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*Original Article*

# Effect of Cost of Construction of Medium-Level Building Projects on Project Productivity in Kirinyaga County, Kenya

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## ABSTRACT

The construction industry is important in society, the economy and the environment. Despite its importance, it is faced with the challenge of the increasing world's urban population at a rate of 200,000 people per day who require affordable housing, social transportation and utility infrastructure. To counter this challenge, the industry will be under a moral obligation to transform by way of reducing construction costs, improving the use of scarce materials and making more eco-efficient over time. Therefore, this study's objective was to evaluate the effect of the cost of construction of medium-level building projects on project productivity in Kirinyaga County, Kenya. The total costs of construction (cost stack) are split into hard costs, soft costs and unforeseen costs. The methodology adopted for data collection was through the administration of structured questionnaires to select seven categories considered to be the main key stakeholders in the construction of building projects. These comprised landlords/homeowners, architects, structural engineers, quantity surveyors, building contractors, construction project managers, and Ministry of Housing and Infrastructure officials. To analyze the results, descriptive statistics and correlational analysis were used. In the analysis, emphasis was placed on the evaluation of the effect of the cost of construction on project completion time, quality and costs. Results from the study show that key factors affecting project productivity through increased costs are delay in payment to contractors and suppliers, high cost of construction materials and choice of construction materials. Other factors are the level of project complexity, site topography, architectural design errors and changes as well as structural design errors and changes.

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## INTRODUCTION

The importance of the construction industry in society, economy and the environment cannot be understated. Martina (2018), explained the role played by the construction sector in the economy by stating that, 'The construction sector plays a central role in the economy of any country, providing the essential structures such as public and private infrastructure and housing'. Despite its importance, the construction industry continues to be faced with a myriad of challenges both externally and internally. Due to the increasing world population, there is a need for affordable housing as well as social, transportation and utility infrastructure. Albert (2023), noted that there is a global housing affordability crisis that is fueled by the rising housing costs in various parts of the world. According to the World Economic Forum report of 2016, to counter the challenge, the construction industry will be under a moral obligation to transform by way of reducing construction costs, improving the use of scarce materials and by way of making buildings more eco-efficient over time.

In the context of this study, medium-level building construction projects refer to low-cost houses/buildings which are designated for individuals earning between Kshs 15,000 and Kshs 49,999 (USD 127 and 424). This is according to a yearly report by the Nairobi Metropolitan Area report cited by Cyton's weekly report of 2022. Traditionally, 'productivity' has been defined as the, 'ratio of input/output'. According to Dozzi, & Abou (1993), productivity improvement is best understood when the construction process is visualized as a complete system, i.e., materials, personnel, equipment, management and money.

Malkanthi *et al*. (2017) opine that to execute a project within the expected budget, the accuracy of the estimation is required so that decision-making can be done on a reliable budget. They further explained that the project cannot be carried out within the budget without monitoring the actual costs as the project is being implemented. The study by Chinthaka *et al*. (2022), categorized the cause of cost overruns into three groups namely: management-related issues, design/methodology/approach-related issues, and project performance-related issues. They listed seven factors that have the most significant effect on the cost of construction projects. These factors are: project management, risk assessment, cost-benefit analysis, construction management, time overrun, decision making and design/methodology approach.

With regard to the cost of construction, Hayley *et al*. (2020), outlined that the total project, 'cost stack' comprises the hard costs, soft costs and the costs of conversion once the project is complete. The hard costs refer to the actual direct costs of putting up the project. They are tangible expenses that you can see, touch and quantify. They include the cost of materials, labour and construction equipment. These form the lion's share and any misunderstanding or miscalculation of these costs can lead to budget overflows, delays and even project failure. Understanding and managing direct costs is important for the successful completion of the project. Ming *et al*. (2021), define these as costs that are traceable to physical activity.

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Soft costs on the other hand encompass those expenses that are often intangible but critical to the project planning and execution. They are generally related to non-construction activities but are no less vital to the project. They are listed as follows: design and architectural fees, legal and permitting fees, inspection and surveys, and financial costs. They account for up to 26 to 33% of the total construction of a residential building (Ade, & Rehm, 2020). Zahirah *et al*. (2013), note that soft costs are hidden additional cost elements which people tend to ignore. Despite its comparatively smaller portion in the total cost amount, its actual value can be expensive and plays an important role in the decision to build.

There are other unforeseen costs that crop up during the actual construction process. Wenwen *et al*. (2022), opined that project environmental factors such as major infectious diseases, natural disasters and project location limitations are some of the unforeseen costs that can cause project cost overrun. These unforeseen costs are unexpected expenses that can suddenly emerge and disrupt even the most meticulously planned project. They arise during the construction process often without a warning. They can arise as a result of factors such as the complexity of the project or due to site constraints. It is important to note that risks associated with the above-stated unforeseen costs include budget overflows, project delays and quality compromises.

