Effect of risk Management practices on Project Performance: A case of the Mafuru-Kimambira Water Supply Project in Mvomero District.

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Abstract

The study examined the effect of risk management practices on project performance using a case of Mafuru-Kimambira Water Supply Project. This study used quantitative research approach together with non-proportional stratified simple random sampling technique to obtain 98 project contractors. The data were collected using the questionnaire method and analyzed using both descriptive statistics and multiple regression model to analyze the effects of risk management practices on project performance. The findings revealed that risk prevention practice was found to be positive and significant, indicating that it has a direct effect on Mafuru-Kimambira water supply project performance, risk transfer was also found to be positive and significant, indicating that it has a direct impact on Mafuru-Kimambira water supply project performance and risk control was found to be positive and significant, indicating that it has a direct impact on project performance. The study emphasize how crucial risk management techniques are to improving the efficiency of water supply initiatives like the Mafuru-Kimambira Water Supply Project. The study recommends that policymakers should contemplate formulating and executing regulations that promote the application of risk prevention, risk transfer, and risk control techniques in project management. These policies might include directives requiring the application of these techniques in project planning and execution, incentives for projects that exhibit excellent risk management, and training courses for project managers on risk management techniques. By ensuring that water supply projects are carried out successfully, these policies may contribute to increased water security and socioeconomic growth.

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1. Introduction

Globally, effective risk management practices have been found to significantly enhance project performance (Tukamuhabwa et al., 2023). For instance, in 2020, companies reported maximum financial impacts of water risks at US$301 billion, five times higher than the cost of addressing them (US$55 billion) (String & Lantagne, 2016). In Sub-Saharan Africa, countries are particularly vulnerable to uncertainties about commodity prices, exchange rates, and interest rates (Mvongo et al., 2021). The IGAD Disaster Risk Management (DRM) program has played a pivotal role in advancing Disaster Risk Reduction (DRR) efforts within the IGAD region (Joseph et al., 2018). The cumulative costs of water point outages in Sub-Saharan Africa over the past two decades are estimated to range from $1.2 billion to $1.5 billion (Theodory & Kitole, 2024).

In East Africa, the Institute of Risk Management organizes events throughout the year to develop risk management knowledge and skills among its members (WHO, 2021). The IGAD DRM program has achieved significant milestones by facilitating the development of regional and national policies and strategies (World Bank, 2023). In Tanzania, the construction industry, which includes water supply projects, contributes significantly to the country's economic development. However, there is a low level of adoption of risk management practices among the construction professionals of the country (Oke et al., 2023; Fumbwe et al., 2021). The United Republic of Tanzania has a high risk of disasters, such as earthquakes, drought, strong wind, flood, and fire, with 363 disasters recorded between 2000 and 2020. In 2021, access to basic drinking water services was at 74 percent, household sanitation 72 percent, and access to handwashing 41.5 percent (World Bank, 2023). Although some progress has been made over the years, the Government of Tanzania still needs to close quite a large gap (Kitole et al., 2023c).

Water supply projects are critical for the socio-economic development of regions worldwide, particularly in areas like Tanzania where access to clean and safe water is a pressing issue. However, these projects often face a multitude of risks, including technical, financial, environmental, and socio-political challenges. Effective risk management practices have been recognized as a key factor in enhancing project performance and mitigating these risks. Despite their importance, the adoption and implementation of these practices in water supply projects, particularly in Tanzania, remain limited. This gap presents a significant problem as it can lead to project delays, cost overruns, and even failure, thereby affecting the overall performance and success of these crucial projects. Therefore, this study aims to investigate the effects of risk management practices on the performance of water supply projects in Tanzania.

