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Investigation on Construction Solid Wastes Management within Building Sites Environment in Kigali City

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Abstract: The largest volume of construction work in the country is mainly concentrated in this city and improper demolition of construction waste cause improper handling to construction sites. The general objective of the study will investigate on the construction solid and demolition waste management in Kigali City. A cross sectional survey among the construction companies was conducted from 60 contractors by purposive sampling. The research targeted all construction practitioners in various active sites of Kigali city. Sources of data for this study were obtained through questionnaires, interviews and site surveys. Descriptive statistics will be applied to analyze quantitative and qualitative data through SPSS 16 and STATA 13.0 computer package. Analysis of Variance was used to test the relationship between Methods of CSWM and its types of demolished waste by level of satisfaction. The key findings showed that the most construction solid waste identified on construction sites were woods; scrap metals; cement; bricks and trees respectively and the construction companies suggested that those wastes are available on their construction sites and they should be demolished properly. The second category of CSWM identified were insulation; nails; plaster; rocks; dirt and asbestos respectively according to their means and standard deviation. Furthermore, for thermal treatment, the study findings concluded that there is open burning and the respondents were fairly on the adopted methods for waste treatment. Secondary there are incineration and Pyrolysis which are used to treatment waste from construction sites and all respondents were not satisfied on their application to treat waste. Lastly the study findings concluded that there are gasification and is not usually used as the heads of sites were very unsatisfied. The cost associated with SWM for practitioners and it is ranged from 6,000,000Frws-9,000,000Frws used cost of Vegetation/ top soil (site clearance), cost of reinforced concrete, cost of Scrap metals, cost of rocks and municipal waste respectively to clean the construction environment.The next category of cost was valued in ranged of waste costing above 3,000,000Frws-6,000,000Frws and those were the cost of bricks/ tiles demolition, cost of wooden materials and other non inert waste demolition, cost of debris of pipes demolition, cost of sewage demolition and cost of chemical waste (waste oil, lubricants, paints& solvents) demolition from the construction sites respectively. The revenues associated on CSWM ranged from 6,000,000Frws -9,000,000Frws for Vegetation/ top soil (site clearance), Reinforced concrete, Scrap metals, Wooden materials and other non inert waste and Municipal waste management that may generate high level of incomes; and from 3,000,000Frws-6,000,000Frws for Rocks, Sewage and Chemical waste (waste oil, lubricants, paints& solvents) waste.

Keywords: Construction waste, demolition waste, waste management and Analysis of Variance (ANOVA).

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I. INTRODUCTION

The rapid urbanization that has been taking place during the 20th century virtually transformed the world into communities of cities and towns facing similar challenges on environmental issues in which most of them have to be addressed at international level (Smith, 2010). Among those environmental issues solid waste management is a critical one because as long as humans have been living in settled communities, solid waste generation has been unavoidable and critical issue both in developed and developing nations. As a result, solid waste management became a worldwide agenda at United Nation conference on environment and development in Rio de janeiro in 1992 with a great emphasis on reducing waste and maximizing environmentally sound waste reuse and recycling at first step in waste management (UNEP, 1996) adapted by (Tam, 2008).

In most African cities the situation of solid waste management is insignificant and inadequate that could associate with different factors. The UNEP (2005) cited by (BPs, 2004) notes that the management of solid waste in Africa is often weak due to lack of appropriate planning, inadequate governance, poor technology, weak enforcement of existing legislation and the lack of economic incentives to promote environmentally sound development. The practice of solid waste management in the region is mostly open dumps without proper control over ecologically or hydrologically sensitive areas. According to UNEP (2004), solid waste generation has become an increasing environmental and public health problem everywhere in the world, particularly in developing countries. Consequently, solid waste is not only increasing in quantity but also changing in composition from less organic to more paper, packing wastes, plastics, glass, metal wastes among other types, a fact leading to the low collection rates (Troschinetz & Mihelcic, 2009). Nowadays construction industry is rapidly growing in developing countries because of increase in standard of living, demands of infrastructure projects and building construction projects as well as natural increase in population. Construction industry plays a key role in socio-economic development of any country. The increase of construction activities due to development increases the generation of construction solid wastes and demolition wastes. It has contributed significantly in waste generation which has become serious problem for every nation (Nagapan, Rahman, & Asmi, 2012).

