includes all issues and processes associated with the generation, processing, and disposal of all categories of wastes produced by human activities or related to human existence; it includes, therefore, the stages of production and minimization, collection, handling and transportation, reuse and recycling, and treatment and disposal of all such wastes (Zake, 2007). Despite the fact that waste handling and transport varies from region to region, country to country, there are waste management concepts that are universally accepted and implemented.

These are the waste hierarchy or the 3Rs (reduce, reuse and recycle), the extended producer responsibility (EPR) and the polluter pay principle. According to NEMA (2000), Solid waste management encompasses generation, collection, transportation and disposal of wastes. Authorities have the responsibility to ensure safe, reliable and cost effective removal and disposal of solid waste Garbage is collected from both the well to do households and poor ones. The management of solid waste is one of the challenges facing many urban areas in the world.

Where there is an aggregation of human settlements with the potential to produce a large amount of solid waste; the collection, transfer and disposal of that waste has been generally assumed by municipal authorities in the developed world. The format varies, however in most urban areas. Garbage is collected either by a government agency or private contractor, and this constitutes a basic and expected government function in the developed world (Zerbock2003). Waste management is undertaken mainly to minimize

the effect of wastes on resource loss and conservation, health, environment, costs and aesthetics.

It incurs financial and social and other costs including ‘ external’ costs. The term includes the issue of ‘ regulation’ of the various aspects of management of wastes. (Gourlay, 1992) Waste management is the process by which products and by-products generated by business and industry are collected, stored, transported, treated, disposed off, recycled or reused in an effort to reduce their effect on human health. Therefore, a properly managed waste; that is well collected and sorted recycled, treated, disposed off ygienically will promote a clean and safe environment to live in. Waste management is practiced by small businesses when they collect and sort their wastes, recycle their wastes, treat their wastes, dispose of their wastes or implement ways of reducing their waste (Simmens2008) Municipal solid waste (MSW) management has become a major issue of concern formany developing nations. The problem is compounded by rapid urbanization rapidlytaking place in many developing countries where 30-50% of populations is urban(Thomas-Hope 1998).

Some of the consequences of previous waste management policies include; continued air and landpollution, the pollution of fresh and marine waters, resulting in the disruption of ecosystem processes, habitat destruction and species loss. The amount of waste produced also places increasing pressure on the country's landfills. Increasing amounts of land set aside for landfills could lead to habitat destruction and species loss. (Gourlay1992). Problem areas of Municipal Solid waste management (MSWM) in developing countries can be identified.

These are described as inadequate service coverage and operational inefficiencies of services; limited utilization of recycling activities; inadequate landfill disposal, and inadequate management of hazardous and health waste. The quantity of waste arising – solid, liquid and gaseous are generally considered to be growing across the globe as a result of increase in the world’s population, increasing industrialization, increasing urbanization and rising standards of living. (Senkoro 2003) Greatly increased recycling in this country could be reached through several measures.

Some analysts claim that 50% to 80% of the nation's natural resources could be recycled or reused in the near future. Some measures to achieve this include enacting a national bottle bill into law, banning disposable plastic items, requiring labels on products made with recyclable materials and the percentages used, using education and advertisements to discourage the " throwaway" mentality, requiring households to separate wastes for recycling (or offering financial incentives for doing so), and decreasing subsidies for virgin-material industries, and providing subsidies for secondary-material industries and waste reduction programs. Simmens2000). Indeed the overall problem of MSW is multi-faceted: many organizations, including the United Nations (UN) and various non-governmental organizations (NGOs) advocate for an integrated approach to MSW management by identifying key stakeholders, identifying specific issues which comprise important “ stumbling blocks”, and making recommendations based on appropriate technologies, local information, and pressing human and environmental health concerns (Thomas-Hope1998). 3. 0 METHODOLOGY

The study was carried out in four different parts of Mathare namely: Mathare North, Flats, Ngei 2 and Madoya. Questionnaires were administered to 2, 060 respondents in these areas. The first part of the questionnaire sought to obtain demographic data such as family size, educational level, occupation and income status. The second part was to obtain information on waste management as regards: cleanliness of the environment, disposal methods and environmental effect of solid wastes among others.

