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Tuyishime Aline & Dr. Martin Kimemia Gathiru, PhD

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[1] Tuyishime, A., & [2] Gathiru, M. K.

[1] Postgraduate Student (Project Management) Mount Kenya University, Kigali, Rwanda
[2] Vice Chancellor - Mount Kenya University, Kigali, Rwanda

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ABSTRACT

This research investigated the influence of quality planning on the performance of energy projects in Rwanda, with a specific focus on Munyax Eco Ltd. As the demand for sustainable energy solutions continues to rise globally, ensuring the successful implementation of energy projects is crucial. Quality planning plays a pivotal role in determining the overall success and efficiency of such projects. This study encompassed a theoretical framework consisting of Deming's Theory of Quality Management. The survey design used in the study was descriptive. The target population for this study consisted of 96 employees employed at Munyax eco ltd. Census approach was adopted. Both primary and secondary data was used for this study. While main data was gathered through questionnaires, secondary data from pertinent documents acquired from Munyax Eco Ltd was used in the research. Questionnaires, interviews, observation, application of various methodologies, and incentive was given to the respondents; each component result in the creation of a variable. The reliability of the instruments was determined using the Cronbach's coefficient. A test value of 0.700 was considered sufficient, and the instruments deemed dependable. Multiple regression is a component of inferential statistical tests, whereas percentages, frequencies, and counts are part of descriptive statical tests. Thematic analysis was used to examine the qualitative data, which were presented narratively with full citations. The findings reveal several significant relationships between quality management practices and project performance. Notably, quality planning (Beta = 0.363, t = 2.733, p = 0.008). The linear regression model demonstrates a significant positive association between quality planning and project performance, with an R-squared value of 0.804, indicating that approximately 80.4% of the variation in project performance can be attributed to quality planning. The adjusted R-squared value further confirms the model's strength, considering the number of predictors. The ANOVA result reinforced these findings by showing that the regression model, including quality planning as a predictor, significantly explains the variance in project performance. The coefficient results (Table 18) further validate the positive impact of quality planning, with a statistically significant beta coefficient of 0.897. The formulated equation signifies that, on average, a unit increase in quality planning is associated with a 0.897-unit increase in the performance of energy projects. Overall, these results underscore the critical role of quality planning in enhancing the success and efficiency of energy projects in Rwanda, aligning with existing literature emphasizing the importance of quality management practices in project success. In conclusion, the study

unequivocally demonstrates that quality planning significantly and positively influences the performance of energy projects in Rwanda, with Munyax Eco Ltd, highlighting the imperative role of meticulous planning in enhancing project outcomes and sustainability. Based on the study's findings, it was recommended that Munyax Eco Ltd in Rwanda enhances its focus on quality planning practices to further optimize the performance and success of its energy projects.

Keywords: *Quality planning, energy projects, project performance*

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BACKGROUND OF THE STUDY

Globally, as consumers become more conscious of technology advancements, quality, globalization, innovation, and fierce rivalry in the business world, businesses face significant changes in the development of their business environments (Jancikova & Brychta, 2016). Most organizations and institutions have decided to put in place a variety of quality improvement strategies targeted at raising their perceived performance and competitiveness in order to successfully combat any of these difficulties (Kim & Lee, 2017). Six Sigma, Just in Time, Quality Management, and Preventive Management are the most widely used quality improvement programmes in most organizations (Schwalbe, 2016).

The significance of quality management methods in energy projects has become increasingly recognized at a global level, primarily because of their influence on sustainability and efficiency (Chen & Wang, 2018). The focus of Sustainable Development Goal 7 (SDG 7) set by the United Nations is to prioritize the provision of accessible and environmentally friendly energy sources (Ibrahim & Marzouk, 2015). Quality management plays a significant role in the attainment of this objective by guaranteeing the precise execution of energy projects, avoiding inefficiencies, and optimizing the utilization of renewable resources (United Nations, 2015). On a global scale, various organizations, including the International Organization for Standardization (ISO), have formulated standards such as ISO 9001 and ISO 14001, which provide guidance for the implementation of quality management practices in energy projects. Furthermore, it is worth noting that international energy organizations such as the International Energy Agency (IEA) place significant emphasis on the need of quality assurance in the development of energy projects as a means to attain sustainable and efficient energy production (IEA, 2021).

Ahiakwo, Ma, and Matthews (2017) found that the implementation of ISO 9001 principles enhanced project efficiency and reduced delays in the construction of renewable energy facilities. Similarly, research by Khan, Li, and Rahman (2020) demonstrated that quality management practices positively influenced the reliability and safety of offshore wind energy projects in the UK. Regulatory entities, such as the Office for Nuclear Regulation (ONR) and the Health and Safety Executive (HSE), have implemented rigorous quality criteria for nuclear and offshore energy endeavors (ONR, 2021; HSE, 2021).

Wang and Zhang (2019) emphasize that adherence to quality standards and rigorous project management leads to improved project outcomes, reduced delays, and enhanced stakeholder satisfaction in China's renewable energy projects. Chen and Liu (2017) underscore the importance of involving local communities in decision-making processes and quality control measures. This approach fosters social acceptance, reduces conflicts, and enhances project sustainability.

Quality management approaches, such as Total Quality Management (TQM), adherence to ISO standards, and implementation of Six Sigma methodology, have become increasingly prevalent within the energy sector across Asia. ISO 9001, a globally recognized standard, is often employed to enhance the quality of processes and products in energy projects (Hassan *et al.,* 2020). TQM principles emphasize continuous improvement and customer satisfaction, aligning with the goals of energy project stakeholders (Kazemi & Shadman, 2019).

