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RISK MANAGEMENT AND SUSTAINABILITY OF SOLID WASTE MANAGEMENT PROJECTS IN KENYA

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ABSTRACT

The purpose of this research was to examine the influence of risk management on sustainability of solid waste management projects with project leadership as moderator in Kenya. Additionally, the research examined the moderating influence of project leadership on the relationship between risk management and sustainability of solid waste management projects in Kenya. The theoretical framework was informed by the resource-based theory. Drawing on the positivist research philosophy, the research employed the correlational cross-sectional survey design. The proportionate stratified random sampling technique was used to select a sample size of 23 county chief officers, 23 directors, 23 deputy directors and 139 sub-county officers from a target population of 47 county chief officers, 47 directors, 47 deputy directors and 290 sub-county officers in charge of solid waste management projects in Kenya. A cross-sectional survey-based approach was used. A self-administered structured questionnaire was used to collect primary data. With the help of 3 research assistants, the researcher utilized the drop and pick method to hand deliver the survey questionnaire to the random sample. The collected data was processed and entered into the statistical package for social sciences (SPSS) version 26 to create a data sheet to be used for analysis. The descriptive statistics and inferential statistics were used for data analysis. The correlation results showed that risk management had a positive and significant relationship with sustainability of solid waste management projects. The regression results showed that risk management had a positive and significant influence on sustainability of solid waste management projects. The results indicated that project leadership had a significant moderating influence on the relationship between risk management and sustainability of solid waste management projects in Kenya. Managers and policy makers should to focus on strengthening risk management to foster the sustainability of solid waste management projects. Future research could examine the moderating influence of project leadership on the relationship between risk management and project sustainability in other sectors.

Key words: *Project Leadership, Risk Management, Sustainability of Solid Waste Management Projects, Kenya*

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INTRODUCTION

The role of solid waste management in achieving sustainable development is emphasized in several international development agendas, charters, and visions (Kanade, Joseph, Ansari, Varghese, & Savale, 2024). Effective solid waste management mitigates adverse health and environmental impacts, conserves resources, and improves the livability of cities (Alqassim, 2021; Alqassim & Ahmad, 2021; Hemidat *et al.*, 2022). However, unsustainable solid waste management practices, exacerbated by rapid urbanization and financial and institutional limitations, negatively impact public health and environmental sustainability (Abubakar *et al.*, 2022; Al-Dailami *et al.*, 2022). The waste management failure can be associated with an unchecked, rising population, indiscriminate consumption of resources, lack of awareness about hygiene, the poor policies implemented by the government, and public irresponsibility in abiding by the rules (Reddy, Khamparia, & Waghmare, 2022).

Solid waste management continues to dominate as a major societal and governance challenge, especially in urban areas overwhelmed by the high rate of population growth and garbage generation (Abubakar *et al.*, 2022). In most countries, solid waste management is characterized by lack of planning, improper disposal, inadequate collection services, inappropriate technologies that suit the local conditions and technical requirements, and insufficient funding (Awino & Apitz, 2024; Hemidat *et al.*, 2022). Solid waste management is an emerging concern for countries around the world, particularly developing nations with limited financial resources, lack of technologies, and an absence of policy framework (Pheakdey, Quan, Khanh, & Xuan, 2022). In most developing countries, solid waste management is mainly limited to collection, transportation, and disposal (Ravichandran & Venkatesan, 2021). Therefore, the provision of an efficient and sustainable waste management system that takes into account the potential impact on public health and the environment is critical to most governments (Bui, Tseng, Tseng, & Lim, 2022).

As the world grapples with environmental and social challenges, the role of project management practices in driving sustainable outcomes becomes increasingly vital (Malik, Ali, Latan, & Jabbour, 2023). The shift is driven by the increasing recognition of the environmental, social, and economic impacts of projects, necessitating a holistic approach that balances these dimensions for the benefit of current and future generations (Gupta, 2021). The integration of sustainability into project management practices is increasingly seen as a critical factor for the long-term success and viability of projects, especially in the context of global challenges such as climate change and social inequality (Orieno, Ndubuisi, Eyo-Udo, Ilojianya, & Biu, 2024). By addressing risk management effectively and exploring emerging trends and research areas, organizations can advance towards more sustainable and resilient project outcomes (Adebayo, Ikevuje, Kwakye, & Esiri, 2024). However, many organizations continue to struggle due to lack of knowledge and practical guidance on how to integrate sustainability dimensions within project management processes (Santos & Fernandes, 2024).

Statement of the Problem

Solid waste management is one of the most important environmental challenges facing countries. Solid waste poses a significant threat to both the global economy and ecosystems (Kanade *et al.*, 2024). Global estimates suggest that 2.01 billion tons of municipal solid waste are generated each year, of which 33% remains unmanaged, which poses a serious challenge towards environmental sustainability (Khan *et al.*, 2022). In developing countries, most cities collect only 50-80% of generated waste after spending 20-50% of their budgets, of which 80-95% are spent on collecting and transporting waste (Muheirwe, Kombe & Kihila, 2022). In African countries, solid waste management still remains a serious challenge with available data showing that, the Sub-Saharan Africa alone generates approximately 180 million tons annually and yet only 11% is disposed properly (Munayi, 2023; Odhiambo, 2022).

The unsustainable solid waste management is attributed to the rapid growth of the population, a booming economy, rapid urbanization, and high standards of living in the community, which have significantly accelerated the rate of solid waste generation (Pheakdey *et al.*, 2022). The increase of human population and urbanization trends, projections suggest that the surge of solid waste generation could reach 3.40 billion tons by 2050 Pudcha, Phongphiphat, & Towprayoon, 2023). Of the generated municipal solid waste, approximately 47% is directed to landfills, 31% undergoes recycling, and the remaining 22% is incinerated (Mor & Ravindra, 2023). Nearly 70% of municipal solid waste is not recycled or repurposed, representing significant loss of valuable supplies, placing a substantial strain on primary resources (Pisuttu *et al.*, 2024). The unsustainable solid waste management practices, exacerbated by rapid urbanization, financial and institutional limitations, negatively impact to public health and environmental sustainability (Al-Dailami *et al.*, 2022).

