THE IMPACT OF URBANIZATION ON THE WASTE MANAGEMENT IN RWANDA. A CASE OF KAGARAMA SECTOR KICUKIRO DISTRICT 2010-2020

RUKEMAMPUNZI Olivier
Dr. MANIRAGABA Abias

Abstract

The study entitled "the impact of urbanization on the waste management in Rwanda. A case of Kagarama sector in Kicukiro District 2010-2020" was conducted to assess how urbanization has affected waste management in Kigali city more specifically in Kagarama sector. Due to the insufficient data from waste collecting companies and secondary sources, primary data were used to complete the data gap. Primary data were collected from a survey of 356 households located in Kagarama sector. Pictures were taken and waypoints were taken using GPS to allocate households and places of poor handled waste. Data analyses were made using descriptive and inferential statistics and special data were interpreted based on the key observations. Findings shows that urbanization in Kigali city is increasing but is associated to unplanned urban houses where which 79.7% in Kagarama sector, Kicukiro district.

Assessment also has revealed that, around 46.5% of households in area of the study are disposing domestic waste in poor landfill, The correlation analysis has shown that urbanization is contributing to 46.4% in waste management while remaining percentage or rate is for other factors not captured by this study. Good urbanization policies and plans could include measures of waste management. Based on the study findings, Kigali city authorities were recommended to develop measures for households handling waste in environment not through waste collection companies. Households also are encouraged to separate waste from the source as well as facilitate by paying waste collection fees. To fill data gap, waste collecting companies were recommended to ensure regular records of waste collected by period and by waste forms.

Key Words: *Impact; Urbanization; Waste Management*

1. Statement of the Problem

Rwanda intends to become a middle-income country by 2024 (NST1 2018-2024) with this target, urbanization is expected to reach 35% moving from 17.31% of 2019 and 16.93% in 2010 [21]. Urban cities in Rwanda were not planned (cities master plan) before 2010, in different places people were constructing houses as they want without respect of any urbanization plan [14]. This has caused rise of slums and placement of people in high-

risk zones. From 2010, the government has made more changes and investments for moving people from high-risk zones to planned habitat areas mainly in Kigali city [21]. In the study conducted by [36] while assessing the status and challenges of waste management in Rwanda, In the city of Kigali, waste is managed by the city of Kigali whereas in other four remaining provinces waste is managed by the districts. Implementation of waste management policy is carried out by a government-owned company called Water and Sanitation Corporation (WASAC) Ltd [11]. The per capita solid waste generation rate in the city of Kigali is equal to 0.57 kg/person/day. A lot of legislations and regulations on waste management are in place but their enforcement is weak. The Government of Rwanda should do more in terms of enforcing waste management legislations and regulations [40].

The study conducted by [31], show that in City of Kigali, approximately 232,870 tons of MSW is generated per year, waste collection and transportation is done by private companies but the only dumpsite present in Kigali is fully controlled by the City of Kigali. Residents pay waste collectors according to their social classes and their locations [9]. There is no official recycling system; recycling activities are informally performed by private companies and some wastes, like plastic bottles, are taken to Uganda and Tanzania to be recycled. People who failure to get waste collection fees, they are supposed to keep the waste in households or elsewhere in the environment which result into poor waste management [30]. There are no measures for managing waste not collected by the companies in Kigali City [18]. Thus, this study intends to assess the impact of urbanization on the waste management in Rwanda [13]. It is limited to households in Kagarama sector on the way they respect urbanization process and how ensuring proper waste management from their households since last ten years [5].

2. Waste disposal in Kicukiro District

In Kicukiro district the main modes of waste disposal used by the private households is Private dust bins (45.5%), Sectors with high proportions of private households that discharge domestic waste in the Private dust bins are Kicukiro (79.1%), Gikondo (77.5%) and Niboye (67.8%) [24], Sectors with high percentages of households using compost dumping are Masaka (59.3%) and Gahanga (44.4%), Sectors with high percentage of private households disposing their waste on the farms are Gahanga (37.3%), Kagarama (25.6%) and Gatenga (23.4%), Public refuse dump is highly used in Niboye (14.6%) and Kicukiro (14.4%) sectors [38][28]. The main modes of waste disposal used by the households vary by area of residence. Urban households evacuate their waste mainly in the private dust bins (51.8%), in the compost dumping (16.5%), In rural areas, the households evacuate their waste mainly, in compost dumping (56.1%) followed by on farms (28%) and in the bush (10.1%) [2].