Of the 2, 060 questionnaires administered 2, 001 were received given 97% response. Household approach was used in determining the rate of waste generation in the area. This involved sorting out and weighingwastes from selected households for three consecutive days. One household was selected from each zone. The rates were obtained by dividing the waste measured (in kg) by the number of people in the household. The average for the area was then obtained by adding individual rates for the different zones and dividing by the number of households used.

Personal interviews were conducted and at same time usingobservationmethod where the occurrence of the social events or phenomenon was recorded. While interviewing, the researcher was guided by both structured and unstructured questionnaires which worked asinterviewguide. The researcher used questionnaires to people who can ably read and write, and interview guide to people who couldn’t read or write hoping that these would be resourceful sources of information. Interview guides were designed and reviewed by the researcher. Both open-ended and closed-ended questionnaires were used for data collection.

Mostly closed-ended questionnaires were used to collect easily analyzable data. A set of question guides were prepared for reference by the researcher and once acceptable the questionnaires were pre-tested before they were finally put to use. Secondary data is the use of already collected data that was not specifically gathered for the research question at hand. The 2009 census and housing report came in handy in knowing the population of the respective areas (GOK 2011). Masterplan on Solid Waste Management in Nairobi in by JICA n 1998 explained the various factors contributing solid waste management problems in Nairobi. Intergrated solid waste management plan for Nairobi for the city of Nairobi(2010) by United Nation Environment programme(UNEP). Solid waste contained in plastic bag was weighed and then sorted into respective groups. The weight of a certain group was divided by total weight and multiplied by 100 to get the percentage. The percentages obtained were tested using analysis of variance (ANOVA) to determinevariation in the composition of waste in the four study areas.

Chi-Square (X2) technique was used to test for relationships between household size and amount of waste generated, educational attitude to people’s waste disposal methods and income versus peoples demand for improved solid waste management. 3. 1 Area and population of Study Mathare is the second largest slum in Kenya after Kibera, and probably the third largest in the south of sub-Sahara Africa. It has an estimated population of more than half a million, which forms almost a quarter of Nairobi city population. The host country has a total population of 38. 6 million (GOK 2011).

The slum is located 4. 5 kilometres from the Nairobi city centre. Initially, Mathare was a quarry but due to protracted poor economic condition that the country has been experiencing in the recent past, this quarry was turned in to informal human settlement . Indeed the population living here is not out of their own choice but rather dictate of the prevailing poor economic condition. The area is characterized with clumped informal structures. There is no proper infrastructure or even a sewer line. One of the greatest challenges of the people in this area is the disposal of the human waste.

There are about a few public toilets, which are only accessible by the very advantaged people, and therefore a good number of the people opt for open toileting and other " flying" toileting. 4. 0 RESULTS Table 1 shows the average family size and the amount of wastes generated. Table 1: Average Family Size and Amount of Wastes Generated Average size of familyTotal respondentsAmount of waste(in Kg)Percentage(of total),% Less than 5 persons84893320. 7 6-10 persons7902278161. 7 More than 10 persons361792. 117. 6 Total20014506. 1100 Table 2 shows the income status of respondents. It aims to show the purchasing power hence consumption.

Table 2: Income Status of Respondents (Per Month) Income, KshsNumber of RespondentsPercentage,% Less than 500076938. 4 6000-1500078039 15000-3000029114. 5 31000-500001105. 5 Above 50000512. 6 Total2001100 Table 3 shows the gravity of solid waste management according to the respondents. Table 3: Seriousness of Solid Waste Management Problem as Perceived by the Respondents. PerceptionNumber of RespondentsPercentage,% Not serious39019. 5 Not very serious26913. 4

Serious41120. 6 Very serious88144. 0 No opinion 502. 5 Total2001100 Table 4 shows the cleanliness of the area according to the respondents.

