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Contractor-Related Factors and Performance of Bridge Construction Projects Implemented by Kenya National Highways Authority (KeNHA) Kenya

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Abstract

The performance of bridge projects in Kenya is poor in terms of completion by schedule, cost, and quality (scope). Yet, there is less evidence of empirical research on what factors contribute to this outcome. This study aimed to bridge this gap by examining the effects of contractor-related factors on the performance of bridge construction projects in Kenya through a case study of the Bridge projects Implemented by the Kenya National Highway Agency (KeNHA). The theory of constraints (TOC) was adopted as its theoretical framework. Descriptive research was used, and the target population was 18 bridge construction projects, which were the units of analysis from 2012 to 2022. In each of these projects, 18 respondents, namely clients, consultants, contractors, engineers, environment and social guards, project managers, stakeholders, subcontractors, technical advisors, and inspectors, were included in a target population of 144 respondents. A census was conducted and a structured questionnaire was administered from which a response rate of 68% was achieved. The information was analyzed using descriptive, correlation, and multiple linear regression analysis. The contractor-related factors considered in the study were staff and management factors. The findings indicated that staff and management factors had a positive and significant outcome on performance of bridge construction projects. The study recommends continuous training and a safe learning environment for staff to improve their skills and performance in future projects. The study also recommends that a special category for bridge contractors be created in Kenya's National Construction Authority rankings to ensure that only qualified contractors implement the Bridge projects.

Keywords

Staff Factors, Management Factors, Performance, Bridge Projects, KeNHA

1. Introduction

Bridges are an important component of today's transportation system because they enhance connection and are crucial for urban and rural society development, helping avoid physical barriers to transport connectivity [1]. Bridges are constructed over valleys, water bodies, and highways, and these sites present unique challenges for construction in terms of material, design, human, and physical aspects. Regarding this, bridge construction is complex compared to road construction projects due to their work breakdown, design, and implementation [2]. The uncertainties in bridge construction projects present certain challenges, including operational logistics, work environment, constrained resources, structural adequacy, and construction sequence [3].

These constraints and challenges have, therefore, been associated with high failure of bridges in different aspects. [4] agrees that there are many bridge failures in the world. Bridge failure is the biggest problem and a great concern for engineers in their careers. There is empirical evidence from China [4], Nepal [5], India [6], Nigeria [7], and Rwanda [8] indicating delay and cost overruns of bridge contracts including hydraulic, trail, motorable bridges, highway bridges, and bridge girders. Yet, in Kenya, little or no research has been conducted.

Several factors have been associated with the performance of construction projects. [9] classified these factors into eight groups: all related to the design team, project, equipment, client, materials, external, labor, and contractors. Other scholars [10] [11] classify these into Critical Success Factors (CSFs); consultant, contractor, supply chain, environment, client, and project-related factors. Based on these factors, most evidence from research has focused less on contractor-related factors and their association with bridge construction projects. This is a contribution to knowledge that this research aimed to make.

2. Statement of the Problem

The Auditor General Report, 2022 indicated that there had been several instances in which irregularities occurred in bridge project implementation in several counties in Kenya. In Nairobi County, more than 40% of bridge projects have stalled with 64% of bridge projects having failed [12]. In Murang'a County, a fifty-meter-long footbridge at Kenol Center had not been completed in time. In Kiambu County, the rehabilitation and capacity enhancement of James Gichuru Junction - Rironi overall project progress was at 72% against a planned progress of 82.71%, indicating a delay. The overall construction time elapsed was 92.22%, against overall project progress of 72%, indicating slow implementation

progress that may call for further extension of time. Other bridge projects outside Nairobi County behind schedule were Kapkures Footbridge, Kiptabsir – Chebongi Footbridge, Kiangonina Footbridge, TirgamoIpisikhu Footbridge, and Kitutu Chache Footbridge [13].

3. Research Objectives

The overall objective of the study was to determine the contractor related factors that influence the performance of bridge construction projects in Kenya.

