ESJ Social Sciences

Quality Planning and Project Success in Electricity Supply Infrastructure Projects in Kenya; A Case of Transmission Infrastructure Projects

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Doi:10.19044/esj.2023.v19n25p53

Submitted: 23 August 2023
Accepted: 23 September 2023
Published: 30 September 2023

Cite As:
Okombe L.A., Gichuhi K., Njuguna J.N. & Obunga F.(2023). *Quality Planning and Project Success in Electricity Supply Infrastructure Projects in Kenya; A Case of Transmission Infrastructure Projects.* European Scientific Journal, ESJ, 19 (25), 53.
https://doi.org/10.19044/esj.2023.v19n25p53

Abstract

Electricity access is a challenge facing many countries in the world more so the developing ones. This challenge is more pronounced in sub-Saharan Africa, where about 597 million people (43%) lack access to electricity. To address the challenge many countries are investing in electricity supply infrastructure projects such as transmission and distribution lines and power plants. Implementation of such projects is however faced with various challenges resulting in failure to achieve the intended objectives. Scholars have proposed solutions to address these challenges but available literature indicates the issue of quality planning in projects has not been exhaustively addressed. The main objective of this study was to assess the influence of quality planning on project success among electricity supply infrastructure projects in Kenya. The study was anchored on the Deming cycle and the Iron Triangle theories. A descriptive study design was employed in this research. The study population was drawn from the Kenya Electricity Transmission Company staff, which implements electricity transmission projects in Kenya. A stratified sampling method coupled with Yamane's formula was employed to identify the sample size of 80 among the staff. 63 responses from the

 ISSN: 1857-7881 (Print) e - ISSN 1857-7431

surveyed staff were obtained and used for the analysis translating to a 78.75% response rate. The findings showed that the study accepted the alternative hypothesis and concluded that there is a significant and positive influence of quality planning on project success. This study concludes that quality planning is a critical factor that enhances project success in electricity infrastructure projects.

Keywords: Quality, Planning, Electricity, Projects, Success

Introduction

Attaining universal electricity access is a challenge for many nations and more so for developing countries due to the cost of electricity supply and competing basic needs such as water and food. According to the (IEA, 2022), globally, 770 million people lack access to electricity which translates to about 10% of the world's population. The bulk comes from sub-Saharan Africa where 597 million people (43%) lack access to electricity. In efforts to increase access to electricity, many countries have committed to the United Nations Sustainable Goal Number 7. This goal is to ensure access to affordable, reliable, sustainable and modern energy for all. One of Africa's Agenda 63 priority areas is achieving a high standard of living, quality of life and well-being for all citizens and access to electricity is one of the key strategies. To that end, many countries in a bid to address the challenge of electricity access are implementing various electricity supply projects.

Electricity supply infrastructure projects are large-scale, capital-intensive projects constructed to supply electricity. They include power plants, transmission and distribution lines. According to (Moretti et al., 2019) the implementation of electricity generation, transmission and distribution projects is one of the strategies that countries are using to achieve universal electricity access. Through electricity supply projects various parts of a country get connected to electricity thus enhancing electricity access to the population. These have however not been adequate in achieving electricity access due to various post-project implementation challenges. These challenges include poor reliability of electricity supply occasioned by the breakdowns of these projects. These challenges point to gaps in the management of these projects during implementation. Such projects may then be considered as not being successful from a quality perspective.

Project success entails the achievement of the planned project objectives. (Pollack et al., 2018) opined that generally project success is achieved when a project is completed within the stipulated time, cost, and quality. The project objectives in the case of electricity infrastructure projects include increased reliability of electricity supply through reduced incidents of breakdowns and completion of the project within the project budget and

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timelines. Cost compliance is important considering the projects are capital intensive. Completion of projects within the stipulated timelines is a key measure of project success as the projects are meant to address particular problems in electricity supply and delays in completion result in the problems persisting which have cost implications for the country. Finally, quality is important as it addresses the achievement of project requirements. This is through the effective implementation of quality management practices.