Despite its growing importance, the integration of sustainability into project management practices is not without challenges (Moreno-Monsalve *et al.*, 2022). Some of which includes, lack of standardized guidelines and metrics for measuring sustainability outcomes in projects, creating difficulties in examineing the true sustainability impact of projects and the comparing of different projects sustainability parameters (Orieno *et al.*, 2024). Many organizations continue to struggle due to lack of knowledge and practical guidance on how to integrate sustainability dimensions within project management processes (Santos & Fernandes, 2024). There is a lag in incorporating sustainability in core project management practices such as the selection of project delivery methods (Ahmed & El-Sayegh, 2024). Notwithstanding a compelling need for reform, sustainability remains a peripheral matter within the project management field (Fathalizadeh *et al.*, 2021). The relationship between project management and sustainability concepts is still widely discussed, but inconclusive (Ferrarez *et al.*, 2023).

Research Objectives

The general objective of this study was to examine the influence of risk management on sustainability of solid waste management projects with project leadership as a moderator in Kenya. The study was guided by the following specific objectives:

- To determine the influence of risk management on sustainability of solid waste management projects in Kenya.
- To establish the moderating influence of project leadership on the relationship between risk management and sustainability of solid waste management projects in Kenya.

Research Hypotheses

In this research, two null hypotheses were tested.

H_{01}: Risk management has no significant influence on sustainability of solid waste management projects in Kenya.

H_{02}: Project leadership has no significant moderating influence on the relationship between risk management and sustainability of solid waste management projects in Kenya.

LITERATURE REVIEW

Resource-Based Theory

The resource-based theory (RBT) of the firm (Barney, 1991; Penrose, 1959; Peteraf, 1993; Wernerfelt, 1984) posits that firms' competitiveness even in the same industry varies based on a firm's resources and capabilities (Zulkiffli, Zaidi, Padlee, & Sukri, 2022). The RBT of the firm provides an explaination as to why some organizations are performing better and how an organization can perform better (Teece, 2023a; Wu, Yan, & Umair, 2023). The RBT of the firm provides a relevant underpinning theory for the research model to examine the influence of risk management on sustainability of solid waste management projects with project leadership as a moderator in Kenya. The RBT of the firm postulates that firms gain competitive advantage through bundles of valuable and rare resources and sustain that advantage over time when such resources are difficult to imitate or non-substitutable by risk managements (Sharma, Alkatheeri, Jabeen, & Sehrawat, 2022). Despite the broad application of the RBT of the firm in multiple disciplines, the theory has attracted certain criticisms which led to the evolution of the dynamic capability theory (Teece, 2023b; Utami & Alamanos, 2022).

Prospect Theory

The prospect theory (Kahneman & Tversky 1979; Tversky 1967) helps in decision-making under conditions of risk (Goyal, Gupta, & Yadav, 2023). The prospect theory (Tversky & Kahneman, 1979) is a theory of behavioral economics, judgment and decision making (Yang & Xiao, 2024). The prospect theory is a relevant theoretical framework that explains the influence of risk management on sustainability of solid waste management projects in Kenya. The prospect theory (Levy, 2003) posits that decisions are framed around a pivotal reference point which may or may not correspond to the status quo, but which nonetheless directly affects risk appetite (Tapas & Pillai, 2022; Wu, Yan, Pan, & Wu, 2023). The prospect theory may be a useful analytic tool for analysing risk-acceptant decision-making in the context of dynamic economic situations (Maina & Mungai, 2023; Yang, 2024).

Contingency Theory

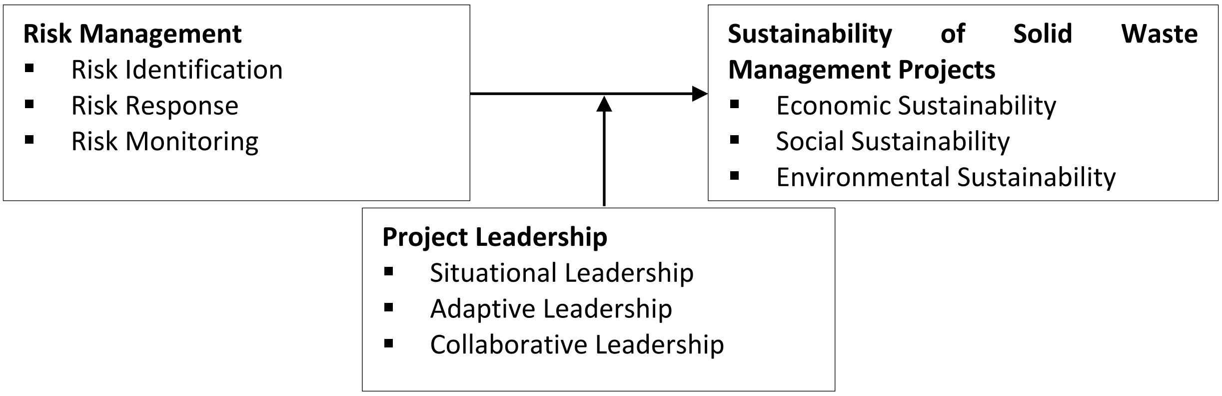
The contingency theory (Fiedler, 1967; Wooton, 1977) assumes that there is no best way to manage an entity (Samkange, Ramkissoon, & Amponsah, 2024). The contingency theory (Fiedler, 1964; Woodward, 1965) postulates that no single strategy may be used to manage a situation or organization (Benmira & Agboola, 2021). The contingency theory principles may help to develop effective management practices influenced by opportunities presented through the interaction of internal and external environmental contingencies (Hud, Arham, & Hanapiyah, 2024). The contingency theory suggests that the effectiveness of leadership, innovation, creative management, and situational competence warrant further research to determine the level of interdependency in decision-making (Muzorewa, 2024). Therefore, the contingency theory provides an appropriate theoretical framework to examine the influence of project leadership on sustainability of solid waste management projects in Kenya.

