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IMPACT OF SHORING AND SCAFFOLDING ON CONSTRUCTION PERFORMANCE IN ADDIS ABABA

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Abstract

The construction sector in Ethiopia contributes significantly to economic growth, but it continues to suffer from delays, cost overruns, and safety risks. This is partly due to inadequate shoring and scaffolding practices. This study investigated the impact of shoring and scaffolding systems on the performance of building construction projects in Addis Ababa. Data were collected from 167 professionals across 57 public projects using questionnaires, interviews, and case studies and were analyzed through descriptive statistics and factor analysis. Findings show that poor practices in shoring and scaffolding lead to collapses, cracks, deflections, and misalignments in concrete structures, while also contributing to up to 5% of project costs and 17.5–27.6% of project durations. Moreover, 51% of site accidents were associated with failures in these systems. Material type (metal vs. eucalyptus), quality of components, and working methodology were found to be the most influential factors. Case study comparisons confirmed that metal systems are safer, faster, and more cost-effective than timber, despite their higher initial cost. The study recommends integrating proper design, planning, and monitoring of shoring and scaffolding early in project development. For the industry, adopting standardized metal systems, enforcing safety training, and implementing quality control can substantially reduce risks, enhance productivity, and improve overall project performance.

Keywords: Cost, Quality, Safety, Scaffolding, Shoring, Project Performance

I. INTRODUCTION

Construction is a key driver of Ethiopia's socioeconomic development, yet the industry faces persistent challenges such as cost overruns, delays, poor workmanship, and safety issues. Among the factors contributing to these problems is the poor performance of temporary works, including

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shoring and scaffolding [1]. Since project success depends on meeting deadlines, budgets, and quality standards, the role of temporary structures in achieving these objectives is critical.

Temporary structures are essential in facilitating permanent construction works, but past studies show they often fail due to poor design, planning, and management. Proper selection, design, and operation of temporary works directly influence a project's cost, quality, safety, and efficiency [2]. Shoring provides temporary support to structures under construction, while scaffolding enables access and supports workers and materials [3]. Historically, timber was the primary material for these systems worldwide, and in Ethiopia, eucalyptus wood is commonly used due to its availability and low cost, though steel use is gradually emerging [4].

Despite their importance, scaffolding and shoring are frequently neglected in terms of safety, cost, and timeliness. Research shows that Ethiopian projects often rely on crew experience rather than proper design standards, leading to unsafe and inefficient practices [4]. Issues such as uneven spacing of shores, lack of standardization, and poor methodology are common, while hazards, including collapse, falling, and material strikes, remain significant risks [5]. These shortcomings highlight the need for improved planning, monitoring, and control of temporary works.

In Ethiopia, reliance on eucalyptus wood for shoring and scaffolding remains common because of its low initial cost and wide availability. However, its limited durability, low reuse potential, and susceptibility to failure make it a less reliable option compared to standardized metal systems. Compounding this issue, many contractors manage temporary works informally by relying on professional experience rather than engineering design standards, which increases risks of collapse, inefficiency, and safety incidents [4]. These challenges highlight why a systematic study of shoring and scaffolding practices is particularly important for Ethiopia, where informal methods and material constraints significantly affect project quality, safety, time, and cost.

Given these challenges, this study investigates the impact of scaffolding and shoring on building construction performance in Ethiopia. By examining their influence on cost, quality, safety, and duration, the study emphasizes the crucial role of temporary works in determining overall project success. Greater attention to shoring and scaffolding practices can help reduce delays, minimize risks, and improve construction outcomes.

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II. RESEARCH METHODOLOGY

A. Study Area Description

As depicted in Fig.1, this research was conducted in Addis Ababa, Ethiopia's capital city, which is the leading commercial and cultural center. It is among the fastest-growing cities in Africa, with an estimated population of about five million, constituting nearly 25% of the country's total urban population. Geographically, the city lies at 9°2' N latitude and 38°45' E longitude, at an average elevation of 2,400 meters above sea level, while Entoto Hill to the north reaches up to 3,200 meters [6]. The study focused on public building projects within Addis Ababa.

Fig.1.: Geographical location of Addis Ababa [6]

B. Research Design

This study employed a descriptive and explanatory research design to investigate how shoring and scaffolding systems influence building construction performance. Both qualitative and quantitative methods were applied. The quantitative approach involved collecting and analyzing numerical data

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to measure variables and make predictions, while the qualitative approach focused on collecting and interpreting non-numerical information. The combined findings were analyzed to assess the effects of scaffolding and shoring in construction projects in Addis Ababa in the results and discussions sections. Then, conclusions and recommendations were derived from the results and discussions that followed.

C. Research Population and Sample Size

The study focused on active public building construction projects in Addis Ababa contracted through the Addis Ababa City Administration Construction Bureau (AACACB) and undertaken by grade one to grade five contractors. These contractors were selected because they are more experienced, employ qualified professionals, and are typically responsible for high-rise projects. Public projects were targeted since many private and commercial projects were suspended due to rising construction costs at the time of this study. It is important to note that the study's focus on public sector projects may limit the generalizability of findings to the private sector, which may operate under different contractual and financial constraints.

