



**Determinants of Risk in Solid Waste Management
Projects, in Kenya (A Case of Solid Waste Management
Projects in Mombasa County)**

Jackson Malii^{a*}, Dr.Fred Mugambi^b

^aDepartment of Entrepreneurship and procurement in the school of human resource development, Jomo Kenyatta university of agriculture and technology Mombasa CBD campus.

^bDepartment of Entrepreneurship and procurement in the school of human resource development, Jomo Kenyatta university of agriculture and technology Mombasa CBD campus.

^aEmail: jacksonmalii@yahoo.com

^bEmail: fmgambi@gmail.com

Abstract

Wastes are as natural as human beings. Man, since history has stayed and lived with wastes, regardless of risks associated with them. The purpose of this research project study was, therefore, to study the determinants of risk in solid wastes projects, in Kenya, where Mombasa County solid wastes projects were taken as a case study. The study, thus covered, solid wastes projects backgrounds, in relation to methods employed, to run and manage them all along history. Further, it also covered their evolution in developed nations and Africa. The research project, was therefore, carried with a general objective of studying the determinants of risk in solid waste projects, in many parts of the world and then related it, with the Kenyan case specifically in Mombasa. Based on this, the research project objectives and questions were therefore framed, specifically in line with, the role of legal framework, technology, personnel skills and policy, as the main study variables as they were assumed to be the influencing factors of solid wastes projects risks, if not managed well. In order to study this conveniently, a target population of eighty eight (88) solid waste projects workers was proportionally selected, out of which a sample size of seventy two (72) solid waste projects workers, was determined, through proportionate stratified random sampling technique.

* Corresponding author

Further, to collect research data, both quantitative and qualitative data collection were used, where questionnaires, interviews and observations were applied. The collected, data was therefore coded, sorted and finally grouped accordingly and eventually, analyzed statistically, using tables, graphs and bar charts and in this way, research study variables were studied. It was therefore found that, use of untrained personnel in SWM projects contributes to more risk likelihood, among solid waste workers than observance of safety measures. However, technology was found to be the most risk influencing factor, in solid wastes projects and thus recommendations were made in line with this.

Keywords: Legal framework; Personnel skills; Policy; Technology..

1. Introduction

Reference [1] referred to any useless, unwanted discarded material that is not a liquid or gas, as solid waste or refuse giving, typical examples such as newspaper, junk mail, day's meal scraps and pieces of bread, waste rice, raked leaves, dust, grass clippings, broken furniture, abandoned materials, animal manure, sewage sludge, industrial refuse or street sweepings. Further, management of this solid waste, referred to as Solid Waste Management (SWM), was thus defined by [2] as collecting, treating, and disposing of solid materials that are discarded because they have served their purpose and are no longer useful. Following is therefore a background of solid waste management project's research study that highlights its history and evolution. In the study, solid waste management problems, encountered by workers as well as the associated risks, all along history, have been highlighted, discussed and eventually a conceptual study framework guide, was arrived at.

1.1. Background of the study

Throughout history, as [3] argued solid wastes have been produced by human, where areas with low population density this production has been negligible, while in highly populated areas biodegradable solid waste was produced in high quantities and released back into the ground with environmental impacts. However, [4] argued that, pre-modern time's solid wastes were mainly ashes and human biodegradable wastes, which were easily released back into the ground locally, with minimum environmental impacts. The researcher further argued that, tools made out of wood or metal were generally reused or passed down through the generations, thus reducing these wastes. In contrast, however, [5] stated that trash throughout history, played tremendous roles, including fossil cementation deep into the earth giving rise to crude oil, but as population increased, as [5] further argued, it started to impact negatively, resulting to diseases, such as bubonic plague, cholera and typhoid fever, that altered the populations of mankind history in Europe, by influencing monarchies.

However, according to [6] report, about Manchester city's wastes management in regards, to diseases connected with its production, stated that SWM practices evolved along with human communities. The reporter further argued that, solid waste management in general, grew and evolved with changes of human life style, living in cities, largely due to changes in the quality of life and human tastes [7], added that, solid waste management gradually evolved from small dumpsites to the well-organized collection points, as well as the latest waste to energy (WTE) solid waste technology.

Nevertheless, solid-waste management technology, skills, policy and legal frameworks continued to evolve as [8] argued, till the latter part of the 19th century, when water tight garbage cans were first introduced in the United States, and sturdier vehicles were used to collect and transport wastes in most parts of Europe. Thus, economic changes, therefore, sustain this evolution in the developed nations, to date.

On the other hand, Kenya a regional commercial hub in Africa, with many economic activities particularly in Nairobi and Mombasa, generates a lot of solid waste, with little management practices. In this respect, [9] argued that, this generation presents typical problems in most of the Kenya's, major towns with very little literature about it. Reference[10]further argued that, 30 to 40 per cent of all solid waste generated in urban areas in Kenya as a whole, remains uncollected. This therefore, messes the country's economy indirectly.

Further, in reference [11] survey report, on the Mombasa County solid waste management projects stated that, the County generates approximately 750 tons of solid waste daily, that is poorly managed with a likely hood of up to 50% disease infection to most of its County dwellers. Currently, as in reference [12]argued, the County Council has no organized or official recycling programs with, most of its sorting done within the County Municipality collection points and dumpsites, by scavengers, after which they sell recyclables to private companies. The public, therefore, perceive solid waste management in Mombasa City and in the country at large as an area which needs great improvement.

1.2. Problem Statement

Problems with disposal of solid wastes can be traced from the time when people first began to congregate in tribes, villages and communities, and as such, accumulation of wastes became a consequence of life. Throwing of wastes into unpaved streets, roadways and vacant land led to breeding of rats with their attendant fleas carrying bubonic plague. In addition, lack of proper SWM resulted to epidemic of plague, the Black Death disease that killed half of fourteenth Century Europeans. This prompted the start of public health control measures in the nineteenth century, where food wastes had to be collected and disposed off in a sanitary manner to control rodents and flies the vectors of disease in connection with public health and improper storage of solid wastes. Industrialized nations as [13] argued, to date generates several pounds of solid waste per consumer making the danger of disposed wastes to be twofold, not only directly in the home, but indirectly in factories that manufacture goods purchased by consumers. In response, many cities in the developed nations, have set up County or municipal garbage collections bodies, in the form of rag and bone men, who buy useful garbage from people and recycle it; a quality waste collection team that would dispose unusable waste [14].

Exposure to hazardous waste according to [11] can affect human health, children being more vulnerable to these pollutants. In fact, as[11] added, direct exposure can lead to infection and even death especially when exposed to chemical pollution as release of chemical wastes into the environment leads to chemical poisoning. Managing solid waste well and affordably, as [15] argued is one of the key challenges of the 21st century, and a key responsibility for cities and County governments. It may not be the biggest vote-winner, but it has the capacity to become a full-scale crisis and a definite vote-loser, if things go wrong [5].

1.3. The research Gaps

Most solid waste pickers in the world are known to die in an alarming rate due to solid waste pollution related diseases and the enticing demand in solid waste picking is still on increase. Wastes in general continues to increase daily along with the related risks, however, as it stand to date not much has been done, in terms of research study, to unveil what contributes to all these, human solid waste related risks among the society. Nevertheless, researches so far done, have concentrated on solid waste management and practices, focusing on re-use, recycle and reduce (3R), a concept adopted by the Japanese industries, that does not take care of risks involved in the whole venture.

However, serious research study on solid waste projects, collection, dumping, recycling and reuse habits to investigate their related effects are so far lacking, the results of which is the witnessed related risks and consequent death to most of the project's workers. In addition the developed world's solid waste workers are also languishing in Greenhouse gases (GHG) impacts that cause death and other health problems to the entire human society. Therefore, aroused by such like study gaps in this societal human ingredient, the researcher carried out a study to investigate the determinants of risk in solid waste management projects in Kenya, in relation to legal framework, technology, personnel skills and policy, assumed to influence risk in solid waste management projects, with particular interest in Mombasa County, and hence bridge the gaps.