3. Conceptual Framework of the Study

Urbanization is the process of making a certain area transformed from rural to urban and this process is characterized by organized settlement, grouped settlement, developed infrastructure, change in living styles, administration around the people, mass movements, development of businesses (legal and illegal), slums etc [4].

All these activities should be associated to the mechanism of moving wastes from the area where people are living for the sake of their life [29][32]. The waste management in urban is suggested to be coordinated by creating proper landfill, waste separation, waste handling mechanism and awareness about waste collection fees collection, effects of poor waste handling methods and waste recycling technology.
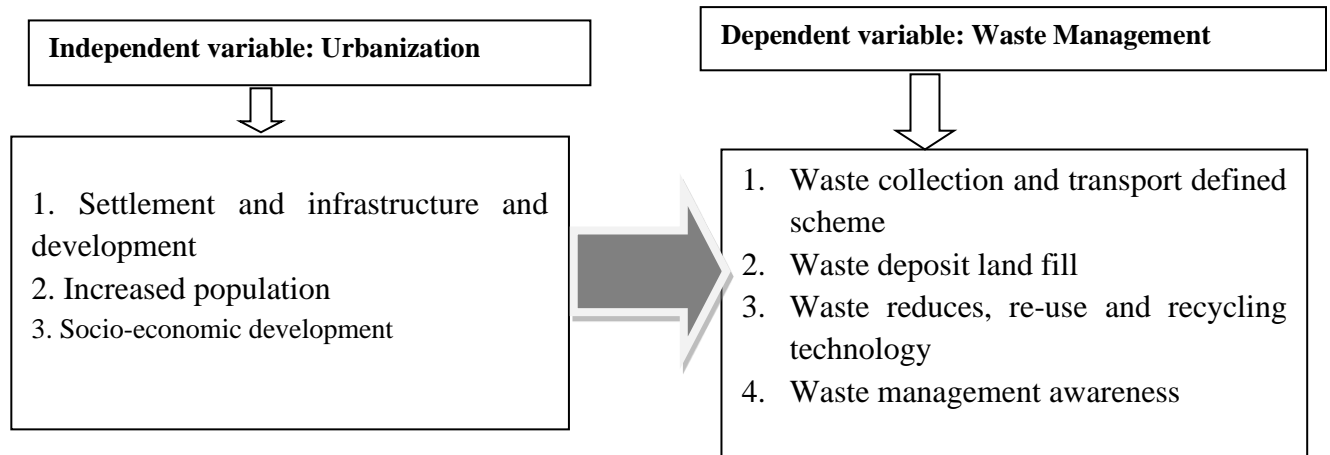
Independent variable: Urbanization	Dependent variable: Waste Management
1. Settlement and infrastructure and development 2. Increased population 3. Socio-economic development	1. Waste collection and transport defined scheme 2. Waste deposit land fill 3. Waste reduces, re-use and recycling technology 4. Waste management awareness

Figure 1: Conceptual Framework of the Study

4. Methodology

Due to the insufficient data from waste collecting companies and secondary sources, primary data were used to complete the data gap [34]. Primary data were collected from a survey of 356 households located in Kagarama sector. Pictures were taken and waypoints were taken using GPS to allocate households and places of poor handled waste. Data analyses were made using descriptive and inferential statistics and special data were interpreted based on the key observations.

5. Objectives of the study and hypothesis

The main aim of this study is to assess the impact of urbanization on the waste management.

The specific objectives of this study are in four folds:
  i.   To assess the process of urbanization in Kagarama Sector, Kicukiro District for the period 2010-2020.
  ii. To evaluate the waste management practice in place in Kagarama Sector, Kicukiro District for the period (2010-2020).
  iii. To evaluate the relationship between urbanization and waste management in Rwanda, specifically in Kagarama Sector.

The study intends to test of the following hypotheses:

H_0: There is no significant impact of urbanization on the waste management in Rwanda

6. Findings

6.1 Process of urbanization in Kagarama Sector, Kicukiro District as implemented in last ten years (2010-2020)

Urbanization is characterized by several characteristics, but in this section and from field observation and evaluation of respondents, the researcher has assessed both general views and households level characteristics on simple observed characteristics which are: Poverty, settlement, population density and movement as well as functionality of local administration authority [23].

