Assessment of Factors for Improving Construction Projects Scheduling

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DOI: https://dx.doi.org/10.51584/IJRIAS.2025.10100000184

Received: 29 October 2025; Accepted: 05 November 2025; Published: 22 November 2025

ABSTRACT

Successful projects delivery are products of constructive construction planning and scheduling put in place ahead of time. However, lack of expertise for preparing an effective project schedule by constructors is a major challenge to projects time. This study employed quantitative research to assess factors that improve construction project scheduling with a hope of improving the expertise of practitioners. A questionnaire survey was used to generate data. Descriptive and inferential statistics using IBM SPSS 23.0 were used to analyse the data. Thirty-six (36) factors were identified in literature and examined. Results indicated that "estimating the number of work periods needed to complete individual activities with estimated resources" was an extremely significant factor in project scheduling with an index value of 0.904. "Developing a work breakdown structure" when preparing a schedule was extremely significant. Further, "Defining the activities needed to complete the work" most greatly determine the improvement of the project scheduling processes with index value of 0.918. The study recommends that practitioners pay attention on the identified factors when preparing schedules which can be incorporated into projects scheduling tools and techniques. This will ensure proper planning and scheduling for construction projects in Nigeria.

Key words: Construction Management; estimating; Projects Scheduling; Planning Tools; Supply Chain; Work Breakdown Structure

INTRODUCTION

Successful delivery of projects relies heavily on effective construction planning and scheduling. Moradi and Sormunen (2022) emphasized the pivotal role of planning in project management. However, concerns have arisen regarding the perceived lack of relevance of construction schedules in the day-to-day operations of construction projects. In addition, it is challenging to implement and adhere to plans, and poor implementation often leads to the need for unplanned compression of schedules to make up for lost time. Notably, proper planning is essential for the effective management of both human and material resources in construction projects (Chen et al., 2020). The construction industry's complex and dynamic nature introduces uncertainty, risk and demanding time constraints (Shamp, 2017). Consequently, the effects of construction delays on costs are of fundamental importance in project planning and execution (Blanc-Brude & Makovsek, 2013).

Construction management experiences series of distinct and independent challenges in comprehensive and new construction projects, separate from business planning and funding processes (Porwal & Hewage, 2013). Bid challenges and scheduling issues emerge shortly after the approval of funding or business plans, leading to project managers grappling with time delays, cost overruns, and quality defects (Meng, 2012). Cost and scheduling overruns present significant challenges in construction projects and contribute to project delays

ISSN No. 2454-6194 | DOI: 10.51584/IJRIAS | Volume X Issue X October2025

(Meng, 2012). A range of factors leads to cost and schedule overruns, impacting business and stakeholders' profits (Ramanathan, Narayanan, & Idrus, 2012).

Overruns and schedule delays are prevalent in construction projects, particularly in developing countries like those in West Africa, where mounting cost overruns and schedule delays have been reported (Hatamleh et al., 2018). The importance of project schedule management and its role in ensuring timely project completion cannot be overstated (PMBOK, 2017). Project scheduling involves arranging, controlling, and optimizing work and workloads, contributing significantly to project success (Griebenow, 2017). An effective schedule management plan includes outlining the work breakdown structure, identifying interdependencies among activities, sequencing tasks, estimating task duration, and managing risks (Beleiu, Crisan, & Nistor, 2016). The inability of project managers to deliver construction projects on time underscores the lack of understanding and application of project planning and scheduling theory in construction (Kassandra & Suhartono, 2018).

The global construction industry faces challenges due to insufficient attention to effective project planning and preplanning stages, impacting project performance (Martinelli & Milosevic, 2016). Overall project processes and requirements play a vital role in developing a project schedule, and overlooking planning issues often results in unsatisfactory project performance (Lee et al., 2018). While several aspects influence the scheduling process, limited attention has been given to specific planning issues and their impact on scheduling.

Challenges in construction project scheduling have been reported in Nigeria (Ogumsemi & Jagboro, 2006; Ma, Cu & Li, 2015; Farshchian, Heravi, and AbouRizk, 2017). Current construction management research focuses on scheduling approaches, tools, techniques, and performance (Sham, 2013; Nlemchukwu, 2017; Su et al., 2018; Rostami et al., 2017; Kannimuthu, 2019; Li et al., 2017). Various authors have pointed out that poor scheduling performance is due to ineffective schedule preparation and management by construction managers (Michael et al., 2018; Mubbarak, 2015; Martinelli & Milosevic, 2016).

It is essential to address the lack of research in scheduling procedures within the Nigerian construction industry to improve project delivery. Evaluation of the existing knowledge base on scheduling processes is necessary to enhance comprehension of essential procedures crucial for proficient planning and overseeing the timely completion of construction projects. The research aims to address specific questions related to scheduling processes and factors for improving construction project scheduling.