1.4. The research study objectives

1.4.1 General objective

The general objective of the study was, thus to study the determinants of risk in solid waste management projects in Kenya, where Mombasa County solid waste management projects, were considered as a case study.

1.4.2 Specific objectives

The research study addressed the following outlined specific objectives, considered in line with the key words research study variables.

- (i) To analyze the role played by legal framework in the determination and management of risk in solid waste management projects.
- (ii) To determine the role of technology in the determination and management of risk in solid waste management projects.
- (iii) To analyze the role of personnel skills in the determination and management of risk in solid waste management projects.
- (iv) To analyze the role played by policy in the determination and management of risk in solid waste management projects.

1.5. The research study questions

The research study, therefore sought to answer the following questions, which were framed in line with specific objectives.

- (i) What role does legal framework play in the determination and management of risks in solid waste projects?
- (ii) What role does technology play in the determination and management of risks in solid waste projects?
- (iii) What role does personnel skills play in the determination and management of risk in solid waste projects?
- (iv) What role does policy play in the determination and management of risks in solid waste projects?

2. Materials and methods

Solid wastes have existed and worried man all along history as it's uncalled for expenditure. Man has therefore sought ways of managing and minimizing this expenditure up to date. In line with this, the study reviewed how it was dealt with by other researchers in relation to the case of Mombasa County solid waste management projects.

In this regard, research study key words variables, were therefore designed in relation to the review gaps findings, so as to study the determinants of risk in solid waste management projects, in Kenya, Mombasa County. In line with this, conceptual framework was designed, that formed the study methodology and related materials for carrying out research study analysis.

2.1 Conceptual framework

Reference [16] referred to conceptual framework as a systematic research endeavor in an area of study, normally developed, in line with a research idea. For the research study, a conceptual framework was designed, to study and analyze four main key words variable components, namely; (i) Legal framework (ii) Technology (iii) Personnel skills and (iv) Policy and as such study their role in the determination and management of risk in SWM projects in Mombasa County; as shown below.

Figure 2.1 shows the conceptual framework that was used to study determinants of risk in solid waste management projects, in Kenya, where Mombasa County solid waste management projects were taken as case for the study. Independent variables, assumed to influence risks were analyzed to study how they determine risk in solid waste management projects.

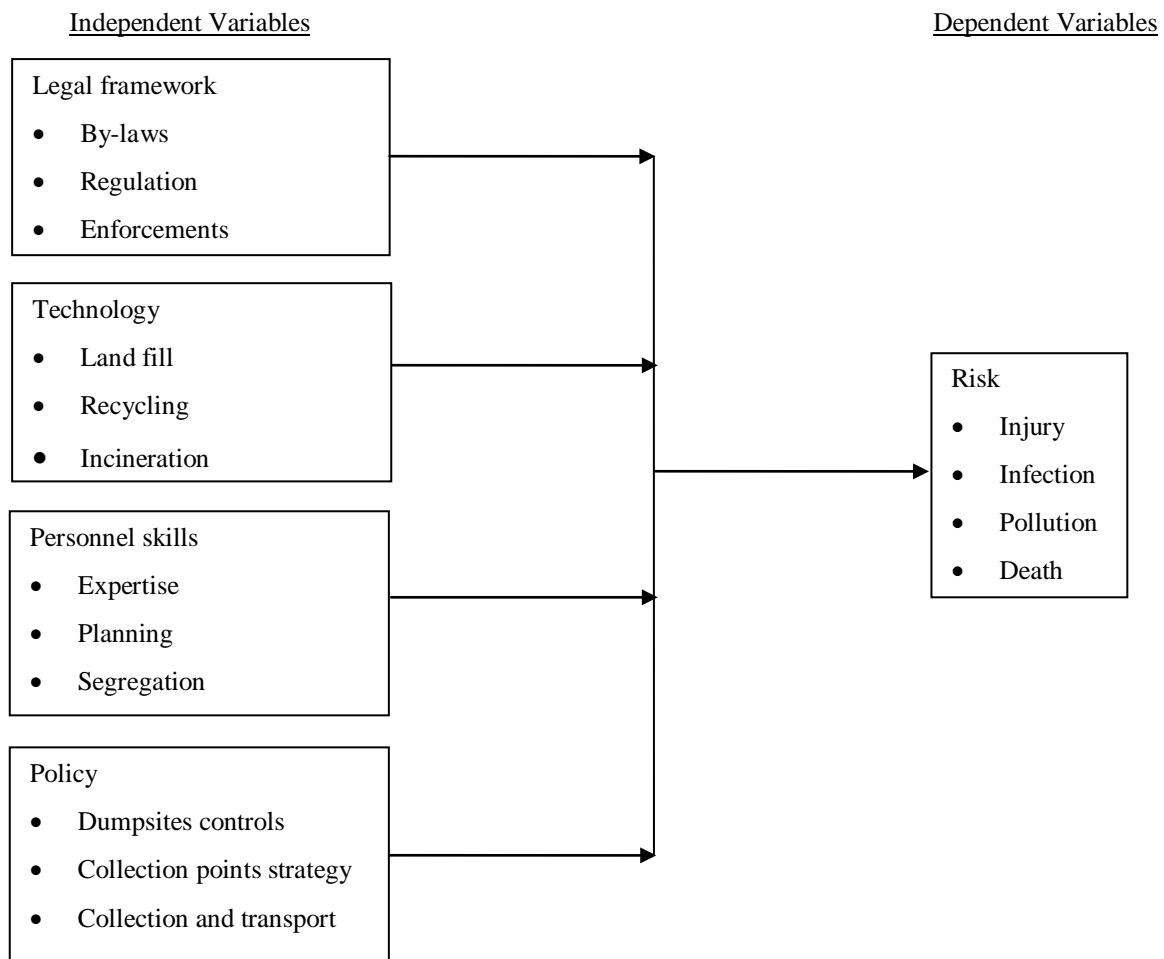


Figure 2.1: Conceptual framework

Source: Authors own research

2.2 The research design

The study used mixed research design approach, that according to reference [17] applies both quantitative and qualitative research design techniques to organize and analyze the research into a single study and as such enable easy understanding of the research problem effectively while, allowing for multiple facets of the phenomenon to be revealed and understood.

2.3 The population

The research project used a study population of eighty eight (88) SWM project workers, normally engaged by Mombasa County government to carry out solid wastes management projects; that according to [18] constituted, the aggregate or totality of objects, subjects or members that conformed to a set of specifications. From this, a sample size of seventy two (72) project workers was therefore, determined for the case study.

Table 2.0: Research study population

County solid waste management Project’s workers.	No. of study population per each
County community based organizations (CBOs) SWM workers at the dumpsites.	28
County SWM projects workers under Mombasa Cement Company.	15
County SWM youth groups at dumpsites.	23
County SWM Individuals initiatives at major dumpsites.	22
Total.	88

Source: Authors own research

Table above shows how this study population was found distributed among the County SWM projects. Table 2.0 provides the research study population targeted and perceived to satisfy the study criteria, as they all belong to Mombasa County government SWM projects, and as well, participate in solid wastes projects work. In this regard they were considered to be the best, for enabling the researcher, to meet the study objectives.

2.4 Sample and sampling technique

A sample according to [19] is a small group obtained from an accessible target study population. Various techniques are applied to choose a study sample size that according to [20] are methods used to draw a sample from the study population in such a manner that facilitates appropriate determination of the study inference, from the population, being studied. For the study, sampling technique used was the proportionate stratified random sampling technique, mainly to achieve a proportional sample size from the heterogeneous study population. In addition, Slovin's statistical formula, represented by, $n = \frac{N}{1+N(e)^2}$ was applied, along with proportionate random technique. Table 2.1 below, shows how the study sample size, n, was achieved.

Table 2.1 provides the method used to come up with study sample size from the study target population. The method was used to determine, the appropriate sample size of seventy two (72) project workers, who were studied. A precision level of 5% was used, at a confidence of 95%.