Table 1: Types of habitats (Imidugudu, etc.), by district (EICV5, EICV4)

Year and District	Umudugudu	Unplanned clustered rural housing	Isolated rural housing	Unplanned urban housing	Small settlement	Modern planned area	Total Nber of HHs (000s)
EICV5 (2016/17)							
Rwanda	**58.9**	**6.5**	**16.8**	**14.2**	**0.7**	**2.8**	**2,708**
Nyarugenge	6.6	0.0	0.4	91.9	0.2	0.8	81
Gasabo	2.8	0.3	1.2	71.2	0.2	24.3	230
Kicukiro	4.8	0.0	0.2	79.7	0.4	14.9	98
EICV4 (2013/14)							
Rwanda	**49.2**	**8.7**	**25.6**	**12.8**	**2.2**	**1.6**	**2,493**
Nyarugenge	0.0	0.0	0.0	100.0	0.0	0.0	73
Gasabo	4.1	4.4	26.8	62.0	0.2	2.5	147
Kicukiro	2.6	0.0	0.3	91.8	0.0	5.3	76

Source: (NISR, 2018)

Reference to table 1, from 2013/14 to 2016/17 people living in Umudugudu were increased from 49.2% to 58.9% all over the country [6]. Unplanned housing rate in district or areas of Kigali city remain high, where 14.2% households in Rwanda live in unplanned urban housing, 91.9% for Nyarugenge district, 71.2% Gasabo and 79.7% in Kicukiro all information for the year 2016/17 [25]. This is the problem for urbanization effects on water and other environmental impacts. It is in that context some people remain living in high-risk zone and sometimes may lose their life mainly in rainy seasons. Once people live in unplanned urban housing area, also meaning that, there is insufficient infrastructure and protection against diseases is still at low level. And this is linked to the fact that, people are not able to ensure proper waste management (collection, transporting and deposit) [26][27].

Table 2: Contribution of households in urbanization process of Kigali City.

Urbanization Characteristics (Household level)	SA+A		D		n	Mean	Stdv.	Comments
	fi	%	fi	%				
The house (where I am living) was constructed with construction permit offered by administration and it is in line with Kigali Master Plan	304	85.4	52	14.6	356	4.16	1.006	Strong Heterogeneity
The place where I am living is not in risk zone	330	92.7	26	7.3	356	4.60	0.825	Strong Heterogeneity
My house has capacity to satisfy all members basic needs	304	85.4	52	14.6	356	4.01	0.940	Strong Heterogeneity
My family is above poverty line	304	85.4	52	14.6	356	3.93	0.896	Strong Heterogeneity
Local leaders or staffs always visit the households to verify the respect of Kigali master plan since last ten years	224	62.9	132	37.1	356	3.40	1.131	Moderate Heterogeneity
Based on my understanding my household merit to live in Kigali City, Kagarama sector as it has capacity to fulfill city requirements	317	89.0	39	11.0	356	3.97	0.790	Strong Heterogeneity

Source: Primary data, December 2020

Reference to the 1st study objectives "to assess the process of urbanization in Kagarama Sector, Kicukiro District for the period 2010-2020" [22]. Households themselves confirm that their houses were not constructed with the approval of Kigali city master plan (14.6%), households living in area of risks (7.3%), households with incapacity for satisfying member's basic needs (14.6%), families under poverty line (14.6%), families which are not regularly consulted by local authorities (37.1%) and Kagarama sector is not fulfilling the requirements of Kigali city master plan (11%).

6.2 Waste management practice in place in Kagarama sector, Kicukiro district as being applied since last ten years (2010-2020)

In this section, the researcher has assessed both general and individual observation on waste management in Kagarama sector as whole and in households as individual. For each among 356 households' members assessed the researcher has assessed general view or perception and observation at household level [7].

Table 3: Individual evaluation on waste management characteristics observed in household

Waste Management (Household level)	SA+A		D		SD		n	Mean	Stdv.	Comments
	fi	%	fi	%	fi	%				
My household has proper sac for keeping wastes	343	96.3	13	3.7	0	0.0	356	4.15	0.591	Strong Heterogeneity
My household does not use waste from other households or dumped in waste sac	343	96.3	13	3.7	0	0.0	356	4.11	0.565	Strong Heterogeneity
Some people take my household waste for re-use	52	14.6	238	66.9	66	18.5	356	2.11	0.872	Moderate Heterogeneity