2. Theoretical framework

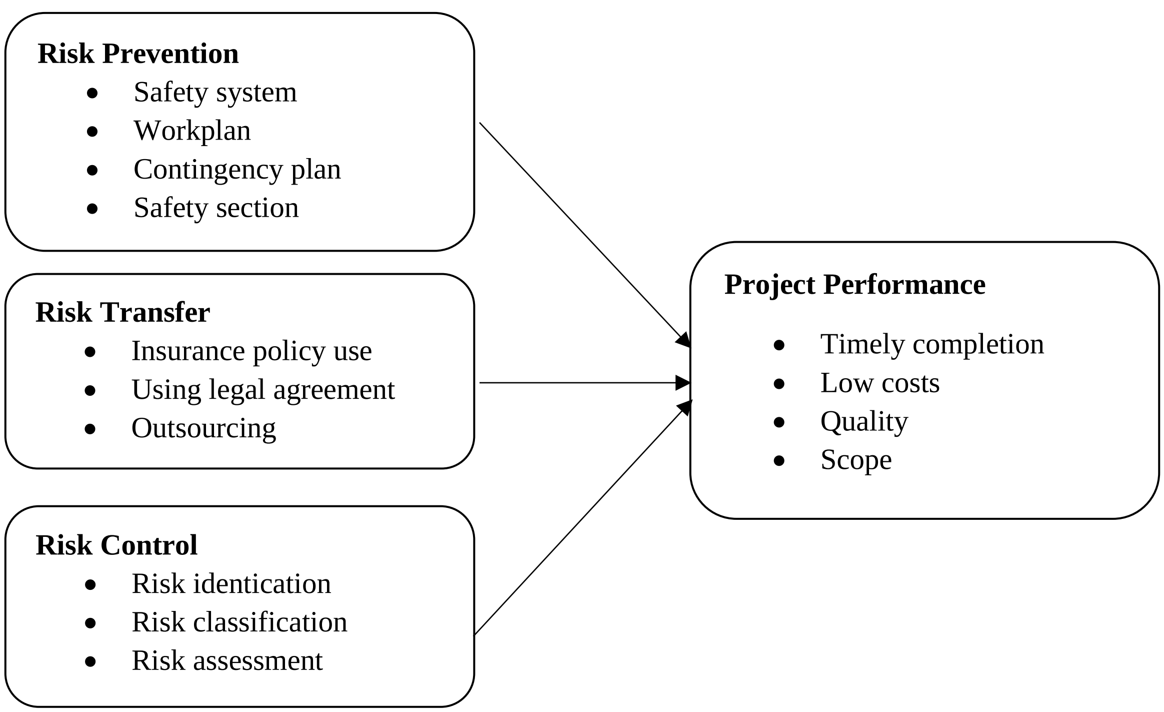
The theoretical underpinning of the study is drawn from the Vroom (1964) theory of expectation which postulates that a person's motivation is determined by how they understand the relationship between their actions and rewards. The theory is divided into three parts: valence, expectation, and instrumentality. The idea that a specific amount of work will yield a specific amount of output is known as expectation. A given outcome's valence indicates how important it is to that specific person. Instrumentality is the relationship between first-level outcomes, such as promotions, and second-level outcomes, such as increases.

Lambright (2010) looked at the Vroom Expectancy Theory model in the context of the construction industry and found that it handles performance variances in terms of the amount of effort an employee is prepared to put in to finish a task. According to Thomas, one might assess a project's performance using a variety of metrics, including productivity, profitability, creativity, effectiveness, and efficiency. Kleinmuntz (1991) contends that managers must determine the outcomes of each employee's values and define acceptable and good performance in terms that are observable and quantifiable in order for employees to understand their bosses' expectations. Project managers in the construction sector also have an obligation to ensure that the intended performance level is truly attainable; they have to establish a connection between the desired outcomes for the workers and specific performance.

In the context of the Mafuru-Kimambira Water Supply Project, the Expectancy Theory can be utilized to investigate how team members' and project managers' expectations impact how they manage risk. If workers believe that participating in risk management practices will lead to successful project outcomes, they will be more likely to do so (high expectancy). This includes the risk prevention, risk transfer, and control techniques you covered in your study.

Thus, the Expectancy Theory provides a theoretical framework for understanding the motivations behind and outcomes of the Mafuru-Kimambira Water Supply Project's use of risk management approaches. It highlights how important it is to align risk management practices with the team's values and aims in order to ensure the project's successful conclusion.

Figure 1 Conceptual framework



Source: Author design (2024)

3. Methodology

3.1 Research design

This study adopted an explanatory research design. An explanatory research design, also known as causal research design, is a type of research design that aims to explore cause-and-effect relationships between variables. It seeks to investigate the impact of an independent variable(s) on a dependent variable(s) and understand the underlying mechanisms or reasons behind the observed relationship (Kitole and Sesabo, 2024). The main objective of an explanatory research design is to determine whether changes in the independent variable(s) result in changes in the dependent variable(s) and to explain why this relationship exists.