The specific objectives of the study were to:

1) Determine the influence of staff factors on the performance of bridge construction projects undertaken by KeNHA.

2) Determine the influence of managerial factors on the performance of bridge construction projects undertaken by KeNHA.

4. Theoretical Framework

The study adopted the Theory of Constraints (TOC) developed by [14], which explains the constraints facing stakeholders engaged in a project and its delivery. The TOC argues that constraints must be managed to avoid complications in project management [15]. Any project possesses an element of uncertainty as to the actual costs, completion date, and scope limitations. The three constraints are cost, scope, and time in project management and have been widely recognized as measures of a successful project.

In project management, triple constraints are requirements for success, and optimizing these concerns contributes to the timely and budget completion of a project and its quality (scope). According to [16], the triple constraints have separate impacts on the performance of construction projects. Still, due to their association, each of the constraints affects the other two, further affecting project goals to a great extent.

The TOC was adapted because it provided the variables for assessing a construction project's performance. Contractors are required to take specific actions to meet time, budget, and quality constraints. The TOC proposes five fundamental elements to circumvent these constraints: identification of constraints, exploiting them, subordinating to exploitation, elevating system performance, and repeating the process [17]. It is hypothesized that if contractors stick to these five steps, it will enhance bridge construction projects' performance.

5. Empirical Literature

In a Jordanian study, [18] ranked factors that influenced the success of construction projects by undertaking a thorough literature review followed by interviews with 66 respondents. The analysis revealed 83 factors leading to delay and cost overruns which were lumped into seven classifications. Contractor-related factors were the highest-ranked factor by the Relative Importance Index (RII). They

included previous experience, participation of the subcontractors, cash flow capability, the flow of the information, use of sufficient quality, cost, time systems, availability of skilled labor, provision of training program to the workers, and safety protection for workers.

[19] used an explorative questionnaire to select significant determinants of delays in construction and how this affected the performance of projects on different sites. The sample consisted of 50 civil engineers, contractors, owners, supervisors, and builders to calculate the RII and important index. Staff factors that influence the performance of delayed projects include Low productivity levels, personal conflicts among laborers, and labor strikes.

In Nepal, [5] focused on the "design and build model" of bridge construction projects by reviewing literature and collecting first-hand data via interviews, as well as secondary data. The perceptions of respondents on the "design and build model" of bridge projects were sought. The findings indicated that the contractors lacked proper management of sites due to inadequate human resources, lack of skill and knowledge, and transfer of staff from one contractor to another, which limited their contribution to projects.

In Indonesia, [20] analyzed road and bridge construction project delay factors using the RII method. They found that scheduling and planning factors from work order plans lacked integrated structure, incorrect methods of work implementation and construction, and mistakes in scheduling and planning were some of the management factors contributing to bridge construction projects.

In South Africa, [21] explored opposing construction-related factors leading to failures in construction labor efficiency by using mixed methods that involved professionals in construction sites in Gauteng and Western provinces. The communication ability of managers on-site, site supervisors' skills, and the planning ability of contractors on-site were important to ensuring efficiency in construction labor. These factors focused on the management capacity of contractors and those working under the supervision of contractors.

[11] evaluated contractors' performance, and ten factors emerged from the review. Of these ten factors, financial stability was among the least ranked, indicating that the three least performed dimensions were local contractors' financial struggles. Managerial capability was one of the three highest-ranked factors, and it was measured by strategic management effectiveness, decision-making consistency, financial management forethought, and efficient human resource management.

6. Methodology

6.1. Research Design

A descriptive research design was used as it allows for collection of information for various variables which are measured to determine their association and relationships among them. Descriptive research design uses scientific methods to

examine the where, what, and when of a subject under investigation [22]. The suitability of this design is that it uses quantitative methods to collect and make sense of information where statistical analysis can be conducted to make conclusions about a population based on variables under investigation.