Triple Bottom Line Theory

The triple bottom line (TBL) theory (Elkington, 1997; Elkington, 2004; Elkington & Rowlands, 1999) suggests that a business should look beyond the one bottom line of profits to achieve sustainability (Aytac, Bautista-Puig, Orduña-Malea, & Tran, 2023). The TBL theory is a theoretical framework for a business model of sustainable development focusing on profit, environment, and people rather than just maximizing profit (Shim, Moon, Lee, & Chung, 2021; Wai, Hong, & Suet, 2023). The TBL theory is centred on three words: people, planet and profit (Pereira & Martins, 2021). The study employs the TBL theory as a theoretical foundation to examine the sustainability of solid waste management projects in Kenya. The TBL theory states that companies need responsible attitudes toward society and the environment as well as focus on economic profit in order to achieve sustainable management (Farooq, Fu, Liu, & Hao, 2021). Therefore, the TBL theory provides an appropriate theoretical framework to examine the moderating influence of project leadership on the relationship between risk management and sustainability of solid waste management projects in Kenya.

Conceptual Framework

The conceptual framework depicts that sustainability of solid waste management projects is conceptualized as the dependent variable. From the conceptual framework, risk management is conceptualized as the independent variables. The conceptual framework suggests that project leadership is conceptualized as the moderating variable. Figure 1 presents the conceptual framework.



Independent Variable **Moderating Variable** **Dependent Variable**

Figure 1: Conceptual Framework

Risk Management

Risk management has gained substantial attention and become a critical area in project management. Project risk management acknowledges that all projects come with risks (Plattfaut, 2022). Risk management encompasses a structured approach to finding, assessing, and mitigating possible threats that could impede project progress or lead to budget overruns (Habib, Eldawla, & Zaki, 2023). The knowledge area of project risk management includes all activities that minimize the risks and their impact, for instance, the activities of risk monitoring, response planning, or response implementation (PMBOK, 2021b). Therefore, risk management is a systematic process that involves identifying, evaluating, and responding to project risks (Elkrghli & Almansour, 2024).

Risk management can enable the project manager, as a continuous planning phase, to improve and overcome positive events (Fazly, Raees, Shafi, Iqbal, & Nawaz, 2024). Recent research has highlighted the paramount importance of risk management in achieving successful outcomes (Iqbal, Nawaz, Ali, Osman, & Hamza, 2024). Risk management is also significant in the project since it involves identifying, evaluating, and controlling risks that may affect the project or cause costs to go overboard (Elkrghli & Almansour, 2024). However, the risk management process exhibits deficiencies in coordination and visibility, particularly in developing countries (Hatamleh, Alzarrad, Alghossoon, Alhusban, & Ogunrinde, 2024).

Project Leadership

For the successful completion of the project, the art and science of guiding a team could be regarded as project leadership (Kaur, Haque, & Gkasis, 2024). The role of the leader turns out to be more important in project management, because the completion of tasks relies heavily on collaboration, coordination, and teamwork (Nauman, Musawir, & Riaz, 2024; Mutua & Muchelule, 2024). Consequently, leadership emerges as a pivotal determinant in contemporary projects characterized by intricacies and volatility (Mozammel & Abdulla, 2024; Oh, Lee, & Zo, 2021).

Project leaders are constantly working to minimize project failures by adopting new leadership practices and strategies to enhance project success in the construction sector (Rehan, Thorpe, & Heravi, 2024a). Effective leaders must cultivate relationships among diverse stakeholders, ensuring that varied perspectives are integrated into project planning and execution (Hanson, Nwakile, Adebayo, & Esiri, 2024). Project leaders demonstrate different styles of leadership (Rehan, Thorpe, & Heravi, 2024b). Nonetheless, there is no conclusive evidence on which style of leadership is more efficient and effective in the completion of a successful project, especially in the field of project management (Kaur *et al.*, 2024).

Project Sustainability

The importance of sustainability in project management cannot be overstated. It represents a critical evolution in the field, aligning project objectives with the broader goals of sustainable development (Orieno *et al.*, 2024). The integration of sustainability into project management practices is increasingly seen as a critical factor for the long-term success and viability of projects, especially in the context of global challenges such as climate change and social inequality (Orieno, Ndubuisi, Eyo-Udo, Ilojianya, & Biu, 2024).

The importance of sustainability in project management is underscored by its potential to enhance project outcomes, foster stakeholder engagement, and contribute to the broader goals of sustainable development (Petrelli *et al.*, 2023). The shift is driven by the increasing recognition of the environmental, social, and economic impacts of projects, necessitating a holistic approach that balances these dimensions for the benefit of current and future generations (Gupta, 2023). In the realm of project management, this shift has led to a reevaluation of traditional practices, emphasizing the integration of environmental, social, and economic considerations into the project lifecycle (Stanitsas & Kirytopoulos, 2023). As the world grapples with environmental and social challenges, the role of project management in driving sustainable outcomes becomes increasingly vital (Gupta *el at*., 2023).

The environmental, social, and economic dimensions of sustainability are intertwined with the core objectives of project management, emphasizing the need for a holistic approach (Orieno *et al.*, 2024). Economic sustainability in project management involves ensuring that projects are financially viable and contribute positively to the economic well-being of the stakeholders and the broader community (Madureira *et al.*, 2022). Social and ethical aspects, including stakeholder engagement and community impact, are essential for maintaining the social license to operate (Huang, Liu, Iqbal, & Shah, 2024). Environmental considerations, such as resource efficiency and pollution reduction, are crucial for the long-term viability of projects (Meng, 2024). The attainment of project sustainability requires integration of sustainability aspects in project management practices (Miano, 2023). However, many organizations continue to struggle due to lack of knowledge and practical guidance on how to integrate sustainability dimensions within project management processes (Santos & Fernandes, 2024).

Empirical Review

Muluka (2023) examined the effect of project risk management on success of digital literacy programme in Western Kenya. The findings showed that project risk management had a positive and significant relationship with success of digital literacy programme. The results indicated that project risk management had a positive and significant effect on success of digital literacy programme.

Chepng'eno (2021) examined the effect of project risk management on sustainability of road projects in Kericho County, Kenya. The findings showed that risk management had a positive and significant relationship with sustainability of road projects. The results indicated that risk management had a positive and significant effect on sustainability of road projects.

Leshinka and Nyaberi (2023) examined the effect of project risk management on implementation of donor funded water and sanitation projects in Central Rift Region, Kenya. The findings showed that project risk management had a positive and significant relationship with implementation of donor funded water and sanitation projects. The results indicated that project risk management had a positive and significant effect on implementation of donor funded water and sanitation projects.