On factors affecting the cost of construction, Cunningham (2013) reported that the cost of construction is influenced by a wide range of factors. He enumerated factors that affect the cost of construction as follows: clients' priorities, quality considerations, cost considerations, time considerations, and the nature of the project. Other factors include: the function of the building, choice of materials, altitude towards sustainability and whole life cycle costs, nature of site, availability of services, and resource availability. Finally, climate, method of procurement, legislative constraints, socio/environmental factors, market conditions and method of construction are amongst other factors noted.

Windapo *et al*. (2018) found that the cost of building materials and subcontracted work on new construction works accounted for 74.6% of the total project costs. One of the major causes of cost overrun is the increase in prices of construction materials as a result of inflation. According to the Kenya Economic Survey report of 2021, there was an increase in the prices of timber, hydrated lime, and reinforcement steel. Similarly, the cost of materials for residential and non-residential buildings increased by 2.4 and 2.3%, respectively.

Statistics derived from the Kenya Economic Survey report of 2023 also reveal that there were rises in the construction inputs price index (CIPI) and construction input inflation. The CIPI measures the changes in the cost of inputs into the construction industry. From the results, this index rose from 106.12 in the fourth quarter of 2021 to 113.65 in the fourth quarter of 2022. Consequently, the CIPI rose from 3.44% in December 2021 to 7.10% in December 2022.

A study by Abid *et al*. (2018) highlighted the following as the most common and influential factors impending construction productivity. They include: non-availability of materials, inadequate supervision, skill shortage, lack of proper tools and equipment, incomplete drawings and specifications, poor communication, rework, poor site layout, adverse weather conditions and change orders. Shamil *et al*. (2009) indicated that factors affecting productivity in a building construction site could be grouped into five, namely, project characteristics, labour characteristics, management system, resource management and internal/external environment.

A study conducted by Adamu *et.al*. (2011) found that low wages, lack of materials and an unfriendly working atmosphere mostly affected productivity. Arditi, & Mochtar (2000) outlined cost management, scheduling, design procedures, labour training and quality control

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as measures that have been for a long time recognized to have substantial potential for productivity improvement; However, Awad *et al*. (2021), pointed out that smart construction technologies can be harnessed to design and build sustainable infrastructure. The technology leverages innovative technologies, data-driven insights, and collaborative governance to optimize resource utilization, reduce environmental impacts, and improve the quality of life for urban residents.

The need to increase the number of affordable housing units in Kenya was leveraged as a justification to carry out this study. A higher demand for affordable housing units against low supply was identified as the problem to be solved through carrying out this study. The objective of the study was therefore to evaluate the effect of the cost of construction of medium-level building projects productivity in Kirinyaga County, Kenya.

## RESEARCH METHODOLOGY

To carry out this study, both descriptive and diagnostic research designs were used. The target population for this study comprised seven (7) groups considered to be key stakeholders in the construction of medium-level buildings. These groups are: landlords/homeowners, architects, structural engineers, quantity surveyors, contractors, construction project managers, and Ministry of Housing and Infrastructure officials.

The sampling technique adopted for the study was stratified random sampling. The sample size comprised of 225respondents subdivided into seven (7) subgroups which were considered to be key stakeholders in the construction sector. They included; 45 landlords/homeowners, 30 architects, 35 structural engineers, 20 quantity surveyors, 35 contractors, 35 construction project managers and 25 Ministry of Housing and Infrastructure officials. Out of the 225 dispatched questionnaires, 202 respondents gave feedback representing 89.8%. In their concluding notes, Mumtaz *et al*. (2020) noted that ‘the strength of samples comes from selecting samples accurately, rather than their sizes’. On their part, Mooi *et al*. (2018) indicated that a carefully selected sample, i.e. 150 and above, is more meaningful than a blindly selected sample. i.e., 300 and above. This assertion resonates very well with this study which had a sample size of 225 participants.

Data was collected through questionnaires which were dispatched to the target subject groups. The questionnaires were subjected to a rating on a Likert scale containing five factors, i.e., 1. Very little extent, 2. Little extent, 3. Neutral, 4. Large extent and 5. Very large extent. The study was supposed to identify key factors affecting the cost of construction through an analysis of their effect on the key variables of project completion time, project quality and project costs. The above-mentioned variables are key to determining the dependent variable of project productivity. The data collected was analyzed through descriptive and correlational analysis using SPSS version 20.

## RESULTS AND DISCUSSION

The costs involved in building construction projects affect construction productivity. In most cases, the cost factor affects project completion time, project quality and project costs. Other project characteristics such as project complexity and site constraints also affect the cost aspect. Equally, costs arising as a result of architectural design errors, architectural design changes, structural design errors and structural design changes negatively affect construction productivity.