Quality management practices refer to those activities in the course of managing a project that ensure the quality of the project outputs is achieved (PMI, 2017). Quality management involves various practices notably planning, assurance and control. Quality planning entails activities meant to define the quality requirements for the projects and strategies for meeting them. These may include benchmarking, undertaking cost-benefit analyses and research. Quality assurance is a preventive process concerned with implementing the quality management plan and thereby ensuring the quality requirements for the project are met. This is undertaken as part of project implementation. Quality control is a curative process undertaken to confirm whether the project met its quality objectives. This is done after the implementation of the project and the necessary corrective action is taken. Implementation of these practices however varies depending on the type of project. In the case of this study, the context is electricity supply infrastructure projects implemented in Kenya.

In Kenya, about 25% of Kenya's population which translates to about fourteen million people lack access to electricity (EPRA, 2022) Achievement of universal electricity access is one of the priority projects for the Kenyan government. The Kenyan government is implementing its National Electrification Strategy, which targets achieving universal electricity access by 2026. The government of Kenya has identified electricity as an enabler for the country's development agendas such as Vision 2030, the Big Four Agenda and currently the Bottom-Up Economic Transformation Agenda. To achieve these commitments, the government should ensure the availability of reliable electricity supply infrastructure. This infrastructure is in terms of electricity generating plants to produce electricity and transmission and distribution lines for the supply of power to various parts of the country. Kenya is organized in various economic sectors and electricity supply projects are implemented in the context of the electricity sub-sector.

The electricity sub-sector in Kenya consists of four main operations that are generation, transmission, distribution and retail. The generation segment is undertaken by Kenya Electricity Generation Company (KenGen), Independent Power Producers (IPPs) and mini-grid operators. KenGen is a government agency that implements generation projects. IPPs are private companies that implement electricity generation projects either individually or

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through public-private partnerships. The transmission segment is a monopoly operation undertaken by the Kenya Electricity Transmission Company (KETRACO) and the distribution segment is undertaken by Kenya Power, licensed mini-grid operators and Rural Electrification and Renewable Energy Corporation (REREC). KETRACO has implemented about seventeen (17) transmission line projects since inception and is currently working on twenty-three (23) others. Kenya Power is responsible for the majority of the distribution of electricity in the country in most of the urban areas. The mini-grid operators who are mostly private implement small-scale distribution projects in areas where the main grid from Kenya Power is not available. REREC is a government agency that implements electricity distribution projects in areas where the main grid has not reached and then hands over the projects to Kenya Power. The subsector is regulated by the Energy and Petroleum Regulatory Authority (EPRA).EPRA undertakes its mandate by licensing electricity projects and ensuring the projects comply with legal and regulatory requirements. EPRA is also mandated to collect and maintain the electricity sub-sector statistics such as generation capacities, transmission projects and other operational metrics.

The total electricity generation capacity in Kenya is 3074.34 MW (EPRA, 2022). This generation consists of geothermal power (30.87%), hydropower (27.24%), wind power (14.17%), Thermal power (21.02%), solar power (5.53%) biomass (0.07%) and off-grid stations (1.10%). The transmission segment consists of high-voltage transmission lines rated at 500kV, 400kV, 220kV and 132kV that transmit electricity from power plants to distribution lines. The transmission network in Kenya is estimated at 6,294km in the various voltage categories. The government of Kenya plans to increase the transmission capacity to 10,000km to enhance electricity access throughout the country in line with Vision 2030. These statistics are an indication of the magnitude of electricity that needs to be supplied across the country hence the need to have reliable electricity infrastructure.

The reliability of the electricity supply in the country has been below the regulatory thresholds (EPRA, 2022). The System Average Interruption Frequency Index (SAIFI) which measures the frequency of power interruptions in electricity supply in Kenya was reported to be 2.13 interruptions per customer (EPRA, 2022) against a benchmark of 1.1 interruptions per customer. The Customer Average Interruption Duration Index (CAIDI), which measures the duration of electricity supply interruptions, was reported as 4.61 hours against a benchmark of 1.36 hours. These indices are indicators of the level of reliability of electricity supply. The poor reliability may be attributed to breakdowns in electricity infrastructure and other challenges in quality management practices. These challenges post-project implementation such as blackouts, regular breakdowns and long

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restoration periods point to possible gaps in quality management practices during power project implementation(Ocharo & Kimutai, 2018). The challenges have detrimental effects on the implementing organizations, the electricity consumers, the economy and the country's development agenda. However various studies have been carried out in the past on project management in a bid to address the project implementation challenges related to quality.