Table 4: Cleanliness of the Area SituationNumber of ResponsesPercentage,% Very dirty59229. 6 Dirty67833. 9 Okay58029. 0 Clean 613. 0 Very clean904. 5 Total2001100 Table 5 matches educational levels with methods of solid waste disposal. Table 5: Matching Educational Levels with Methods of Solid Waste Disposal. Disposal methods Respondents by Educational Level No EducationLittle EducationHigher EducationRow Total% Street bins9814018041821 Throw on open land3012192154127 Bury it5030391196 Feed to animals302120713. 5 In drains /street1991503138019 Burn it1011399933916. 9 Burn/bury it2151611336. Total8007504512001100 Table 6 shows the frequency of solid waste removal by government. This aims to show the seriousness of government in solving the problem. Table 6: Frequency of Solid Waste Removal by Government FrequencyNumber of ResponsesPercentage,% Daily1306. 5 Weekly28814. 4 Once a month (at most)56128. 0 Not at all102251. 1 Total2001100 Public awareness is important in enlightening the people on the effects of improper solid waste management. It aims at reducing the cascade effects. Table 7: Environmental Awareness Campaign AwarenessNumber of ResponsesPercentage,% Yes66033 No134167 Total2001100

Table 8: Household Solid Waste Composition in Mathare Sample CompositionNgei 2Mathare NorthFlatsPercentage,% Putrescibles21151617. 3 Polythene/cellophane40221519 Paper14101412. 7 Metal1011910 Glass 71098. 7 Textiles 9121311. 3 Fines (ash, dust and sand)10121412 Miscellaneous 9 810 9 Table 9 shows solid waste generation in the study

area. Table 9: Rates of Household Solid Waste Generation in Mathare ZoneRate (in kg/p/day) Mathare North0. 49 Flats0. 41 Ngei 20. 45 Madoya0. 44 Table 10: ANOVA Statistic for HoI CompositionNgei 2(x1)Mathare North(x2)Flats(x3) (X1)2(x2)2(x3)2 Putrescibles211516441225256

Polythene/cellophane202215400484225 Paper141014256100256 Metal1019100181 Glass71094910081 Textiles9131381169169 Fines (ash, dust and sand)101214100144256 Miscellaneous98108164100 F0. 05 (2, 21)= 2. 49 Table 11: ANOVA F- Ratio Table for HoI (a) Source of Variance, (SV)(b) Sum of Squares, (SS)(c) Degree of Freedom (D/F)(d) Variance Estimate (V/E) Between Samples37502535. 71 Within Samples-336621160. 29 Total Variance38423 Table 12: Chi-Square Frequency Table for HoII Household SizeNumber of ResponsesAmount in KgPercentage,% Less than 5 persons84893320. 7 6-10 persons792278161. 7

More than 10 persons36179217. 6 X20. 05(2)= 5. 99 5. 0 DISCUSSION Majority (59%) of the respondents fall within the economically active group (20- 50 years). The interest here is that they have the purchasing power to consume and hence generate wastes. A good proportion of the respondents are married. But singles dominate by a narrow margin. Married life affects family size which in turn influences consumption patterns and waste generation and management. Married people encourage meals that are African in nature and minimum packaged food with attendant wastes like cellophane materials.

Single people on the other hand consume more of packaged foods which generate cellophane materials as wastes. With respect to the family size, most families have less than 5 members, or at most 6-10persons as depicted

in Table 1. Large familiesgenerate more waste than small size families. Income status of a people is an instrumental factor in demanding for goods andservices. The income status of the respondents is presented in Table 2. The table reveals that 39% of the respondents earn between 6, 000. 00 –15, 000. 00 per month; while 38. 4% of the respondents earn less than 5, 000. 00 per month.

The rest earn above 15, 000. 00 per month. These figures were chosen because they represent the ranges within which peoples income fall. It is clear that low income earners (? 15, 000. 00) dominate the sample surveyed (77. 4%) The gravity of a problem is visualized by the perception of the people affected or concerned. In the study area, majority of the people considered the problem of managing solid wastes as very serious (44%) as indicated in Table 3. In terms of cleanliness of the area, about 64% of the people described the area as being either very dirty or dirty (see Table 4).

The preference of educated people to adopt better methods of waste disposal could be higher than illiterates, see Table 7. It is obvious from the table that most of the people who throw refuse on open land and drains are uneducated. Those who keep waste bins or burn it are mostly those with higher education. In general 46% of the respondents either throw their waste on land or in drains/street. Only 21% of the respondents deposit their waste in bins where they can be transferred to the designated points for ultimate disposal.