Several researchers and construction practitioners indicate that construction solid waste and demolition wastes emanate during planning, design, procurement, and construction stage (Nagapan, Rahman, Asmi, Memon, & Latif, 2012). The waste also influences economical dynamics of society and has an important effect on the environment and surroundings (Kralj, 2011). Construction waste and demolition wastes are produced from a range of construction activities and materials. However, it must be mentioned that not every activity and material will produce equal amount of waste (Lu & Yuan, 2011). According to Muleya and Kamalondo (2017), sources of waste include unused materials, incorrect materials, surplus stencils or nails, packages of construction materials or components, surplus concrete materials resulting from fractures or deformations due to improper storage or preservation of construction materials and components arriving at the construction site. Others include poor material handling, erroneous cuttings, improper or faulty equipment, poor storage facilities, poor workmanship and inaccurate measurements. Most of the waste generating factors identified above originate mainly from site operations and general residual (Yeheyis, Hewage, Alam, Eskicioglu, & Sadiq, 2013). Construction solid wastes and demolition wastes has been labelled to be one of the major problems in the construction industry that presents significant implications on the efficiency in the industry as well as the adverse impacts on the environment (Saikia & de Brito, 2010). Kigali City was started in 1907 as a small colonial outpost. Initially it was supposed to be inhabited by at least 300,000 people. Recently, it is inhabited by population of more than 1.3 million inhabitants (NISR, 2016) cited by (Niragire, 2017). It has never had any clear master plan to reorganize the planning and settlement since the colonial era, in spite of the rapid and ever increasing numbers of inhabitants. This has exerted strenuous pressure on the infrastructure which has resulted in many complex problems regarding settlement notably waste management.

Nowadays, Kigali is a growing city and is also facing significant challenges in relation to construction solid wastes and demolition wastes management. Waste generation is increasing, while a sizeable portion of it, is disposed on improperly located and operated dumpsites, resulting in adverse impacts on environment and health. The country has a backlog in waste legislation enforcement as well as in coordination and promotion of existing efforts to recycle and dispose waste properly (MININFRA, 2014) cited by (Durant, 2012). The Government of Rwanda has an ambition to implement integrated solid waste and demolition management in ways that are protective to human health and the environment. Though there is a system of collection and transportation of construction solid waste across the country, construction solid wastes and demolition wastes management in Kigali faces many challenges including lack of sorting and separation at source, poor disposal and management of dumping sites, poor treatment and exploitation of the generated solid waste and demolition, among others. Through radio and TV broadcasts, signposts and workshop trainings REMA encourages construction practitioners to dispose wastes properly, by sorting them and separating them by their categories. However, implementation is still low (MINIRENA, 2014) adapted by (Durant, 2012). Development of infrastructures in any country generates construction activities and this contributes to the massive quantities of construction solid waste and demolition waste that are generated by the development business every year, and this can cause significant implications on the efficiency in the industry as well as the adverse impacts on the environment. Yet, Kigali city is amongst developing cities in Africa, where construction projects increase every year and due to the increasing number of construction projects throughout the city, it is logical that there is an increase in the construction solid waste and demolition waste. This grow would enhance the need for having an effective waste management plan and drive towards that as a requirement by all the contractors and construction firms. The completion of projects within budget and schedule are the goal of construction companies and any additional efficiencies result in profit. Study abroad showed that over production, poor handling, incorrect storage, incorrect ordering, design change, manufacturing defects and rework are factors that contribute in wastages. In a study conducted in Zambia and reported in the Africa Review Report on waste management (Mwesigye et al., 2009) was concluded that poor waste management practices in particular the widespread dumping of wastes in water bodies and uncontrolled dump sites aggravates the problems of generally low sanitation levels across the African continent. But no specific study conducted in Rwanda on the same issues. This study finally will consider the feasibility of respective perspectives of stakeholders regarding the use of a site waste management plan as a method of mitigating the generation of construction waste from the design through to the construction phase. Waste Management on construction sites had become a major focus due to construction waste's negative effect on land depletion and deterioration, energy consumption and noise pollution, and it has been considered to be a major source of environmental pollution for its solid waste generation and dust and gas emission and this highlighted the researcher's needs to investigate on the construction solid waste and demolition management with focus on Kigali city construction active sites.

II. OBJECTIVES OF THE PAPER

The paper seeks to to investigate on construction solid wastes management within building sites environment in Kigali city, Rwanda. The specific objectives of this paper have been grouped into three folds:

- To identify different types of construction solid waste and demolition wastes on the sites
- To explore various methods used on construction sites for waste collection, treatment and disposal
- To quantify effectively the cost and revenues of solid waste management from construction practitioners in Kigali city

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The work focuses on outlining a theoretical recovery strategy to effectively manage the construction Solid Waste in the construction and building place of the CSWM practitioners for improvement methods of disposals, treatment, reuse, recycling and landfills.