According to (PMI, 2017), quality planning refers to the process of identifying a project's quality requirements and documenting the actions that will be taken to meet these requirements. Some of the activities include benchmarking, undertaking cost-benefit analyses and developing project quality plans. The quality plan is a subset of the overall project management plan used to inform the quality management activities in the course of the project. (Chen & Li, 2019) in their research on Engineering Quality Management Based on the PDCA Cycle concluded that the principle of the PDCA cycle should be applied to achieve the optimal level of project quality management. In the PDCA cycle, the P stands for planning whereby the quality management goals and quality assurance work plans are developed. This study considered the influence of the PDCA cycle in totality on construction projects with no specific focus on quality planning. The study also focused on construction projects in general.

Other researchers assessed the relationship between project management practices and project performance (Unegbu et al., 2022). Their study was carried out in the context of the construction industry in Nigeria. The study employed a survey design whereby questionnaires were used for data collection and the structural equation model for analysis. The study concluded that the highest relationship existed between customer satisfaction and project success. This conclusion relates to the current study whereby customer satisfaction is related to the quality metrics defined during the quality-planning phase. This study was however not conducted in the Kenyan context and did not address the energy sector.

(Keenan & Rostami, 2021) undertook a more specific study where they analyzed the impact of quality management systems (QMS) on construction performance in the North West of England. Quality management systems entail planning before the implementation of quality-related activities and are based on the Deming cycle. The study used a mixed-method research design and incorporated quantitative and qualitative approaches. It concluded that the implementation of a QMS has a positive effect on construction performance. This study however was undertaken in the context of England and did not bring out the influence of quality planning on project success. Available literature indicates that no study has been conducted in Kenya to examine the influence of quality planning on project success. The literature has examined other project management practices such as stakeholder

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participation, risk management, procurement management, soft skills, project initiation, execution, planning and control and aspects of quality planning. This study therefore sought to bridge this knowledge gap and examine the influence of quality planning on the successful implementation of electricity supply projects in Kenya.

Methods

This study was guided by descriptive research. According to (Obwatho, 2014), this study design is useful in observing and describing the behaviour of a subject without influencing it in any way, to get a general overview of the subject of investigation. The descriptive design enables the researcher to get an understanding of the state of affairs, as they exist (Etyang, 2018). It is also useful in describing the relationship among the study variables (Christensen et al., 2015) The study aimed to describe the relationship between quality planning and project success considering that from available literature no similar studies in the context of the electricity supply sub-sector in Kenya have been undertaken. Therefore, the descriptive research design was ideal for this study. The study population was 100 staff from the Kenya Electricity Transmission Company involved in various aspects of project management. 80 staff were sampled for the study representing the various job groups. The sample size was obtained using the Yamane formula which was used to determine the sample size because the population was finite.

$$n= N/ (1+ Ne^2)$$

Where
n = corrected sample size, N=population size, and e =Margin of error, e =0.05 based on the research conditions. In case our population is 100.

$$100/ (1+100(0.05^2) =80$$

The sampling method employed was stratified sampling to minimize bias during data collection and to ensure that staff in the various job groups are considered in the study.

The study employed questionnaires as the data collection instrument. The questionnaire was administered to the staff involved in project management. The questionnaire primarily used summated rating scales to measure the various objectives of the study. This ensured the validity and reliability of the measure (Christensen et al., 2015).

In this study, the Cronbach alpha test was used to test the reliability of the questionnaires. Cronbach alpha tests the internal consistency among the various responses and the higher the alpha, the higher the reliability of the items. Quantitatively, this will translate to, the closer the alpha value is to one

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the more reliable the items. George & Mallery (2003) as cited in (Shahirah & Moi, 2019) opine that when the alpha value is >0.9 the reliability is excellent, > 0.8 the reliability is good and >0.7 the reliability is acceptable. The Cronbach Alpha values for the questionnaire used were observed to be above 0.7 and therefore acceptable for use. The validity of the research instruments was assessed through content analysis.