2.5 Research instruments.

Reference [21] defined research study instruments, as tools used by a researcher to collect study information in the most suitable way. These instruments, as reference [22] argued must be both valid and precise in order to ensure that, the researcher gets detailed study information that will lead to a precise study inference. Mostly used research instruments are; interviews, questionnaires, tests, scales, rating and checklists, which are normally designed to measure variable(s), characteristic(s), or information of interest. The research project study used a combination of polar questions, likert scale, five points’ questions and structured questionnaires, along with interviews and observations as its instruments to collect study data information.

2.6 Data collection procedure

Reference [23] referred to data collection, as the process of gathering and measuring information the variables of interest to establish a systematic fashion and as such enable one, to answer the stated research questions, test hypotheses, and eventually evaluate the research study outcomes. To collect data for the research study, both quantitative and qualitative data collection procedures-the mixed approach method technique was used.

Quantitative data collection procedure was used alongside observations to enable recording of well-defined events such as the major types of risks encountered by solid waste pickers in the SWM projects in Mombasa County, while qualitative method, used interviews and discussions and in this way enabled an in-depth study of key expert’s ideas and opinions, suitable for the study flexibility.

Table 2.1: Proportionate stratified random sampling technique

County SWM project workers		The study population	Proportional Percentage of 100% - the sampling fraction	Use of Slovin's Formula i.e. $n = \frac{N}{1 + N(e)^2}$	
Strata	No. of SWM workers in each category	Percentage in each category- (Proportionate %)	Proportionate sampling technique –using $n=(N/1+Ne^2)$, taking Precision of 5%	The sample size in each category	
CBOs, SWM workers at dumpsites	28	$\frac{28}{88} = 0.31818$ or 32%	$72 \times 0.32 =$	23	
Mombasa cement Co. SWM workers	15	$\frac{15}{88} = 0.17045$ or 17%	$72 \times 0.17 =$	12	
County Youth groups in SWM work at dumps	23	$\frac{23}{88} = 0.2614$ or 26%	$72 \times 0.26 =$	19	
Individual initiatives at dumpsites	22	$\frac{22}{88} = 0.25$ or 25%	$72 \times 0.25 =$	18	
Total	88	100%		72	

Source: Authors own research

2.7 Pilot test

The researcher conducted face-to-face interviews together with observations, in which case ten (10) questionnaires were distributed for the pilot tests, specifically, in the Mombasa Island and Likoni, and this way got in touch with SWM workers at the ground and in the process assessed the situation.

From, this a response rate of six (6) out the ten (10) questionnaires issued, was achieved, amounting to, 60% response rate. Further the pilot test revealed that, all solid wastes collected from Likoni constituency, are transferred to Mombasa County Island, where they are then taken to Mwakirunge, the main dumpsite. In addition, it helped to identify the research study population size, of eighty eight (88) SWM projects workers, engaged by County government to undertake SWM projects.

2.8 Data processing and analysis

2.8.1 Data processing

Data processing according to reference [24] is collection and manipulation of data items to produce meaningful information. Further, as Carl argued, it involves examining and scrutinizing the collected data in order to transform it, into useful information. To conduct this process, the collected data was edited and coded, in order to align all relevant data, in line with the research study interest. For this to be attained all data collected by use questionnaires were coded and grouped together to ensure that, similar ideas were identified, sorted and recorded in line with the intended analysis. In addition, specific expert opinions and observations were further studied to identify any hidden meaning that was aligned with research variables idea and as such enabled easy identification of the real research study problem. Further, experts and common worker's collected data opinions, were sorted categorically, in order determine the risk influencing factors among solid waste workers. The whole of these data were then grouped and organized according to each stratum, as specified in the research sample size, so as to ensure easy quantification and analysis. Eventually, the data was then classified accordingly, that made relevant comparisons, among the SWM project workers risks, in the Mombasa County to be achieved.

2.8.2 Data analysis

Reference [25] referred to data analysis as the process of inspecting, cleaning, transforming, and modeling the processed data, in order to identify useful information it represents, that is used to suggest precise study conclusion and thus, support research study decision making.

This, as reference [25] further argued is only done by use of various research study data analysis tools, part which are statistical methods, usually aided by computer software. However, to carry out data analysis, for this research study, frequency distribution data analysis tools were used, in order to come up with histograms and hence compared the research study variables relationships. Data collected by use of observations were analyzed by use of descriptive statistics data analysis tools, where a measure of central tendency was studied in regards to the common factors that influences risk among solid waste workers.

To confirm the dominant age groups in solid waste management projects as well as the most affected age group, cross-tabulation data analysis tools, together with bar charts were used to study how they relate within different solid waste projects risks, among the project workers. In addition, to study how solid waste projects safety measures, related with risk determinants, regression data analysis tool was applied.

Further, pie charts and text analytic data analysis tools were also used, to support qualitative data analysis technique and hence made it easy to analyze expert opinions on the determinants of risk in solid wastes management projects. Further, checklist data analysis tools alongside, each information were used to cross check data validity, reliability and precision for the analyzed information. Eventually, this enabled the researcher to come up with appropriate conclusion and recommendation, relevant to the research study objectives.

3. Results

3.1 Introduction

Results of determinants of risk in solid waste management Projects, in Kenya where Mombasa county solid waste's management projects, were taken as a case study were analyzed, in relation to stipulation of the research design. Statistical illustrations of how data was collected, presented, analyzed, were therefore provided. To carry out this, various tools of analysis were used in line with research study materials and methodology.

3.2 Data collection

Data collection for this study was done both quantitatively and qualitatively as stipulated in research study design methodology. In line with this, questionnaires were distributed to the sampled SWM projects working groups, alongside observations for the quantitative data, while at the same time, interviews were conducted among solid waste projects experts, for qualitative data collection.

3.2.1 Data collection response rate.

Data collection response rate is the proportion of responding to the questions, against failing to respond [26]. Table 3.2.1, provides the results of the collected data, in the form of response rate, where sixty four (64) questionnaires distributed, out of seventy two (72) were returned representing a response rate of 89%. The whole data collection response rate was statistically, cross tabulated as shown above.

Table 3.2.1, provides data collection response rate results, achieved from selected study locations, where response rate attained, was 89%. In the table, the case study quantity numbers, of respondents are indicated in the first column in each case, while the second column indicates the response quantity number value. Further, this response rate was analyzed in form of a bar chart to provide statistical study results comparison, as shown in figure 3.2.1a below.

Figure 3.2.1a, indicates data collection response rate results, achieved after collecting and sorting out the returned questionnaires. The response rate realized was 89%, where 11% of the questionnaires were not returned, signifying a successful study response. Further response rate analysis was carried out, to study whether SWM project's workers took the case study, positively or negatively and in addition, to determine the SWM projects workers cooperation, in regards to the study.

In addition, it was also found necessary to determine how successful the data collection instruments were, as well as their validity and reliability. In this case, cross data tabulation bar charts, were used to support this, and at the same time study the response rate in relation to statistical response curve, and thus compare level of precision set in the research study methodology with that, which was achieved on collection sites.

Table 3.2.1: Response rate cross tabulation

SWM projects	No at Kibarani& Changamwe	No Returned	No at Mwakirunge &kisauni	No. Returned	No at Island & Likoni	No. Returned	No at Nyali & Kongowea	No Returned	Total Response
CBOs	5	5	7	4	6	5	5	4	18/23 73%
Mombasa cement Co.SWM workers	4	3	3	3	4	4	2	2	12/12 100%
Youth Groups	6	6	4	4	4	4	5	5	19/19 100%
Individual Initiatives	4	4	3	3	7	4	4	4	15/18 83%
Total/% Response	19	18	16	14	21	16	16	16	64/72 = 89%

Source: Authors own research

Figure 3.2.1b below shows, the response rate bar chart breakdown study analysis results, done across various SWM projects study groups.