Gatumi (2022) examined the effect of project leadership on sustainability of food security projects in counties within arid lands, Kenya. The results indicated that project leadership had a positive and significant relationship with sustainability of food security projects. The results indicated that project leadership had a positive and significant effect on sustainability of food security projects.

METHODOLOGY

The research was anchored on a positivist research philosophy. Drawing on a quantitative non-experimental research methodology, the research utilized a correlational cross-sectional survey research design to examine the non-causal relationship between study variables.

The target population consisted of 47 county chief officers, 47 directors, 47 deputy directors and 290 sub-county officers in the department of environment in charge of solid waste management projects in Kenya. The unit of analysis consisted of the solid waste management projects, while the unit of observation consisted of the project implementation team in charge of solid waste management projects in Kenya.

The sampling frame for this study consisted of the list of the 47 county chief officers, 47 directors, 47 deputy directors and 290 sub-county officers in charge of solid waste management projects in Kenya.

The Yamane (1967)'s formula was used to determine the desired sample size at the 5% significance level:

$$n = \frac{N}{1+Ne^2)} \qquad n = \frac{431}{1+431(0.05)^2)} \quad = \quad 208$$

Where:

n = Sample Size

N = Target Population

e = level of precision (sample error)

Therefore, the minimum recommended sample size consisted of 23 county chief officers, 23 directors, 23 deputy directors and 139 sub-county officers in the department of environment in charge of solid waste management projects in Kenya.

The proportionate stratified random sampling technique was used to select a sample size of 23 county chief officers, 23 directors, 23 deputy directors and 139 sub-county officers from a target population of 47 county chief officers, 47 directors, 47 deputy directors and 290 sub-county officers in charge of solid waste management projects in Kenya. The choice of the proportionate stratified random sampling technique was justified by the heterogeneous target population.

A self-administered structured questionnaire was the means for collecting primary data.

The simple linear regressions model was specified as:

$Y = \beta_0 + \beta_1 X + \varepsilon$ …………………………….…. Equation 1

Where:

Y = Sustainability of Solid Waste Management Projects

X = Stakeholder Management

β_0 = Constant Term

β_1 = Regression Coefficients to be estimated

ε = Stochastic Error Term

The hierarchical moderated multiple linear regression models were specified as:

$Y = \beta_0 + \beta_2 X + \varepsilon$ ………………………………….. Equation 2.

$Y = \beta_0 + \beta_3 X + \beta_4 Z + \varepsilon$ ………….….…………… Equation 3.

$Y = \beta_0 + \beta_5 X + \beta_6 Z + \beta_7 X*Z + \varepsilon$ ………………… Equation 4.

Where:

Y = Sustainability of Solid Waste Management Projects (the dependent variable),

X = Stakeholder management (the independent variable)

β_0 = Constant (the coefficient of the Y intercept)

$\beta_2 - \beta_6$ = Regression coefficients to be determined,

Z = Project Leadership (the moderating variable),

X*Z = Stakeholder Management* Project Leadership (the interactive variable),

ε = Stochastic Error Term

FINDINGS

Out of the 208 survey questionnaires distributed for main study, only 168 usable survey questionnaires were received. Therefore, there was a valid response rate of 80.8%.

Diagnostic Results

Normality Test Results

The normality test was performed using the Kolmogorov-Smirnov test and the Shapiro-Wilk test were performed. The Kolmogorov-Smirnov test and the Shapiro-Wilk test are most widely used methods to test the normality of the data (Bell *et al.*, 2022). From the normality test results, the p-values of the Kolmogorov-Smirnov test and the Shapiro-Wilk test were greater than 0.05 ($p > 0.05$), suggesting that the data was assumed to approximately meet the normality assumptions. Generally, if the p-value is less than or equal to the significance level, the decision is to reject the null hypothesis and conclude that the data do not follow a normal distribution (Hair *et al.*, 2021). Table 1 presents the normality test results.

Table 1: Normality Test Results

	Kolmogorov-Smirnov[a]			Shapiro-Wilk			
Variable	**Statistic**	**df**	**Sig.**	**Statistic**	**df**	**Sig.**	**Decision**
Risk management (X)	.154	168	.170	.970	168	.176	Normal Distribution
Project Leadership (Z)	.093	168	.200*	.973	168	.493	Normal Distribution
Sustainability of Solid Waste Management Projects (Y)	.051	168	.090	.993	168	.207	Normal Distribution

Linearity Test Results

The linearity test results showed that risk management had a strong positive and significant linear relationship with sustainability of solid waste management projects ($r = 0.733$, $p \leq 0.05$). The linearity test results indicated that risk management had a moderately strong positive and significant linear relationship with project leadership ($r = 0.609$, $p \leq 0.05$). The linearity test results showed that project leadership had a strong positive and significant linear relationship with sustainability of solid waste management projects ($r = 0.852$, $p \leq 0.05$). The linearity test results suggested that the assumption of linearity was not violated (Hair *et al.*, 2021). Table 2 presents the linearity test.

Table 2: Linearity Test Results

Variable		X	Z	Y
Risk management (X)	Pearson Correlation	1		
	Sig. (2-tailed)			
	N	168		
Project Leadership (Z)	Pearson Correlation	.609**	1	
	Sig. (2-tailed)	.000		
	N	168	168	
Sustainability of Solid Waste Management Projects (Y)	Pearson Correlation	.733**	.852**	1
	Sig. (2-tailed)	.000	.000	
	N	168	168	168

**. Correlation is significant at the 0.01 level (2-tailed).

Homoscedasticity Test Results

The Levene's test for equality of variance was performed for the homoscedasticity test. The presence of homoscedasticity or the absence of heteroscedasticity is an assumption most commonly tested using the Levene's test for equality of variance (Bell *et al.*, 2022). The homoscedasticity test results showed that Levene's statistics for each of the study variables were non-significant with p-values greater than 0.05, suggesting that equal variance was assumed. Table 3 presents the homoscedasticity test results of the study variables.