Data was presented by the use of figures and tables. This brought out the assessment of quality planning on project success in electricity supply infrastructure projects. The data collected from the questionnaires were edited to remove errors of commission and omission and thereafter coded. After coding, the data was uploaded into the Statistical Package for the Social Sciences (SPSS) software for further processing and analysis. Data analysis entailed descriptive statistics. Descriptive statistics such as mean, mode and median were used to describe the data collected. Other descriptive statistics employed included measures of dispersion, asymmetry and relationship. Inferential statistics were employed to analyze association, causality and test the null hypotheses. The correlation between the variables was analyzed using Karl Pearson's coefficient of correlation. Regression analysis was used to analyze the relationship between the independent variable which is quality planning and the dependent variable, which is project success. Pearson correlation and regression analysis were used to test the hypotheses. Linear regression was used to determine the strength of the relationship between the dependent variable and the independent variables. The linear regression model adopted the form $Y = C + M1X_1$ to describe the relationship between the dependent and independent variables.

Results

The study aimed to examine the influence of quality planning on project success in electricity supply infrastructure projects in Kenya using a 5-point Likert Scale where 1-Strongly Disagree (SD), 2-Disagree (d), 3-Neutral (N), 4-Agree (A) and 5-Strongly Agree (SA). The results in Table 1 with a composite mean of 3.59 and standard deviation of 0.785 indicated that respondents agreed that quality planning enhances project success in electricity supply infrastructure projects in Kenya

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Table 1. Quality Planning and Project Success Level of Agreement Outcome

Statement	Outcome (F, %)					Mean	Std. Dev
	1	2	3	4	5		
The organization has documented procedures for quality planning	-	3(4.8)	28(44.4)	28(44.4)	4(6.3)	3.90	.797
Customer requirements inform quality planning	-	2(3.2)	8(12.7)	42(66.7)	11(17.5)	3.90	.712
Lessons learnt from previous projects are considered when planning the quality of projects	-	3(4.8)	21(33.3)	27(42.9)	12(19)	3.76	.817
The organization undertakes benchmarking exercises when planning for the quality of projects	-	8(12.7)	24(38.1)	25(39.7)	6(9.5)	3.46	.839
The quality requirements for all projects are documented	-	6(9.5)	23(36.5)	28(44.4)	6(9.5)	3.54	.800
Cost-benefit analysis of the quality requirements is carried out for all projects during quality planning	-	7(11.1)	25(39.7)	24(38.1)	7(11.1)	3.49	.840
A plan exists for all projects to guide quality management	-	3(4.8)	28(44.4)	28(44.4)	4(6.3)	3.52	.692
Composite Mean and Standard Deviation						**3.59**	**0.785**

*Percent are in Brackets; F – Frequency

Seven statements were developed to measure the extent to which quality planning influences project success. Statement (1), the organization has documented procedures for quality planning: Out of the 63 respondents who participated in the study, 3 (4.8%) disagreed with the statement, 28(44.4%) were neutral, 28(44.4%) agreed and 4(6.3%) strongly agreed. This finding shows that 32(50.8%) agreed, 3(4.8%) disagreed and 28(44.4%) were neutral. This item had a mean of 3.90 and a standard deviation of 0.797 which is higher than the composite mean of 3.59 with a standard deviation of 0.785.

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This implies that documented procedures for quality planning positively influence project success of electricity infrastructure projects.

Statement (2), Customer requirements inform quality planning. Out of the 63 respondents who participated in the study, 2 (3.2%) disagreed with the statement, 8(12.7%) were neutral, 42(66.7%) agreed and 11(17.5%) strongly agreed. This finding shows that 53(84.1%) agreed, 2(3.2%) disagreed and 8(12.7%) were neutral. This item had a mean of 3.90 and a standard deviation of 0.712 which is higher than the composite mean of 3.59 with a standard deviation of 0.785. This implies that customer requirements positively influence project success of electricity infrastructure projects.