Construction Industry

The Construction Industry (CI) is crucial for the overall development of an economy, especially in rapidly growing economies like India. With an average annual growth rate of 8-10%, construction projects are the primary mode of building and represent the largest government asset in many developing countries. Engineers manage over 90% of construction projects, highlighting their pivotal role in the industry.

In many developing nations especially across Africa governments prioritize infrastructure development through the construction, rehabilitation, and maintenance of key assets. In the case of Nigeria, a notable indicator of progress is the growing activity within its construction industry. This positive trend is offset by systemic challenges, including significant industry disorganization and fragmentation. A large proportion of construction firms remain small-scale, with only a few reaching medium to large-scale status. Even among these, many lack robust professional management practices and an efficient work culture. These deficiencies serve as critical indicators of underlying structural weaknesses, often resulting in project inefficiencies, prolonged timelines, and escalating costs (Williams, 2017).

Addo-Abedi (2017) narrated that construction practices worldwide are rapidly evolving in terms of technology and organization, with the industry's reputation closely tied to its performance. Addressing these challenges requires novel management techniques and a non-traditional research approach, such as design science and action research. Advocating for collaborative production planning, emphasizing workflow reliability, and

ISSN No. 2454-6194 | DOI: 10.51584/IJRIAS | Volume X Issue X October2025

improving communication systems is crucial for maximizing customer value and enhancing industry performance.

In challenging the traditional approach to construction, the industry must prioritize the promotion of trust and transparency to optimize customer value and improve overall performance. These strategic reforms cannot be overstated, as they can have a significant impact on the efficiency and effectiveness of the construction industry (Kassandra, 2018).

Construction Project Delay

Construction delays are a global issue, impacting various countries, including Pakistan and Nigeria. These delays can lead to disputes, budget overruns, and even bankruptcy. To minimize these issues, it is crucial for clients to select potential contractors based on several selection criteria. Delays are defined as time overruns beyond the completion date specified in a contract or beyond the agreed-upon date for project delivery. The success of a project is determined by three factors: quality, costs, and time, also known as the iron triangle (Retik, 2018).

Several studies have been conducted on causes, effects, and solutions to construction project delays in Nigeria. Causes include political instability, lack of quality and materials availabilities, poor communication, weather conditions, poor site conditions, and non-utilization of building construction professionals. Effects of delay can be defined as changes occurring as a direct result of action by the time overrun (McKinney, 2018).

Delays can cause dispute, negotiation, lawsuit, total desertion, litigation, and abandonment. Delays can result in loss of wealth, time, and capacity for different parties. Owners experience loss of income and unavailability of facilities, while contractors experience money for extra spending on equipment and materials and hiring labor. Time and cost overruns have been a major recurring problem in the construction industry (Ahiaga-Dagbui, 2014).

Researchers have conducted studies on the causes of construction delays in developing countries worldwide, identifying various factors leading to delays. Some similarities with Nigeria as a developing country can be observed in the perception of contractors, consultants, project managers, and contractors (Michael¸ 2018.

Construction Scheduling

Project success is crucial for profit-making in any construction organization, and project schedule management is essential for timely completion. However, the industry has been plagued by delays and cost overruns, indicating a lack of integration of advanced construction scheduling. This has led to dissatisfaction among clients and stakeholders with the industry's results. Accurate cost estimating and control are essential elements for project success, and scheduling plays a significant role in controlling costs and estimating projects (Sham, 2017).

The fragmented and unorganized nature of the industry has led to the underappreciation of the roles of construction planners. In Ghana, construction planners are almost non-existent, with project managers taking on this role. This highlights the limited number of competent construction planners in the industry, leading to less qualified personnel being responsible for construction schedules (Heesom, 2014).

The construction industry has consistently demanded higher standards, and construction planners have been at the forefront of these developments. However, the industry has not adequately planned to meet client demands, leading to low productivity and dissatisfaction. The unpredictability of construction delivery time and budgets also contributes to gaps in current scheduling practices (Thillai, 2010).

To make the industry attractive to investors and potential recruits, the integration of technology to improve working efficiency and existing practices is necessary. The construction scheduling process is the focus of this

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achievement, and the following subsections will discuss theoretical developments in construction planning and scheduling and techniques (Kannimuthu, 2019).

Construction Project Performance

Project performance is a complex concept influenced by both internal and external factors. While some internal factors can be addressed by the project team, others, such as social factors, corruption, and political interference, are beyond the team's control. The PMI (2004) recommends five interrelated process groups, including initiation, planning, execution, monitoring, and closing. Monitoring and controlling are crucial for collecting, measuring, and disseminating performance information, enabling process improvement. Performance measurement is essential for decision-making and ensuring better project outcomes, particularly in the construction industry (Lu, 2016).