Table 3: Homoscedasticity Test Results

Variable	Levene Statistic	df1	df2	sig	Remarks
Risk management (X)	4.85	1	168	.278	Equal Variance Assumed
Project leadership (Z)	3.66	1	168	.298	Equal Variance Assumed
Sustainability of solid waste management projects (Y)	4.51	1	168	.265	Equal Variance Assumed

Autocorrelation Test Results

The Durbin-Watson test was performed for autocorrelation test. The autocorrelation test results showed that the Durbin-Watson test had a value of 1.953, falling within the optimum range of 1.5 to 2.5, suggesting that there was no autocorrelation detected in the in the residual values in the datasets (Hair *et al.*, 2021). Table 4 presents the model summary results.

Table 4: Autocorrelation Test Results

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.733[a]	.537	.534	.292	
2	.893[b]	.798	.796	.193	
3	.912[c]	.831	.828	.177	1.953

a. Predictors: (Constant), Risk management (X)
b. Predictors: (Constant), Risk management (X), Project leadership (Z)
c. Predictors: (Constant), Risk management (X), Project leadership (Z), Risk management* Project leadership (X*Z)
d. Dependent Variable: Sustainability of solid waste management projects (Y)

Multicollinearity Test Results

The variance inflation factor (VIF) values and tolerance values for each of the independent variables were used for the multicollinearity test. The multicollinearity test results indicated that for each of the independent variables, the VIF values were less than 10, while the tolerance values were greater than 0.1, suggesting that there was no significant multicollinearity that needed to be corrected. Generally, if the VIF value is higher than 10 or the tolerance value is lower than 0.1, there is significant multicollinearity that needs to be corrected (Davino *et al.*, 2022). Table 5 presents the multicollinearity test results.

Table 5: Multicollinearity Test Results

Model		Unstandardized Coefficients		Standardized Coefficients			Collinearity Statistics	
		B	Std. Error	Beta	t	Sig.	Tolerance	VIF
1	(Constant)	2.180	.108		20.159	.000		
	Risk management (X)	.441	.028	.769	15.517	.000	1.000	1.000
2	(Constant)	.253	.161		1.567	.119		
	Risk management (X)	.214	.026	.373	8.267	.000	.577	1.733
	Project leadership (Z)	.713	.053	.609	13.484	.000	.852	1.174
3	(Constant)	.609	.130		4.692	.000		
	Risk management (X)	.099	.023	.173	4.329	.000	.848	1.179
	Project leadership (Z)	.266	.059	.227	4.496	.000	.580	1.724
	Risk management* Project leadership (X*Z)	.475	.045	.602	10.466	.000	.661	1.513

a. Dependent Variable: Sustainability of Solid Waste Management Projects (Y)

Correlation Results

The Pearson's product moment correlation analysis was performed to confirm or deny the relationships between the study variables. The correlation results indicated that risk management had a strong positive and significant relationship with sustainability of solid waste management projects (r = 0.733, p ≤ 0.05). The results showed that risk management had a moderately strong positive and significant relationship with project leadership (r = 0.609, p ≤ 0.05). The results indicated that project leadership had a strong positive and significant relationship with sustainability of solid waste management projects (r = 0.852, p ≤ 0.05). Table 6 presents the correlation results.

Table 6: Correlation Results

Variable		X	Z	Y
Risk management (X)	Pearson Correlation	1		
	Sig. (2-tailed)			
	N	168		
Project Leadership (Z)	Pearson Correlation	.609**	1	
	Sig. (2-tailed)	.000		
	N	168	168	
Sustainability of Solid Waste Management Projects (Y)	Pearson Correlation	.733**	.852**	1
	Sig. (2-tailed)	.000	.000	
	N	168	168	168

**. Correlation is significant at the 0.01 level (2-tailed).

Simple Linear Regression Results

A simple linear analysis was performed with sustainability of solid waste management projects as the dependent variable and risk management as the predictor variable.

Model Summary

From the model summary in table, the value of coefficient of correlation (R) was 0.733, suggesting that there was a strong positive correlation between the risk management and sustainability of solid waste management projects in Kenya. The value of coefficient of determination (R^2) was 0.537, suggesting that the overall model as a whole (the model involving constant, risk management) was able to significantly predict and explain approximately 53.7% of the variance in the sustainability of solid waste management projects in Kenya. The value of the adjusted R^2 was 0.534, suggesting that the overall model as a whole (the model involving constant, risk management) significantly predicted and explained 53.4% of the variance in the sustainability of solid waste management projects in Kenya.

The value of the std. error of the estimate was 0.274, suggesting that there could be other factors not included in the model in the current study that could also predict and explain the remaining 46.6% of the variance in the sustainability of solid waste management projects in Kenya. Therefore, there is in need for future research to discover the other variables not included in the model in the current study that also predict the remaining variance in the sustainability of solid waste management projects in Kenya. Table 7 presents the model summary results.

Table 7: Model Summary[b] Results

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.733[a]	.537	.534	.292

a. Predictors: (Constant), Risk Management (X)

b. Dependent Variable: Sustainability of Solid Waste Management Projects (Y)

Analysis of Variance

From the Analysis of Variance (ANOVA) table, the overall model as a whole (the model involving constant, risk management), achieved a high degree of fit, as reflected by $R^2 = 0.537$, adj. $R^2 = 0.534$, $F (1, 166) = 192.288$, $p \leq 0.05$. The null hypothesis was that the overall model as a whole (the model involving constant, risk management) was not able to significantly predict the sustainability of solid waste management projects in Kenya. However, the alternative hypothesis was that the overall model as a whole (the model involving constant, risk management) was able to significantly predict the sustainability of solid waste management projects in Kenya. From the results, the null hypothesis was rejected in favor of the alternative hypothesis. Therefore, the overall model as a whole (the model involving constant, risk management) was able to significantly predict the sustainability of solid waste management projects in Kenya. Table 8 presents the ANOVA results.