### Effect of Costs of Building Materials on Project Completion Time

 

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**Table 1: Effect of Cost Factors of Building Materials on Project Completion Time**

| S. No | Factor | Highest score (%) | Ranking | Lowest score (%) | Ranking | Mean | Stdev |
|---|---|---|---|---|---|---|---|
| 1 | Unreliable supplies of materials | 51.5 | Large extent | 7.9 | Very little extent | 3.53 | 1.181 |
| 2 | Payment delays to contractors and suppliers | 50.5 | Large extent | 2.5 | Very little extent | 4.10 | 0.906 |
| 3 | Materials delivery delays | 45.5 | Large extent | 5.0 | Very little extent | 3.51 | 1.156 |
| 4 | Temporal or permanent abandonment of the project | 37.6 | Very large extent | 3.0 | Very little extent | 3.82 | 1.181 |
| 5 | Creates constraints in the improvement of housing conditions in low-income countries | 38.5 | Large extent | 5.0 | Very little extent | 3.56 | 1.083 |
| 6 | Materials shortages | 35.1 | Little extent | 11.0 | Very little extent | 3.41 | 1.276 |

In the table: Stdev., the standard deviation

Reliably, results on the cost of building materials on the project completion time are shown in Table 1. Based on the mean score, the results show that payment delays to contractors and suppliers (4.10), temporal or permanent abandonment of the project (3.82), creation of constraints in the improvement of housing conditions in low-income countries (3.56), unreliable supply of materials (3.53), materials delivery delays (3.51) and materials shortages (3.41) were some of the factors identified as affecting project completion time in that order of importance. Under descriptive statistics, a higher mean implies that many respondents agreed with the variable while a lower standard deviation indicates that there was good stability of ideas (Sediqi, & Sayeed, 2022). In quantitative surveys, the collected data can be ranked based on mean scores to reveal trends, averages and frequencies (Higson *et al*., 2022). The following ranking criteria are adopted. 1= Very poor (≥1.00 and ≤ 1.80), 2= Poor (≥1.81 and ≤ 2.60) ,3= Good (≥2.61 and ≤ 3.40), 4= Very good (≥3.41 and ≤ 4.20), 5= Excellent (≥4.21and ≤ 5.00)

Ary *et al*. (2010) stated that Steven's Scale of Measurement of measuring both Likert-type and Likert scale data consists of four categories namely; nominal, ordinal, interval and ratio. Since this study was a Likert scale type, a composite score (sum or mean) was calculated from Likert-type items. This score provided the mean (a measure of central tendency) and standard deviation (a measure of variability), (Boone *et al*., 2012). Researchers agree that the responses on a Likert-type scale are arranged in some ranking order. However, this scale does not show the relative magnitude and distance between responses quantitively (Ankur, *et al*, 2015). In the context of this study, the 5-point Likert scale ratings, i.e., Very little extent, Little extent, Neutral, Large extent and Very large extent refer to the percentage frequency with which an item is mentioned starting with the lowest to the highest in that order.

On a large extent scale, 50.5% of the respondents indicated that payment delays to contractors were the single most important factor affecting project completion time. It had a higher mean of 4.10 and a lower standard deviation of 0.906. However, with a mean of 3.53 and a standard deviation of 1.181, unreliable supply of materials represented the highest frequency of 51.5% on a large extent scale. The materials shortage factor had the lowest mean of 3.41 and the highest standard deviation of 1.276 among the factors analyzed implying that it was the least factor affecting

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project completion time. The price fluctuations in the cost of construction materials can arise as a result of various external factors such as lingering tariffs and quotas, increased construction activities as well as instances of hoarding and profiteering. These aspects in most cases lead to the unavailability of construction materials and hence increased costs.

### Effect of Cost of Building Materials on Project Quality

**Table 2: Effect of Cost Factors of Building Materials on Project Quality**

| S. No | Factor | Highest score (%) | Ranking | Lowest score (%) | Ranking | Mean | Stdev |
|---|---|---|---|---|---|---|---|
| 1 | Use of substandard and insufficient building materials by the contractors | 44.6 | Large extent | 2.0 | Very little extent | 4.15 | 0.950 |
| 2 | Fixed insufficient budgets by the clients | 52.0 | Large extent | 2.5 | Very little extent | 4.05 | 0.884 |
| 3 | Use of low-quality workmanship by the contractors | 41.1 | Large extent | 4.0 | Very little extent | 3.91 | 1.089 |
| 4 | Poor-quality materials can lead to the collapse of buildings | 63.4 | Very large extent | 1.5 | Very little extent | 4.50 | 0.812 |

Table 2, on the other hand, shows the effect of the cost of building materials on project quality, The results indicate that considering the large extent scale, 63.4% of the respondents indicated that the use of poor-quality materials can lead to the collapse of buildings. This finding stood out as the most critical factor affecting the project quality when compared with the others. It had a higher mean of 4.50 and a lower standard deviation of 0.812. This finding is in agreement with the results by the National Construction Authority (NCA) on the failure and collapse of buildings in Kenya (2020) which identified five (5) causes as, poor workmanship, use of substandard materials, poor structural design, non-compliance to stationery and safety requirements and inadequate maintenance in that order of importance respectively.