III. RESEARCH METHODOLOGY

After collecting data, the researcher continued to processing, analysis and interpretation of data. The data collected were summarized, coded, and entered in the computer using Microsoft Office Excel and were analyzed by using STATA computer program, version 13. Both descriptive and quantitative analysis was carried out. The study covered a total sample of 60 construction companies in Kigali city and the surrounding areas based on purposive sampling system. Information was collected through questionnaire, interview and field observations. The qualitative data was collected through the use of surveying questionnaire. Descriptive analysis by frequency, percentage, means and standards deviations were used. Analysis of Variance (ANOVA) was used to test the relationship between the level of significance regressed to methods used to CSWM and types of CSW demolished for proper handling and testing their significance levels.

IV. RESULTS AND DISCUSSION

4.1.1 Profession of the of the respondents from the companies

Table 4.2 pertained to distribution of respondents by physical characteristics from the sampled respondents servicing in the selected companies in Kigali city. For the profession of the sampled respondents, the summary statistics revealed that about 19 (31.67%) were site engineers, 29 (48.33%) were the quantity surveyors; 10(16.67%) were the architectures while the remaining of 1 (1.67%) of the interviewed respondents were clerk of works and foreman working in the company respectively.

Table4. 1: Profession of respondents from selected companies in Kigali city

Profession of the of head	*Freq.*	*Percent*	*Cum.*
Site Engineer	19	31.67	31.67
Quantity surveyor	29	48.33	80
Architect	10	16.67	96.67
Clerk of Works	1	1.67	98.33
Foreman	1	1.67	100
Total	60	100	

4.1.2 Years of experience in participation in CSWM in Kigali city

Table 4.3 summarized the distribution of interviewed respondents by years of experience of the companies involvement in construction solid waste management as Construction Companies working in Kigali city as the case of interest. The summary statistics showed that about 17(28.33%) have an experience ranging between 0-5 years, 31(51.67%) have an experience varying between 6-10 years while only 12 (20%) of the interviewed had an experience ranging between 11-15 years of experience in construction solid waste management in Kigali city.

Table4. 2: Years of experience in participation in CSWM in Kigali city

Years of experience in CSWM	*Freq.*	*Percent*	*Cum.*
0-5 years	17	28.33	28.33
6-10 years	31	51.67	80
11-15 years	12	20	100
Total	60	100	

4.1.3 Level of education of the respondents from the companies

The majority of the households in Kigali city have high educational background. This high educational background of the respondents influences their active participation and handling of municipal solid waste management within their working construction companies. Therefore to upgrade their understanding about the problems caused by wastes from construction sites continue and organized training and awareness campaigns are needed. Based on results from figure 4.3, the findings indicated that about 30(50%) of the respondents completed bachelor education while about 25(41.67%) completed master's degree and only 4(6.67%) have completed secondary school education.

Those who had Philosophic high diploma (PhD) of education constitute about 1(1.67%) respectively. This is an implication that most of construction companies know deeply the solid waste management and contributes to the cleanness ok the Kigali city.

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The fact of educated employees affected urban areas where large quantities of garbage are produced and not cleared, they enter into municipal drainage systems, blocks drains, and pollute runoff waters and consequently surface and ground water and the findings agree (Sano, 2007) cited in (Ekane, Kjellén, Noel, & Fogde, 2012).

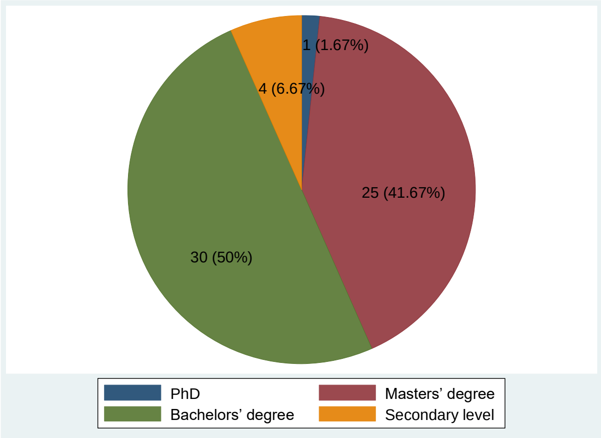

Figure4. 1: Level of education of the respondents from the companies in CSWM in Kigali city

4.1.4 Type of position of the respondents in the companies

Table 4.4 indicated the distribution of interviewed respondents from the sampled construction companies operating in Kigali city as the case of interest. Findings revealed that about 24 (40%) were the sites engineers, followed by 17(28.33%) who were procures, a little bite followed by 8 (13.3%) who were supervisors and thereafter there 5(8.3%) who were the managers in the companies. Based on types of position held and past experience, however, this does not undermine at all the past experience of the employee which involves knowledge, skills, practice and situational familiarity to the performance of the company and these are consistent with the research conducted by (Ailabouni, Gidado, & Painting, 2007).