Table 8: ANOVA[a] Results

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	16.391	1	16.391	192.288	.000[b]
	Residual	14.150	166	.085		
	Total	30.540	167			

a. Dependent Variable: Sustainability of Solid Waste Management Projects (Y)

b. Predictors: (Constant), Risk Management (X)

Regression Coefficients

From the coefficients table, when the unstandardized regression coefficients (B) were substituted to the simple linear regression model specified for the study, the final predictive equation was:

$Y = 1.835 + 0.534X$

The final predictive equation suggested that holding all factors in to account constant (risk management), constant at zero, the sustainability of solid waste management projects would be 1.835 in Kenya. The final predictive equation suggested that with all other factors held constant, a unit increase in risk management would lead to 0.534 unit increase in the sustainability of solid waste management projects in Kenya. The regression results indicated that risk management had a positive and significant influence on the sustainability of solid waste management projects ($\beta = 0.733$; $t = 13.867$; $p \leq 0.05$) in Kenya. Table 9 presents the multiple regressions coefficients results.

Table 9: Regression Coefficients[a] Results

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	1.835	.145		12.627	.000
	Risk management (X)	.534	.039	.733	13.867	.000

a. Dependent Variable: Sustainability of Solid Waste Management Projects (Y)

Moderated Multiple Regression Results

A moderated multiple linear regression analysis was performed to test the moderating influence of project leadership in the relationship between risk management and sustainability of solid waste management projects in Kenya.

Model Summary

From the model summary table, it is clear that the value of the coefficient of correlation (R) was 0.733

for model 1, suggesting a strong positive correlation between the predictor variable (risk management) and sustainability of solid waste management projects in Kenya. The value of the coefficient of determination (R^2) was 0.537 for model 1, suggesting that the overall model (the model involving constant and risk management) could significantly predict and explain approximately 53.7% of the variance in the sustainability of solid waste management projects in Kenya. The value of the adjusted R^2 was 0.534 for model 1, suggesting that the overall model (the model involving constant and risk management) significantly predicted approximately 53.4% of the variance in the sustainability of solid waste management projects in Kenya. The value of the std. error of the estimate was 0.292 for model 1, suggesting that there could be other factors not included in the model that could predict the remaining 46.6% of the variance in the sustainability of solid waste management projects in Kenya.

From the model summary table, it is clear that the value of the coefficient of correlation (R) was 0.893 for model 2, suggesting a strong positive correlation between the predictor variables (risk management and project leadership) and sustainability of solid waste management projects in Kenya. The value of the coefficient of determination (R^2) was 0.798 for model 2, suggesting that the overall model (the model involving constant, risk management and project leadership) could significantly predict and explain approximately 79.8% of the variance in the sustainability of solid waste management projects in Kenya. The value of the adjusted R^2 was 0.796 for model 2, suggested that the overall model (the model involving constant, risk management and project leadership) significantly predicted approximately 79.6% of the variance in the sustainability of solid waste management projects in Kenya. The value of the std. error of the estimate was 0.193 for model 2, suggesting that there could be other factors not included in the model that could predict the remaining 20.4% of the variance in the sustainability of solid waste management projects in Kenya.

From the model summary table, it is clear that the value of the coefficient of correlation (R) was 0.912 for model 3, suggesting a strong positive correlation between the predictor variables (risk management, project leadership and risk management *project leadership) and sustainability of solid waste management projects in Kenya. The value of the coefficient of determination (R^2) was 0.831 for model 3, suggesting that the overall model (the model involving constant, risk management, project leadership and risk management*project leadership) as a whole could significantly predict and explain approximately 83.1% of the variance in the sustainability of solid waste management projects in Kenya. The value of the adjusted R^2 was 0.828 for model 3, suggesting that the overall model (the model involving constant, risk management, project leadership and risk management*project leadership) significantly predicted approximately 82.8% of the variance in the sustainability of solid waste management projects in Kenya. The value of the std. error of the estimate was 0.177 for model 3, suggesting that there are other factors not included in the model that could predict the remaining 17.2% of the variance in the sustainability of solid waste management projects in Kenya.

From the model summary table, the Durbin-Watson test statistic had a value of 1.953, falling within the optimum range of 1.5 to 2.5, suggesting that there was no severe autocorrelation detected in the in the residual values in the datasets. Generally, Durbin-Watson statistics falling within the optimum range of 1.5 to 2.5 indicate that there is no severe autocorrelation detected in the in the residual values in the datasets (Hair *et al.*, 2021). Table 10 presents the moderated multiple linear regression's model summary results.

Table 10: Model Summary[d] Results

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.733[a]	.537	.534	.292	
2	.893[b]	.798	.796	.193	
3	.912[c]	.831	.828	.177	1.953

a. Predictors: (Constant), Risk management (X)

b. Predictors: (Constant), Risk management (X), Project leadership (Z)

c. Predictors: (Constant), Risk management (X), Project leadership (Z), Risk management* Project leadership (X*Z)

d. Dependent Variable: Sustainability of solid waste management projects (Y)

ANOVA[a]

From the ANOVA table results, the overall model 1 (the model involving constant, risk management), as a whole achieved a high degree of fit, as reflected by $R^2 = 0.537$, adj. $R^2 = 0.534$, F (1, 166) = 192.288, $p \leq 0.05$. The null hypothesis was that the linear combination of predictor variables was not able to significantly predict the sustainability of solid waste management projects in Kenya. However, the alternative hypothesis was that the linear combination of predictor variables was able to significantly predict the sustainability of solid waste management projects in Kenya. The regression results showed that the linear combination of predictor variables (risk management) was able to significantly predict the variance in the sustainability of solid waste management projects in Kenya in Kenya. The null hypothesis was rejected in favor of the alternative hypothesis. Therefore, the decision was that risk management significantly predict the sustainability of solid waste management projects in Kenya.

From the ANOVA table results, the overall model 2 (the model involving constant, risk management and project leadership), as a whole achieved a high degree of fit, as reflected by $R^2 = 0.798$, adj. $R^2 = 0.796$, F (2, 165) = 326.432, $p \leq 0.05$. The null hypothesis was that the linear combination of predictor variables (risk management and project leadership) was not able to significantly predict the sustainability of solid waste management projects in Kenya. However, the alternative hypothesis was that the linear combination of predictor variables (risk management and project leadership) was able to significantly predict the sustainability of solid waste management projects in Kenya. The regression results showed that the linear combination of predictor variables (risk management and project leadership) significantly predicted the variance in the sustainability of solid waste management projects in Kenya. The null hypothesis was rejected in favor of the alternative hypothesis. Therefore, the decision was that the linear combination of predictor variables (risk management and project leadership) significantly predict sustainability of solid waste management projects in Kenya.