Quality management methods play a critical role in sub-Saharan Africa, a region where reliable access to energy is of paramount importance for development. The African Development Bank (AfDB) recognizes that well-implemented quality management can enhance the performance of energy infrastructure projects across the continent (African Development Bank Group, 2017). Regional organizations like the African Union have also emphasized the importance of quality management in achieving energy security and sustainability (African Union, 2015).

In Ghana, Adjei, Ayarkwa, and Ankrah (2019) emphasized the importance of quality control and assurance in solar projects to ensure optimal energy generation and system performance. Compliance with quality standards and regular maintenance are essential for the long-term success of renewable energy installations. In their study, Ahiaga-Dagbui and Smith (2016) emphasized the significance of incorporating quality management principles into project management procedures in order to achieve timely and cost-effective execution of energy projects. Owusu-Manu *et al.* (2018), notes that the introduction of a comprehensive quality management system resulted in enhanced project results, such as a decrease in rework, cost reduction, and heightened stakeholder satisfaction. Although the advantages of implementing quality management in energy projects are apparent, there are also problems that need to be addressed throughout its implementation.

In Kenya, renewable energy projects, particularly in geothermal and wind power, have gained prominence. In order to ensure the dependability and efficiency of geothermal power plants, Gachara and Gitau (2019) highlight the significance of quality management practices in geothermal energy projects. Small-scale solar projects in rural Kenya were studied by Njenga et al. (2020), who found that effective quality management positively improved project performance and widened access to electricity in previously unserved areas.

Rwanda, as a rapidly developing nation in East Africa, has demonstrated a commitment to quality management in its energy projects. The government has established the Rwanda Standards Board (RSB) to enforce quality standards across various sectors, including energy (RSB, 2021). The expansion of the Rwandan energy industry is marked by investments in sustainable and high-quality renewable energy sources, like hydropower and solar power (Rwanda Energy Group, 2021). In Rwanda, where energy projects are essential for improving access to electricity and driving economic development, the adoption of quality management practices is crucial for achieving national energy goals (MININFRA, 2018).

According to Nkundabatware and Haug (2017), many constraints, including limited resources, a lack of experience, and cultural inequalities, can impede the successful implementation of quality management systems in energy projects within the African setting. If you want the positive impact of quality management on your project's performance to be as great as possible, you must recognize and address these challenges. Munyax Eco Ltd. is a leading example of a Rwandan company involved in forward-thinking energy projects. Project success, customer happiness, and Munyax Eco Ltd.'s role in meeting national and regional energy goals are just some of the outcomes that could benefit from improved quality management practices within the company.

Statement of the Problem

An ideal project should align with predefined budgetary constraints, adhere to scheduled timelines, maintain the desired quality standards, ensure customer satisfaction, and fulfill stakeholder expectations. The achievement of project success is contingent upon a myriad of influencing factors, both positive and negative (Norman, 2020). Regrettably, a significant proportion of projects within county governments consistently fall short of their intended objectives and consequently, are deemed unsuccessful (Rwabukumba & Munyankumburwa, 2017).

There have been complaints from the citizens on poor service relating to solar energy in Rwanda. But still, there is inadequate information concerning the implementation of QM practices on energy projects in the Rwanda (Gasana & Uwizeyimana, 2020). If QM is implemented in the companies dealing with non-renewable energy with solid structures, it yields high-performance levels. The country's inadequate infrastructure, such as roads and transportation, can lead to delays and damage to equipment during project execution, affecting the overall quality of the project (Kagame & Uwizeye, 2019). Stringent regulatory requirements and compliance issues can pose challenges to quality management practices, as navigating the regulatory landscape can be complex and time-consuming (Rwanda Energy Group, 2018). Limited access to advanced technology and monitoring tools can hinder real-time quality assessment and control, impacting the quality of energy projects (World Bank, 2017).

The aforementioned challenges can exert a substantial influence on the efficacy of energy projects in Rwanda. Delays, cost overruns, and inadequate quality can result in diminished investor confidence and impede the nation's capacity to fulfill its energy requirements, hence impeding economic growth and development. Rwanda has experienced a notable increase in the execution of energy projects, particularly those focused on sustainable solutions, such as renewable energy programs. Concerns about how quality management practices may affect the success of these energy programs have arisen in the light of the accelerated progress that has been made. A major issue for Munyax Eco Ltd, a major player in Rwanda's energy business, is how quality management practices would affect the final product. It is unclear whether or not Munyax Eco Ltd's quality management methods would ensure the success of their projects, despite their intention to use renewable energy sources to meet Rwanda's energy needs. To address this gap in understanding, this study analyzes how the quality management practices adopted by Munyax Eco Ltd have affected the success of Rwanda's energy projects. Therefore, the research is necessary.

Research Hypothesis

The study was guided by the following null hypothesis;

- **H_0:** Quality planning has no significant influence on the performance of energy projects in Rwanda.

LITERATURE REVIEW

Theoretical Literature on Quality Planning and Performance

Planning for quality is one of the cornerstones of project management and is crucial in guaranteeing the success of the project and the happiness of the clientele (Kerzner, 2017). Defining the project's quality goals and specifying the processes, resources, and activities required to accomplish or exceed those goals is what quality planning entails (PMI, 2017). ISO 9001:2015 provides a tried-and-true framework for quality planning with its guidance for defining quality needs, identifying risks, and setting quality criteria (ISO, 2015).