3.2 Data source

Both primary and secondary approaches were employed in the study. A self-administered, semi-structured questionnaire was used to gather primary data from the project contractors. Experts stress that a sample must be sufficiently large to get accurate estimates since Mugenda (2005) states that sample size influences the precision within which population value can be approximated. On the other hand, a representative sample, according to Mugenda and Mugenda (2000), comprises at least 10% or 20% of the population; for this reason, the 40% selection was deemed representative for the study. The study's sample size consisted of 98 respondents who were members of the Mafuru-Kimambira water supply project team and who are essential to the project's execution.

Therefore, the purpose of the study was to find out from the respondents which practices had been employed in the past and how successful they were in achieving project performance. These people were chosen at random to guarantee that enough data is gathered for the study.

3.3 Analytical modelling

In this study the multiple liner regression model (MLR) was employed to establish effects of the project risks management practices on the project performances. The choice of the model is based on the fat the nature of the outcome variable is numerical (continuous) which therefore lies in the normal or general assumption of the ordinary least square model (OLS).

A multiple linear regression model can be expressed as;

$$Y = g(X_1, X_2, \ldots, X_n) + \varepsilon$$

Whereas the deterministic function $g(X_1, X_2, \ldots, X_n)$ indicate the relationship between Y and $X_1, X_2, \ldots, X_n$) and the error term ε comes from the variability. Therefore, the Multiple linear regression model is an extension of the simple linear regression model with an extended number of independent variables given that $\varepsilon \sim N(0, \sigma^2)$. Therefore, the extended model with multiple parameters under the study will be presented as;

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_n X_n + \varepsilon$$

Since the value of parameters are important for understanding degrees of change of the outcome variables due to the change in the explanatory variables, it is important to estimates values for each parameter.

$$\boldsymbol{Y} = \begin{pmatrix} Y_1 \\ Y_2 \\ \vdots \\ Y_n \end{pmatrix}_{n\times 1} \quad \times = \begin{pmatrix} 1 & X_{11} & X_{12} & \cdots & X_{1n} \\ 1 & X_{21} & X_{22} & \cdots & X_{2n} \\ \vdots & \vdots & \vdots & \ddots & X_{np} \\ 1 & X_{n1} & X_{n2} & \cdots & \end{pmatrix}_{n\times(p+1)}$$

$$\beta = \begin{pmatrix} \beta_0 \\ \beta_1 \\ \beta_2 \\ \vdots \\ \beta_n \end{pmatrix}_{n\times(p+1)} \qquad \varepsilon = \begin{pmatrix} \varepsilon_1 \\ \varepsilon_2 \\ \vdots \\ \varepsilon_n \end{pmatrix}_{n\times 1}$$

Whereas X_{ij} is the measurement on the j^{th} independent variable for the i^{th} individual, for $i = 1, 2, \dots, n$ and $j = 1, 2, \dots, n$. Therefore, with this definition the general model representing the current study is given as:

$$Y_i = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \varepsilon$$

Whereas X_1 = Risk Prevention, X_2 is Risk Transfer, and X_3 is the Risk Control, and the β_0 is the constant value which the level of project performance given all other variables are constant. Moreover, the description of the variables used in this study has been explained in Table 1.

Table 1 Description of Variables and Measurements

Variables	Items to be studied	Scale adopted	Type of scale	Measurement
Project Performance (Dependent variable)	Timely completion Costs Quality Scope	*5=Strongly Disagree* *4= Disagree* *3= Neutral* *2=Agree* *1=Strongly Agree*	Ordinal	Likert scale
Risk Prevention (Independent variable)	Safety systems Detailed workplan Contingency plan Safety inspection	*5=Strongly Disagree* *4= Disagree* *3= Neutral* *2=Agree* *1=Strongly Agree*	Ordinal	Likert scale
Risk transfer (Independent variable)	Insurance policy use Using legal agreement	*5=Strongly Disagree* *4= Disagree* *3= Neutral* *2=Agree* *1=Strongly Agree*	Ordinal	Likert scale
Risk control (Independent variable)	Risk identification Risk classification Risk assessment	*5=Strongly Disagree* *4= Disagree* *3= Neutral* *2=Agree* *1=Strongly Agree*	Ordinal Ordinal	Likert scale Likert scale