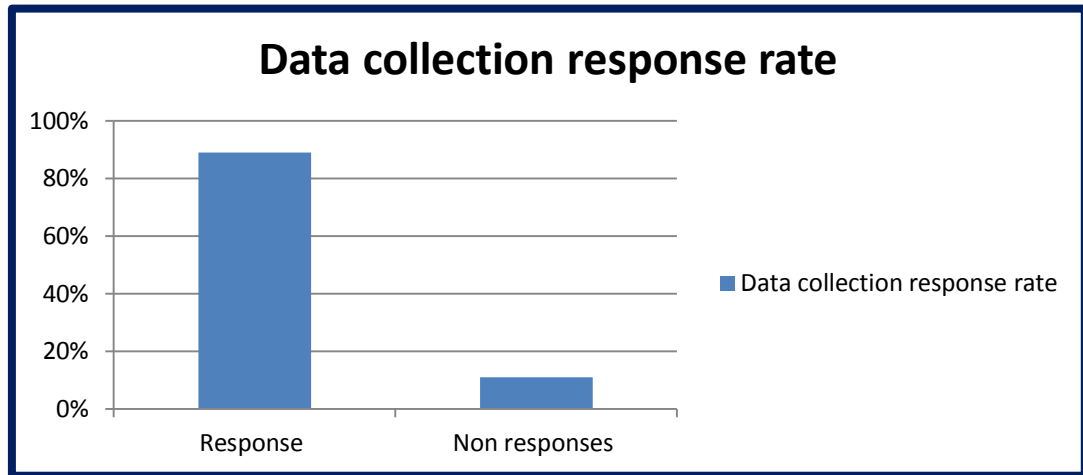


Figure 3.2.1a: Data collection response rate

Source: Authors own research

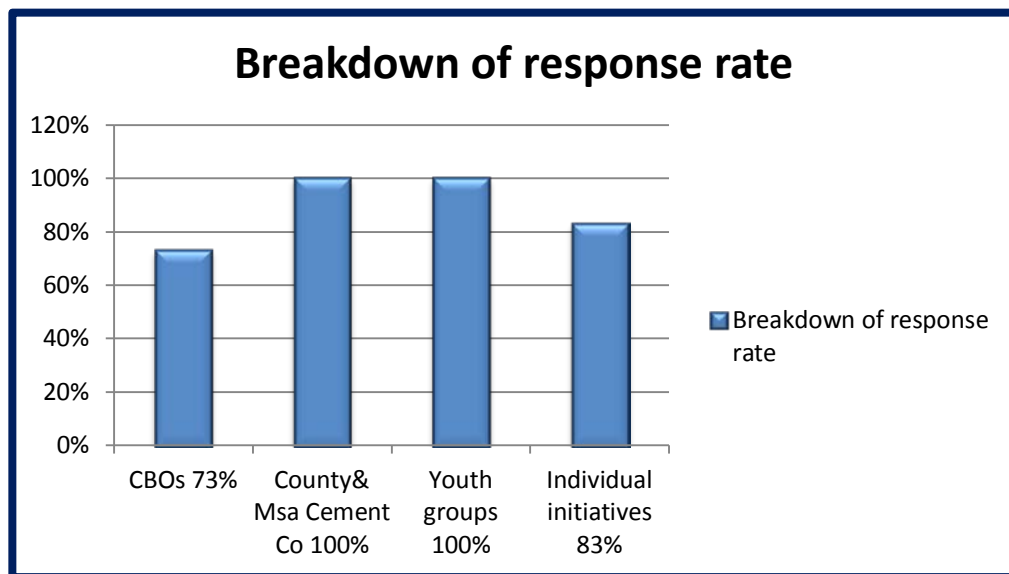


Figure 3.2.1b: Response rate breakdown

Source: Authors own research

Table 3.2.1 provides response rate breakdown analysis results, realized from various SWM projects study groups in Mombasa County. From the bar chart it was realized that, response rate followed a normal frequency curve distribution, as shown in figure 3.2.1c below.

Figure 3.2.1c, shows the normal curve realized after plotting data response rate analysis results. The Standard Normal curve, produced, a standard mean of 100, represented by the highest point of the curve and a standard deviation of approximately 80, represented by the distance from the center of the curve to the farthest sides of the curve. In this regard, if a data set follows normal distribution, as shown in figure 4.3.1c, then about 68% of

the observations falls within of the mean , which in this case, usually has an interval of (-1,1). Thus, about 95% of the observations fall within a, 2 standard deviations of the mean, which is within the interval of (-2, 2) for the standard normal curve.

From research study sample size determination, illustrated in table 3.1 in the research design, precision level $e=0.05$, and a confidence level of 95%, that in this case confirms, the research study anticipated precision level, preset in the research design.

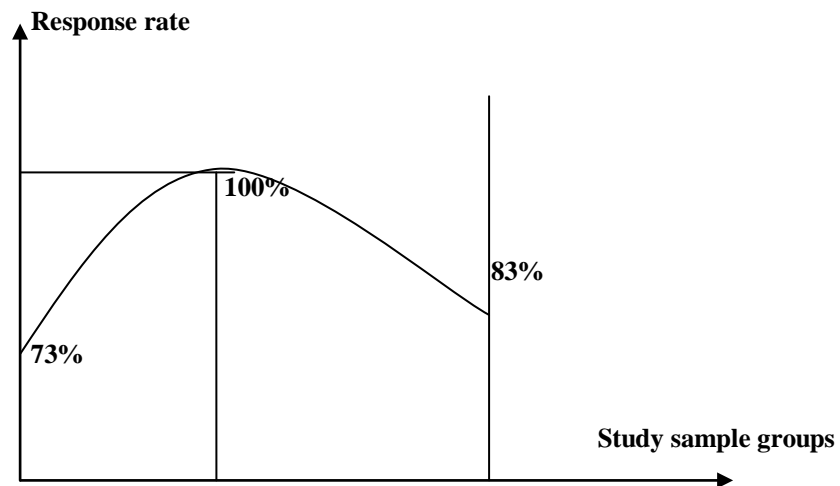


Figure 3.2.1c: Response rate distribution curve

Source: Whittingham, Regression model analysis.

3.3 Research analysis

Research data analysis provided the results of the research project study, in relation to key study variables, on the determinants of risk in solid waste management projects, in Kenya Mombasa County. Reference was thus made in relation to the research study objectives and questions so as to ensure the results were in line with determinants of risk in solid wastes management projects, in Kenya, Mombasa County.

3.3.1 Legal framework in SWM projects safety

The role of legal framework in relation to SWM projects work, in Mombasa County was analyzed in line with, the assumption that, legal framework enforcements would determine and manage risk in Mombasa county, solid waste's management projects. Table 3.3.1a, below provides the statistical linkert five points tabulation that provides results in relation to the assumption, of the projects workers perceptions. The role of legal framework in the determination and management of risks in solid wastes projects was, thus studied.

Table 3.3.1a below provides quantity values, of perceptions for the Mombasa County respondents, regarding key challenge in terms of SWM projects in the Mombasa County that the workers have faced for a long time. In this regard, respondents from the real SWM projects work were tabulated and their views in relation to these challenges analyzed. In relation to the above analysis, it was found that, majority disagree with use of legal frame work that, the County claimed to enforce.

However, 35% disagreed with the County SWM projects legal framework, as they claimed there was no regular supply of safety gears to protect workers, against disease infections while, 10% strongly disagree. These views were further, analyzed by use of a bar chart, as shown in the figure below.