Table4. 3: Type of position of the respondents in the company

Type of position in the company	*Freq.*	*Percent*	*Cum.*
Site Engineers	24	40	40
Designers	6	10	50
Managers	5	8.33	58.33
Procurers	17	28.33	86.67
Supervisors	8	13.33	100
Total	60	100	

4.1.5 Identification of types of construction solid wastes and demolition wastes on sites

Table 4.5 pertained to distribution of findings from sampled respondents by types of construction solid waste and demolition wastes on sites. The results were analysed through the likert scale rule, means and standard deviation. Based on summary of descriptive statistics, the most construction solid waste identified on construction sites were woods (mean=3.817, SD=0.567); scrap metals (mean=3.814, SD=0.572); cement (mean=3.833, SD=0.526); bricks (mean=3.797, SD=0.664) and trees (mean=3.525, SD=0.653) respectively and the construction companies suggested that those wastes are available on their construction sites and they should be demolished properly. The second category of CSWM identified were insulation (mean=3.083, SD=0.829); nails (mean=3.033, SD=0.843); plaster (mean=2.719, SD=0.818); rocks (mean=3.133, SD=0.769); dirt (mean=2.8, SD=0.684) and asbestos (mean=3.291, SD=0.658) respectively and the construction workers from construction companies suggested that they were neutral available in the construction sites. The remaining types of CSWM like electrical wiring, Rebar, Tree stumps, Rubble, Lead, Plasterboard, Paint thinners, Strippers, Fluorescent bulbs and Aerosol cans were also fairly available on their construction sites as the mean is in ranged of scale 2 of the likert scale rule. The findings agree with the research conducted by (Chini & Bruening, 2003) cited in (Yuan, 2013) found that after each step in the process of construction, all nails should be removed and the materials should be sorted, stacked, and cleaned.

Table4. 4: Identification of types of construction solid wastes and demolition wastes on sites

	1		***2***		***3***		***4***		***5***				
	NA		***FA***		***NA***		***A***		***EA***		***Obs***	***Mean***	***SD***
CSWM	*f*	*%*	*f*	*%*	*f*	*%*	*f*	*%*	*f*	*%*			
Insulation	1.0	1.7	11.0	18.3	34.0	56.7	10.0	16.7	4.0	6.7	60	3.083	0.829
Nails			16	26.67	30	50	10	16.67	4	6.7	60	3.033	0.843
Electrical wiring	7	12	27	45	24	40	2	3.33			60	2.35	0.732
Rebar	28	49	22	38.6	7	12					57	1.632	0.698
Wood					16	27	39	65	5	8.3	60	3.817	0.567

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Plaster	4	7	17	29.82	27	47	9	15.79			57	2.719	0.818
Scrap metal					16	27	38	64.41	5	8.5	59	3.814	0.572
Cement					14	23	42	70	4	6.7	60	3.833	0.526
Bricks			2	3.39	14	24	37	62.71	6	10	59	3.797	0.664
Trees			3	5.08	24	41	30	50.85	2	3.4	59	3.525	0.653
Tree stumps	13	22	34	56.67	13	22					60	2.01	0.664
Rubble	13	22	35	58.33	12	20					60	1.983	0.651
Dirt	1	1.7	18	30	33	55	8	13.33			60	2.8	0.684
Rocks			14	23.33	24	40	22	36.67			60	3.133	0.769
Lead	27	46	27	45.76	5	8.5					59	1.627	0.641
Asbestos			6	10.91	27	49	22	40			55	3.291	0.658
Plasterboard	9	16	30	52.63	18	32					57	2.158	0.676
Paint thinners	15	25	33	55.93	11	19					59	1.932	0.666
Strippers	5	8.6	37	63.79	13	22	3	5.17			58	2.241	0.683
Fluorescent bulbs	7	12	28	48.28	14	24	9	15.52			58	2.431	0.901
Aerosol cans	10	17	30	50.85	19	32					59	2.153	0.690

Note: 1= Not available, 2= Fairy available, 3= Neutral available, 4= Available and 5= Enough available