4. Results

4.1 Reliability test

The study tested the reliability of ten (10) questionnaire items using a statistical measure known as Cronbach's alpha. The results indicated a reliability value of 0.895, suggesting strong internal consistency among the items in the questionnaire. Cronbach's alpha is commonly used to assess the reliability or consistency of a set of items that are intended to measure a single construct or concept. A higher Cronbach's alpha value indicates a higher level of internal consistency among the items, implying that they are measuring the same underlying construct reliably. As recommended by Dimoso and Andrew (2023) the minimum acceptable level of 0.7 as recommended. It is also within the maximum acceptable limit of 0.95 for Cronbach's Alpha value. These results are presented in Table 2.

Table 2 Item-Total Statistics

	Cronbach's Alpha if Item Deleted
V200a – Safety system	0.923
V200b – Work plan	0.899
V200c – Contingency plan	0.893
V200d – Safety inspection	0.890
V200e – planning	0.917
V300a – insurance policy use	0.885
V400a – risk identification	0.890
V400b -risk classification	0.893
V500a -Time	0.888
V500b – low costs	0.891
V500c – quality	0.890
V500e -scope	0.888
Total	**0.895**

4.2 Descriptive statistics

In this section, a descriptive statistic on the three risk management practices and the project performances were analyzed on in order to understand the general characteristic of the variables under the investigations of which mean, standard deviations, factor loading, and eigenvalue and the variance were presented as shown in table 3. Specifically, results in Table 3 show that the mean score for risk prevention is 3.4404. However, the standard deviation of 1.1953 indicates variability in the responses, implying that within the project, there are those with stronger and weaker use of risk prevention practice. The high factor loading of 0.81 underscores a robust correlation between the use of risk prevention practice and their influence on project performance. Furthermore, the eigenvalue of 41.10 indicates that risk prevention practice contributes to explaining 41.1% of the variability observed in project performance.

Moreover, the mean score for risk transfer is 4.0204, indicating a relatively high level of the use of risk transfer affecting project performance. The standard deviation of 1.1962 suggests some variation in the responses. The factor loading of 0.71 indicates a moderately strong relationship between risk transfer practices and project performance. The eigenvalue of 70.72 suggests that risk transfer practice explain 70.7% of the variance in project performance. The relatively high mean score indicates that Risk Transfer have a significant effect on project performance.

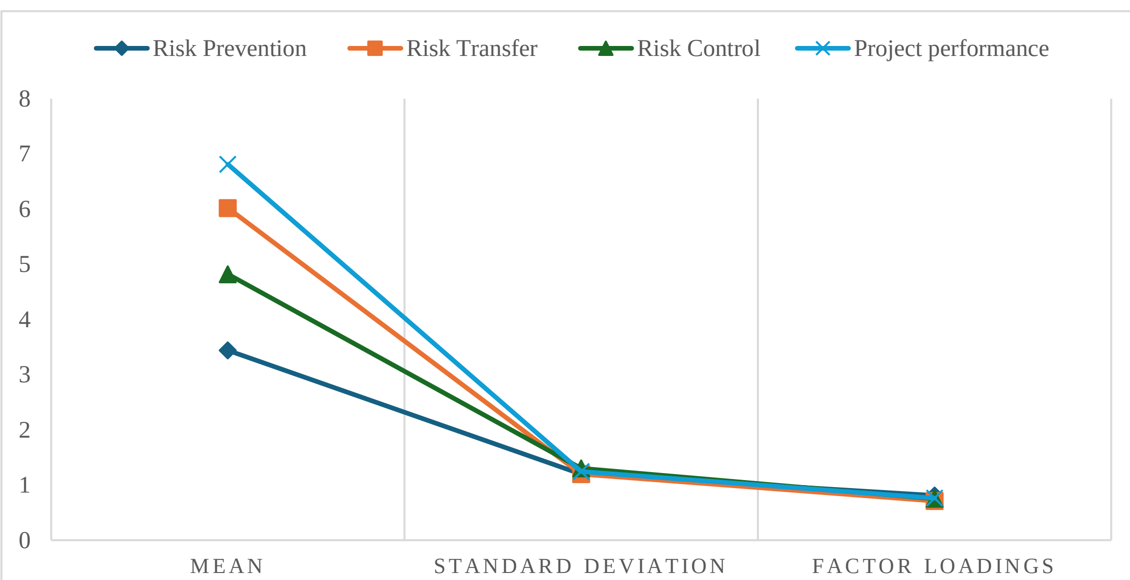
Additionally, results show that the mean score for risk control is 3.8214, indicating a moderate level of the use of risk control. The standard deviation of 1.3022 suggests some variation in the responses. The factor loading of 0.75 indicates a moderately strong relationship between risk control and project performance. The eigenvalue of 67.23 suggests that risk control explain 67.2% of the variance in project performance. The moderate mean score suggests that risk control play a significant role in project performance.