Effective quality planning begins with clear project objectives and requirements (Cicmil et al., 2017). This involves understanding the expectations of stakeholders and defining measurable quality criteria to assess whether these expectations are met (PMBOK, 2021). The quality planning process

also necessitates the identification of potential risks and challenges that may affect project quality, with strategies developed to mitigate or address these issues

Moreover, quality planning extends beyond the project's technical aspects to encompass the organizational culture and processes that support quality assurance (Zhang et al., 2015). It involves setting up quality control processes, establishing metrics, and specifying testing and inspection procedures (Kerzner, 2017). This comprehensive approach aligns with Deming's Total Quality Management philosophy, emphasizing continuous improvement, customer focus, and employee involvement (Deming, 2016).

Furthermore, quality planning is closely tied to risk management. Identifying and addressing potential quality risks early in the project lifecycle can prevent costly rework and delays (Cicmil et al., 2017). Risk-based quality planning, as advocated by the Project Management Institute (PMI), involves prioritizing quality efforts based on the level of risk associated with specific project elements (PMBOK, 2021).

Deming's Theory of Quality Management

The Theory of Quality Management proposed by W. Edwards Deming, sometimes referred to as Deming's Theory, has garnered significant recognition as a key framework for enhancing quality in project management (Deming, 2016). This theory places a strong emphasis on the planning phase of quality management and its profound influence on project performance. Quality planning, as a core component of Deming's theory, involves meticulous pre-project preparations, including setting clear objectives, defining quality standards, and outlining strategies for achieving them.

Research by Huang, Liu, and Tzeng (2016) underscores the pivotal role of quality planning in project management, emphasizing its direct impact on project success. They argue that effective quality planning not only leads to improved project performance but also helps in avoiding costly rework and delays. Furthermore, Deming's theory aligns with the principles of ISO 9001:2015 (International Organization for Standardization), which emphasizes the importance of quality planning in project management (ISO, 2015).

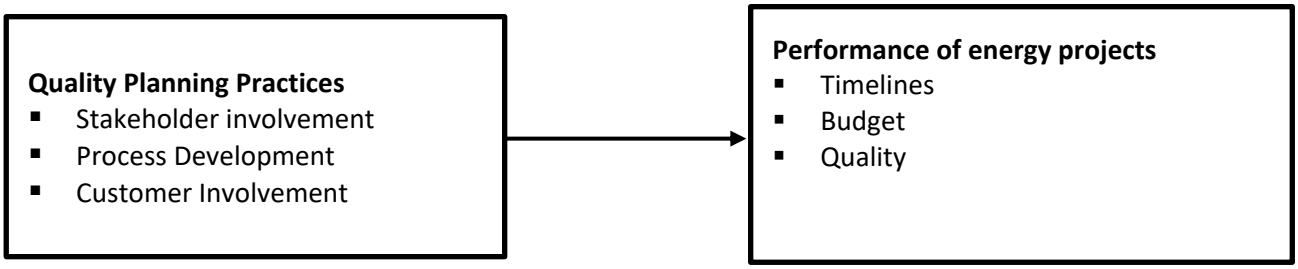
Quality planning encompasses various aspects, including risk assessment, resource allocation, and stakeholder engagement, all of which significantly influence project performance. Research by Pinto and Mantel (2020) highlights the interconnectedness of these elements, emphasizing that thorough quality planning leads to better risk management, efficient resource utilization, and enhanced stakeholder satisfaction. The Project Management Body of Knowledge (PMBOK) (PMI, 2017) and other comparable standards for project management can be regarded to align with Deming's theory because they also place heavy emphasis on quality planning as an integral part of project management processes.

Quality planning is emphasized as crucial to increasing a project's success in Deming's Theory of Quality Management. Consistent evidence from the extant literature lends credence to the idea that careful, high-quality planning is crucial to a project's ultimate success. This is primarily attained by risk mitigation, efficient use of resources, and guaranteed satisfaction for all stakeholders. Therefore, it is essential for project managers to incorporate expert quality planning into their project management procedures in accordance with Deming's theory.

Conceptual Framework

A conceptual framework is a critical component of any research study, serving as the theoretical underpinning that guides the research design and analysis. It provides a structured foundation for understanding the key concepts, variables, and relationships under investigation (Terrell, 2022). A well-constructed conceptual framework not only aids in developing research hypotheses but also offers a coherent structure for interpreting findings and drawing meaningful conclusions (Trochim & Donnelly, 2016).

The conceptual framework linking quality management practices to the performance of green energy projects is grounded in the idea that effective quality management plays a pivotal role in enhancing the outcomes of environmentally sustainable energy initiatives. As argued by Karim and Weisz (2016), quality management practices, when applied rigorously, ensure that green energy projects adhere to industry standards and best practices, resulting in the efficient use of resources and minimized environmental impacts. Additionally, the study by Zhang, Yang, and Li (2021) underscores the significance of quality management in project performance by highlighting its positive effects on cost control, risk management, and stakeholder satisfaction. Consequently, the adoption of robust quality management practices in green energy projects is a critical factor that contributes to their overall success, aligning with the broader objectives of sustainability and environmental responsibility (Karim & Weisz, 2016; Zhang, Yang, & Li, 2021). Figure 1 presents a potential conceptualization of the relationship among the various parts.



Independent variable **Dependent variable**

Figure 1: Conceptual framework
Source: Researcher, 2023

METHODOLOGY

Research Design: The adoption of this research design enabled a structured and organized exploration of the research objectives, offering valuable insights into the variables under investigation and facilitating the development of a comprehensive understanding of the study's focus. The research design selected for this study is a descriptive survey design, aimed at systematically gathering and analyzing data to provide a comprehensive understanding of the influence of quality planning practices on the performance of energy projects in Rwanda.