According to AACACB's 2014 performance report, 57 public building projects were under construction by contractors in the specified grades. All 57 projects were included as the study population because their size was manageable for data collection.

Purposive sampling was applied to select respondents based on job position, experience, availability, and willingness to participate. From each project, four professionals, such as site engineers, project managers, office engineers, safety engineers, general foremen, and consultants, were chosen. This number was based on a pilot study, which found that an average of four qualified professionals per project site could provide relevant insights into the issues under investigation.

D. Primary Data Collection Techniques

1) Primary Data Sources: Primary data were obtained through questionnaires, interviews, and site visits from contracting companies engaged in projects awarded by the Addis Ababa City Administration Construction Bureau.

a) Questionnaire: A structured questionnaire was administered to professionals and employees directly involved in scaffolding and shoring works. Both closed-ended and open-ended questions

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were included. The open-ended questions allowed respondents to freely express their views, supplementing the restricted options in the closed-ended questions. The questionnaire was developed based on in-person observations and targeted the major project performance indicators: cost, quality, timeliness, and safety. It consisted of three sections: general information about the project site, respondent's role, and contractor grade; the types of scaffolding and shoring systems employed; and the impacts and influencing factors of scaffolding and shoring systems on construction performance in terms of cost, quality, timeliness, and safety. Additional space was provided for respondents to include further comments or detailed explanations.

b) Interviews: Semi-structured face-to-face interviews were conducted with selected experts to gain deeper insights into their experiences and perspectives on scaffolding and shoring practices.

c) Case Study: Two project sites were examined as case studies to assess the time and cost implications of different scaffolding and shoring systems. One site utilized eucalyptus wood, while the other employed metal systems. This comparison provided practical evidence of the effects of material choice on project performance.

2) Secondary Data: Secondary data was collected from a variety of published and unpublished sources to complement the primary data. These included journals, government reports, standards, company documents, dissertations, dictionaries, and reliable internet resources. The use of secondary data provided additional context and supported the validation of primary findings.

E. Data Collection Process

To facilitate data collection, the researcher obtained an official letter of permission outlining the purpose of the study. Following this, participants were informed about the objectives of the research, and their voluntary consent was secured. Questionnaires were distributed directly by the researcher, ensuring participants had adequate time to complete them without disruption. The study relied entirely on the willingness of respondents to participate. In addition, site observations were conducted and photographs were taken to substantiate questionnaire findings and interview responses.

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F. Data Analysis

A combination of descriptive statistics, SPSS, and Microsoft Excel was employed to analyze both qualitative and quantitative data. The analysis aimed to evaluate the impact of shoring and scaffolding systems on building project performance. Results were presented using tables and graphs for clarity.

Descriptive methods provided an overview of findings. These were further interpreted and discussed in relation to cost, concrete quality, safety, and construction speed. Respondents rated potential factors influencing shoring and scaffolding performance using a five-point Likert scale. These responses were then transformed into a Relative Importance Index (RII), allowing for the ranking of factors. Finally, factor analysis was applied to identify the most significant variables affecting performance.

III. RESULTS AND DISCUSSIONS

A. Profiles of Respondents and Selected Building Projects

1) Questionnaire Response Rate: A total of 167 questionnaires were distributed to contractors and consultants. Of these, 135 were completed and found valid for analysis, representing a response rate of 80.8%. In addition, one professional from each project was interviewed to capture insights not fully addressed in the survey and to gather more in-depth qualitative information on shoring and scaffolding practices. Furthermore, two projects were selected as case studies to provide a detailed analysis and contextual understanding.

2) Grade of Contractors: The survey respondents included general contractors (GC1–4) and building contractors (BC1–3) currently engaged in public building projects in Addis Ababa. As illustrated in Fig. 2, GC-1 contractors accounted for 31.6% of respondents, followed by GC-2 with 19.3%, GC-3 with 15.8%, and GC-4 with 8.8%. Both BC-1 and BC-2 contractors represented 12.3% each. The largest share of respondents came from GC-1 and GC-2 contractors.

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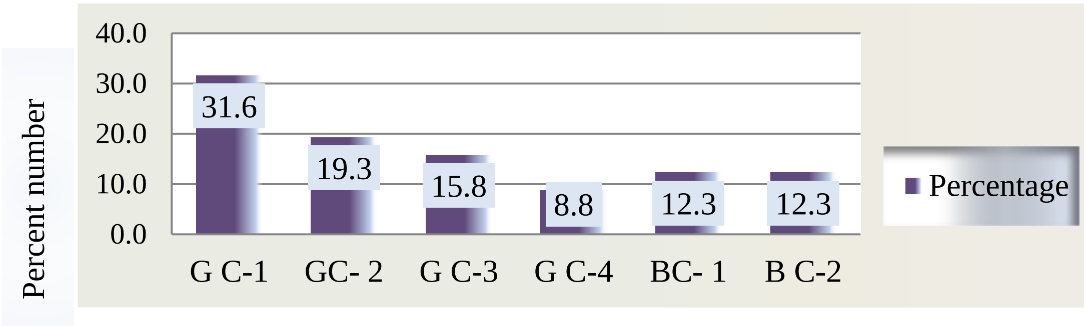

Fig. 2.: Profiles of selected companies

3) Position and Experience of Respondents: As can be noted from Table I below, the professional experience of respondents varied across the selected building construction projects. About 40% had 8–12 years of experience in the industry, 27% had 4–8 years, 26% had more than 12 years, and 7% had less than 4 years of experience. This distribution indicates that the majority of respondents held senior positions on construction sites and possessed sufficient expertise to provide reliable and informed responses.