4.1.6 Methods used on construction sites for waste collection, treatment and disposal

In a building demolition project, almost the whole building structure including the substructure, superstructure and external landscape will become demolition waste. The characteristics of the demolition wastes may vary depending on the types of structures demolished and the demolition technique used. The study findings presented in table 4.6 summarized the Methods used on construction sites for waste collection, treatment and disposal in Kigali city. For thermal treatment, the study findings indicated that there are open burning (mean=3.12, SD=0.846) and the respondents were fairly on the adopted methods for waste treatment. Secondary there are incineration (mean=2.067, SD=0.733) and Pyrolysis (mean=1.754, SD=0.576) which are used to treatment waste from construction sites and all respondents were not satisfied on their application to treat waste. Lastly there are gasification (mean=1.3929, SD=0.493) and is not usually used as the heads of sites were very unsatisfied.

For dumps and Landfills, the study findings revealed that there are sanitary landfills (mean=4.1, SD=0.477) which is used during the waste management from the construction sites and respondents were satisfied on their application on the sites. Furthermore, there are two methods commonly used in dumps and landfills; controlled dumps (mean=2.85, SD=0.633) and bioreactor landfills (mean=3.25; SD=0.628) and all respondents were fairy satisfied on their application on construction sites. Lastly for biological waste treatment, there is composting (mean=2.783, SD=0.739) and also respondents from the construction sites were fairly satisfied. In addition there is anaerobic digestion (mean=1.8; SD=0.659) implying that the respondents from the construction sites in Kigali city and the surrounding areas were not satisfied on the application when treating the waste from the construction areas. The level of satisfaction differ according to materials categories. Each of these categories of material (waste) requires a different set of criteria for its management. For example, waste material generated from civil engineering works such as site formation, is mainly soil, sand, and rubble. This source of waste is usually minimized by balancing cutting and filling on a project basis. A set of engineering standards is already available to govern the use of excavated materials for filling (refer to General Specifications of Civil Engineering Works). Therefore, this thesis is mainly concerned with measures for the reduction of waste generated from the other building works categories. The findings are consistent with the research conducted by (Yusof, 2006) cited in (Mohamad et al., 2018).

Table4. 5: Methods used on construction sites for waste collection, treatment and disposal

	1		*2*		*3*		*4*		*5*				
	VU		***NS***		***F***		***S***		***VS***		***Obs***	***Mean***	***SD***
	f	**%**	**f**	**%**	**f**	**%**	**f**	**%**	**f**	**%**			
Thermal Treatment													
Incineration	11	18	37	61.67	9	15	3	5			60	2.0667	0.733
Gasification	34	61	22	39.29							56	1.3929	0.493
Pyrolysis	18	32	35	61.4	4	7					57	1.7544	0.576
Open Burning	3	5	9	15	26	43	22	36.67			60	3.1167	0.846

Dumps and Landfills													
Sanitary landfills					4	6.7	46	76.67	10	17	60	4.1	0.477
Controlled dumps	2	3.3	11	18.33	41	68	6	10			60	2.85	0.633
Bioreactor landfills			6	10	33	55	21	35			60	3.25	0.628
Biological Waste Treatment													
Composting	2	3.3	18	30	31	52	9	15			60	2.7833	0.739
Anaerobic digestion	20	33	32	53.33	8	13					60	1.8	0.659

Note: 1= Very unsatisfactory, 2= Not satisfactory, 3= Fair, 4= Satisfactory and 5= Very satisfactory