This is in consonance with the observations of, Muthiomi et al (2005) that solid waste management fall short of expectations in urban areas of Kenya because of use of unconventional and non environmental friendly methods of

disposal. Table 6 shows the frequency of removal of solid wastes by government agencies. Majority(51. 1%) of the respondents reported that wastes are not removed from their areas. While 28% said wastes are evacuated at most monthly. This delay in the removal of wastes from points of generation constitutes a potential source of pollution.

For instance, pollution of groundwater by leaching and percolation and stream waters by surface runoff. Besides delay in evacuation, public enlightenment campaigns to sensitize the public on the need to preserve the quality of the environment have not being satisfactory as indicated in Table 7. The household solid waste composition in Mathare was studied by sorting and weighing. Three zones namely Ngei 2, Mathare North and flats were selected for this study. It is clear from Table 8 that the dominant materials are putrescibles (food remnants, fresh leaves and vegetation etc). The decomposable wastes could be reused as compost manures.

Others such as papers and metals are recyclable. Table 9 shows rate of solid waste generation in the study area. Mathare North generates 0. 49 kg/p/day and is the highest for the area. While the least value of 0. 41 kg/p/day was obtained in Flats. On average, the rate of generation of solid waste in Mathare area was calculated to be 0. 44 kg/p/day. 5. 1 Statistical Analysis HYPOTHESIS I Ho – There is no significant variation in the composition of household solid waste generated in Mathare. The data in Table 8 was subjected to ANOVA F ratio test because of its reliability in testing variation among samples.

The statistics is shownin Tables 10a and 10b. The computed ANOVA issummarized as follows: i. Total Variance (Total Sum of Square, TSS) =? X2-

(? x)2 = 384 N ii. Total Degrees of Freedom (D/F total) = N – 1 = 24 -1 = 23 iii. Between Samples Sum of Squares(BSS) = ? x1+ (? x2)2 + (? x3)2 = 3750 nx1 nx2 nx3 iv. Between Samples D/F = K – 1 = 8 – 1 = 7 v. Within Samples Sum of Squares, WSS = TSS – BSS = 384 -3750 = -3366 vi. WSS D/F = D/F total – BSS D/F = 23 – 7= 16 F-calculated = 3. 34(2. 5), while the value of F from table is 2. 49. Hence we reject Ho and H1 because F calculated is greater than F-tabulated. This implies there is significant variation in the composition of the household solid wastes generated in Mathare. HYPOTHESIS II Ho – There is no significant relationship between household size and amount of wastes generated. The Chi-Square statistics was employed for this analysis. It's appropriate in this case because it compares differences between observed and expected (theoretical) frequencies. The values in column three below (Table 13) are obtained from Table 3.

The expected frequency for a unicollumn table is given by the mean as 150. 2. While Chi-Square is given as X2 = ? (0-E) 2/2 and Degree of Freedom (D/F) = N – 1 = 3 - 1 = 2. The critical value of X2 of 2 at 0. 05 level is 5. 99 from table (less than 164 calculated, see Table 13). Hence we reject Ho and accept H1. This means there is significant relationship between household size and amount of wastes generated. The results of the Chi-Square test on the other parameters revealed that: i. Education has significant effect on the people's disposal methods. ii.

The effect of income on willingness topay for solid waste managementservices is significant. 5. 2 Conclusions and Recommendations In developing countries, urban generated solid waste crisis is highly attributed to three factors: rapid increase in population, heavy consumption

pattern of urban dwellers and inefficiency of the authorities whose statutory roles include efficient refuse management. The Ministry of Environment(2002) attributed the problem of solid waste in urban areas to the following: i) Overgrowing urban population with its characteristic increase in the rate of solid waste generation; i) Inability of the local government councils to cope with the problem of solid waste management due to inadequate technical and financial resources; iii) Peoples belief that solid waste management is a social service and hence their unwillingness to pay for disposal charges ; iv) The inability of people to discern what constitute wastes and reusable wastes. Poor solid waste management has the potential of causing flooding. It also encourages the spread of diseases, pollution of ground and surface waters, air pollution, land pollution and can distort the beauty of an area.