Table 3.3.1a: Legal framework in Mombasa County SWM projects

Statement	strongly agree	Agree	Neutral	Disagree	Strongly disagree
Interpretation	5	4	3	2	1
Solid waste workers are provided with safety gears.	1	2	6	15	23
Safety at work is strongly adhered to.	0	0	8	19	20
County cleanness is observed	5	8	0	21	13
County SW collection are enforced	3	1	18	12	13
Total rating per each	40	44	96	134	69

Source: Authors own research

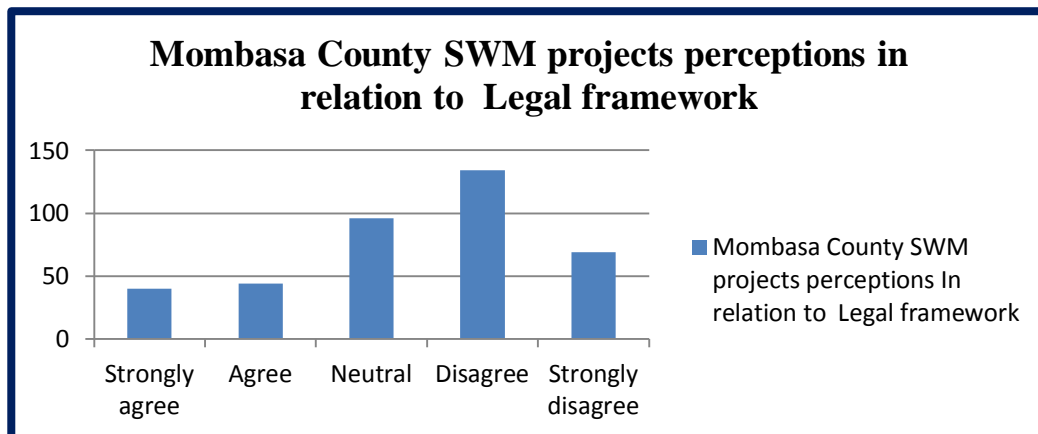


Figure 3.3a: Legal framework perception

Source: Authors own research

The figure 3.3a provides perceptions of Mombasa County SWM projects workers, in relation to the role of legal framework, as concerns, by laws, enforcement and regulations, applied to ensure, safe working environment among solid waste management projects workers. Majority of them disagreed, with use legal framework in the determination and management of risks in solid wastes projects.

3.3.2 The role of personnel skills in Mombasa county SWM projects

The role of personnel skills in the determination and management of risks in solid waste projects was analyzed and studied in relation to sub key words variable of; planning, expertise and ability to sort/segregate solid wastes into valuable and invaluable components. Workers ability in relation to these variables was thus studied and cross tabulated as shown in table 3.3.2a below, where percentage results in regards to determination and management of risk in solid wastes projects among Mombasa County projects workers was achieved.

Table 3.3.2a: Personnel skills in Mombasa County SWM projects

Statement	strongly agree	Agree	Neutral	Disagree	Strongly disagree
Interpretation	5	4	3	2	1
Mombasa County SWM projects staff have expertise in SW work.	4	3	4	17	19
Mombasa County SWM Projects are well planned.	5	1	0	23	18
Segregation/sorting in Mombasa County SWM projects is done well.	15	11	3	13	5
SWM planning is key to good SW projects risks Reduction.	13	10	0	16	8
Total rating per each.	185	100	21	138	50

Source: Authors own research

Table 3.3.2a above provides perceptions results of Mombasa County SWM projects personnel, in regards to the role of skills in the determination and management of risks in solid wastes projects. The perception’s analysis indicated that, 37% of the sampled projects workers strongly agreed that, personnel skills were key to healthy and safe work environment, while 30%, who disagreed. To study this further, County SWM projects expert’s percentage opinions were statistically cross tabulated, and compared with the above analyzed questionnaires perceptions as shown in table 3.3.2b below.

Table 3.3.2b provides SWM project’s expert’s opinion on personnel skills, analyzed in percentages in regards to Mombasa County solid waste management projects sub key variables of; planning, workers expertise and solid waste sorting or segregation. Application of these key sub variables, in relation to skills among solid waste management projects workers was analyzed in line with the determination and management of risks in solid wastes projects. From the above table, application on average was found to be 36%, while determinations and management of risks were analyzed and presented as shown in the sane table alongside application.

This revealed that, most of the solid waste project’s workers, lacked appropriate skills for carrying out projects work effectively and as such they were found to conduct a lot of risks among themselves. This confirmed, literature review study analysis, that majority of solid waste’s projects workers in many nations, lack related professional skills. However, majority of them, in the case study were found to be experts in solid wastes sorting, the contributing factor being the value of recovered materials in the exercise, as they are recycled locally. This was found to determine a lot of risks among projects workers, as indicated in the same table above. Further, the data was plotted to study the opinions relationships, in the determination and management of risks in Mombasa County solid waste management projects, as shown in figure 3.3b below.

Table 3.3.2b: Personnel skills

Personnel skills	⇒	Planning	Expertise	Sorting/Segregation
% Application				
in SW projects		37%	23%	48%
% Determination of				
Risks		72%	62%	53%
% Management of				
Risks		88%	77%	56%

Source: Authors own research

Figure 3.3b above is a statistical bar chart used to analyze and establish the relationships, in regard, to the role of personnel skill in the determination and management of risk in solid waste projects, Mombasa County.

The analysis was done in relation to planning, expertise and sorting/segregation skills. The essence was, to study and understand how risk determines or manages risk, on application of each skill. In each case it was identified the risk magnitude that would be expected or managed, upon application of relevant skill as shown per each variable category in the figure above.

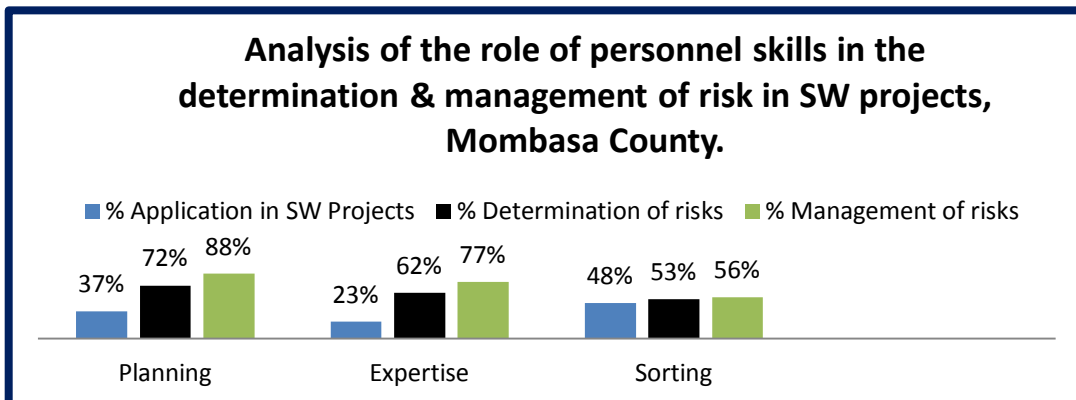


Figure 3.3b: The role of personnel skills

Source: Authors own research

3.3.3 Policy in relation to Mombasa County projects worker’s safety

Policy is a course or principle of action adopted or proposed by a government, party, business, or individual[27]. Mombasa County solid waste management projects policy is mandated to guide the government to ensure safe and healthy environment in the County City business areas as well as residential places. In addition, it sets standards, for solid waste management projects work and thus ensure it’s done, free from any danger and risks. Nevertheless, solid wastes are rampant in the county, with stinking smell witnessed all over, the County dumpsites collection points.

Table3.3.3a: Mombasa County SWM projects policy.

Statement	strongly agree	Agree	Neutral	Disagree	Strongly disagree
Interpretation	5	4	3	2	1
Policy controls SW dumps.	15	12	6	8	6
County SW collection strategy is provided	.4	0	8	23	22
County SW transport is well organized	.5	27	19	1	4
Dumpsites control would Minimize projects diseases.	28	14	18	2	3
Total rating per each	260	112	117	104	45

Source: Authors own research

Table 3.3.3a provides quantity rating results of Mombasa County solid waste management projects policy implementation, in terms of projects workers perceptions in regard, to use of policy in the determination and management of solid waste management projects. The analysis established that, 260 solid waste management projects workers, strongly agreed, policy appropriately determines and manages project’s risks and ensure they are minimized at worker. However, 53% perceived that, County Policy gives a low deal when it comes to controlling and management of solid wastes and thus contributing, to unplanned solid wastes dumpsites scatter in many parts of the County City center and residential locations. In this regard, further analysis was done by use of scatter diagram to determine strength of policy in the County, in relation to solid waste management projects as shown the figure below.