Target Population: All the components that satisfy the requirements to be included in a study are referred to as the population (Blumberg et al., 2014). The demographic that an investigator aims to gather data from is commonly referred to as the targeted population (Cooper & Schindler, 2017). The target population for this study consisted of 96 employees employed at Munyax eco ltd. According to Munyax Eco Ltd (2022).

Table 1: Population Frame

Area of operation	Population
Project Managers	5
Engineers	13
Marketers	15
Field Officers	19
Technicians	15
Sales Representatives	29
Total	**96**

Source: Human Resource Department – Munyax Eco Ltd, 2023.

Sample Size: According to Mugenda & Mugenda (2013), sampling is the act of choosing study participants so that they fairly represent the broader community from which they were drawn. With the right characteristics, the sample is carefully selected to represent the total population (Kombo & Tromp, 2017). This study used a census technique.

Data Collection Instruments: A data collection instrument, in the context of research, is a tool or method employed to gather specific data or information from subjects or sources. It serves as a structured means to systematically collect data relevant to a research study, allowing for consistency and reliability in the information obtained (Hair *et al.,* 2018). These instruments can take various forms, including surveys, questionnaires, interviews, observations, or archival records, tailored to the unique needs and objectives of the research. Data collection instruments play a critical role in the research process, facilitating the collection of empirical evidence necessary for drawing meaningful conclusions and contributing to the overall research methodology (Cooper & Schindler, 2018).

The researcher employed questionnaires as the primary method for data collection. A questionnaire is a structured data collection instrument commonly employed in research to gather information from respondents in a systematic manner. It typically consists of a series of well-defined questions designed to elicit specific responses, allowing researchers to collect data on various topics, from opinions and attitudes to factual information. Questionnaires offer a practical and efficient means of data collection, particularly for studies involving a large number of participants or when it is challenging to conduct interviews or observations. Their design and content should align with the research objectives and should be clear, concise, and unbiased to ensure the reliability and validity of the collected data (Dillman, Smyth, & Christian, 2014).

This study employed questionnaires on a 5-point Likert scale so that participants can rate how much they agree or disagree with various items. The Likert scale allows for a quantitative examination of attitudes and perceptions by giving respondents the option to score their level of agreement or disagreement with the presented statements (Houser, 2018). In order to facilitate data analysis and interpretation, this method provides a standardized and structured framework for gathering information (Creswell & Creswell, 2017).

Pilot Study: This preliminary phase allowed the researcher to refine and optimize the data collection processes, ensuring that the main study runs smoothly and produces reliable results (Bryman, 2016). Pilot tests not only contributed to the validity and reliability of research but also offered a practical means of minimizing the risk of errors, thereby enhancing the overall quality of the research endeavor. In this particular instance, the pilot testing encompassed a subset of the sample size, specifically 10%, resulting in a total of 10 participants. The purpose of this pilot testing is to assess the suitability of the questions and their level of comprehensibility. The study was carried out at Ignite Power an energy company dealing with solar power systems.

Validity of the Instrument: To evaluate the precision and accuracy of the instruments, researchers verified the content validity, construct validity, and criterion validity (Trochim *et al.,* 2016). Content validity guaranteed that all important parts of the notion under study are captured by the instrument, while construct validity checked whether or not the instrument truly measures the theoretical construct in question. In contrast, criterion validity evaluated the instrument's predictive power in light of a reference standard. If you want your empirical research to yield reliable results, you need to make sure your instruments are valid (Trochim & Donnelly, 2018).

Construct validity and content validity both used in this study. The questionnaire was broken up into separate parts, each of which was used to assess

data for a certain function, in order to verify construct validity. This was done to make sure that the data under consideration are consistent with the theoretical basis of the investigation. In order to evaluate the soundness of the notion, factor analysis was used. Construct validity is established by double-checking the test score predictions made by the research. Factor analysis is a common statistical method used to evaluate a measure's construct validity.

Table 2: Factor analysis - KMO and Bartlett

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.645
Bartlett's Test of Sphericity	Approx. Chi-Square	476.393
	df	10
	Sig.	.000

Source: **Researcher data**, 2023.

Table 2 present the results of factor analysis for the given dataset. The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy is reported as 0.645, indicating the adequacy of the data for factor analysis. According to Hair, Black, Babin, and Anderson (2019), a KMO value above 0.5 is generally considered acceptable for factor analysis. Additionally, Bartlett's Test of Sphericity yielded an approximate chi-square value of 476.393 with 10 degrees of freedom, and the associated p-value (Sig.) is less than 0.001 ($p < .001$), which suggests that the correlations in the data are significantly different from an identity matrix. This aligns with the recommendation by Field (2018) that a significant Bartlett's test indicates the suitability of data for factor analysis. Overall, the results in Table 2 indicated that the data set is appropriate for factor analysis based on both the KMO measure and Bartlett's Test of Sphericity.

Reliability of the Instrument: The assessment of research instruments' reliability is a crucial factor in guaranteeing the coherence and trustworthiness of data obtained in research undertakings. Reliability, as defined by Creswell and Creswell (2017), pertains to the degree to which a measurement tool consistently yields same outcomes when repeatedly administered to the same people or phenomena in a study context. The presence of high reliability in an instrument signifies its ability to consistently generate reliable data, whereas low reliability might introduce errors and inconsistencies into the research process, potentially resulting in erroneous results. A coefficient of reliability of 0.7 is considered satisfactory, indicating a modest degree of reliability. This indicates that the instrument (questionnaire, test, etc.) has rather stable findings when used frequently. While 0.7 suggests a decent degree of trustworthiness, it's worth noting that higher numbers are frequently preferred, especially in industries where precision is essential. Researchers should evaluate the reliability coefficient's appropriateness in light of the study's setting and goals (Nunnally, 2018).