6.2. Target Population

A target population describes the unit of observation and the unit of analysis; the unit of observation was 18 types of bridges ongoing and completed bridge projects at KeNHA from 2012 to 2022, as summarized in **Table 1**. In each of these projects, 18 respondents, namely clients, consultants, contractors, engineers, environment and social guards, project managers, stakeholders, subcontractors, technical advisors, and inspectors, were included in a target population of 144 respondents.

Table 1. Target population.

Type of bridge	Number
Steel Girder	8
Composite bridge	3
Steel Truss Bridge	5
Pre-Stressed Concrete Girder	1
Concrete Girder	1
Total	**18**

Source: (KeNHA, 2022).

6.3. Sampling Techniques

All 144 clients, consultants, contractors, engineers, environment and social guards, project managers, stakeholders, subcontractors, technical advisors, and inspectors were recruited into the sample size by the census.

6.4. Data Collection and Analysis

A structured questionnaire was administered, and out of the 144 forms administered, 98 were returned. The Statistical Package for the Social Sciences (SPSS) was used to analyze the data, beginning with descriptive statistical analysis using frequency distributions and measures of central tendency (Mean and Standard Deviation). The next phase was undertaking Pearson's (r) correlation analysis to analyze the strength of association between variables and multiple linear regression analysis to determine the effect of staff and management factors on the performance of bridge construction projects following this model:

$$Y_1 = \beta_0 + \beta_1 X_1 + \beta_2 X_2$$

where:

$\beta_0 =$ Y intercept;

$\beta_1 \cdots \beta_4$ = βeta coefficients of independent variables;

Y_1 = Performance of bridge construction projects;
X_1 = Staff factors;
X_2 = Management factors.

7. Findings

7.1. Descriptive Findings

Table 2 shows moderate agreement with staff factors (M = 3.37, SD = 1.007) and management factors (M = 3.33, SD = 1.047). The same was observed for the project performance factors, where respondents were in moderate agreement that bridge projects were completed within budget (M = 3.05, SD = 1.287) and within specified quality (M = 3.92, SD = 1.012). The respondents disagreed on timely completion of bridge projects (M = 2.82, SD = 1.319).

Table 2. Descriptive statistics.

Variable	N	Mean	Std. Deviation
Staff factors	98	3.37	1.007
Management factors	98	3.33	1.047
Timely completion	98	2.82	1.319
Quality completion	98	3.92	1.012
Cost completion	98	3.05	1.287

7.2. Regression Findings

Table 3 shows that staff factors (β = 0.362, p = 0.038) and management factors (β = 0.383, p = 0.010) had a positive and significant effect on the performance of bridge construction projects. This means that an increase in staff and management factors would yield a positive outcome.

Table 3. Regression coefficients.

	Unstandardized Coefficients	Sig.
	B	
(Constant)	2.904	0.000
Staff factors	0.362	0.038
Management factors	0.383	0.010

8. Discussion

8.1. Staff Factors and Performance of Bridge Construction Projects

The findings revealed that respondents agreed there was availability of skilled labour for bridge projects completion and this was attributed to the rich human capital investments that the organisation has made in terms of its staff. KeNHA remains home to the leading professionals in engineering and constant staff de-

velopment is supported by the organisation by providing training and development in domestic and international programmes. This implies that there is no limit to the quality of staff for implementing bridge projects. Secondly, respondents indicated that personal conflict was not a concern for bridge construction projects at KeNHA. This can be attributed to the teamwork spirit which is one of the core values of KeNHA which is also transferred to other actors including contractors during bridge construction projects.

Labour strikes have been shown to affect implementation of construction projects. However, the respondents indicate that these were not a concern at KeNHA and therefore this factor may not affect implementation of bridge projects. This can be attributed to the private nature of organisations that are engaged into contracts with KeNHA for implementation of projects and this limits the chance for any dissatisfaction of staff with the conditions for these projects. The findings also revealed that national holidays were not a factor that affected bridge construction projects and this may be due to the agreement between parties on the time delivery of a project. This implies that contractors were implementing bridge construction projects on the agreed schedule in contracts.