TABLE I: Position and experience of respondents

Position of the respondent	Percentage	The experience of the respondent ranges			
		0 to 4 years	4 to 8 years	8 to 12 years	more than 12 years
Project manager	24	-	10	14	8
Site engineer	30	6	12	12	10
Safety engineer	9	-	5	3	4
Office engineer	26	4	6	15	10
General Forman	12	-	4	8	4
Total	100	10	37	52	36

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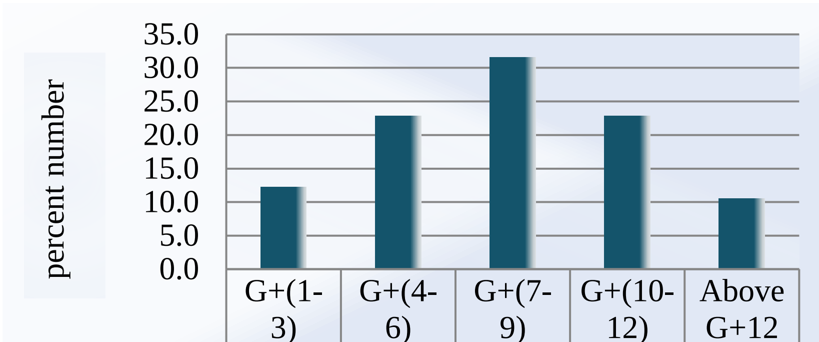
4) The Stories of the Buildings: The level of building construction projects considered in this study is presented in Fig. 3. The findings indicate that 31.6% of the projects fall within the range of G+ (7–9) stories. This is followed by 22.8% each in the ranges of G+ (4–6) and G+ (10–12). Projects with G+ (1–3) account for 12.3%, while the smallest share, 10.5%, corresponds to buildings with more than G+12 stories.



	G+(1-3)	G+(4-6)	G+(7-9)	G+(10-12)	Above G+12
percentage	12.3	22.8	31.6	22.8	10.5

Fig. 3.: The stories of the buildings

The statistical profile of respondents and projects provides important context for interpreting the study's findings. The predominance of highly experienced professionals (over two-thirds with more than eight years in the field) suggests that the responses reflect informed insights into practical challenges of shoring and scaffolding. The dominance of GC-1 and GC-2 contractors, who are typically responsible for high-rise and complex projects, indicates that the results are particularly relevant to large-scale constructions where the risks and costs of failure are higher. Similarly, the distribution of projects by building stories, with a significant proportion in the G+7 to G+12 range, underscores the growing demand for safe and efficient temporary works in vertical construction. Collectively, these statistics imply that the issues identified in this study are not isolated to small-scale projects but represent systemic challenges in Ethiopia's urban construction sector, with implications for both policy and industry practice.

B. Materials used in Shoring and Scaffolding System

In Addis Ababa's building construction projects, shoring and scaffolding systems are primarily made from eucalyptus wood, steel, or a combination of both. Despite the advantages of steel, many contractors continue to rely on eucalyptus wood due to its low cost and easy availability, a trend consistent with earlier findings by Biruk (2012). As shown in Fig. 4, the survey results indicate

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that 42% of projects use eucalyptus wood, 37% use steel, and 21% use a combination of the two materials, showing that eucalyptus wood remains the dominant choice in most construction sites.