Figure 3.3, provides a linear regression analysis used to analyze, how policy in Mombasa County solid waste management projects, determines and manage risk among the project’s workers. The analysis established that, 95% strongly agreed that, Mombasa County Policy gives low deal in the management and control of solid wastes. This was confirmed by use of linear study analysis of the best fit line, shown above. Such kind of a line, takes the form of $Y = a+bx+c$, where, a is the Y intercept, b is the gradient, x the independent variable, Y the dependent variable and c, the error constant. From the figure, using the best fit option and drawing a line, it was established that, 3 out 5 strongly agree that, policy in the County was not enforced to the detriment of SWM

projects workers against 2 out 5 who disagree, within an error of 1.5.

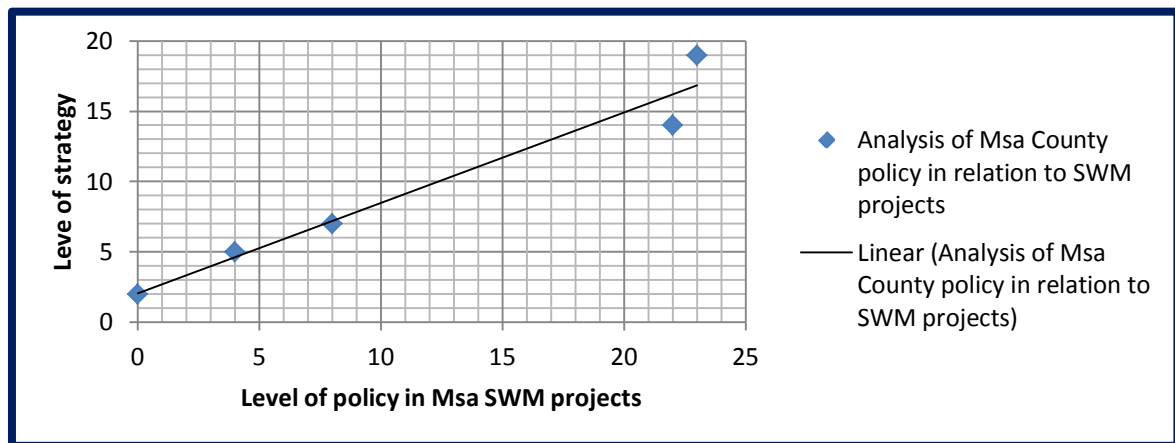


Figure3.3: Policy in the determination and management of SW risks

Source: Authors own research

3.3.4 The role of Technology in solid waste management projects

The role of technology in the determination and management of solid waste’s projects was analyzed in relation to; landfill technology, done at Kibarani-Changamwe, incineration technology, that the County is piloting in collaboration with Mombasa cement Company at Kibarani Mombasa, recycling technology, which done locally in the County and segregation or sorting, done by waste pickers and youth groups. Results of Solid waste management projects workers perceptions were analyzed as shown table 3.3.4a below.

Table 3.3.4a: Technology in Mombasa County SWM projects

Statement	strongly agree	Agree	Neutral	Disagree	Strongly disagree
Interpretation	5	4	3	2	1
Landfill Technology is used in Msa County SWM projects.	1	7	2	16	21
Use of landfills minimizes SW related diseases.	15	13	0	11	8
SW recycling would Minimize risks.	11	8	0	12	16
SW incineration Contributes to global risks.	13	12	18	1	3
Total rating per each	30	29	20	40	48

Source: Authors own research

Table 3.3.4a, provides quantity values analysis, of the Mombasa County SWM projects workers perceptions, in regard to SWM projects technology use, in the County. Analysis of the total rating per each opinion revealed that, County SWM projects workers had little idea on what SWM technology was all about. However, looking at landfill and incineration technologies alone, it was realized that, 93% perceived that, solid wastes technology would, minimize risk against 7% who believed, it would contribute to increase of risks. Further, use technology in the County solid waste projects in relation to landfill technology was plotted to study how it relates to risks impacts, as shown in figure 3.4a.

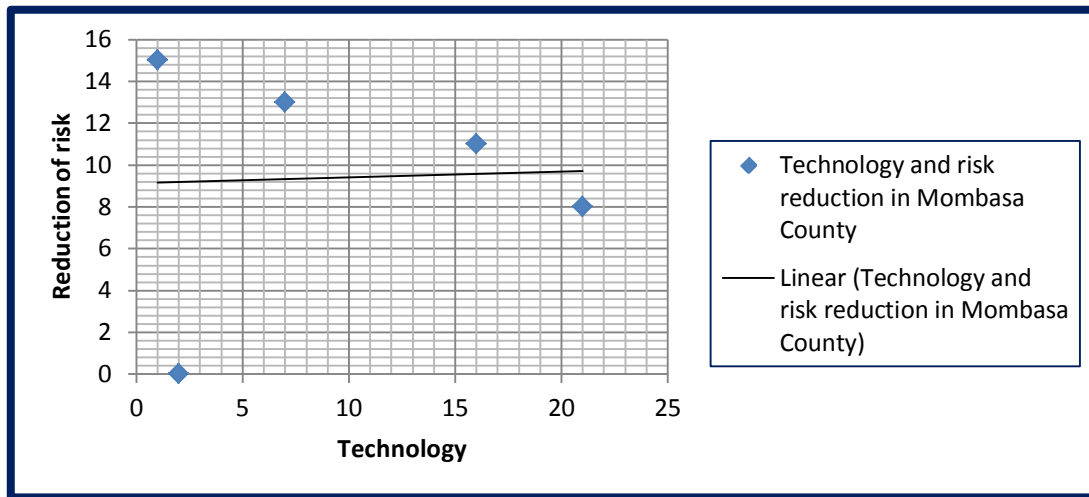


Figure 3.4a: Technology and risks reduction

Source: Authors own research

Table 3.3.4b: Mombasa County Technology application in SWM projects

Technology	landfill	Incineration	Recycling	Sorting
% Application in Mombasa County .	43%	28%	57%	37%
Level of risk in relation to literature review.	33%	78%	62%	54%
Expert's opinion on risk level with each	27%	88%	71%	33%

Source: Authors own research

Figure 3.4a provides a statistical scatter regression analysis relationship between technology and risk reduction in Mombasa County solid waste Management projects. Results line of fit indicated that, the variables relationship between technology in regard to solid waste management projects and risk reduction, being farther apart, showing that technology contributes very little in solid waste management projects risk reductions, at the detriments of projects workers. This disapproved the perception that technology reduces and manages solid wastes risks revealed in the literature review. Expert opinion on the same issue of technology and its role in the

management and determination of risk in solid waste project's, was further analyzed and statistically cross tabulated, in order to study how it relates with risk determination and management as shown in table 3.3.4b.

Table 3.3.4b, provides solid waste management technology data analysis, used to study various technologies used to manage solid waste's projects in Mombasa County. Results of application levels for each was analyzed as shown in the table above. Recycling technology was found to be highly practiced in the County and as such, attracting many youth groups and women and as a result, leading to high risks among them. Expert opinion revealed that incineration technology, that involves burning wastes in an enclosed housing furnace, was more risky than any other method used, however, its level of application in the County was found to be low. Nevertheless, at Kibarani dumpsite, open solid waste burning was found to be commonly used, contributing to solid waste project's workers risk. Thus, these technologies were found be, minimally applied in the County, at the expense of very outdated solid waste's techniques, found to determine a lot of risks in the management of these projects (see table 3.3.4b above). Further, study about expert opinion in regard to same issue was studied and presented as shown below.