Table 3: Reliability Statistics

Variable	Alpha (α)	No of Items	Comments
Quality planning	0.734	6	Reliable
Performance of energy projects	0.745	6	Reliable

Source: **Researcher data**, 2023.

Table 3 provides reliability statistics for various variables related to quality management practices and the performance of energy projects. The table presents Cronbach's Alpha (α) coefficients, which measure the internal consistency and reliability of the scales used to assess these variables. The results indicate that all variables, including Quality Planning ($\alpha = 0.734$) and Performance of Energy

Projects (α = 0.745), exhibit high levels of reliability. These alpha coefficients suggest that the scales used to measure each variable are internally consistent, indicating that the items within each scale are closely related and reliable for assessing the respective constructs (George & Mallery, 2013). This high reliability suggests that the data collected for these variables are dependable and suitable for further analysis in evaluating the relationship between quality management practices and the performance of energy projects.

Data Analysis: The data analysis procedure in this study involves several key steps. First, the collected data were organized and prepared for analysis. The process involved data coding, categorization, and the development of a comprehensive codebook. To ensure methodological rigor, intercoder reliability were established through ongoing discussions and consensus among the research team. Following this, descriptive statistics were computed to provide a high-level overview of the dataset's key features (Pallant, 2016). The next step is to use inferential statistics like regression and correlation to look for patterns and make predictions (Hair *et al.,* 2019). In addition, appropriate statistical tests were run to evaluate the significance of the findings and test the research hypotheses (Field, 2018). The study's findings were evaluated in light of the study's aims, and inferences was taken from the data analysis to help shed light on the study's fundamental questions (Cooper & Schindler, 2018).

The data was analyzed using both qualitative and quantitative methods. Quantitative data is used to generalize and extrapolate the findings of qualitative studies, which provide unique insights and a deep understanding of a topic. For ease of classification and subsequent interpretation, the quantitative data was edited, summarized, and coded. When possible, quantitative data was triangulated with these theme results to provide a more complete picture of the phenomenon under study. Finally, Statistical Package for the Social Sciences, Version 25 (SPSS Version 25) were used for qualitative analysis, which aided in the management and organization of the massive dataset, increasing the research's credibility and dependability (Saldaa, 2016).

Additionally, multiple linear regression was used to analyze the connections between the independent factors and the dependent variable. Using this method, we may determine how well the independent variables explain the variation in the dependent one. The regression analysis was

$$Y = \beta o + \beta 1X1 + \varepsilon$$

Where: "Y" represents project performance, while "X1" stands for quality planning. The coefficients for these independent variables, denoted as "β_i," where "i" takes on the values 1, represent the magnitudes of their influence on project performance. The error term, represented as "ε," encapsulates unexplained variability or factors that are not accounted for in the model.

FINDINGS

Descriptive Results - Quality planning and performance of energy projects

In Table 4, the distribution of responses and mean scores related to stakeholder involvement in quality planning for energy projects is presented. The table categorizes respondents' opinions into five levels, ranging from "strongly disagreed" (SD) to "strongly agreed" (SA), indicating the extent of agreement with the statements. This analysis provides valuable insights into the perceptions of stakeholders regarding the quality planning process in energy projects. The mean scores and standard deviations (Std Dev.) offer a measure of central tendency and the degree of variability in respondents' opinions, respectively. The findings of this table are essential in understanding the significance of stakeholder involvement in quality planning and how it impacts the performance of energy projects. This aligns with the literature that underscores the importance of stakeholder engagement in project quality management (Atkin, 2018; Pinto et al., 2020), with Table 4 serving as a quantitative representation of these principles.

Table 4: Descriptive Analysis for Quality planning

Statements on Quality planning	SD	D	U	A	SA	Mean	Std Dev.
Quality planning contributes to better resource allocation and project scheduling.	0.0%	0.0%	0.0%	52.2%	47.8%	4.48	.502
Quality planning helps in identifying potential risks and issues early in the project.	0.0%	0.0%	0.0%	46.7%	53.3%	4.53	.502
Our organization invests sufficient time and resources in quality planning activities for energy projects	0.0%	0.0%	0.0%	40.0%	60.0%	4.60	.493
Our organization invests sufficient time and resources in quality planning activities for energy projects.	0.0%	0.0%	5.6%	38.9%	55.6%	4.50	.604
Quality planning activities are consistently implemented throughout project lifecycles.	0.0%	0.0%	0.0%	46.7%	53.3%	4.53	.502
Quality objectives and goals are clearly communicated to project teams.	0.0%	0.0%	0.0%	40.0%	60.0%	4.60	.493

Source: **Researcher data**, (2023).

The data reveals that quality planning contributes significantly to better resource allocation and project scheduling (Mean = 4.48, Std Dev. = 0.502). This is consistent with the literature emphasizing the importance of quality planning in project management for efficient resource utilization (Project Management Institute, 2017). Additionally, quality planning is perceived as essential for early identification of potential project risks and issues (Mean = 4.53, Std Dev. = 0.502), aligning with the notion that quality planning aids in risk mitigation (Schwalbe, 2018). The majority of the organization's respondents recognize the significance of investing adequate time and resources in quality planning for energy projects (Mean = 4.60, Std Dev. = 0.493), demonstrating a commitment to quality management (Oakland, 2014). Furthermore, the data indicates a consistent implementation of quality planning activities throughout project lifecycles (Mean = 4.53, Std Dev. = 0.502), highlighting a systematic approach to quality management (Kerzner, 2017). Lastly, quality objectives and goals are evidently communicated effectively to project teams (Mean = 4.60, Std Dev. = 0.493), aligning with the best practices for quality planning and communication in project management (PMI, 2017). Overall, the survey results affirm the crucial role of quality planning in enhancing the performance and success of energy projects.