Table 3 Descriptive statistics of the study variables

Factor Name	Sample Size (N)	Mean	Standard Deviation	Factor Loadings	Eigenvalue	Variance Explained
Risk Prevention	98	3.4404	1.1953	0.81	41.10	41.1%
Risk Transfer	98	4.0204	1.1962	0.71	70.72	70.7%
Risk Control	98	3.8214	1.3022	0.75	67.23	67.2%
Project performance	98	3.8129	1.2418	0.76	69.28	69.3%

Furthermore, the mean score for project performance is 3.8129, indicating a moderate level of performance of the Mafuru-Kimambira water supply project. The standard deviation of 1.2418 suggests some variation in the level of project performance. The factor loading of 0.76 indicates a moderately strong relationship between the study variables and project performance. The eigenvalue of 69.28 suggests that the study variables explain 69.3% of the variance in project performance.

Figure 2: Relationship between project performance and risk management practices



Results in Figure 2 show that an increase in the mean of risk prevention, risk transfer, and risk control in as project mitigation measures increase the project performances. This is indicated by the parallel of the three risk mitigation practices with the project performances. Generally, results implies that effective implementation of the risk mitigation practices enhances the project success. Therefore, projects that proactively invest in risk management and thereafter be able to identify this risk have higher chances of achieving project objectives on time and therefore increases chances for its success.

4.2 Effect of risk prevention on project performance

The coefficient for risk prevention practice was found to be positive and significant, indicating that it has a direct effect on Mafuru-Kimambira water supply project performance. Specifically, results in Table 4 revealed that risk prevention practice significantly affect Mafuru-Kimambira water supply project performance (β=0.309, t=3.421, p=0.001). The risk prevention variable has a positive coefficient of 0.309, which indicates that for every unit increase in risk prevention practice, there is a 0.309 unit increase in project performance, holding other variables constant. This means that when project contractors use risk prevention practice, they are more likely to ensure timely completion of project at lower costs. Similar findings were obtained by Hidayatno et al., (2015) in Nairobi City County, Kenya, which established that risk management practices, including risk prevention, had a significant and positive effect on the performance of construction projects. Another study by Arif and Pathirana (2022) also added that having good risk prevention practices it enables the increase in the success of the project.

The coefficient for risk transfer was found to be positive and significant, indicating that it has a direct impact on Mafuru-Kimambira water supply project performance. The results implies that risk transfer has significant effect on project performance (β=0.397, t=4.161, p=0.000). Risk transfer having a positive coefficient implies that for every unit increase in risks mitigation through transferring, there is a 0.397 unit increase in project performances, holding other variables constant. Similar study conducted in Nairobi City County, Kenya, established that risk management practices, including risk transfer, had a significant and positive effect on the performance of construction projects (Njuguna, 2019; Kitole and Sesabo, 2022). The study concluded that risk transfer had a significant and mostly affected the performance of the projects. Another study conducted by Kiarie (2017) aimed to establish the effects of risk management strategies on the project performance of small and medium information communication technology (ICT) enterprises in Nairobi, Kenya. The study found a positive relationship between risk transfer affecting project performance and ICT project performance for SMEs in Kenya