It could even result in road accident due to obstruction of traffic flow, for instance where refuse are dumped on streets and roads. The processes of field survey, data collection, administration of questionnaires and data analysis has been presented in this report. Based on the findings, the following conclusions are drawn: 1. Demographic variables like occupancy rate, socio-economic class and education affect solid waste management. The greater the size of the household the greater the tendency to generate more wastes. 2.

Many people (64% of the respondents)believe that it is the responsibility of the government to manage solid waste and hence have care free attitude towards the management of the environment 3. Government’s management of solidwaste is inadequate. This manifests indelays in collection of wastes

for disposal and near absence of service in some areas. Also, public enlightenment campaigns have not been satisfactory. 4. There is significant variation in thecomposition of household wastes; the dominant materials are putrescibles and polyphone/cellophane. It is therefore recommended that: Government’s effort should be intensified in the areas of awareness campaigns, provision of equipment and personnel in removing solid wastes as well as ensuring compliance with existing environmental laws. ? Composting the putrescible part of the wastes will be a source of raw material inorganic fertilizer blending plants. 7. 0 REFERENCES 1. Beede, D. N. , Bloom, D. E. ,(1995) The economics of municipal solid waste. World BankResearch Observer, 10(2) 2. Evaluations of Waste Treatment and Disposal Technologies for Municipal SolidWaste. Applied Ecology 58, pp. 2009-255. Kapoor B. S (2001). Environmental Sanitation.

Chand and company. Ltd. New Delhi 3. NEERI (1996) Report “ Strategy Paper on Solid Waste Management in India”, pp. 1-7. 4. National Environment Management Authority, 2000 5. NEMA,(1998). Caring for our Environment A Handbook for Local leaders, NEMA in conjunction with Friedrich Ebert stiftung (FES). 6. Zerbock O. (2003). Urban Solid Waste Management, Waste Reduction in Developing Countries. Available on http://www. cee. mtu. educ/peacecorps/documents-july03. wastereduction and incineration FINAL. PDF. 7. DEAT. (1999a). National Waste Management Strategy: National waste management strategies and action plans, South Africa.

Strategy formulation phase. Version D, 15 October 1999. 8. Agarwal, A. , Singhmar, A. , Kulshrestha, M. , and Mittal, A. K. (2005). „ Municipal solid waste recycling and associated markets in Delhi, India?. Resources,

Conservation and Recycling. 9. Ebreo, A. , & Vining, J. (2000). Motives as predictors of the public’s attitudes toward solid waste issues. Environmental Management. 10. Adekoge, O. S. , 1990. Waste Management within the Context of Sustainable Development, FEPA Abuja. 11. Hudson, J. F and David, H. M. , 1997. Solid Waste Generation and Service Quality. Journal of Environ. Eng. Division ASCE 103, pp 935-946 12.

Onibokun, A and Kumuyi A. J. , 1999. Ibadan, Nigeria in: Onibokun A. G (Ed) Managingthe Monster: Urban Waste andGovernance in Africa IDRC pp 49-100 13. Ministry of planning , Government of kenya, 2009, Kenya census of population and housing 6. 0 APPENDIX This questionnaire was designed for a research on problems of solid waste management in Mathare. The answers provided therefore shall be treated confidentially. SECTION A: BIO DATA 1. Gender: a. Male b. Female 2. Age: a. Less than 17 yearsb. more than 17 years 3. Marital status: a. Single b. Married 4. Average family size and waste generated: a. Less than 5 persons . 6-10 persons c. More than 10 persons 5. Income status of the respondent: a. Less than 5000 c. 16000-30000 e. Above 50000 b. 6000-15000 d. 31000-50000 5. Educational background: a. No education b. Little education c. Higher education SECTION B: ATTITUDES AND PERCEPTIONS OF PEOPLE 6. Gravity of Solid Waste Management Problem as Perceived by the Respondent: a. Not serious b. Not very serious c. serious cerious d. Very serious e. No opinion 7. How clean is the area? a. Very dirty b.

Dirty c. okay d. Clean e. Very clean 8. Are there any environmental awareness campaigns carried out? a. Yes b. No 9. How frequent does the government remove solid waste? a. daily b. weekly c. Once a month (at

most) d. Not at all 10. How do you dispose of your refuse? a. Street bins b. Throw on open land c. Bury it d. Feed to animals e. In drains/street f. Burn it g. Burn/bury it