**Table 3: Correlation Matrix for Cost Factors on Project Completion Time, Quality and Costs**

| | 1 | 2 | 3 | 4. | 5. | 6. | 7 | 8 | 9 | 10 | 11 | 12. | 13 | 14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1.000 | .399 | .484 | .344 | .155 | .335 | .286 | .147 | .226 | .127 | .195 | .380 | .270 | .254 |
| 2 | .399 | 1.000 | .411 | .428 | .143 | .323 | .284 | .262 | .232 | .210 | .214 | .242 | .154 | .160 |
| 3 | .484 | .411 | 1.000 | .358 | .232 | .521 | .165 | .182 | .249 | .127 | .185 | .233 | .229 | .234 |
| 4 | .344 | .428 | .358 | 1.000 | .300 | .411 | .328 | .274 | .273 | .289 | .089 | .078 | .250 | .123 |
| 5 | .155 | .143 | .232 | .300 | 1.000 | .176 | .153 | .385 | .191 | .174 | .050 | .151 | .394 | .376 |
| 6 | .335 | .323 | .521 | .411 | .176 | 1.000 | .199 | .218 | .244 | .174 | .013 | .159 | .067 | .129 |
| 7 | .286 | .284 | .165 | .328 | .153 | .199 | 1.000 | .449 | .586 | .377 | .196 | .201 | .300 | .307 |
| 8 | .147 | .262 | .182 | .274 | .385 | .218 | .449 | 1.000 | .439 | .214 | .158 | .296 | .387 | .360 |
| 9 | .226 | .232 | .249 | .273 | .191 | .244 | .586 | .439 | 1.000 | .274 | .093 | .109 | .192 | .321 |
| 10 | .127 | .210 | .127 | .289 | .174 | .174 | .377 | .214 | .274 | 1.000 | .363 | .154 | .092 | .173 |
| 11 | .195 | .214 | .185 | .089 | .050 | .013 | .196 | .158 | .093 | .363 | 1.000 | .506 | .255 | .211 |
| 12 | .380 | .242 | .233 | .078 | .151 | .159 | .201 | .296 | .109 | .154 | .506 | 1.000 | .392 | .327 |
| 13 | .270 | .154 | .229 | .250 | .394 | .067 | .300 | .387 | .192 | .092 | .255 | .392 | 1.000 | .444 |
| 14 | .254 | .160 | .234 | .123 | .376 | .129 | .307 | .360 | .321 | .173 | .211 | .327 | .444 | 1.000 |

 

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In the table: **1**, unreliable supplies of materials; **2**, payment delays to contractors and suppliers; **3**, materials delivery delays; **4**, temporal or permanent abandonment of the project; **5**, creates constraints in the improvement of housing conditions in low-income countries; **6**, materials shortages; **7**, use of substandard and insufficient building materials by the contractors; **8**, fixed insufficient budgets by the clients; **9**, use of low-quality workmanship by the contractors; **10**, poor quality materials can lead to the collapse of buildings; **11**, high cost of materials creates supply shortages and hence high prices; **12**, creates logistical difficulties; **13**, customers are charged for costs that are passed onto them; **14**, the choice of materials affects the overall cost, that is, some are relatively affordable while others are expensive.

The high cost of building materials negatively affects the quality of the project. The results from this study (Table 3) indicate that correlations of above 0.40 were recorded between the following three independent variables namely; the use of substandard and insufficient building materials by the contractors, fixed insufficient budgets by the clients and the use of low-quality workmanship by the contractors. The implication derived from this correlation is that insufficient budgets pave the way for procurement of substandard and insufficient building materials which in turn leads to a low-quality end product. Further, fixed insufficient budgets on the part of the client may leave no room for maneuverability in the event there is price fluctuation which in turn may entice the client to procure substandard materials to complete the project. The use of unskilled labour can also greatly contribute to the low quality of the end product. Sihle, & Christopher (2022) found out that contractors not only see the adverse side of utilizing unskilled labour but are also keen on deriving the positive aspects such as payment of low wages, financial gain and training on the job.

### Effect of Cost of Building Materials on Project Costs

**Table 4: Effect of Cost Factors of Building Materials on Project Costs**

| S. No | Factor | Highest score (%) | Ranking | Lowest score (%) | Ranking | Mean | Stdev |
|---|---|---|---|---|---|---|---|
| 1 | The high cost of materials creates supply shortages and hence high prices | 45.0 | Large extent | 3.5 | Very little extent | 3.81 | 1.081 |
| 2 | Creates logistical difficulties | 39.6 | Large extent | 5.0 | Very little extent | 3.43 | 1.132 |
| 3 | Customers are charged for costs that are passed on to them | 48.0 | Large extent | 3.0 | Very little extent | 4.02 | 0.954 |
| 4 | The choice of materials affects the overall cost, that is, some are relatively affordable while others are expensive | 43.6 | Very large extent | 3.0 | Very little extent | 4.03 | 0.999 |