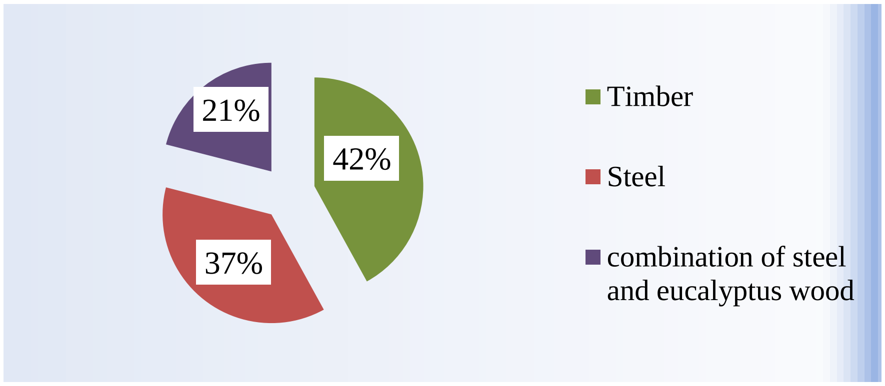

Fig. 4: Scaffolding and shoring material

C. Design of Shoring and Scaffolding

The design of shoring and scaffolding systems aims to establish proper spacing and ensure each component has sufficient strength to withstand loads and pressures. While this process should be overseen by licensed engineers, construction managers are expected to understand the fundamentals to review and request designs. However, survey results presented in Table II reveal a significant disparity: 66.7% of contractors do not prepare formal designs and instead rely on experience for material selection, erection, and stripping methods. Only 33.3% incorporate design considerations, such as load capacity and inspections, using standards like EBCS (66.7%) and ACI (33.3%). This indicates that shoring and scaffolding systems are still managed informally rather than through systematic engineering design in most projects.

TABLE II: Design of shoring and scaffolding

No.	Item	Response	Frequency	Percentage (%)
1.	Method of selecting and design of shoring and scaffolding material	Based on the experience of contractor professionals	90	66.7
		Using design code and standard inspection approvals	45	33.3
2.	Design codes (standards) are commonly used	EBCS	30	66.7
		ACI	15	33.3

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Field observations revealed that some projects use overly dense eucalyptus shoring systems due to contractors' fear of structural collapse stemming from the absence of proper design for prop spacing. This practice leads to excessive material use that increases project costs, while also creating congested workspaces that hinder worker movement and slow construction progress. To minimize risks and improve efficiency, contractors are advised to follow proper design standards when planning and implementing shoring and scaffolding systems.

These findings reveal a critical gap between formal engineering standards and on-site practices in Ethiopia's building construction sector. The reliance on experience rather than systematic design not only increases the risk of structural failure but also results in inefficiencies such as material overuse, congested workspaces, and reduced productivity. This informal approach reflects both the limited availability of skilled design expertise for temporary works and the industry's tendency to undervalue shoring and scaffolding compared to permanent structural elements. The broader implication is that unless design standards for temporary structures are institutionalized and enforced, projects will continue to face quality, cost, and safety setbacks. Strengthening regulatory oversight, integrating shoring and scaffolding design into contract requirements, and enhancing professional training could help bridge this gap and improve overall project performance.

D. Major Factors Affecting the Performance of Shoring and Scaffolding Systems

1) Factors Affecting Quality Performance: Based on an extensive literature review, the major factors that affect the quality of concrete structure and lead to shoring system failure in Addis Ababa building construction projects were presented in Table III.

The study identified the top ten causes of shoring system failures in Addis Ababa building construction projects based on mean scores ranging from 3.5 to 5. The most critical factor was insufficient load-carrying capacity (mean value 4.91), followed by the use of defective members (4.56), and inclined or non-rigid props (4.43). Inadequate spacing between members and excessive or concentrated loads (4.17) were also significant contributors, highlighting both structural and operational shortcomings that align with findings from previous studies.

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TABLE III: Descriptive statistics of shoring failure factors

Cause of failure of shoring and scaffolding	Mean	Rank
Insufficient load-carrying capacity	4.91	1
Use of defective members	4.56	2
Used inclined/none-rigid props	4.43	3
Inadequate spacing between members	4.17	4
Concentrated /excessive load due to construction material	4.17	5
Improper /premature shoring/scaffolding removal	3.82	6
Use of a defective pin/rod to hold the props at the required heights	3.80	7
Dislocation of the base plate	3.60	8
Improper mud sill installation (mudsill- a plank frame or small footing on the ground used as a base for a shore or post in shoring and scaffolding	3.52	9
Impact load during concrete pouring	3.52	

Other major causes of failure included premature removal of shoring or scaffolding (3.82), the use of defective pins or rods (3.80), and dislocation of base plates (3.60). Additional issues of improper mud sill installation and impact loads during concrete pouring both scored a mean value of 3.52, further exacerbating the risks. These failures can result in serious consequences, including accidents, injuries, loss of life, and significant cost and time overruns, underlining the importance of systematic failure analysis and strict adherence to design and safety standards.

Beyond preventing failures, scaffolding plays a vital role in enhancing construction quality and productivity. Interviews revealed that scaffolding improves worker safety, creates a more efficient work environment, and reduces physical strain, thereby motivating employees and enabling them to focus on quality output. Unsafe conditions, by contrast, cause stress, reduce productivity, and lead to project disruptions. Thus, scaffolding not only ensures safety but also indirectly supports better project performance by fostering a secure, efficient, and high-quality construction process.

2) Factors Affecting Safety Performance: As shown in Table IV below, 26 factors that affect safety in shoring and scaffolding systems in building construction, which were categorized into four major factor sources as environmental, technical, human, and organisational factors, were considered.