Based on analysis of variance model (ANOVA model), and analysing the relationship between CSWM and satisfaction on demolition wastes on sites in solid waste management system which include all methods of demolition on sites, analysis of variance was used at 1%, 5% and 10% level of significance. Issues of CSWM methods including disposal, landfill, incineration, reuse and recycling related to level of satisfaction of CSWM practitioners in solid waste management appear to affect both level of satisfaction and the applied methods in Kigali city as the case of interest. Table4.9 shows results of statistical analysis conducted to determine the relationships between CSWM methods and level of satisfaction from the view of respondents affecting solid waste management and lessons taught to household members on sanitation issues in the Kigali City. In Table4.9 the analysis reveals that significant correlations exit between the respondents' disposal and incineration and the related to level of satisfaction from the practitioners of CSWM based on sanitation issues. The model indicated that there is high correlation between predicted variable and explanatory variable with R^2=63.94% indicating that model accounted only 0.6394 of explanatory variables and there are other factors that may affect level of satisfaction based on CSWM methods respectively. A significant variable of disposal to level of satisfaction of CSWM with (p- value 0.0076 <0.05; DF=4; F=4.03) at 5% level of significance implies that many respondents were thinking that the disposal of CSWM from the construction sites and the surrounding areas in Kigali city is solely responsible for ensuring clean surroundings and it is likely that the people may not support clean up campaigns meant for making the surroundings clean. These findings agree with the research conducted by (Sood, 2004) cited in (Osafo, 2015; Sankoh, Yan, & Tran, 2014) who confirms that with the establishment of the Freetown Waste Management Company, the public tend to have the view that the FWMC should be solely responsible for managing waste in the town and may keep it clean. The findings also showed that the incineration methods was also statistically significant at 5% level of significance (p- value of 0.0008<0.001; DF=4; F=5.81) level of significance implies that incineration is one of the methods that contractors of construction building are applying to incinerate the garbage and other construction solid waste from the sites that may not generate benefits directly without recycling or reuse process. Sample size is denoted by N, total degree of freedom (df) = N-1 while the ratio of the mean square deviation is given as the F statistic with significance level (P). Where p<0.05; 0.001 and 0.1 respectively and there is an indication of strong variation with R^2=63.94%. The results of the analysis of variance (ANOVA) technique on the impacts of level of satisfaction on solid waste to the environment of the respondents and the construction companies as contractors were found to be statistically significant. The findings are coherent with the research conducted by Sankoh et al. (2014) found that there is Poor visual appearance of the city, traffic congestion, flooding and accidents. These effects have a negative impact on official and tourist visits and foreign investments since Freetown is the gate way to Sierra Leone (Awosan et al., 2017; Oyekale, 2017; Sankoh et al., 2014).

Table4. 6: Relationship between CSWM methods and level of satisfaction of practitioners

Source	Partial SS	df	MS	F	Prob>F
Model	35.58464	18	1.976924	4.04	0.0001
Disposal	7.886463	4	1.971616	4.03	0.0076**
Incineration	11.38005	4	2.845013	5.81	0.0008***
Landfill	0.44004	4	0.11001	0.22	0.923
Reuse	1.368177	3	0.456059	0.93	0.434
Recycling	0.127735	3	0.042578	0.09	0.9668
Residual	20.06536	41	0.489399		
Total	55.65	59	0.94322		
Number of Obs		=			60
Root MSE		=			0.699571
R-squared		=			0.6394
Adj R-squared		=			0.4811

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Relationship between waste demolished and level of satisfaction on demolition wastes on sites was discussed and analyzed by using ANOVA to predict the variation of level of satisfaction and explanatory variables which were demolished CSW from the construction sites at 1%, 5% and 10% level of significance. The ANOVA model indicated that there is high coefficient of determination with R^2=0.7048 or 70.48% of the total variation. This implies that the fitted variables accounted only 70.48% of the CSW demolished from the sites and there are some few factors that may also affect the level of satisfaction on the CSW demolished from the construction sites in Kigali city. The ANOVA results revealed that there are only three CSW demolished from the sites which were statistically significant at 5% level of significance to affected the level of satisfaction which including bricks/tiles with (p-value of 0.0355<0.05, DF=2, F=3.7); scrap metals

(p-value=0.0089<0.05, DF=3, F=4.55) and debris of pipes (p-value of 0.0313<0.05, DF=2, F=3.85) were the CSW demolished from the construction sites in Kigali city. The reason of significant is that some of the respondents thought it was appropriate for individuals to share in the responsibility of cleaning their own surrounding and working place. Those respondents who thought individuals must be responsible for cleaning their own surroundings gave reasons as, dirty surroundings cause diseases, effects of bad odour resulting from dirty surroundings and saving individual's money. Besides the reasons given by respondents that individuals should take responsibility for the cleanliness of their surroundings, there are other reasons. These reasons include the general impressions of visitors to the Kigali city since it is the gate way to the country. Individuals should therefore help in the cleaning of their surroundings. The reasons given for not doing it suggest low level of respondents' knowledge concerning sanitation issues and the findings are in line with the research conducted by Sankoh et al. (2014) who found that that there was a significant positive correlation between the respondents' level of education and their perceptions about cleaning their own surroundings (+0.8846 at 5% level with p<0.05). This means that majority of the households do not educate their members on the need to clean the surroundings while few of them do(Cao, Xu, & Liu, 2018).