Most often, the increase in the cost of building materials creates supply shortages which in turn lead to other challenges such as uncertainty, price fluctuations, and influence of the final price of the finished product/service amongst others. This observation is reinforced by the results from this study (Table 4) which shows a high correlation of 0.506 between the high cost of materials and the creation of logistical difficulties. Likewise, the choice of any construction material has an impact on the overall cost of the project because some are relatively affordable while others are expensive. Results from this study (Table 4) show that 48.0% of the respondents agreed with the view that any increase in the cost of building materials

 

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is usually passed onto the client in terms of the variation costs. The ripple effect of the variation costs is that project costs increase to a certain margin.

**Table 5: Total Variance for the Cost of Construction of Building Projects**

| Component | Initial Eigenvalues | | | Extraction Sums of Squared Loadings | | | Rotation Sums of Squared Loadings | | |
|---|---|---|---|---|---|---|---|---|---|
| | **Total** | **% of Variance** | **Cumulative %** | **Total** | **% of Variance** | **Cumulative %** | **Total** | **% of Variance** | **Cumulative %** |
| 1 | 4.359 | 31.137 | 31.137 | 4.359 | 31.137 | 31.137 | 2.573 | 18.382 | 18.382 |
| 2 | 1.592 | 11.372 | 42.509 | 1.592 | 11.372 | 42.509 | 2.202 | 15.727 | 34.108 |
| 3 | 1.398 | 9.983 | 52.492 | 1.398 | 9.983 | 52.492 | 2.084 | 14.886 | 48.994 |
| 4 | 1.236 | 8.826 | 61.318 | 1.236 | 8.826 | 61.318 | 1.725 | 12.324 | 61.318 |
| 5 | .911 | 6.504 | 67.822 | | | | | | |
| 6 | .745 | 5.319 | 73.141 | | | | | | |
| 7 | .679 | 4.852 | 77.993 | | | | | | |
| 8 | .603 | 4.310 | 82.303 | | | | | | |
| 9 | .523 | 3.734 | 86.037 | | | | | | |
| 10 | .497 | 3.547 | 89.584 | | | | | | |
| 11 | .420 | 3.000 | 92.584 | | | | | | |
| 12 | .381 | 2.718 | 95.302 | | | | | | |
| 13 | .349 | 2.494 | 97.796 | | | | | | |
| 14 | .309 | 2.204 | 100.000 | | | | | | |

Extraction Method: Principal Component Analysis

The data loadings for the cost factors extracted from the data output in Table 5 produced four components essential for analysis. These are the components whose eigenvalues are greater than 1. The established Kaiser-Meyer-Olkin (KMO) measure of sample adequacy for the fourteen analyzed factors was 0.791 while Bartlett's test of sphericity was 0.000 and the Cronbach's alpha value was 0.824. Component 1 is renamed the construction materials procurement factor and was considered to be the most important component. It had a variance of 31.14%. The factors clustered around this component underscored the importance of procurement and its effect on project success. The second component is renamed the Construction materials cost factor since its emphasis was on the influence of the cost of materials on project productivity.

Effect of Complexity of a Building on Project Completion Time, Quality and Cost

**Table 6: Effect of Complexity Factors on Project Completion Time, Quality and Costs**

| S. No | Factor | Highest score (%) | Ranking | Lowest score (%) | Ranking | Mean | Stdev |
|---|---|---|---|---|---|---|---|
| 1 | Reduces the project's success | 26.2 | Large extent | 11.9 | Very little extent | 2.87 | 1.326 |
| 2 | It requires a strict planning, coordinating and controlling requirement | 44.6 | Large extent | 1.0 | Very little extent | 4.08 | 0.924 |
| 3 | There are roles with unknown procedures, roles managed for the first time and phase overlap | 39.6 | Large extent | 7.4 | Very little extent | 3.43 | 1.136 |
| 4 | Affects project outcomes such as time, cost, quality, and safety amongst others | 49.0 | Large extent | 6.4 | Very little extent | 3.63 | 1.118 |

 