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TABLE IV: Ranking of factors affecting the safety of shoring and scaffolding systems

Factors	RII	RANK
Improper foundation	0.742	3
No guardrail and lifeline	0.735	7
Excessive load	0.818	1
Defective scaffolding material	0.742	3
Improper use of PPE	0.738	6
Lack of protective equipment	0.701	9
Poor technical condition of the scaffolding	0.738	5
No safe work procedure	0.695	10
Lack of monitoring by the site supervisor	0.721	8
Lack of training	0.750	2

The study identified several critical factors influencing safety in building construction related to shoring and scaffolding. The leading cause is excessive load, with an RII value of 0.818, which often results in scaffold collapse when the applied load exceeds its carrying capacity. Lack of worker training follows closely with an RII of 0.750, highlighting the need for proper instruction both for those erecting scaffolds and those working on them [7]. Other significant factors include improper foundations and defective scaffolding materials (RII 0.742), which compromise stability and load distribution, as supported by Robert. Poor technical conditions of scaffolding and shoring (RII 0.738), often caused by defective design or manufacturing, also emerged as a major safety risk.

In addition, several other factors contribute to scaffolding and shoring accidents, including improper use of personal protective equipment (PPE), lack of guardrails and lifelines, inadequate site supervision, absence of protective equipment, unsafe work procedures, unskilled workers, and defective scaffolding materials. These issues, with RII values ranging from 0.735 to 0.683, reflect both technical shortcomings and human factors that increase the likelihood of accidents. Collectively, these findings emphasize the urgent need for stricter safety measures, proper training,

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and adherence to technical standards in order to minimize risks and improve safety performance in building construction projects.

3) Factors Affecting Time in Shoring and Scaffolding Construction: As shown in Fig.5 below, the survey results revealed that the type of shoring and scaffolding material is the most significant factor affecting construction time, with a mean score of 4.111, as steel systems are faster to install than timber systems. [4]. Delays in inspection and approval (mean 4.089) were identified as the second major factor, since work cannot proceed without the supervisor's approval [10]. The third factor was the number and efficiency of crew members (mean 4.030), followed by poor site layout planning (mean 3.919), which can disrupt workflow and reduce productivity. Other factors influencing speed include poor site conditions, occasional overtime, project size and complexity, lack of tools and equipment, rework, and adverse weather, with mean values ranging between 3.681 and 3.519.

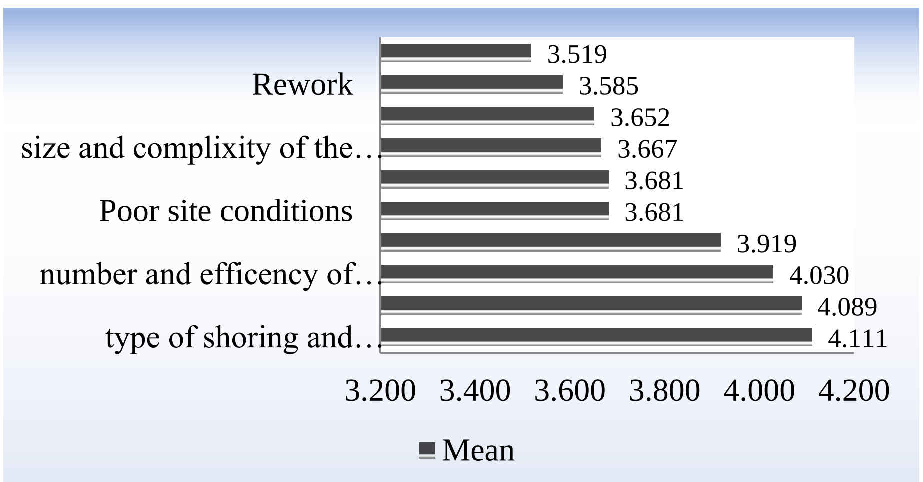

Fig. 5.: Factors affecting the speed of construction

4) Factors Affecting Cost of Shoring and Scaffolding Systems: The study identified the main factors affecting the cost of shoring and scaffolding systems. The most significant factor was the type of material used (mean 4.0889), with metal scaffolding being more expensive than timber due to its higher safety and easier assembly.

The second factor was the volume and complexity of work (mean 3.7778), since complex projects require additional materials and accessories [10]. The third factor was the type of shoring and

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scaffolding system used (mean 3.7185), as different systems—such as double, single, or suspended scaffolding, and flying or raking shoring—require varied construction methods and components, often leading to higher rental costs. Availability of materials was identified as the fourth factor (mean 3.444), as shortages can delay work, waste labor resources, and increase overall project costs.

As depicted in Table V, additional factors influencing cost include site location, material strength, seasonal timing of rentals, price fluctuations, construction methodology, and the number of scaffolding sections used, with mean values ranging from 3.4444 to 3.0444. These findings align with earlier research and highlight that being aware of such cost drivers can help contractors and project managers reduce the economic burden of shoring and scaffolding in building construction projects.