From the ANOVA table results, the overall model 3 (the model involving constant, risk management, project leadership and risk management*project leadership), as a whole achieved a high degree of fit, as reflected by $R^2 = 0.831$, adj. $R^2 = 0.828$, F (3, 164) = 268.922, $p \leq 0.05$. The null hypothesis was that the linear combination of predictor variables (risk management, project leadership and risk management*project leadership) was not able to significantly predict the sustainability of solid waste management projects in Kenya. However, the alternative hypothesis was that the linear combination of predictor variables (risk management, project leadership and risk management*project leadership) was able to significantly predict the sustainability of solid waste management projects in Kenya. Table 11 presents

Table 11: ANOVA[a] Results

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	16.391	1	16.391	192.288	.000[b]
	Residual	14.150	166	.085		
	Total	30.540	167			
2	Regression	24.379	2	12.189	326.432	.000[c]
	Residual	6.161	165	.037		
	Total	30.540	167			
3	Regression	25.381	3	8.460	268.922	.000[d]
	Residual	5.159	164	.031		
	Total	30.540	167			

a. Dependent Variable: Sustainability of Solid Waste Management Projects (Y)
b. Predictors: (Constant), Risk management (X)
c. Predictors: (Constant), Risk management (X), Project Leadership (Z)
d. Predictors: (Constant), Risk management (X), Project Leadership (Z), Risk management* Project Leadership (X*Z)

the standard multiple linear regression's ANOVA results.

Regression Coefficients[a] Results

From the coefficients table, when the unstandardized regression coefficients (B) were substituted to the moderated multiple regression models specified for the study, the final predictive equations were:

Y = 1.835 + 0.534X .... Equation 1

Y = -0.036 + 0.248X + 0.755Z .... Equation 2

Y = 0.646 + 0.195X + 0.472Z + 0.042X*Z... Equation 3

The first final predictive equation suggested that holding all factors in to account constant (risk management), constant at zero, and the sustainability of solid waste management projects would be 1.835 in Kenya. The first final predictive equation suggested that with all other factors held constant, a unit increase in risk management would lead to 0.534 unit increase in the sustainability of solid waste management projects in Kenya.

The second final predictive equation suggested that holding all factors in to account constant (risk management and project leadership), constant at zero, the sustainability of solid waste management projects would be -0.036 in Kenya. The second final predictive equation suggested that with all other factors held constant, a unit increase in risk management would lead to 0.248 unit increase in the sustainability of solid waste management projects in Kenya. The second final predictive equation suggested that with all other factors held constant, a unit increase in project leadership would lead to 0.755 unit decrease in the sustainability of solid waste management projects in Kenya.

The third final predictive equation suggested that holding all factors in to account constant (risk management, project leadership and risk management*project leadership), constant at zero, the sustainability of solid waste management projects would be 0.646 in Kenya. The third final predictive equation suggested that with all other factors held constant, a unit increase in risk management would lead to 0.195 unit increase in the sustainability of solid waste management projects in Kenya. The third final predictive equation suggested that with all other factors held constant, a unit increase in project leadership would lead to 0.472 unit increase in the sustainability of solid waste management projects in Kenya. Furthermore, the third final predictive equation suggested that with all other factors held constant, a unit increase in risk management*project leadership would lead to 0.042 unit increase in the sustainability of solid waste management projects in Kenya.

In the first step for the moderation testing, the independent variable (risk management) was regressed on the dependent variable (performance) in Kenya. Therefore, model 1 was fitted with risk management predicting sustainability of solid waste management projects in Kenya. From the regression coefficients table in model 1, the regression results indicated that risk management had positive and significant influence on the sustainability of solid waste management projects ($\beta_2 = 0.733$; $t = 13.867$; $p \leq 0.05$) in Kenya.

In the second step for the moderation testing, the independent variable (risk management) and the moderating variable (project leadership) were regressed on the dependent variable (performance) in Kenya. From the regression coefficients table in model 2, the regression results indicated that risk management had positive and significant influence on the sustainability of solid waste management projects ($\beta_3 = 0.340$; $t = 7.717$; $p \leq 0.05$) in Kenya. The regression results indicated that project leadership had a positive and significant influence on the sustainability of solid waste management projects ($\beta_4 = 0.645$; $t = 14.626$; $p \leq 0.05$) in Kenya.

In the third step for the moderation testing, the independent variable (risk management) and the moderating variable (project leadership) and the interaction term (risk management* project leadership) were regressed on sustainability of solid waste management projects. From the regression coefficients table in model 3, the regression results indicated that risk management had a positive and significant influence on the sustainability of solid waste management projects ($\beta_5 = 0.268$; $t = 6.306$; $p \leq 0.05$) in Kenya. The regression results indicated that project leadership had a positive and significant influence on the sustainability of solid waste management projects ($\beta_6 = 0.404$; $t = 6.859$; $p \leq 0.05$) in Kenya. The regression results indicated that risk management * project leadership (the interactive term) had a positive and significant influence on the sustainability of solid waste management projects ($\beta_7 = 0.343$; $t = 5.643$; $p \leq 0.05$) in Kenya. Table 12 presents the moderated multiple linear regression coefficients results.

Table 12: Moderated Multiple Regression Coefficients[a] Results

Model		Unstandardized Coefficients		Standardized Coefficients			Collinearity Statistics	
		B	Std. Error	Beta	t	Sig.	Tolerance	VIF
1	(Constant)	1.835	.145		12.627	.000		
	Risk management (X)	.534	.039	.733	13.867	.000	1.000	1.000
2	(Constant)	-.036	.160		-.224	.823		
	Risk management (X)	.248	.032	.340	7.717	.000	.577	1.733
	Project leadership (Z)	.755	.052	.645	14.626	.000	.852	1.174
3	(Constant)	.646	.190		3.397	.001		
	Risk management (X)	.195	.031	.268	6.306	.000	.848	1.179
	Project leadership (Z)	.472	.069	.404	6.859	.000	.580	1.724
	Risk management* Project leadership (X*Z)	.042	.007	.343	5.643	.000	.661	1.513

a. Dependent Variable: Sustainability of Solid Waste Management Projects (Y)

Hypotheses Test Results

In this research, 2 null hypotheses were tested. The hypotheses were tested at 5% level of significance, $\alpha = 0.05$, $t = 1.960$, and 95% confidence level to statistically help draw acceptable and realistic inferences. Therefore, the decision rule was to reject the null hypothesis H_0i if the $P \leq 0.05$, and otherwise fail to reject the null hypothesis H_0i if the $P > 0.05$.