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| S. No | Factor | Highest score (%) | Ranking | Lowest score (%) | Ranking | Mean | Stdev |
|---|---|---|---|---|---|---|---|
| 5 | Exists physical demanding tasks requiring the use of sophisticated equipment | 40.1 | Large extent | 4.0 | Very little extent | 3.71 | 1.132 |
| 6 | The relationship that complexity reduces team performance exists | 36.6 | Large extent | 8.4 | Very little extent | 3.06 | 1.189 |
| 7 | Affects project planning and control | 40.1 | Large extent | 10.4 | Very little extent | 3.30 | 1.234 |
| 8 | Affects project outcomes such as quality, time, cost, and safety amongst others | 45.0 | Large extent | 9.9 | Very little extent | 3.58 | 1.232 |
| 9 | Increased level of complexity implies more people, newer technologies and increased internal and external factors | 40.1 | Large extent | 4.0 | Very little extent | 3.87 | 1.123 |
| 10 | Hinders clear Identification of goals and objectives | 23.3 | Large extent | 4.0 | Very little extent | 2.60 | 1.160 |
| 11 | Affects the selection of an appropriate project organization form | 33.7 | Large extent | 5.9 | Very little extent | 2.92 | 1.203 |
| 12 | As a result of unknown factors, there are high risks to schedule, budget and quality | 47.0 | Large extent | 6.9 | Very little extent | 3.64 | 1.121 |
| 13 | Affects project outcomes such as quality, time, cost, and safety amongst others | 54.0 | Large extent | 4.5 | Very little extent | 3.93 | 1.027 |
| 14 | Increased level of complexity implies more people, newer technologies and increased internal and external factors | 46.0 | Large extent | 2.5 | Very little extent | 3.97 | 1.004 |
| 15 | Due to unknown factors, there are high risks to schedule, budget and quality | 48.0 | Large extent | 4.5 | Very little extent | 3.80 | 1.046 |

The complexity factor in a building project negatively affects outcomes such as project completion time, quality and safety amongst others. To a large extent scale, this aspect was reinforced by 49.0% of the respondents (Table 6). The project complexity can easily be controlled through strict planning, coordinating and controlling requirements. Through a comparison of the mean and standard deviation of the variable factors considered, this aspect came out as the most important factor by posting a higher mean of 4.08 and a low standard deviation of 0.924. This finding agrees with that of construction cost consultants in London (2023) who reported that the impact of project complexity on cost can be countered through prioritizing risk management and contingency planning.

The need for more people and newer technologies coupled with increased internal and external factors are project complexity aspects that impact its quality. The increase in the level of project complexity is directly proportional to its negative effect on quality. Based on a large extent scale, this finding was supported by 40.1% of the respondents. This finding also agrees with that of Lan (2017) who found that project complexity is negatively correlated with project performance. This is to be interpreted that, increasing levels of complexity reduces project performance

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It was established that 54.0% of the respondents averred that complexity has an effect on outcomes such as quality, time, cost and safety amongst others. It was observed that 48.0% of the respondents reinforced the fact that due to unknown factors, there is a risk to schedule, budget and quality. This finding resonates well with that reported by Flyvbjerg *et al*. (2002), and Ashaolu, & Olaniram (2015) who reported that cost overrun is a common cause of projects being labelled a failure, especially the complex ones.

**Table 7: Total Variance for the Impact of Complexity on the Cost of Building Construction Projects**

| Component | Initial Eigenvalues | | | Extraction Sums of Squared Loadings | | | Rotation Sums of Squared Loadings | | |
|---|---|---|---|---|---|---|---|---|---|
| | Total | % of Variance | Cumulative % | Total | % of Variance | Cumulative % | Total | % of Variance | Cumulative % |
| 1 | 5.484 | 36.558 | 36.558 | 5.484 | 36.558 | 36.558 | 3.216 | 21.437 | 21.437 |
| 2 | 1.720 | 11.466 | 48.024 | 1.720 | 11.466 | 48.024 | 2.864 | 19.091 | 40.528 |
| 3 | 1.275 | 8.497 | 56.521 | 1.275 | 8.497 | 56.521 | 2.399 | 15.993 | 56.521 |
| 4 | .909 | 6.057 | 62.578 | | | | | | |
| 5 | .843 | 5.622 | 68.200 | | | | | | |
| 6 | .781 | 5.205 | 73.404 | | | | | | |
| 7 | .681 | 4.542 | 77.946 | | | | | | |
| 8 | .584 | 3.895 | 81.841 | | | | | | |
| 9 | .542 | 3.612 | 85.454 | | | | | | |
| 10 | .486 | 3.240 | 88.694 | | | | | | |
| 11 | .421 | 2.804 | 91.497 | | | | | | |
| 12 | .356 | 2.375 | 93.873 | | | | | | |
| 13 | .319 | 2.129 | 96.002 | | | | | | |
| 14 | .308 | 2.052 | 98.054 | | | | | | |
| 15 | .292 | 1.946 | 100.000 | | | | | | |

Extraction Method: Principal Component Analysis.

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The data loadings for the impact of complexity on cost extracted from the data output (Table 7) produced four components essential for analysis. These are the components whose eigenvalues are greater than 1. The established Kaiser-Meyer-Olkin (KMO) measure of sample adequacy was 0.861 while Bartlett's Test of sphericity was 0.000. Three principal components essential for analysis were extracted and renamed as follows. Component 1 is renamed Construction Project Complexity Outcome Factor. This first major component had a variance of 36.56% and laid more emphasis on how complexity affects productivity outcomes such as quality, time, cost, and safety among others. Component 2 is renamed the Construction Project Complexity Level Factor. It has a variance of 11.47% and it sought to explain the effect of the level of project complexity on the project costs, i.e., as the level of complexity increases, there is a need for more people, newer technologies and increased internal and external factors which in turn negatively impacts on project costs. Component 3 is renamed construction project complexity performance factor. This component laid emphasis on the relationship between complexity and team performance, i.e., it sought to explain the fact that there exists a relationship between complexity and team performance. This finding could be used to generalize that as the level of complexity increases, then team performance is negatively affected. The component had a variance of 8.50%.