TABLE V: Factors affecting the cost of shoring and scaffolding

Factors affecting cost of shoring and scaffolding	Mean	Rank
Type of shoring and scaffolding material	4.0889	1
The number of scaffolding sections used can be factored using the	3.0444	10
The time of year in which the scaffolding and shoring is being rented and the number of scaffolding and shoring rentals in the area.	3.1259	7
Volume and complexity of the work,	3.7778	2
Methodology adopted to execute the work	3.0444	9
Type of the scaffolding and shoring	3.7185	3
Strength of scaffolding and shoring	3.2444	6
Repetition of material	3.1259	7
Location of the site	3.3778	5
Fluctuation of material cost,	3.0741	8
Availability of shoring and scaffolding material,	3.4444	4

Although metal scaffolding and shoring have a higher initial cost compared to eucalyptus wood, they are more durable, reusable, and can significantly reduce overall project costs by speeding up construction, minimizing waste, and providing long-term service. In contrast, eucalyptus wood is cheaper upfront but has limited reuse potential, typically lasting for only one project, though case studies show it can sometimes be reused four to eight times. Survey results revealed that 92% of respondents view metal scaffolding as crucial for lowering costs despite its expense, yet most

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contractors still rely on eucalyptus wood due to budget constraints. Previous studies, including [4], confirm that H-frame metal scaffolding offers cost and time advantages over eucalyptus. Overall, the study concludes that the performance of shoring and scaffolding systems in building construction is mainly influenced by material quality, the type of system used, and the working methodology applied.

The analysis of quality, safety, time, and cost factors demonstrates that deficiencies in shoring and scaffolding performance are deeply interconnected. For example, inadequate load-carrying capacity and defective materials not only compromise concrete quality but also create safety hazards and delay progress through rework or collapse recovery. Similarly, delays in inspection and poor crew efficiency, initially categorized as time-related issues, also drive up project costs and expose workers to unsafe conditions. The findings thus suggest that addressing a single performance dimension in isolation will not be sufficient; rather, a holistic approach is required that integrates material quality control, adherence to design standards, workforce training, and systematic supervision. From an industry perspective, this implies that scaffolding and shoring should be managed as critical project systems with dedicated planning, budget allocation, and monitoring mechanisms, rather than as secondary or temporary works. Such a shift could significantly reduce risks while enhancing overall efficiency and reliability in Ethiopia's construction sector.

E. Effect of Shoring and Scaffolding Systems on Performance of Building Constructions

1) Effect on the Quality Performance of Building Construction: As presented in Table VI below, the RII-based survey revealed that shoring and scaffolding systems have a major impact on concrete structure quality. The most critical issue was slab bending from shoring settlement (RII = 0.849), usually due to unstable soil or poorly installed shores. Other major concerns were poor structural integrity from low-quality materials and workmanship (RII = 0.797) and cracks/deflections from premature shore removal (RII = 0.791). Additional risks include structural collapse (RII = 0.779), slab misalignment from shoring misplacement (RII = 0.759), and lateral deformation from inadequate bracing (RII = 0.753). Overall, both proper design and execution of shoring/scaffolding are essential for the safety, serviceability, and durability of concrete structures.

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TABLE VI: Quality problem related to shoring and scaffolding

Effect of shoring on the quality of concrete structure	RII	Rank
Bending of the slab caused by the settlement of the shoring system	0.849	1
Poor structural integrity due to poor quality of shoring material and poor workmanship of shoring work.	0.797	2
Crack and deflection resulted from the premature removal of the shoring and unstable shoring system	0.791	3
Collapse or failure of the concrete and shoring structure due to a poor shoring system.	0.779	4
Misalignment of the shoring system permits the misalignment of the concrete slab	0.759	5
Lateral deformation due to poor bracing of the shoring system	0.753	6
Shoring and scaffolding systems do not affect the quality of the concrete structure	0.290	7

2) Effect on Safety Performance of Building Construction: Fig. 6 shows the survey result of injuries and accidents that occurred in their project site. Survey results show that 32% of site accidents were due to scaffolding systems and 19% due to shoring systems, meaning nearly half of construction hazards originate from these two systems. [4] further, it was found that projects using eucalyptus wood for shoring and scaffolding experienced incidents more frequently than those using metal systems.

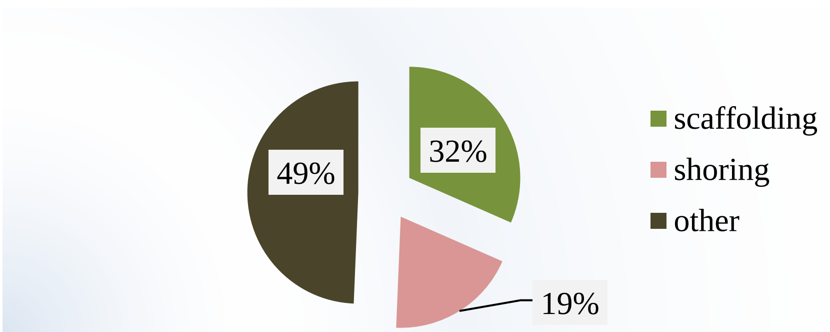

Fig. 6:. Rate of accidents due to shoring and scaffolding

As shown in Fig. 7, the survey, incidents and injuries were classified as near miss, first aid, medical attention, and fatality. Results showed that 62.1% of scaffolding-related and 56.7% of shoring-related cases required only first aid. Near misses accounted for 22.9% in shoring and 17.2% in scaffolding, while about 20.8% (scaffolding) and 20.7% (shoring) needed medical attention. No fatalities were reported in the surveyed projects;