Statement (3), Lessons learnt from previous projects are considered when planning the quality of projects. Out of the 63 respondents who participated in the study, 3(4.8%) disagreed with the statement, 21(33.3%) were neutral, 27(42.9%) agreed and 12(19%) strongly agreed. This finding shows that 39(61.9%) agreed, 3(4.8%) disagreed and 21(33.3%) were neutral. This item had a mean of 3.76 and a standard deviation of 0.817 which is higher than the composite mean of 3.59 with a standard deviation of 0.785. This implies that consideration of lessons learnt from previous projects positively influences project success of electricity infrastructure projects.

Statement (4), the organization undertakes benchmarking exercises when planning for the quality of projects. Out of the 63 respondents who participated in the study, 8(12.7%) disagreed with the statement, 24(38.1%) were neutral, 25(39.7%) agreed and 6(9.5%) strongly agreed. This finding shows that 31(49.2%) agreed, 8(12.7%) disagreed and 24(38.1%) were neutral. This item had a mean of 3.46 and a standard deviation of 0.839 which is lower than the composite mean of 3.59 with a standard deviation of 0.785. This implies that undertaking benchmarking exercises when planning for the quality of projects does not positively influence project success of electricity infrastructure projects.

Statement (5), the quality requirements for all project projects are documented. Out of the 63 respondents who participated in the study, 6(9.5%) disagreed with the statement, 23(36.5%) were neutral, 28(44.4%) agreed and 6(9.5%) strongly agreed. This finding shows that 34(54%) agreed, 6(9.5%) disagreed and 23(36.5%) were neutral. This item had a mean of 3.54 and a standard deviation of 0.800 which is lower than the composite mean of 3.59 with a standard deviation of 0.785. This implies that documenting quality requirements for all projects does not positively influence project success of electricity infrastructure projects.

Statement (6), cost-benefit analysis of the quality requirements is carried out for all projects during quality planning. Out of the 63 respondents who participated in the study, 7(11.1%) disagreed with the statement, 25(39.7%) were neutral, 24(38.1%) agreed and 7(11.1%) strongly agreed. This

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finding shows that 31(49.2%) agreed, 7(11.1%) disagreed and 25(39.7%) were neutral. This item had a mean of 3.49 and a standard deviation of 0.840 which is lower than the composite mean of 3.59 with a standard deviation of 0.785. This implies that carrying out a cost-benefit analysis of quality requirements for all projects during quality planning does not positively influence project success of electricity infrastructure projects.

Statement (7), a plan exists for all projects to guide quality management. Out of the 63 respondents who participated in the study, 3(4.8%) disagreed with the statement, 28(44.4%) were neutral, 28(44.4%) agreed and 4(6.3%) strongly agreed. This finding shows that 32(50.8%) agreed, 3(4.8%) disagreed and 28(44.4%) were neutral. This item had a mean of 3.52 and a standard deviation of 0.692 which is lower than the composite mean of 3.59 with a standard deviation of 0.785. This implies that having a plan for all projects to guide quality management does not positively influence project success of electricity infrastructure projects.

Correlation and regression analysis were both conducted to determine the relationship between quality planning and project success. The results for the inferential statistics were as follows. The study examined the correlation between quality planning on project success and obtained the following results. Table 2 results indicated a moderate relationship between qualities planning on project success, $r(63) = 0.408, p < 0.01$. this implies that quality planning enhances project success in electricity infrastructure projects.

Table 2. Correlation of quality planning and project success

		Project Success	**Quality Planning**
Quality Planning	Correlation	.408**	1
	Sig.(2-tailed)	0.001	

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

To further analyze the influence of quality planning on project success a regression analysis was carried out on the two variables. The results of the analysis are presented in Table 3.

Table 3. Regression Analysis Results

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.535[a]	.286	.250	.40246

Generally, the regression output found that quality planning significantly influences project success in electricity supply infrastructure projects in Kenya (B= 0.084, P<.001). The findings suggest that there is a positive relationship between quality planning and project success and this was deduced as (Y=1.231+0.084X1).