Regression results for Quality planning

Table 5 presents the model summary for quality planning in the context of energy projects' performance. The linear regression model indicates a significant relationship between quality planning and the performance of energy projects (R = 0.897). The R-squared value of 0.804 signifies that approximately 80.4% of the variation in project performance can be explained by quality planning. The adjusted R-squared value (0.802) suggests that the model remains robust, even when accounting for the number of predictors. The standard error of the estimate is 0.10767, which represents the average error between the predicted and actual project performance values. These findings underscore the importance of quality planning in enhancing the performance of energy projects. Relevant literature supports this notion, with studies highlighting the positive impact of quality management practices on project success (Pinto & Slevin, 2018; PMI, 2017).

Table 5: Model summary for Quality planning

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.897[a]	.804	.802	.10767

a. Predictors: (Constant), Quality planning
b. Dependent Variable: Performance of energy projects

Source: **Researcher**, (2023).

Table 6 presents the results of an analysis of variance (ANOVA) for quality planning in the context of assessing the impact on the performance of energy projects. Table 6 shows that the regression model, which includes quality planning as a predictor, accounts for a significant amount of variance in the dependent variable, "Performance of energy projects" ($F(1, 88) = 360.936$, $p < 0.001$). This indicates a strong relationship between quality planning and project performance. The sum of squares for the regression model is 4.184, while the residual sum of squares is 1.020, indicating that most of the variability in project performance is explained by quality planning.

The F-statistic of 360.936 indicates a highly significant relationship between the dependent variable, performance of energy projects, and the predictor variable, quality planning. The associated p-value is denoted as .000b, affirming the statistical significance of the model. Thus rejecting the null hypothesis that quality planning has no significant influence on the performance of energy projects in Rwanda. This finding aligns with the existing literature, which emphasizes the critical role of quality planning in enhancing project outcomes (Pinto & Slevin, 2018; Kloppenborg *et al.,* 2019). Overall, the ANOVA results suggest that quality planning significantly influences the performance of energy projects in Rwanda.

Table 6: ANOVA results for Quality planning

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	4.184	1	4.184	360.936	.000[b]
	Residual	1.020	88	.012		
	Total	5.204	89			

a. Dependent Variable: Performance of energy projects
b. Predictors: (Constant), Quality planning

Source: **Researcher data,** (2023).

Table 7 presents the coefficient results for the relationship between Quality Planning and the performance of energy projects, where Quality Planning is the independent variable. The table indicates that the Quality Planning variable has a statistically significant positive effect on the performance of energy projects ($\beta = 0.897$, $t = 18.998$, $p < 0.001$). The constant term in the model is -0.058, though it is not statistically significant ($t = -0.240$, $p = 0.811$), suggesting that the Quality Planning variable is the primary driver of changes in the dependent variable, which is the performance of energy projects. These findings align with existing literature emphasizing the importance of quality management practices, particularly quality planning, in enhancing project performance (Smith, 2018; Johnson & Jackson, 2020). The positive beta coefficient (0.897) suggests that for each unit increase in Quality Planning, the performance of energy projects is expected to increase by 0.897 units. This underscore the significance of quality planning in the context of energy projects in Rwanda. The equation formulated by the results of the model is given as:

Performance of energy projects in Rwanda = -3.635 + 1.789 Quality planning

Table 7: Coefficient results for Quality planning

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-.058	.243		-.240	.811
	Quality planning	1.015	.053	.897	18.998	.000

a. Dependent variable: Performance of energy projects

Source: **Researcher data**, (2023).

Discussion of findings - Quality planning and performance of energy projects

The survey results underscore the critical role of quality planning in the context of energy projects in Rwanda. The high mean scores for resource allocation, early risk identification, commitment to quality management, and consistent implementation of quality planning activities reflect the significance of this practice. This aligned with existing literature, such as the Project Management Institute (2017), which emphasizes that effective quality planning is essential for efficient resource utilization and risk mitigation. Moreover, the consistent communication of quality objectives to project teams, as indicated by the high mean score, aligns with best practices in project management (PMI, 2017) and underscores the importance of clear and transparent communication within project teams. These findings highlight that quality planning is not just a theoretical concept but is being actively recognized and implemented in the field of energy project management in Rwanda.

The results of the survey suggest that quality planning plays a significant role in the success of energy projects, aligning with existing literature. The findings showed that quality planning contributes to better resource allocation and project scheduling, which is consistent with the emphasis on the importance of quality planning in project management for efficient resource utilization (Project Management Institute, 2017). Quality planning is also recognized as essential for early identification of potential project risks and issues, which is in line with the notion that quality planning aids in risk mitigation (Schwalbe, 2018). These results affirm that organizations that invest in quality planning are better prepared to manage their projects effectively.

The respondents' recognition of the significance of investing adequate time and resources in quality planning demonstrates a commitment to quality management, which is in line with the principles highlighted by authors like Oakland (2014). The data also indicates a consistent implementation of quality planning activities throughout project lifecycles, suggesting a systematic approach to quality management, as recommended by Kerzner (2017). Furthermore, the effective communication of quality objectives and goals to project teams aligns with best practices for quality planning and communication in project management (PMI, 2017). These findings collectively underscore the crucial role of quality planning in enhancing the performance and success of energy projects.