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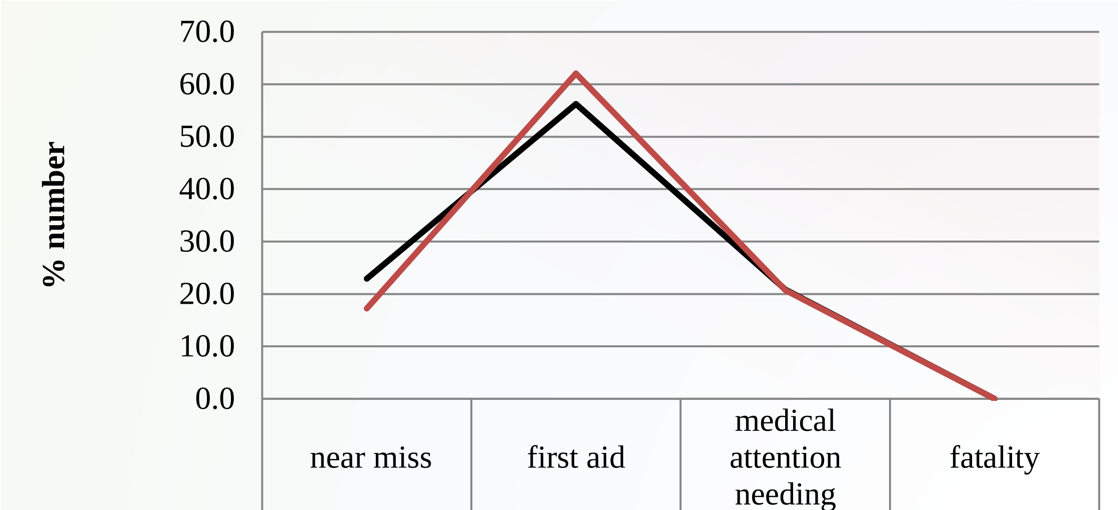
Corresponding author- **Feseha Sahile**



	near miss	first aid	medical attention needing	fatality
shoring	22.9	56.3	20.8	0.0
scaffolding	17.2	62.1	20.7	0.0

Fig. 7.: Incident caused by shoring and scaffolding

[11] highlighted that scaffolding and shoring accidents increase project expenses both directly and indirectly. While health and safety systems typically cost only 0.5–3% of total project costs, the cost of accidents is much higher, often surpassing prevention costs. Contractors bear indirect expenses such as lost productivity, cleanup, replacement, delays, supervision, rescheduling, transportation, and wages for injured workers during recovery.

3) Effect on Time Performance of Building Construction Project: This study also quantified the time share of the shoring system within a single floor cycle using data from 57 project sites. The average values, derived through interpolation of site data, were used to analyze the speed and efficiency of shoring operations.

The basic data are: -

1. he averages number of crew for one floor at a time is six.
2. Average productivity by considering six crew members for each shoring material (height of the building was considered).
    - Eucalyptus wood = 4.2 m^2/hr
    - Metal = 6.8 m^2/ hr

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In order to calculate the time share of shoring in the total duration of the project, this study considered two building projects as case studies. The detailed information is presented in Table VII.

Case study results show that shoring and scaffolding activities account for 17.5% of project duration when using metal systems compared to 27.6% when using eucalyptus wood. The longer time for timber systems is due to on-site measuring, cutting, fixing, and their limited reusability. Metal systems, by contrast, are faster to assemble/disassemble, reduce costs, and are more suitable for high-rise projects. Observations also revealed that eucalyptus wood systems are less safe, less environmentally friendly, and efficient. Interviews confirmed unanimous agreement among respondents that metal shoring and scaffolding systems are superior to timber systems in terms of safety, time, and cost.

4) Effect on the Cost Performance of Building Construction Projects: According to the respondents, the cost of shoring and scaffolding is the main criterion to select the type of shoring and scaffolding systems in a given project.

TABLE VII: Project information for the case

	Project 1	**Project 2**
Location	A.A, nifas silk lafto, woreda 12	Addis Ababa, Arada sub city, Woreda 3
Story of building	B+ G+ 7 office Building	2G+8 mixed Building
Project duration	540 days	720 days
Total floor area	646.35 m^2 *8(No.of floor)=5171m^2	742.5 m^2*9= 6682.5
Type of shoring and scaffolding	Metal	Eucalyptus wood,
Productivity (by 6 labourers)	6.8 m^2/hr or 54.43m^2/day	4.2 m^2/hr or 33.6 m^2/day
Total project cost	90 million birr	130 million birrs
Time share of shoring and scaffolding	5171m^2/54.43 m^2/day = 95 day 17.5% of total duration	6682.5m^2/33.6 m^2/day =199day 27.6 % of the total duration of the project

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The cost of shoring and scaffolding will, of course, vary substantially depending on the project. To analyze the effect of shoring and scaffolding systems on the building construction project cost, this study calculates the cost share of shoring and scaffolding systems. The following information, as depicted in Table VIII, is used for calculating the cost of the shoring and scaffolding system.