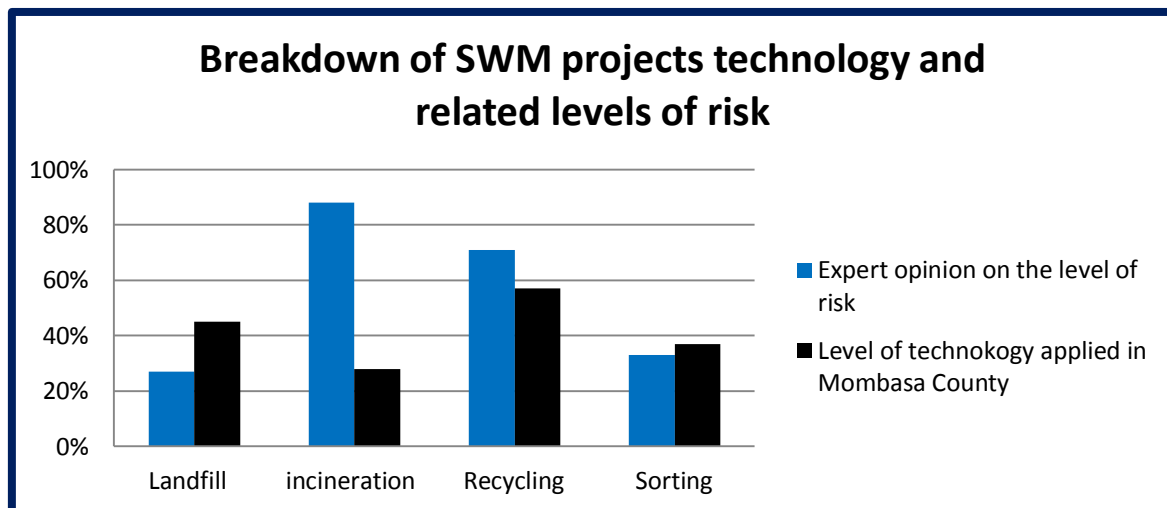


Figure 3.4b: Expert opinion on Technology application and risks levels

Source: Authors own research

Figure 4.3b provides percentages of technology levels applied in Mombasa County solid waste management projects in comparison with levels of risks, in regards to Mombasa County SWM projects expert's opinion. A keen look of the opinions in relation to SWM project's technology showed that, they assumed a normal curve, with confidence of 95% and precision level of $e= 5\%$. This falls under the study precision level hypothesized, in the research study design, thus confirming the validity and reliability of the study tools of analysis.

4. Discussions

The purpose of this research was to study the determinants of risk in solids waste management projects, in Kenya, where Mombasa County solid waste management projects were taken as a case study. Research study analysis and discussions were therefore made in line with the literature review findings that were then compared

with research study key study objective variables, so as to ensure objective conclusions and recommendations.

4.1 Legal framework in Mombasa County SWM projects.

Legal framework was analyzed in relation to the determination and management of risks in solid waste projects, in Mombasa County. Study sub key variables analyzed were; by-laws, regulations and enforcements, which were assumed to either, determine or manage risk in the SWM projects. These variables were then analyzed, in order to understand, how they contribute in laying out laws, for managing solid waste projects and thus determine and manage risks among solid waste project's workers. In this regard, the study confirmed legal framework, in relation to law enforcements and regulations, determines solid wastes risks, and as well manages them, as long as safety gears are adhered to.

Further, it established that, the Mombasa County has well laid down laws and procedures for regulating solid waste's dumping in the County. However, from various case study groups it was revealed that, though the county has well laid down legal frameworks, for dealing with wastes in general, including solid wastes, little enforcements were made, making County residents, solid waste workers and general public to suffer from risk related impacts.

On the other hand, political pressure was also found to play a big role in deterring proper and appropriate management of these projects. Nevertheless, most solid waste management projects, in the County, were found to be done under pressure of ensuring county cleanliness, due to the witnessed increase of County small business enterprises, which produces a lot of solid waste, without proper disposal. However, if solid waste legal framework was well enforced and regulated, it would manage and reduce solid wastes risks by 75%, as it's internationally accepted. Further, legal framework in relation to reduction of risk was plotted to study what causes dumpsites remain uncollected for a long time. Hence, illiteracy was found to be the cause of such delays, as many county solid waste workers had no idea of the consequences associates with uncollected solid wastes.

4.2 Personnel skills in Mombasa County SWM projects

Research study discussions in regard to personnel skills confirmed, they play a big role in the determination and management of risks in solid waste projects. In this context, well trained personnel, with expertise would reduce solid waste project's risks among workers alone by 65%, not even considering how much it would be reduced among residents and the public in general.

In developed world solid waste management projects are to date, taken as income generating projects, due advanced solid waste management skills among solid waste workers. However, in Mombasa County and Kenya in general, this is not the case, as many solid waste projects are undertaken by unskilled workers, resulting to a lot of risks among them and to innocent Kenyans. The research study, therefore, evidenced that, personnel skills determines and manages risk in solid waste projects.

4.3 Policy and the Mombasa County SWM projects

The role played by policy in the determination and management of risks in solid waste management projects in Mombasa County was analyzed in relation to measures put in place by County government to ensure solid wastes are controlled, both within the city center and residential places. Among solid waste workers consulted, it was revealed that, the Mombasa county solid waste management policy is meant to ensure constituencies and villages are kept clean and free from wastes and litters. However, the County lacks clear guidelines for ensuring collection points are strategically placed, at convenient locations to ensure elaborate wastes dumpsites controls. Nevertheless, the study established that, policy in the Mombasa County determines and manages solid waste projects risks on average by 42%, a level below 50%, due to lack of political good will. Expert opinions on the other hand revealed that, County solid waste's management policy was not enforced and thus the unplanned solid waste dumping, especially at residential areas and main markets. Therefore, the County was found to lack well organized policy measures, and hence witnessing up to 73% risks levels within its solid waste management projects. This confirmed that, policy alone cannot work without being enforced by law of inspectorate, found to be lacking in the county solid waste management projects.

4.4 Technology in SWM project's risk in Mombasa County

Technology employed to manage solid waste projects in developed world, includes among others; incineration, landfill, recycling and composting technology, all of which are expensive and harmful in the long run. Case study discussions among Mombasa County solid wastes project's workers, established that, landfill solid waste technology, was to a greater extend practiced in Kibarani Mombasa, though very expensive and risky. Expert opinion confirmed that, incineration technology was harmful to residents and ecosystem due to its endless production of gaseous fumes known to be extremely dangerous. However, its application in Kenya was realized to very minimal due to its related cost.

Use of recycling technology was confirmed to be very risky, especially when safety measures are not observed in the whole recycling chain. County solid waste management project's recycling technology chain was found to consist mostly, youth groups, who take the initiative as a business ventures. They therefore, observe little or no safety measures with many of them found to be suffering from skin diseases. Various study discussion established that, technology in the management of solid wastes, would determine and manage risks among solid waste workers, as it has done in many other countries in the developed nations. However, in the long run it was found to be very expensive and risky.

5. Conclusions

Cities and major towns in the world are run by Municipals or Cities/County councils. Responsibilities of these councils being to ensure towns and cities are kept clean and free from litters. However, many towns and cities suffer from the menace of uncollected wastes and the related risks, results of which are disease's increase and economic retardation. Among these wastes, are solid wastes which in most developed nations are considered as a raw materials that to date have proved to be dangerous and risky in developing world. However, no much

research study has been done in this area, in relation to the determinants of risks, in solid waste's projects.

The research study, therefore, studied the causes of risk, in solid waste management projects, in relation to legal framework, technology, personnel skills, and policy as the main variables and identified the influencing factors, among which technology was found to determine these risks, but at the same time influence most of them than any other. In Africa, the impacts of solid wastes were evidenced in various parts, particularly in the Gulf of Aden and Egypt, where 5% solid wastes, released to the sea, caused up to 250 deaths to seabirds and 25 marine animals. Nevertheless, projects are being done in many African towns and cities, including Kenya to curb these risks, regardless of the dangers and difficulties, which are encountered. Many projects workers have suffered, to the point of death while undertaking these projects, but the determinants of risks, in these projects are little or not taken seriously. This, therefore, propelled the researcher, to carry out this research study project.

6. Recommendations

Wastes are part and parcel of human nature, where solid wastes are just, a sub set. Studies have shown that, there is life in wastes, as organisms, like germs and other micro organisms that corrode, solid wastes metallic materials live there. However, man cannot do without waste and in fact, as it stands to date it is a resource, of heat energy, which drives the world's economy. A man therefore, should learn to live and stay with solid wastes amicably and thus, the need to study the determinants of risks in solid wastes projects, especially in Africa and particularly in Kenya. Further, research has evidenced that, solid wastes risks reduces among projects workers if vigilance is enforced with a lot safety measures. This research study, therefore, came up with the following recommendations; for safe and working relationship, between solid wastes and man.