Table 4: Effects of risk management practices on project performances

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
	(Constant)	-8.687E-17	0.043		0.000	1.000
	Risk Prevention	0.309	0.090	0.309	3.421	0.001
	Risk Transfer	0.397	0.095	0.397	4.161	0.000
	Risk Control	0.258	0.080	0.258	3.213	0.002

a. Dependent Variable: Project Performance

The coefficient for risk control was found to be positive and significant, indicating that it has a direct impact on project performance (β=0.258, t=3.213, p=0.000). Therefore, as project management increases risk control, the project performances is expected to increase by 0.258. Similar study by Su and Khallaf (2022) found that knowledge on the influence of risk on project performance is an important part of risk management. They identified risks control in aspects of project performance such as cost and schedule, and developed tools or approaches to assess the influence of risk on project performance. Another study conducted in Nairobi City County, Kenya, revealed that risk management practices, including risk control, had a significant impact on the performance of construction projects (Mwangi & Ngugi, 2018). The study found that the most prevalent risk management practices employed were costing of projects, project designing, and dispute over land and construction.

4.3 Hypothesis Test on the effects of risk management practices on project performances

The results from Table 5 reveal significant positive effects of various risk management practices on the performance of the Mafuru Kimambira water supply project. Specifically, the hypothesis tests demonstrate that risk prevention, risk transfer, and risk control measures all have statistically significant impacts on project performance, as evidenced by their respective low significance values of 0.001, 0.000, and 0.002. Accepting all three hypotheses suggests that the implementation of these risk management practices positively influences project outcomes. This implies that strategies aimed at preventing, transferring, and controlling project risks contribute significantly to the overall success of the water supply project. These findings underscore the importance of comprehensive risk management approaches in infrastructure development initiatives, emphasizing the need for proactive measures to mitigate risks and enhance project performance.

Table 5 Hypothesis test

Hypothesis	Relationship	Sig .value	Decision
There is significant effect of risk prevention on Mafuru Kimambira water supply project performance	Positive	0.001	Accept H_1
There is significant effect of risk transfer on Mafuru Kimambira water supply project performance	Positive	0.000	Accept H_1
There is significant effect of risk control on Mafuru Kimambira water supply project performance	Positive	0.002	Accept H_1

4.4 Model diagnostic tests of variables

Prior to conducting multiple regression analysis, diagnostic tests were performed to ensure adherence to regression assumptions (Kitole et al. 2024). These assumptions include the normal distribution of data (normality), the absence of correlation between independent variables (multicollinearity), and equal variance between independent and dependent variables (homoscedasticity). This study confirmed adherence to these assumptions by conducting diagnostic tests for normality, multicollinearity, and homoscedasticity.