Waste Management (Household level)	SA+A		D		SD		n	Mean	Stdv.	Comments
	fi	%	fi	%	fi	%				
My Household is always ensuring waste separation in different sacs	143	40.2	160	44.9	53	14.9	356	2.76	1.313	Moderate Heterogeneity
All household's member (in my household) is aware about the effects of poor waste management (except children under 7 years (primary education ages))	265	74.4	26	7.3	65	18.3	356	3.79	0.993	Strong Heterogeneity
I think waste collected in my household are dumped in proper place	238	66.9	26	7.3	92	25.8	356	3.67	1.126	Strong Heterogeneity
My household regularly pay waste collection fees (4,000 Rwfs per month)	265	74.4	91	25.6	0	0.0	356	3.71	1.081	Strong Heterogeneity
The local administration is communicating regularly about measures and policies for waste management	237	66.6	119	33.4	0	0.0	356	3.52	1.137	Strong Heterogeneity

Source: Primary data, December 2020

From all items assessed the lowest mean is 2.11 (which is weak mean) and the highest mean is 4.15 (strong mean) while to all items assessed the standard deviation remain heterogeneity (greater than 0.5). The households in Kagarama sector are not having proper sacs for keeping waste at household level (3.7%), some households (or children from other households) use waste from other households (3.7%), 14.6% of households members were observed other households using waste from their households, around 50% of households in Kagarama sector are not separating waste at household level, 25.6% of households are with households members who are not aware about effects resulted from poor waste handling and disposal, while around 33% households think that waste take from their households are not transported to proper landfill, 25.6% households are not regularly paying waste collection fees to the companies and 33.4% are not receiving communication from local authorities about waste management policies and guidelines in Kagarama sector.

6.3 Relationship between urbanization and waste management in Rwanda, specifically in Kagarama Sector

Analysis of relationship between urbanization and waste management was made using both Pearson correlation and linear regression analysis. The researcher has summarized data obtained from primary assessment of independent variable to 356 assessed respondents and same for dependent variable [3].

Table 4: Descriptive statistics

	Mean	Std. Deviation	N
Urbanization	3.642135	.5133924	356
Waste Management	3.489232	.2906355	356

Source: Primary data, December 2020

For independent variable, the mean was 3.642 to 3.489 for dependent variable, respectively the standard deviation was 0.512 (heterogeneity) to 0.290 (homogeneity). This meaning that urbanization process is good in Kagarama sector but not well implemented, there is still area for improvements and waste management also in Kagarama sector is not fully properly implemented at sector and household level in Kagarama sector.

Table 5: Correlation between household growth, urbanization rate and Waste generation per capita per year

Correlations

Tested indicators		Waste Generated per household /Year in Kigali	Household growth in Kicukiro District	Urbanization Growth
Waste Generated per household /Year in Kigali	Pearson Correlation	1	.915[*]	.841[*]
	Sig. (2-tailed)		.011	.036
	N	6	6	6
Household growth in Kicukiro District	Pearson Correlation	.915[*]	1	.979[**]
	Sig. (2-tailed)	.011		.000
	N	6	11	11
Urbanization Growth	Pearson Correlation	.841[*]	.979[**]	1
	Sig. (2-tailed)	.036	.000	
	N	6	11	11

*. Correlation is significant at the 0.05 level (2-tailed).
**. Correlation is significant at the 0.01 level (2-tailed).
Source: (Josephine, 2020)

As seen from table 5, reference to the findings of the study conducted by Josephine (2020), waste generation per household per year in Rwanda (urban areas) was estimated to 876kg in 2010; 2,920kg in 2012; 3,650kg in 2014; 3,650kg in 2016; 4,380 in 2018 increased to 5,110kg by 2020. The information on waste generation was tested versus household's growth in Kicukiro district and urbanization rate growth in Kigali city since 2010 to 2020.

The test results show that urbanization rate is correlated to waste generation at 84.1% and this correlation is statistically significant (p = 0.036<0.05) [10]; households' growth in Kicukiro district also is correlated at 91.5% to waste generation and this correlation is also statistically significant (p=0.011<0.05). This confirm that once households are increasing also waste generated are increasing, and if households are increasing without respect of urbanization master plan, it will be difficult to ensure waste management. In the other case also, urbanization growth is in the same was to waste generation. Good planners and management of urban areas always plan for urbanization growth and waste management.