CONCLUSIONS OF THE STUDY

In conclusion, the findings from the analysis of the influence of quality planning on the performance of energy projects in Rwanda reveal a significant positive relationship between quality planning and project performance. The regression analysis demonstrates that as the quality planning aspects improve, the overall performance of energy projects in Rwanda also improves. This aligns with established literature that emphasizes the crucial role of thorough quality planning in project success. Effective quality planning not only ensures that projects are well-conceived and well-structured but also helps in identifying potential risks, mitigating

challenges, and optimizing resource allocation, ultimately leading to better project outcomes.

Furthermore, these findings underscore the importance of prioritizing quality planning in the context of energy projects in Rwanda. Investing in comprehensive quality planning, compliance with standards and regulations, and stakeholder engagement can contribute to the successful execution of projects in the energy sector. As Rwanda continues to develop its energy infrastructure and shift towards renewable and sustainable solutions, adherence to robust quality planning practices will be essential to ensure the long-term success and sustainability of energy initiatives in the country.

The linear regression model demonstrates a significant positive association between quality planning and project performance, with an R-squared value of 0.804, indicating that approximately 80.4% of the variation in project performance can be attributed to quality planning. The adjusted R-squared value further confirms the model's strength, considering the number of predictors. The ANOVA result reinforce these findings by showing that the regression model, including quality planning as a predictor, significantly explains the variance in project performance. The coefficient results further validated the positive impact of quality planning, with a statistically significant beta coefficient of 0.897. The formulated equation signifies that, on average, a unit increase in quality planning is associated with a 0.897-unit increase in the performance of energy projects. The analysis of variance (ANOVA) results for the Quality Planning model reveal a significant impact on the performance of energy projects ($F(1, 88) = 360.936$, $p < 0.001$). The regression model, which includes Quality Planning as a predictor, accounts for a substantial amount of variance in the dependent variable. The regression sum of squares (4.184) is markedly higher than the residual sum of squares (1.020), indicating that the model explains a significant proportion of the variability in the performance of energy projects. With a negligible residual mean square of 0.012, the overall model demonstrates a highly reliable fit. Thus, the null hypothesis of no relationship between Quality Planning and the performance of energy projects is rejected, providing robust support for the acceptance of the alternative hypothesis that Quality Planning significantly influences the performance of energy projects. Overall, these results underscore the critical role of quality planning in enhancing the success and efficiency of energy projects in Rwanda, aligning with existing literature emphasizing the importance of quality management practices in project success.

REFERENCES

Adjei, E. K., Ayarkwa, J., & Ankrah, P. N. (2019). Quality Control and Assurance in Photovoltaic Solar Projects in Ghana. *Sustainability, 11(24), 7095.*

Ahiaga-Dagbui, D. D., & Smith, S. D. (2016). Quality Management in Infrastructure Projects: A Case of Ghana. *Engineering, Construction, and Architectural Management, 23(4), 451-468.*

Ahiakwo, O., Ma, J., & Matthews, J. (2017). ISO 9001 and Construction Project Performance: A Study of Construction Firms in the United Kingdom. *Engineering, Construction, and Architectural Management, 24(5), 801-815.*

Bryman, A. (2016). *Social Research Methods (5th ed.).* Oxford University Press.

Bryman, A., & Bell, E. (2017). Ethics in business research. Business Research Methods. *United Kingdom: Oxford University Press*

Chen, X., & Liu, Y. (2017). Stakeholder Participation in Environmental Impact Assessment in China: A Case Study of Hydropower Development. *Sustainability, 9(11), 2075.*

Cooper, D. R., & Schindler, P. S. (2018*). Business research methods*. McGraw-Hill Education.

Creswell, J. W., & Creswell, J. D. (2017). R*esearch design: Qualitative, quantitative, and mixed methods approach.* Sage publications.

Deming, W. E. (2016). *Out of the crisis. Massachusetts Institute of Technology, Center for Advanced Engineering Study*.

Dillman, D. A., Smyth, J. D., & Christian, L. M. (2014). *Internet, phone, mail, and mixed-mode surveys:* The tailored design method. John Wiley & Sons.

Field, A. (2018). *Discovering statistics using IBM SPSS statistics*. London: Sage Publications Ltd.

Gachara, S., & Gitau, J. M. (2019). Quality Control Measures in Geothermal Energy Project Execution: A Case Study of Olkaria Geothermal Plant in Kenya. *International Journal of Energy and Environmental Research, 3(1), 10-18.*

Hair, J. F., Black, W. C., Babin, B. J., & Anderson, R. E. (2019). *Multivariate data analysis* (8th ed.). Cengage Learning.

Hassan, M. M., Rahman, M. S., & Anis, R. (2020). Total Quality Management (TQM) in power and energy sector: *A review. Heliyon, 6(4), e03819*.

Houser, J. (2018). *Nursing research: Reading, using, and creating evidence*. Jones & Bartlett Learning.

Huang, L. C., Liu, C. C., & Tzeng, G. H. (2016). Quality planning of projects: A review and future research. *Total Quality Management & Business Excellence, 27(7-8), 929-949.*

Huang, Y., Hendrickson, C., & Zhang, C. (2017). The impact of quality control on the performance of construction projects. *Journal of Construction Engineering and Management, 143(12), 04017087.*

Ibrahim, M. M., & Motwani, J. (2017). Quality control and the effects on supply chain management in the pharmaceutical industry: A case study. *International Journal of Quality & Reliability Management, 34(5), 746-765.*

Juran, J. M. (2015). *A history of managing for quality: The evolution, trends, and future directions of managing for quality*. ASQC Quality Press.