### Effect of Site Constraints on Project Completion Time, Quality and Costs

**Table 8: Effect of Site Constraints Factors on Project Completion Time, Quality and Costs**

| S. No | Factor | Highest score (%) | Ranking | Lowest score (%) | Ranking | Mean | Stdev |
|---|---|---|---|---|---|---|---|
| 1 | The site topography affects architecture, the need for excavation or fill, visualization of the structure and route selection. | 45.5 | Large extent | 1.5 | Very little extent | 4.12 | 0.944 |
| 2 | Utilities such as underground cables, electricity cables and rights of way amongst others. | 46 | Large extent | 1.5 | Very little extent | 3.95 | 0.994 |
| 3 | Geotechnical aspects such as surface and subsurface exploration. | 47.5 | Large extent | 3.5 | Very little extent | 3.85 | 1.069 |
| 4 | Traffic. | 38.2 | Large extent | 8.0 | Very little extent | 3.38 | 1.186 |
| 5 | A sudden rise in cost negatively affects project quality | 50 | Large extent | 6.9 | Very little extent | 3.5 | 1.130 |
| 6 | Adjustment of the project scope has an effect on project costs and completion time which in turn negatively affects project quality. | 51.5 | Large extent | 5 | Very little extent | 3.78 | 1.150 |
| 7 | The change in scope or a delay in delivery of materials ultimately affects project completion time which in turn negatively affects project quality. | 40.6 | Large extent | 5 | Very little extent | 3.73 | 1.049 |
| 8 | If site constraints have a bearing on cost, scope and time, then the quality aspect is also negatively affected. | 43.1 | Large extent | 6.9 | Very little extent | 3.63 | 1.87 |
| 9 | Causes cost overruns | 57.4 | Large extent | 2 | Very little extent | 3.93 | 0.938 |
| 10 | The changes in scope and time cause an increase in project expenditure. | 50.5 | Large extent | 1.5 | Very little extent | 4.14 | 0.881 |

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By comparing means and standard deviations, site topography came out on top of the list of site constraints affecting project completion time (Table 8). This is because it affects architecture, the need for excavation or fill, visualization of the structure and route selection. This factor had a higher mean of 4.12 and a lower standard deviation of 0.944. Equally, the adjustment of the project scope was found to impact project costs and time which in turn negatively affects project quality. On the large extent scale, 51.5% of the respondents supported this view. In terms of comparing means, this factor had the highest mean of 3.78 and the lowest standard deviation of 1.049. Adjustment of project scope could mean anything like an increase in project size, use of new construction methods, use of a specialized machine/equipment or even use of specialized labour. If no prior funds were planned to accommodate this change of scope, then, the quality aspect would certainly be compromised in an effort to contain the changes. The increase in project costs is directly proportional to changes in project scope and time. The change implies more financial resources are required to mitigate the effect. To a large extent scale, this view was supported by 50.5% of the respondents.

**Table 9: Total Variance Explained for Site Constraints Factors**

| Component | Initial Eigenvalues | | | Extraction Sums of Squared Loadings | | | Rotation Sums of Squared Loadings | | |
|---|---|---|---|---|---|---|---|---|---|
| | Total | % of Variance | Cumulative % | Total | % of Variance | Cumulative % | Total | % of Variance | Cumulative % |
| 1 | 4.143 | 41.434 | 41.434 | 4.143 | 41.434 | 41.434 | 3.117 | 31.174 | 31.174 |
| 2 | 1.398 | 13.981 | 55.416 | 1.398 | 13.981 | 55.416 | 2.424 | 24.242 | 55.416 |
| 3 | .907 | 9.074 | 64.489 | | | | | | |
| 4 | .794 | 7.936 | 72.425 | | | | | | |
| 5 | .634 | 6.338 | 78.764 | | | | | | |
| 6 | .555 | 5.554 | 84.318 | | | | | | |
| 7 | .506 | 5.062 | 89.379 | | | | | | |
| 8 | .416 | 4.157 | 93.536 | | | | | | |
| 9 | .349 | 3.489 | 97.025 | | | | | | |
| 10 | .298 | 2.975 | 100.000 | | | | | | |

Extraction Method: Principal Component Analysis.