7. Conclusion

The study was aimed at assessing the impact of urbanization on the waste management in Rwanda based on the case of Kagarama sector. Secondary data assessment has shown that in Rwanda urbanization is growing faster from 16.5% to 21.9% respectively from 2010 to 2020. Poor households in urban areas of Kigali city are reducing from 28.5% to 15.8% 2005/6 to 2016/17 respectively. However, urbanization in Kigali city is increasing it is associated to unplanned urban houses where this occupies 91.9% of houses in Nyarugenge district, 71.2% Gasabo and 79.7% in Kicukiro district. Assessment also has revealed that, around 46.5% of households in Kigali city are deposing domestic waste in non-prepared landfill, means 46.5% households in Kigali city are not implementing waste management policies and practices. The assessment from respondents shows that only 59.25 of households in Kigali city do not separate waste at household level before taken by companies or deposited in landfill. The correlation analysis has also shown that urbanization is contributing to 46.4% in waste management while remaining percentage or rate is for other factors not captured by this study. Urbanization growth and household's growth in urban areas is increasing in the same way as waste generation per household increases in Rwanda unparticular in Kigali city [8]. All in all, there is positive correlation between urbanization and waste generation and management in Rwanda, and that correlation is statistically significant. Thus, the researcher failed to accept the null hypothesis "H_0: There is no significant impact of urbanization on the waste management in Rwanda" in favor of its opposite.

8. Recommendations

The following recommendations were suggested by the researcher: (a) **To improve Kigali City master plan implementation**: Kagarama sector is urbanized area in Kicukiro district, Kigali City but they are not respecting modern urban housing system. They are recommended to ensure that Kigali master plan was respected, and authorities could not be corrupted to move against the urban plan [1]. (b) **To implement waste management measures and best practices**: The assessment found that around 46% of households in Kagarama sector, Kigali city are not ensuring proper waste management from their households, we encourage authorities to supervisor and monitor house to house these who failed to ensure waste separation, and these not paying waste collection fees to waste collection companies and propose sanctions to them.

REFERENCES

[1] Abrelpe. (2018). *Panorama dos Resíduos Sólidos no Brasil 2011. São Paulo (report): ABRELPE; .*

[2] Achankeng. (2017). *Globalization, urbanization and municipal solid waste management in Africa. In: African Studies Association of Australasia and the Pacific 2003 Conference Proceedings - African on a Global Stage;* . http://wiego.org/sites/wiego.org/files/publications/files/Achankeng_Globalization_Urbanization_MSWMgmt_Africa.pdf [Accessed: 24-08-2020].

[3] Achankeng et al. (2003). *Globalization, Urbanization and Municipal Solid Waste Management inAfrica.* African Studies Association of Australasia and the Pacific 2003 Conference Proceedings - African on a Global Stage.

[4] Bairoch. (1991). *Cities and economic development: from the dawn of history to the present.* (U of Chicago Press, 1991).

[5] Bazeley. (2017). *Does local government work for women?* Fawcett Society.

[6] Chauhan. (2018). *Urbanization and environment: Lessons from theory and practice for urban policy.* Mumbai, Maharashtra, India: Indian Institute of Technology Bombay.

[7] City of Kigali. (2008). *Personal Communication. November 2008.* City of Kigali, Kigali.

[8] Claire. (2018). *Waste management challenges for cities in developing countries.* Waste Management. 33 (1): 220–232. doi:10.1016/j.wasman.2018.09.008.

[9] Davis. (1965). *The urbanization of the human population. Scientific American 213(3): 41-53 .*

[10] Dimpal. (2012). *Urbanization and Solid Waste Management in India: Present Practices and Future Challenges.* Procedia - Social and Behavioral Sciences 37:437–447.

[11] Dimpal. (2017). Urbanization and solid waste management in India: Present practices and future challenges: Department of Economics,MMH College,,Ghaziabad, Uttar Pradesh, India: International Conference on Emerging Economies – Prospects and Challenges (ICEE- 2012).

[12] Eder. (1995). *Engineering design art, science and relationships.* Design Studies16 (1):117-127. 1995.

[13] GGGI. (2019). *Solid Waste Management in Secondary Cities of Rwanda -Muhanga & Huye: Situation assessment and*

potential intervention areas. Huye & Muhanga: Global Green Growth Institut.

[14] Gutberlet. (2017). *aste in the City: Challenges and Opportunities for Urban Agglomerations, Urban Agglomeration, Mustafa Ergen, IntechOpen, DOI: 10.5772/intechopen.72047.* . https://www.intechopen.com/books/urban-agglomeration/waste-in-the-city-challenges-and-opportunities-for-urban-agglomerations.