Hypothesis One Test Results

The H_01 predicted that risk management has no significant influence on sustainability of solid waste management projects in Kenya. The decision rule was to reject the H_01 if the $\beta_1 \neq 0$, $t \geq 1.960$, $P \leq 0.05$, and otherwise fail to reject the H_01 if the $\beta_1 = 0$, $t < 1.960$, $P > 0.05$. The regression results indicated that risk management had a positive and significant influence on sustainability of solid waste management projects ($\beta_4 = 0.195$; $t = 3.238$; $p \leq 0.05$) in Kenya. In model 1, the regression results indicated that risk management had positive and significant influence on the sustainability of solid waste management projects ($\beta_2 = 0.707$; $t = 14.578$; $p \leq 0.05$) in Kenya. The H_01 was rejected in the favor of the H_A1. Therefore, decision was made that risk management has a significant influence on sustainability of solid waste management projects in Kenya.

Hypothesis Two Test Results

The H_02 predicted that project leadership has no significant moderating influence on the relationship between risk management and sustainability of solid waste management projects in Kenya. The moderated hierarchical multiple regression results showed that project leadership significant moderating influence on the relationship between risk management and sustainability of solid waste management projects in Kenya.

In model 2, the regression results indicated that risk management had positive and significant influence on the sustainability of solid waste management projects ($\beta_3 = 0.379$; $t = 11.564$; $p \leq 0.05$) in Kenya. Additionally, for model 2, the regression results indicated that project leadership had a positive and significant influence on the sustainability of solid waste management projects ($\beta_4 = 0.661$; $t = 20.174$; $p \leq 0.05$) in Kenya.

In model 3, the regression results indicated that project leadership had a positive and significant influence on the sustainability of solid waste management projects ($\beta_6 = 0.571$; $t = 17.497$; $p \leq 0.05$) in Kenya. Besides, for model 3, the regression results indicated that risk management*project leadership (the interactive term) had a positive and significant influence on the sustainability of solid waste management projects ($\beta_7 = 0.207$; $t = 6.770$; $p \leq 0.05$) in Kenya. Therefore, the H_02 was rejected. The decision was made that project leadership had a positive and significant moderating influence on the relationship between risk management and sustainability of solid waste management projects in Kenya. Table 13 presents the hypotheses test results.

Table 13: Hypotheses Test Results

Hypothesis				B	t	Sig.	Decision
H_01:	Risk management has no significant influence on sustainability of solid waste management projects in Kenya.			.733	13.867	.000	Reject the H_01
H_02:	Project leadership has no significant moderating influence on the relationship between risk management and sustainability of solid waste management projects in Kenya.						Reject the H_02
	Risk management	→	Sustainability of solid waste management projects	.268	6.306	.000	
	Project leadership	→	Sustainability of solid waste management projects	.404	6.859	.000	
	Risk management * Project leadership	→	Sustainability of solid waste management projects	.343	5.643	.000	

Discussions

The purpose of this quantitative correlational study was to examine the influence of risk management on sustainability of solid waste management projects and the moderating influence on the relationship between risk management and sustainability of solid waste management projects in Kenya. Specifically, the research sought to examine the influence of risk management on sustainability of solid waste management projects in Kenya. The correlation results indicated that risk management had a positive and significant relationship with sustainability of solid waste management projects in Kenya. The regression results showed that risk management on sustainability of solid waste management projects in Kenya. The results are consistent with the results of prior studies (Chepng'eno, 2021; Mole, 2023; Muluka, 2023). However, the results are inconsistent with the results of previous research (Pinudom *et al.*, 2024).

The research examined the moderating influence on the relationship between risk management and sustainability of solid waste management projects in Kenya. The regression results indicated that project leadership had a significant moderating influence on the relationship between risk management and sustainability of solid waste management projects in Kenya. The findings are consistent with the results of previous studies (Liaqat *et al.*, 2024).

CONCLUSION AND RECOMMENDATIONS

The purpose of this research was to examine the influence of risk management on sustainability of solid waste management projects and the moderating influence of project leadership on the relationship between strategic and sustainability of solid waste management projects with project leadership as a moderator in Kenya. Specifically, the research sought to establish the influence of risk management on sustainability of solid waste management projects in Kenya. The research found that risk management had a positive and significant influence on sustainability of solid waste management projects in Kenya. Therefore, the first conclusion was that has a positive and significant influence on sustainability of solid waste management projects.

The research sought to examine the moderating influence on the relationship between risk management and sustainability of solid waste management projects in Kenya. The research found that project leadership had a significant moderating influence on the relationship between risk management and sustainability of solid waste management projects in Kenya. Therefore, the second conclusion was that project leadership has significant moderating influence on the relationship between risk management and sustainability of solid waste management projects.

From the findings of this research, the research recommends that managers and practitioners should implement effective risk management to foster sustainability of solid waste management projects.

From the findings of this research, the research recommends that policy makers should initiate review of the existing polices to encourage managers and practitioners to implement effective risk management to foster sustainability of solid waste management projects.

Limitations and Future Research

This research generates novel insights into the influence of risk management on sustainability of solid waste management projects with project leadership as a moderator in Kenya. However, the current research has a number of limitations that need to be taken into consideration. First, as the research was limited to the risk management and sustainability of solid waste management projects in Kenya. Subsequently, caution should be taken when attempting to generalize the results beyond risk management and project sustainability in other contexts or regions. Future research should examine the influence of risk management on project sustainability with project leadership as a moderator in other sectors or contexts. Second, as the research relied on a cross-sectional survey design, no inferences about the causality of relationships can be made. Future researchers should consider conducting a longitudinal study on risk management and project sustainability with project leadership as a moderator in other contexts or sectors. Future research should address several areas, such as replicating the study with a more global sample, including other languages and cultures.

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