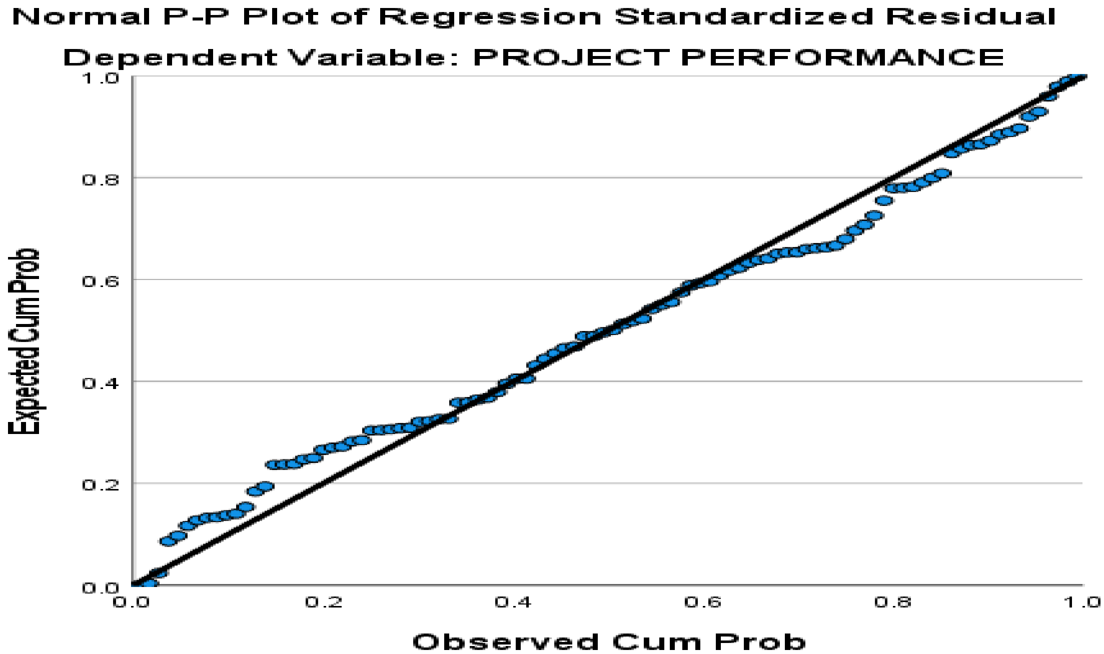
4.4.1 Normality Test

To assess the normality of the dependent variable, which is project performance, both the Kolmogorov-Smirnov and Shapiro-Wilk tests were conducted. The normality test results indicated that the data for the project performance variable were normally distributed. This was evidenced by the p-values obtained from both the Kolmogorov-Smirnov and Shapiro-Wilk tests, which were less than the level of significance ($\alpha = 0.05$), with values of 0.000. The results are presented in Table 6 and Figure 3 below revealed that project performance was normally distributed since data lies the line of best fit.

Table 6 Normality Test

	Kolmogorov-Smirnova			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Project Performance	0.287	98	0.000	0.709	98	0.000

Figure 3 Normal Distribution Curve for project performance



4.4.2 Multicollinearity

The Multicollinearity test was used to see whether there could be any correlations between the variables. Multicollinearity is a problem that can result in unstable and hard to interpret regression coefficients and can render significance tests invalid. This problem arises when two or more variables in the model are correlated and provide redundant information regarding the response (Kitole, 2023). To detect potential multicollinearity in the regression model, VIF analysis was employed in this study to examine the dependent variables. With the VIF, a value larger than 5 denotes that the variable is substantially linked with other explanatory factors, as per (Kothari 2004). Moreover, tolerance may be used to find Multicollinearity. The research encountered Multicollinearity if the tolerance value is less than 0.2 or 0.1 (Kitole and Utouh, 2023).

The results from Table 7 below reveals that the VIF for risk prevention was 4.454, for risk transfer was 4.968 and risk control was 3.519, these values are less than 5, this means that the value are not correlated and can fit for regression model. Furthermore, Tolerance indicated that risk prevention was 0.225, for risk transfer was 0.201 and for risk control was 0.284, these values are greater than 0.2, this means that value are not correlated and can fit for regression model.

Table 7 Multicollinearity

Model	Collinearity Statistics	
	Tolerance	**VIF**
Risk Prevention	0.225	4.454
Risk Transfer	0.201	4.968
Risk Control	0.284	3.519

4.4.3 Heteroscedasticity

Heteroscedasticity refers to the absence of uniform error variance, which can happen when there is non-normal distribution of responses or when the error term doesn't maintain uniform variance (Kitole et al. 2023a). Since one of the basic assumptions of regression is that the error term remains constant in all observations of a study, it's crucial to ensure that the variance of errors remains constant (homoscedasticity) among independent variables to produce consistent responses and achieve better outcomes (Kitole et al. 2023b). To check for heteroscedasticity in the independent variables, an ANOVA is therefore shown in Table 8. The findings conclude that there is heteroscedasticity since the p-value of 0000 which is less than 0.05, rejecting the null hypothesis.

Table 8 ANOVA Test for Heteroscedasticity

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	6.390	3	2.130	22.564	.000b
	Residual	8.873	94	.094		
	Total	15.263	97			

a. Dependent Variable: sqresid

b. Predictors: (Constant), risk prevention, risk transfer, risk control

5. Conclusion

This study has shown that risk management or mitigation practices of risk prevention, risk transfer, and risk control have a direct and considerable impact on project performance, as shown by their positive and significant coefficients. Therefore, this result signifies that risk management techniques are important towards improving performance and chances for the success of the implemented projects.

Moreover, this study informs the importance of establishing good risk mitigation strategies and development robust risk mitigation strategies that will enhance the likelihood of project success. Therefore, the project suggests in most of the private, public or self-initiated projects there should be a well-designed risk strategy that will help to identify and work upon the identified risks. Additionally, by integrating these techniques in the project life cycle can help to increase chances for the project success and inform stakeholder on the possible risks and how to overcome them.

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