The data loadings for the impact of site constraints on cost extracted from the data output Table 9 produced two components essential for analysis. The established Kaiser-Meyer-Olkin (KMO) measure of sample adequacy was 0.822 whereas Bartlett's Test of sphericity was 0.000. Two principal components were extracted and renamed as follows. Component 1 is renamed Construction project scope and geotechnical aspects factor and had a variance of 41.43%. It is majorly concerned with the effect of change in scope and geotechnical aspects (Utilities and exploration), i.e. their occurrence negatively impacts project costs. Component no 2 is renamed Construction Project Constraints on Quality Performance Factor and had a variance of 13.98%. This finding reinforces the view that site constraints negatively affect project quality as a result of the need for more resources and time overrun which in turn spills over to increased project costs.

**Effect of Architectural Design Errors and Changes on Project Costs**

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**Table 10: Effect of Architectural Design Errors on Project Costs**

| S. No | Factor | Highest score (%) | Ranking | Lowest score (%) | Ranking | Mean | Stdev |
|---|---|---|---|---|---|---|---|
| 1 | Causes engineering failure | 39.1 | Large extent | 13.9 | Very little extent | 3.27 | 1.316 |
| 2 | Design error accounts for a certain percentage of variation costs | 53.0 | Large extent | 4.5 | Very little extent | 3.86 | 1.039 |
| 3 | Causes project delays and hence cost overruns | 47.8 | Large extent | 2.5 | Very little extent | 3.88 | 1.005 |
| 4 | Poor design leads to other problems such as constructability | 50.0 | Large extent | 3.0 | Very little extent | 3.97 | 1.004 |

The effect of architectural design errors on the project cost is presented in Table 10. The results show that at least 53.0% of the respondents agreed with the observation that design errors account for a certain percentage of variation costs. The fact that more than 50% of the respondents indicated that design error impacts construction costs is a wake-up call that design errors can no longer be underestimated or ignored. This finding is in agreement with the results of a study by Oluwaseun *et al*. (2017), who reported that design error accounts for up to 36% of variation cost.

**Table 11: Effect of Architectural Design Changes on Project Costs**

| S. No | Factor | Highest score (%) | Ranking | Lowest score (%) | Ranking | Mean | Stdev |
|---|---|---|---|---|---|---|---|
| 1 | This leads to the wastage of materials and conflicts between the parties involved and hence failure of the project | 51.0 | Large extent | 5.0 | Very little extent | 3.72 | 1.118 |
| 2 | This leads to reworks which affects the overall cost and morale of the workers) | 47.5 | Large extent | 3.5 | Very little extent | 3.93 | 1.037 |
| 3 | This leads to a loss of labor productivity and hence cost overruns and project delay | 45.5 | Large extent | 6.5 | Very little extent | 3.76 | 1.166 |
| 4 | Increases indirect costs due to later events of claims and disputes | 46.5 | Large extent | 3,0 | Very little extent | 3.94 | 1.023 |

Likewise, architectural design changes carry a considerable impact on construction costs. In this study, 51% of the respondents indicated that these changes (Table 11) lead to wastage of materials and conflicts between the parties involved and hence contribute to project failure. The results of this study also show that design changes increase indirect costs as a result of later events of claims and disputes.

### Effect of Structural Design Errors and Changes on Project Costs

Structural design errors have a considerable impact on construction costs while poor design leads to other problems such as constructability. From this study, 53.0% of the respondents indicated that design errors account for a certain percentage of variation costs while 50.0% reported that poor design leads to other problems such as constructability. The severity of the problems

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brought about by design errors and poor design could go further than escalation of construction costs but can also lead to failure and collapse of the structure. National Construction Authority (NCA) of Kenya, (2020) found out that poor structural design was responsible for 25.0% of the cause of building failure and collapse in Kenya.

## CONCLUSION AND RECOMMENDATION

The aim of this study was to explore the effect of the cost of construction on building project productivity. Oftentimes, the clients rely on the budgeted cost to complete the project within the parameters of project budget, quality and time but the reality is that this is not always achievable. When there arise costs overrun, it can be overwhelming to the client and at its worst can lead to project failure and consequent project abandonment.

Based on the results derived from this study, some of the key contributors to cost overrun are; delays in payment of contractors and suppliers. Delay in payment to contractors and suppliers causes time overrun which in turn causes cost overrun. The high cost of construction materials creates logistical difficulties which in turn contributes to increased construction costs. The choice of construction materials has a bearing on the overall construction costs because some are relatively affordable while others are not. The increase in the level of a building's complexity implies more people, newer technologies and increased internal and external factors. Results of this study further show that change in scope and time contributes to increased project costs, Equally, site topography came out on top of the list of site constraints factors affecting project completion time, quality and costs since it affects architecture, need for excavation or fill and visualization of the structure and route selection. Results also show that architectural and structural design errors and changes lead to increased project costs since poor design leads to other problems such as constructability while architectural design changes cause increased costs due to later events of claims and disputes.

To counter the adverse effect of cost overrun on building project productivity, it is important to identify and address both preconstruction and construction trigger factors. Equally, during the construction stage, strict planning and control must be exercised so as to stick to the project budget and schedule.

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