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The objective of the study was to examine the influence of quality planning on project success among electricity supply infrastructure projects. Karl Pearson's correlation coefficient and regression analysis were employed to test the study hypothesis. The study hypothesis, Ho there is no statistically significant relationship between quality planning and project success in electricity supply infrastructure projects, was tested at a 5% level of significance. The Pearson coefficient ($r=0.408$, $p<0.01$) indicated that there is a moderately positive correlation between quality planning and project success. These results indicated that quality planning has a positive influence on project success of electricity infrastructure projects in that enhancement in quality planning practices increases the ability of the project to meet its objectives. The regression analysis results were deduced as ($Y=1.231+0.084X1$). This implies that efforts to improve quality planning will increase project success by 0.084 or 8.4%. The p-value obtained from the analysis was 0.01 indicating that there is a significant relationship between quality planning and project success. These findings led to the rejection of the null hypothesis;

H0; There is no statistically significant relationship between quality planning and project success in electricity supply infrastructure projects and accepting the alternative hypothesis H1: There is a statistically significant relationship between quality planning and Project Success in electricity supply infrastructure projects.

Discussion

This study examined the influence of quality planning on project success. The descriptive results indicated that nearly all the respondents agreed that both customer requirements inform quality planning and lessons learnt from previous projects are considered when planning the quality of projects. Notably, the organization undertakes benchmarking exercises when planning for the quality of projects. The quality requirements for all projects are documented. The documentation of all requirements and procedures is synonymous with the implementation of quality management systems (QMS). This study established that KETRACO also implements a QMS system. This agrees with the study by (Keenan & Rostami, 2021) that assessed the impact of quality management systems on project success. The study concluded that the implementation of a QMS has a positive effect on construction performance. This study however was undertaken in the context of England and did not bring out the influence of quality planning on project success. The results from the Likert scale analysis indicated that quality planning positively influences project success. This finding agrees with (Chen & Li, 2019) who established that the application of the PDCA cycle which employs planning as the first stage has a positive influence on project success. These findings were

 ISSN: 1857-7881 (Print) e - ISSN 1857-7431

further confirmed by correlation analysis where it was established that quality planning is positively correlated to project success. Regression results that tested the hypothesis revealed that quality planning has a significant and positive influence on project success.

Overall, the outcome of this study reflects the findings of (Chen & Li, 2019) who established that the PDCA cycle has a positive impact on project quality management. The PDCA cycle is also the primary theory that this study was anchored on. The PDCA cycle is also the basis for the ISO 9001:2015 quality management system that the study also established as one of the planning initiatives being undertaken by KETRACO. It is worth noting that the earlier work done did not explicitly assess the influence of quality planning but rather its sub-components. (Chen & Li, 2019) who assessed the influence of the PDCA cycle on project quality management focused on the entire cycle which is planning, doing, checking and acting. Their study, therefore, did not isolate project quality planning as a variable for analysis. It therefore follows that based on the study findings and similar work undertaken in the past quality planning does have a critical influence on project success and should be given due consideration during project implementation.

Conclusion

The objective of this study was to examine the influence of quality planning on project success among electricity supply infrastructure projects. Following statistical analysis, the study concluded that there is a significant positive relationship between quality planning and project success among electricity supply infrastructure projects. Further, the constituent variables of quality planning such as documentation of procedures, customer requirements, lessons learnt and quality plan development have a significant and positive influence on project success.

Human Studies

The study involved humans who responded to the study questionnaires.The study was approved by the Africa Nazarene University Review Board and the National Commission for Science technology and Innovation which regulates research in Kenya. The principles of the Helsinki Declaration for human participants have been followed in this research work.

Conflicts of Interest

There was no conflict of interest in the study as it was undertaken as part of my postgraduate research work for academic purposes.

 ISSN: 1857-7881 (Print) e - ISSN 1857-7431

Data Availability: All of the data are included in the content of the paper.

Funding Statement: The authors did not obtain any funding for this research.

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