- (i) Waste and solid waste is not a problem, but the problem is the imperfection within a man and thus the whole natural problem. Therefore, man should perfect ways of living with wastes in general.
- (ii) Solid wastes in many developed nations are used as a raw material. However, this has not benefited many countries both in the developed and developing nation. Therefore, further, research study should be done to transform solid wastes into useful resources, at minimal risks.
- (iii) Burning of solid wastes normally done by incineration technology and currently being practiced by Mombasa County government should enforce safe measures so as to reduce gaseous risk related pollutions.
- (iv) Youth groups and private organizations carrying out solid waste projects work; should use well trained personnel.
- (v) The most obvious environmental damage caused by solid waste is aesthetic, i.e. waste that litter public areas, is ugly and smelly. Counties and municipal councils should, therefore instill measures to curb this menace.
- (vi) Solid waste management projects should be detached from the County environmental section for better

performance.

- (vii) Solid waste collection should be given more time to ensure all garbage trucks within the cities and major towns are emptied in time.
- (viii) Waste in general, should be considered as part of production cycle, consumption and recovery and thus be assessed in relation to environmental sustainability.
- (ix) Solid waste workers should not be considered as filthy and inferior, but should be given support and where possible trained.
- (x) Mombasa County should devise decentralized SWM projects, as this will contribute to a cleaner local environment and in this way maintain pure surface and ground water, healthy soils, and clean air.
- (xi) Social stigmas and taboos surrounding waste should be removed from people and instead be taught to perceive waste as a lucrative resource from which one could make a living.
- (xii) The public in Kenya should be taught, about need of keeping cities and major towns clean.
- (xiii) Further study may be done on the role of solid wastes projects in developing countries, particularly Kenya

Acknowledgment

Much appreciation goes to all Jomo Kenyatta University of Agriculture and Technology (JKUAT), Mombasa Campus fraternity for their assistance, during this research project endeavor. I really appreciate, the presiding university examining panel, for the genuine criticism, that perfected this research study and subsequent research paper script. Special appreciation goes to Dr, Fred Mugambi, my research project supervisor, for his tireless and continued guidance during the whole process of carrying out the research project study and much more during the research paper script compiling. I really appreciate his genuine guidance. I can forget my colleague and friend Mr. Wanjala, who also offered considerable assistance. I should also thank my lecturers for enabling me to acquire enough knowledge to carry out this study. Lastly I appreciate my classmates for keeping me on toes as I compiled this script.

References

- [1]Diaz, L.F. and L.L. Eggerth, (2002). *Waste Characterization Study*. Ulaanbaatar, Mongolia, WHO/WPRO, Manila, Philippines.
- [2]Nathanson D.A. (2010). "Waste implications in the US army". *Sanitation in the US army for health operations*. (Vol.13.No 3,pp.34-45).
- [3]Cyert, P. R, (2004). "Historical study on man and production activities", *early history on human nature at*

work, GA Publications. pp 345-369.

[4] Coleman W.C. (1999). "Waste and human activities at landfills and in dumpsites", *evolution of human activities in search of food*, (Vol. 9, No.10, pp.60-70).

[5] Collins A. V. (2006). "Diseases and work in the ancient times", *Impacts at work in history of mankind*, Publications of man history (Vol.34, No.34, pp.346-390).

[6] Edwin K. & Johnson, L.(2010), "TQM, Chaos and Complexity," *Human Systems Management* (Vol.14. No. 4, pp. 1-16).

[7] Huhtala, A., (1997). "A post-consumer waste management model for determining optimal levels of recycling and landfilling". *Environmental and Resource Economics*, 10, pp. 301-314.

[8] Wilson, H. F. (2000). *Ethnography: "A way of seeing"*, Walnut Creek, CA: AltaMira Press.

[9] Ikiara et al., (2012). "The informal solid waste sector in Egypt": *prospects for formalization*, published by Community and Institutional Development, Cairo, Egypt, 65 pp. 456-460.

[10] Otieno P.J. (2013). "Solid waste in Kenya Nairobi", *Kenya solid waste and impact of plastics to the society* (Vol. No.34, pp. 235-345).

[11] Davidson, G. (2013). "Waste Management Practices", [Online]. Available: [http://www.dal.ca/content/dam/dalhoosie/pdf/sustainability/Waste%20Management%20Literature%20Review%20Final%20June%202011%20\(1.49%20MB\).pdf](http://www.dal.ca/content/dam/dalhoosie/pdf/sustainability/Waste%20Management%20Literature%20Review%20Final%20June%202011%20(1.49%20MB).pdf).

[12] Kaseva, M.E., S.B. Mbuligwe, and G. Kassenga, (2010). "Recycling inorganic domestic solid wastes: results from a pilot study in Dares Salaam City, Tanzania". *Resources Conservation and Recycling*, 35, pp. 243-257.

[13] Willies E.R (2012) Environment, Table 2.15 "Disease Prevention: Coverage and Quality". Table 3.6: Water pollution, Table 3.11: Urban Environment; [Online]. Available: <http://www.worldbank.org/data/wdi2012/wditext> [accessed 25/06/07].

[14] Daniel, J., G.J.M. Velders, S. Solomon, M. McFarland, and S.A. Montzka, (2013). "Present and future sources and emissions of halocarbons": *Toward new constraints*. *Journal of Geophysical Research*, 112(D02301), pp. 1-11.

[15] Morris, J.R., P.S. Phillips, and A.D. Read, (2011). "The UK landfill tax: financial implications for local authorities". *Public Money and Management*, 20(3), pp. 51-54.

[16] Robert O.P. (2000). "Quantitative research work", *A guide to research and analysis in project work study*. (Vol. 24, pp. 78-100).

- [17] Yin, W.H. (2003). "Quantitative techniques in research study", *the use of quantitative technique in experimental research*, (Vol. 19, No.20 pp.13-40).
- [18] Polit and Hungler (1999). "Population in research study", *How to select a suitable population for a research study* (Vol. 24, No.12, pp. 40-45).
- [19] Mugenda and Mugenda (1999). "Research Methods", *Quantitative and Qualitative approaches in research Method*, Nairobi: Acts Press, (revised, 2003).
- [20] Kanupriya (2012). *Research study as a means gaining Knowledge*, Publication on research and knowledge gain (Vol. 23. No. 2, pp. 23-34).
- [21] Biddix W.A (1999). "Solid waste technology in developed world", *Study of the influencing factors in solid wastes at work*, edited by Richard Jessor, Anne Colby, and Richard A. Shweder OCLC 4659.
- [22] Osborne A.G. (2000). "Research instruments management in a research study", Publication on the use of research instruments (Vol. 45, No.2, pp. 234-240).
- [23] Arthur, O. Q. (2009). "Conceptual framework as a guide to study", *the case of quantitative study in experimental work*, University of California, USA.
- [24] Carl (2006). "Data processing in a research study", *how to carry out data processing and analysis in research study*, University of California, USA.
- [25] Adler, P.A. & Adler, P. (2008). *Context and meaning in social inquiry*, edited by Richard Jessor, Anne Colby, and Richard A. Shweder OCLC 4659.
- [26] Curtin, Richard, Stanley Presser and Eleanor Singer. (2000). "The Effects of Response Rate Changes on the Index of Consumer Sentiment" *Public Opinion Quarterly* 64(4): 413-428.
- [27] Torjman, " (٧٠٠٠) Caledon Institute of Social Policy", *implementing the measure and assessing its impact*, (Vol. 35. No.12, pp. 235-255).

Acronyms

- CBD** Central business division
- CBO** Community based organizations
- Co.** Company
- GHG** Green house gases

JKUAT Jomo Kenyatta University of Agriculture and Technology

Msa. Mombasa

SW Solid wastes

SWM Solid wastes management

WTE Waste to Energy

3R Re-use, Recycle, Reduce