The results indicated that unit increase in staff factors would result in a 0.362 increase in bridge construction projects performance and this was significant at the 95% confidence level ($p = 0.038$). This suggests when staff is available throughout the project implementation process, there is a greater chance for better bridge construction project performance. These findings go against other studies that have found that staff factors have a negative influence on bridge construction performance. This evidence was from Norway, [23], where respondents were involved in the two bridge projects in which language barriers among staff affected the performance of projects. In one of the cases, the client had to shut down the building site on some occasions because they observed working teams with no English or Norwegian-speaking personnel.

Supporting the significance of staff factors, [24] found that competent and professional administrative staff also play a role in preparing reports and archiving the results of the tests carried out; if the selection of human resources is carried out correctly, various problems that occur in the field can be resolved immediately. Other staff factors that have been shown to affect the performance of bridge construction projects include a shortage of skilled labor [25], while [26] found that staff needs to emphasize the importance of notification timeframes at project team meetings and during deliberations about prospective works suggesting the importance of effective communication among staff.

8.2. Management Factors and Performance of Bridge Construction Projects

The findings revealed a positive and significant effect of management factors on bridge construction projects performance. A unit increase in management fac-

tors would result in a 0.383 increase in performance of bridge construction projects at the 95 % confidence level (p = 0.010). The high environmental impact of bridge construction causes numerous dilemmas in decision making related to the choice of the best material, technological solutions, and time schedules. This makes decision making a critical management factor. The respondents agreed that there was timely decision making in bridge construction projects implementation indicating that this was the most critical management factor for contractors. Timely and consistent decision making is critical in project management but this also becomes more important for bridge construction projects as they experience more change design orders and also suffer from environmental and man-made factors during their implementation. The capacity building supported by KeNHA to its contractors has improved their managerial capacity in project management practice.

The importance of management factors in enhancing bridge construction performance has also been reported in earlier studies and has been shown to be either positive or negative. [27] revealed that managers in bridge construction should pay more attention to the decision-making process, especially when firms seek to meet the requirements of sustainable development. Demonstrating the same outcome, [23] revealed that levels of schedule management were not satisfactory in parts of the girder bridge projects in Norway, and the main reason for this was the welding subcontractor not acquiring the desired quality of material, which led to multiple requests for rework. In South Africa, [26] showed that stakeholder management was a vital aspect in ensuring the success of a construction project. It also showed that although the local community is considered a stakeholder, minimal consideration and engagement are given to the local community as a stakeholder.

9. Conclusions

The staff factors were found to have a positive effect on performance of bridge construction projects and this means that availability of skilled labour throughout the project implantation of bridge construction projects at KeNHA would have a positive outcome on their performance.

The findings indicated that site factors had a negative but insignificant effect on performance of bridge construction projects leading to the conclusion that site factors did not affect performance of bridge construction projects at KeNHA.

Third, financial factors were found to have a negative effect on performance of bridge construction projects undertaken at KeNHA. The study concludes that inadequate cash flow by contractors, cost escalation of materials, inadequate fund allocations, contractor's financial difficulties, and delayed payments resulted in poor performance of bridge projects.

Fourth, management factors had a positive effect on performance of bridge construction projects and this effect was achieved by making timely decisions

during the project implementation phase.

10. Recommendations

The study found that low productivity and lack of observing workers moderately affected the performance of bridge construction projects. Therefore, the study recommends for contractors to assess what format of working hours their staff are productive and adopt these when undertaking bridge construction projects. These include such formats as weekend work, overnight work, or overtime.

In addition, contractors should provide continuous training and safety protocols during projects to create an atmosphere of safety and learning and improve their capacity for future projects.

The outcome indicated that timely decision-making was a critical component of management during the construction of bridge projects. The study, therefore, recommends that contractors be empowered with decision-making skills training during implementation, as bridge projects are iterative and complex and demand the adoption of flexible and innovative strategies in unexpected settings.

The study also recommends that a special category for bridge contractors be created in Kenya's National Construction Authority rankings to ensure that only qualified contractors implement the Bridge projects.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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