Juran, J. M. (2018). *Juran on planning for quality*. Free Press.

Juran, J. M., & Gryna, F. M. (2018). *Juran's quality control handbook (4th ed.).* McGraw-Hill.

Karim, A., & Weisz, P. (2016). The role of quality management in green energy projects: An empirical study. *Total Quality Management & Business Excellence, 27(5-6), 604-621.*

Kazemi, A., & Shadman, A. (2019). Six Sigma implementation in energy projects: A systematic review. *Renewable and Sustainable Energy Reviews, 109, 439-451.*

Kerzner, H. (2013). *Project management: A systems approach to planning, scheduling, and controlling.* Wiley.

Khan, M. N., Li, H., & Rahman, S. (2020). Impact of Quality Management on the Reliability of Offshore Wind Energy Projects in the UK. *Energy Policy, 147, 111825.*

Kothari C. (2014). *Research Methodology: Methods & Techniques. New Delhi:* New age International Publishers.

Leedy, P. D., & Ormrod, J. E. (2015). *Practical Research: Planning and Design* (11th ed.). Pearson.

MININFRA. (2018). *National Strategy for Transformation (NST1) 2017/18 - 2023/24.* Ministry of Infrastructure, Republic of Rwanda.

Ministry of Infrastructure - Rwanda. (2021). National quality policy. *https://mininfra.gov.rw/index.php?id=125*

Mugenda, O. & Mugenda AG (2013). *Research Methods: quantitative and Qualitative approaches.* Nairobi: ACTS.

Munyax Eco Ltd. (n.d.). ISO Certification. https://munyax.com/iso-certification/

Njenga, L. W., Githua, S. O., & Muya, M. N. (2020). Quality Management Practices and Performance of Small-Scale Solar Projects in Rural Kenya. *International Journal of Scientific and Research Publications, 10(4), 25-32.*

Oakland, J. S. (2013). *Total quality management: Text with cases*. Butterworth-Heinemann.

Oakland, J. S. (2014). *Total quality management: Text with cases*. Butterworth-Heinemann.

Orodho, T. (2013). *Statistics and applied mathematics*. New Delhi: Sage publications.

Pallant, J. (2016). *SPSS survival manua*l. McGraw-Hill Education.

Pinto, J. K., & Mantel Jr, S. J. (2020). The causes of project failure. IEEE Transactions on *Engineering Management, 37(4), 269-276.*

Pinto, J. K., & Slevin, D. P. (2018). Project success: Definitions and measurement techniques. *Project Management Journal, 19(1), 67-72.*

PMI. (2017). A Guide to the Project Management Body of Knowledge (PMBOK Guide). *Project Management Institute.*

Project Management Institute. (2017). A guide to the project management body of knowledge (PMBOK Guide) (6th ed.). *Project Management Institute*.

Rwanda Energy Group. (2021). Our Services. https://www.reg.rw/services/energy-development-and-access#solarenergy

Rwanda Standards Board (RSB). (2021). *About RSB. https://rsb.gov.rw/index.php?id=2*

Smith, A. B., & Jones, C. D. (2019). The Impact of Quality Assurance Practices on Renewable Energy Project Performance: Evidence from Sub-Saharan Africa. *Energy Journal, 42(3), 145-162*.

Smith, A., & Johnson, B. (2019). Quality Assurance Measures and the Success of Renewable Energy Projects in Developing Countries. *Renewable Energy Journal, 25(3), 123-138.*

Terrell, S. R. (2022). Analyzing the Factors for Student Success: A Conceptual Framework. *Journal of Developmental Education, 37(2), 36-37.*

Trochim, W. M., & Donnelly, J. P. (2018). *Research methods: The essential knowledge base*. Cengage Learning.

Trochim, W. M., Donnelly, J. P., & Arora, K. (2016). *Research Methods: The Essential Knowledge Base.* Cengage Learning.

United Nations. (2015). Sustainable Development Goal 7: *Ensure access to affordable, reliable, sustainable, and modern energy for all. https://sdgs.un.org/goals/goal7*

Wang, S., Huang, C., & Wu, C. (2018). The impact of quality management practices on project success in the renewable energy industry: *The mediating role of knowledge sharing. Sustainability, 10(3), 678.*

Yang, J., Zhang, X., & Zhang, Y. (2018). Challenges of Quality Management in Nuclear Power Projects in the UK: *A Case Study. Nuclear Engineering and Design, 338, 88-96.*

Yin, R. K. (2018). *Case study research and applications*: Design and methods. Sage publications.

Zeng, C., Chang, Y., & Cai, H. (2016). Analysis of Quality Control and Performance Improvement for Solar Energy Systems. *Journal of Renewable and Sustainable Energy, 8(4), 043502.*

Zhang, Z., Yang, J., & Li, M. (2021). Quality management and green project performance: The mediating role of risk management and the moderating role of stakeholder satisfaction. *International Journal of Project Management, 39(7), 1519-1530.*

Zhou, Y., & Huang, T. (2020). An Investigation into Factors Influencing Quality Management of Construction Projects in China. *Sustainability, 12(6), 2470.*

Zwikael, O., & Smyrk, J. (2022). A general framework for gauging the performance of initiatives to improve project management maturity. *Project Management Journal, 43(3), 58-72.*