[15] Haidari. (2014). *Women's participation in local governance in Tanzania.*

[16] Hubka. (1988). *Theory of Technical Systems. A Total Concept Theory for Engineering Design.* Springer Verlag: Berlin. 1988.

[17] Jain. (2007). *Sustainable Development and Waste Management, Environews, Newsletter ISEB India Vol. 13 No.1 January 2007 .*

[18] Josephine. (2020). *Research on Landfill and Composting Guidelines in Kigali City , Rwanda Based on China ' s Experience.* Kigali City: www.semanticscholar.org/paper/Research-on-Landfill-and-Composting-Guidelines.

[19] Kuhlman. (1990). *Organized versus spontaneous settlement of refugees in Africa.* Wageningen, Netherlands: Wageningen University & Research.

[20] Lydie. (2013). *Urban cities and waste generation in developing countries: a GIS evaluation of two cities in Burkina Faso.* Journal of Urban and Environmental Engineering .

[21] MINECOFIN. (2019). *National Strategy for Transformation 1 2018-2024.* Kigali: National Institute of Statistics of Rwanda.

[22] MININFRA. (2018). *Urbanisation & rural settlementsector strategic plan for national strategy for transformation 2018/19 -23/24.* Kigali: Republic of Rwanda.

[23] NISR. (2014). Kigali: General Population and Housing Census (4th GPHC 2012): MINECOFIN.

[24] NISR. (2015). Household Living Conditions Survey EICV3 2013/2014 National Institute of Statistics of Rwanda.

[25] NISR. (2018). Kigali: Household Living Condition Survey (EICV 5 2016/17): National Institute of Statistics of Rwanda.

[26] NISR. (2018). Household Living Condition Surveys (EICV2 2005/06; EICV2 2010/11; EICV4 2013/14 and EICV5 2016/17, Kigali: National Institute of Statistics.

[27] NISR. (2018). *Household Living Condition Surveys (EICV2 2005/06; EICV2 2010/11; EICV4 2013/14 and EICV5 2016/17.* Kigali: National Institute of Statistics.

[28] NISR. (2019). *Gender Statistics Survey 2018.* National Institute of Statistics of Rwanda.

[29] Plourde. (1972). *A model of waste accumulation and disposal,.* Canadian Journal ofEconomics, Vol. 5, 119-125.

[30] Pohjola. (2014). *henomenon driven process design methodology: Formal representation.* . Proc. CHISA´98. CD-ROM of full texts. Czech Society of Chemical Engineering: Prague. 2014.

[31] RDIS. (2018). *WasteManagement for Environmental Protectionin Rwanda.* Kigali: Rural Development Inter-Diocesan Service.

[32] REMA. (2007). *Bugesera Pilot Integrated Ecosystem Assessment. Final Report. Rwanda Environment Management Authority (REMA), United Nations Environment Programme (UNEP) and United Nations Development Programme (UNDP), Kigali.*

[33] ROR. (2008). *Economic Development And Poverty Reduction Strategy, 2008-2012.* Ministry of Finance and Economic Planning, Republic of Rwanda (ROR), Kigali.

[34] Sida. (2019). *Urban solid waste management.* Supplement to Sida's policy for urban developmentFighting Poverty in an Urban World.

[35] Smith. (1993). *The challenges of environmentally sound and efficient regulation of waste the need for enhanced international understanding.* ournal of Environmental Law 5(1): 91-107. 1993.

[36] Kabera, T., K. (2019). *Solid Waste Management in Rwanda: Status and Challenges.* pp.287-305: Coĺlege of Science and Technology, University of Rwanda.

[37] Ugwuanyi. (2012). *Urbanization and solid waste management challenges in nigeria.* University of Nigeria: Environment project.

[38] Van et al. (2018). *Optimizing Vehicle Routing with Path and Carbon Dioxide Emission for Municipal Waste Collection in Ha Giang, Vietnam.* Industrial Networks and Intelligent Systems, Springer International Publishing, 221, pp. 212–227.

[39] Wertz. (2010). *Economic factors influencing households' production of refuse,* . Journalof Environmental Economics and Management, Vol. 2, 263-272.

[40] Wilson. (1972). *Settlement Patterns and Community Organization: Cross-Cultural Codes 3.* Published By: University of Pittsburgh- Of the Commonwealth System of Higher.