Table4. 7: Relationship between CSW demolition and level of satisfaction of practitioners

Source	Partial SS	df	MS	F	Prob>F
Model	39.22349	26	1.508596	3.03	0.0015
Vegetation/ top soil	1.663089	2	0.831545	1.67	0.2037
Reinforced concrete	5.362166	4	1.340542	2.69	0.0479
Bricks/ Tiles	3.684489	2	1.842245	3.7	0.0355**
Scrap metals	6.795987	3	2.265329	4.55	0.0089**
Wooden materials	2.651559	3	0.883853	1.78	0.171
Rocks	1.868884	3	0.622961	1.25	0.307
Debris of pipes	3.83684	2	1.91842	3.85	0.0313**
Sewage	0.923177	2	0.461589	0.93	0.4057
Municipal waste	0.614622	3	0.204874	0.41	0.7457
Chemical waste	0.334437	2	0.167218	0.34	0.7171
Residual	16.42651	33	0.497773		
Total	55.65	59	.943220339		
Number of Obs		=			60
Root MSE		=			0.70553
R-squared		=			0.7048
Adj R-squared		=			0.4723

4.2.3 Cost of solid waste management from construction practitioners in Kigali city

Among the key components of vision 2020 is to develop infrastructure management through developed strategies of new buildings in Kigali city. Among all the methods used by contractors in solid waste management, other disposal sites achieve highest percentage followed by sanitary landfill whilst the least is incineration. Other disposal sites are the open dumpsites that have illegal dumping or have accumulate large quantities of garbage which require the high cost accrued from the construction sites to either landfill or disposal sites.

Based on results presented in table 4.10, the most solid waste requesting high cost was ranging from 6,000,000Frws-9,000,000Frws and those were categorized as cost of Vegetation/ top soil (site clearance), cost of reinforced concrete, cost of Scrap metals, cost of rocks and municipal waste respectively to clean the construction environment. The next category of cost was valued in ranged of waste costing above 3,000,000Frws-6,000,000Frws and those were the cost of bricks/ tiles demolition, cost of wooden materials and other non inert waste demolition, cost of debris of pipes demolition, cost of sewage demolition and cost of chemical waste (waste oil, lubricants, paints& solvents) demolition from the construction sites respectively. Based on point view of the discussion, the cost accrued in waste management is high and there is a need of minimization in cost value to increase the profitability of the company up to any discount.

The findings agree with the research conducted by (Augustine, 2011) cited in (Akhir, 2015) who found that average disposal costs using waste minimization initiatives accounted for 0.3% of the project value due to wastage being halved. Quantities of waste were as low as one third of normal wastage rates on some of the sites (Augustine, 2011) cited in (Akhir, 2015; Imimole, 2018).

Table4. 8: Cost of solid waste management from construction practitioners in Kigali city

Codes of cost	*1*		*2*		*3*		*4*				
Cost Intervals	*< 3M*		*3M-6M*		*6M-9M*		*> 9M*		*Mean*	*Obs*	*SD*
	f	*%*	*f*	*%*	*f*	*%*	*f*	*%*			
Vegetation/ top soil (site clearance)	1	1.67	19	31.67	39	65	1	1.67	2.667	60	0.542
Reinforced concrete			4	6.67	25	41.67	31	51.67	3.450	60	0.622
Bricks/ Tiles	4	6.67	34	56.67	22	36.67			2.300	60	0.591
Scrap metals			5	8.33	29	48.33	26	43.33	3.350	60	0.633
Wooden materials and other non inert waste	6	10	26	43.33	25	41.67	3	5	2.417	60	0.743
Rocks			19	31.67	36	60	5	8.33	2.767	60	0.593
Debris of pipes	4	6.67	42	70	14	23.33			2.167	60	0.526
Sewage	15	25	38	63.33	7	11.67			1.867	60	0.596
Municipal waste			8	13.33	33	55	19	31.67	3.183		0.651
Chemical waste (waste oil, lubricants, paints& solvents)	6	10	36	60	18	30			2.200	60	0.605