TABLE VIII: Cost information of shoring and scaffolding [12]

Type of material	Unit	Price(Birr)	Reusability
Eucalyptus wood dia. 10 cm-12cm, length. 8m	Pcs	260	>4
Eucalyptus wood dia. 8cm – 10 cm, length 4m	Pcs	150	>4
H-frame 0.80m x 1.5m x3m Height	Full set	11,500	>40
H-frame (daily rental)	m^2	5.2	-
RHS 60cmx60cmx1.5cmx6m	Pcs	2500	>40
Nail	Kg	300	1.5
Black wire 2.5	Kg	200	-

$$\text{Output per crew} = \frac{\text{Productivity}}{\text{No crew x 8hr/day}}$$

$$\text{Eucalyptus wood shoring output} = \frac{106.64\text{m}^2\text{/day}}{\text{8 crew x 8hr/day}} = 1.26\text{m}^2\text{/hr.}$$

$$\text{Metal shoring output} = \frac{170\text{ m}^2\text{/day}}{\text{8 crew x 8hr/day}} = 2.65\text{ m}^2\text{/hr.}$$

The direct unit cost analysis was performed using the minimal reusability of each material. Four times were considered to be possible using eucalyptus wood. Owning the material or renting the material were the two options studied for metal shoring. When a material is owned, it may be reused 40 times; however, when a material is rented, the construction and dismantling timeframes are 10 days and 21 days, respectively. Spacing between eucalyptus wood posts is 60cm, and wastage is assumed as 10%. And the Spacing of H–frame is 0.8 m and 1.87m in longitudinal and transversal direction. Based on the above assumption, this paper calculated the cost breakdown for slab shoring. Using project information, the total share of shoring and scaffolding cost was obtained and is shown in Table IX.

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TABLE IX: Cost share of shoring and scaffolding

	project 1	project 2
Total project cost	90,000,000	130,000,000
Unit price	107.2birr/m^2 for own and for rent 211.3 birr/m^2	762.1
Quantity	5217.7 m^2	6727.7 m^2
Total cost (birr)	559,337.44 Birr if material is owned and 1,102,500	5,127,180.17
Percentage	0.6 % owned and 1.2% for rent	4.50%

As shown in the table above, the cost share of the shoring and scaffolding system to the total project cost is 1.2% for metal shoring and scaffolding if material is rented, and 0.6% if material is owned and reused more than 40 times for project 1, and 4.5% for eucalyptus wood for project 2. Based on the result, this study concludes that the cost range of shoring and scaffolding covers up to 5% of the total project cost, depending on the type of shoring and scaffolding system.

The combined results highlight that shoring and scaffolding are not just technical site activities but critical determinants of overall project success. The evidence that these systems can account for up to 30% of project duration and 5% of total costs illustrates their disproportionate influence on resource allocation. The link between system type and accident rates further demonstrates how material and methodological choices directly translate into worker safety outcomes. Beyond the immediate project level, these findings carry broader implications for Ethiopia's construction industry: continued reliance on eucalyptus wood and informal practices risks perpetuating inefficiencies, safety hazards, and cost overruns. By contrast, transitioning toward standardized metal systems and enforcing design-based planning could significantly improve productivity, reduce delays, and enhance structural reliability. Thus, investment in proper shoring and scaffolding should be viewed not as an ancillary expense but as a strategic priority with long-term benefits for industry competitiveness and urban development.

IV. CONCLUSION

This study examined the impact of shoring and scaffolding systems on construction project performance in Addis Ababa with a focus on cost, quality, safety, and time. The findings clearly demonstrate that these temporary works play a decisive role in project outcomes and should be regarded as integral to construction planning and management.

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In terms of quality, poor design and reliance on defective or informal shoring and scaffolding practices were shown to cause slab bending, cracks, misalignment, and even structural collapse, directly undermining project objectives of delivering safe and durable buildings. Regarding safety, the study revealed that over half of construction accidents are linked to failures in shoring and scaffolding, with eucalyptus wood systems posing greater risks compared to standardized metal systems. For time performance, case studies demonstrated that shoring and scaffolding account for 17.5% of project duration when using metal systems and 27.6% when using eucalyptus wood, highlighting their significant influence on schedule adherence. With respect to cost, shoring and scaffolding can represent up to 5% of total project budgets, with material type, reusability, and methodology emerging as the most critical cost drivers.

These results confirm the central argument of this study that shoring and scaffolding systems, though temporary, are fundamental determinants of construction project performance. The study recommends that contractors, consultants, and policymakers prioritize the integration of proper design, material selection, and systematic planning for these systems. By moving away from informal practices and adopting standardized approaches, particularly through the wider use of metal scaffolding and strict adherence to engineering standards, the Ethiopian construction industry can enhance structural reliability, reduce risks, improve efficiency, and ultimately achieve better project outcomes in line with its development goals.

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