M: Millions

4.2.3.1 Revenues of solid waste management from construction practitioners in Kigali city

The construction of roads, houses, bridges or anything requiring engineering services for individuals or the government, involves many resources including cash in hand. The build up of the cost of these projects significantly includes the cost of waste. Unfortunately, most contractors or construction companies have failed to initiate measures to reduce the cost of waste to boost their monthly and annual revenues and in turns reduce the burden they inflict on their clients in the form of exorbitant charges. Consequently, prospective clients aggravate the situation by engaging non-professionals and sometimes are unable to clearly state their designs. Based on the assumption and basing on the findings presented in table 4.11 indicating the Revenues of solid waste management from construction practitioners in Kigali city as demotion or treatment, the summary of descriptive statistics revealed that most of waste from construction sites could be resolved and most of them earned the benefits ranging from 6,000,000 Frws - 9,000,000Frws and those were categorized as Vegetation/ top soil (site clearance), Reinforced concrete, Scrap metals, Wooden materials and other non inert waste and Municipal waste management that may generate high level of incomes as their average mean is located in 3 category of likert scale rule. The second category construction solid waste management that may generates ranged from 3,000,000Frws-6,000,000Frws and those were categorized as Rocks, Sewage and Chemical waste (waste oil, lubricants, paints& solvents) waste as the mean was located in 2 range of likert scale rule. Based on findings and discussion given here, waste management, and after treatment and resale, could generate high income for practitioners of CSWM in Kigali city through proper handling, disposal and treatment. The findings are coherent with the research conducted by (Begum, Siwar, Pereira, & Jaafar, 2006) cited in (Senaratne, Gerace, Mirza, Tam, & Kang, 2016) who found that waste minimization is economically feasible and also plays an important role for the improvement of environmental management. Furthermore (Begum et al., 2006) cited in (Senaratne et al., 2016) they ascertain that there would be an economic instruments for minimizing construction waste to be used to raise revenue for environmental policy, encourage prevention efforts, serve to discourage the least desirable disposal practices, as well as to avoid the negative consequences of environmental unfriendly treatment and disposal practices of construction waste materials.

Table4. 9: Revenues of solid waste management from construction practitioners in Kigali city

Codes of Revenues	*1*		*2*		*3*		*4*				
Revenues Intervals	*<3M*		*3M-6M*		*6M-9M*		*> 9M*		*Obs*	*Mean*	*SD*
	f	*%*	*f*	*%*	*f*	*%*	*f*	*%*			
Vegetation/ top soil (site clearance)			4	6.67	32	53.33	24	40	60	3.333	0.601
Reinforced concrete			2	3.33	46	76.67	12	20	60	3.167	0.457
Bricks/ Tiles			38	63.33	22	36.67			60	2.367	0.486

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Scrap metals			2	3.33	30	50	28	46.67	60	3.433	0.563
Wooden materials and other non inert waste			24	40	29	48.33	7	11.67	60	2.717	0.666
Rocks	9	15	27	45	24	40			60	2.250	0.704
Debris of pipes	8	14.6	31	56.36	16	29.09			55	2.145	0.650
Sewage			43	75.44	14	24.56			57	2.246	0.434
Municipal waste			8	13.33	43	71.67	9	15	60	3.017	0.537
Chemical waste (waste oil, lubricants, paints& solvents)	11	20.4	40	74.07	3	5.56			54	1.852	0.492

M: Millions

V. CONCLUSION AND RECOMMENDATIONS

The study findings concluded that the most construction solid waste identified on construction sites were woods; scrap metals; cement; bricks and trees respectively and the construction companies suggested that those wastes are available on their construction sites and they should be demolished properly. The second category of CSWM identified were insulation; nails; plaster; rocks; dirt and asbestos respectively according to their means and standard deviation. The study findings concluded that the Methods used on construction sites for waste were collection, treatment and disposal in Kigali city. For thermal treatment, the study findings concluded that there is open burning and the respondents were fairly on the adopted methods for waste treatment. Secondary there are incineration and Pyrolysis which are used to treatment waste from construction sites and all respondents were not satisfied on their application to treat waste. Lastly the study findings concluded that there are gasification and is not usually used as the heads of sites were very unsatisfied. Based on results, the study findings concluded that there is cost associated with SWM for practitioners and it is ranged from 6,000,000Frws-9,000,000Frws used cost of Vegetation/ top soil (site clearance), cost of reinforced concrete, cost of Scrap metals, cost of rocks and municipal waste respectively to clean the construction environment. The next category of cost was valued in ranged of waste costing above 3,000,000Frws-6,000,000Frws and those were the cost of bricks/ tiles demolition, cost of wooden materials and other non inert waste demolition, cost of debris of pipes demolition, cost of sewage demolition and cost of chemical waste (waste oil, lubricants, paints& solvents) demolition from the construction sites respectively. Based on summary of descriptive statistics the benefits ranged from 6,000,000Frws -9,000,000Frws and those were categorized as Vegetation/ top soil (site clearance), Reinforced concrete, Scrap metals, Wooden materials and other non inert waste and Municipal waste management that may generate high level of incomes. The second category construction solid waste management that may generates ranged from 3,000,000Frws-6,000,000Frws and those were categorized as Rocks, Sewage and Chemical waste (waste oil, lubricants, paints& solvents) waste.

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