Critical success factors, or factors that influence project success or failure, are crucial for organizations to develop strategic strength areas. Identifying these factors and potential pitfalls helps project teams manage uncertainties effectively. Researchers have developed frameworks for success factors, focusing on project management in general. Shenhar et al. (2002) identified three types of success factors: those independent of project characteristics, uncertainty-influenced, and scope-influenced. Daboun et al. (2023) provided a framework for grouping project performance factors into factor groups, allowing for the identification of other relevant factors based on the project context.

RESEARCH METHODOLOGY

The study utilized a quantitative, inferential approach to conduct the research, to achieve the aim. This typically involves survey research, where a sample of the population is studied to determine its characteristics, and it is inferred that the population shares these characteristics.

Population and Sample Size

The population for this study comprised construction professionals in Nigeria, including project managers and contractors engaged across various domains such as consultancy, contracting, and public infrastructure development. Respondents were drawn from key locations Federal Capital Territory (FCT) Abuja, Lagos, Kano, Port Harcourt, and Kaduna and included registered members of professional bodies such as the Chartered Institute of Project Managers of Nigeria (CIPMN), which regulates and certifies project management professionals, as well as personnel affiliated with the Bureau of Public Procurement (BPP), the national regulatory agency responsible for standardizing public procurement and maintaining the database of certified contractors and consultants.

Due to the absence of a centralized or accessible national database of construction professionals, a purposive sampling technique was employed. This approach enabled the deliberate selection of participants who possessed the relevant experience and qualifications required to provide informed responses. A total of 40 respondents, selected based on professional registration and involvement in construction projects, were included in the study to ensure adequate representation of the wider professional landscape in the Nigerian construction sector.

Data Collection

Data for this research were collected using structured questionnaires, which served as the primary instrument for gathering quantitative responses from construction professionals. The questionnaire was designed to enable respondents to assess and rank the importance, level of consideration, and areas for improvement related to construction project scheduling practices in Nigeria. To enhance reach and ensure inclusivity, the questionnaire was administered through a hybrid distribution strategy both in physical (hard copy) format and electronically

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(via e-questionnaire platforms). This approach facilitated broader participation across various regions and ensured that the data collected were comprehensive, reliable, and suitable for in-depth analysis.

Data Analysis

The study analyzed data using both descriptive and inferential statistics. Descriptive tools such as frequency, weighted mean, and standard deviation summarized key responses on scheduling practices. For inferential analysis, regression analysis was used to examine the relationship between organizational factors and scheduling performance. Linear regression helped identify which variables significantly influenced scheduling effectiveness, making it suitable for the nature of the data and the study's objectives.

RESULTS AND DISCUSSION

Table 1: General Information of the Respondents

S/N	Variables	Frequency	Percentages (%)
1.	**Age Group**		
a.	Less than 25 years	5	10.0
b.	26 - less than 40 years	13	26.0
c.	40 - less than 55 years	21	42.0
d.	55 years & above	11	22.0
	Total	**40**	**100.0**
2.	**Gender**		
a.	Male	31	82.0
b.	Female	9	18.0
	Total	**40**	**100.0**
3.	**Highest Educational Attainment**		
a.	High School	1	2.0
b.	Diploma	8	36.0
c.	Bachelor degree	26	52.0
D	Master degree	4	8.0
e.	PhD	1	2.0
	Total	**40**	**100.0**
4.	**Years of Experience**		
a.	Less than 5 years	8	16.0
b.	5-9 years	10	28.0
c.	10-14 years	16	40.0

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d.	15-19 years	7	14.0
e.	20 years and more	1	2.0
	Total	**40**	**100.0**
5.	**Unit/Department**		
a.	Construction Manager	10	20.0
b.	Site Engineer	8	16.0
c.	Stores/Warehouse	5	10.0
d.	Construction Supervisor	8	16.0
e.	Procurement & Logistics	19	38.0
	Total	**40**	**100.0**

The demographic analysis in Table 1 shows that the majority of respondents (42%) fall within the age group of 40 to less than 55 years, with 26% aged 25 to less than 40 years, and a smaller proportion under 25 or over 55. Gender distribution reveals a dominance of male respondents (82%), compared to females (18%). Educational qualifications indicate that most respondents (52%) hold a Bachelor's degree, followed by 36% with diplomas, while only a few possess Master's or PhDs. This suggests a highly educated respondent base capable of providing informed feedback.

In terms of professional experience, 40% of respondents have between 10 and 14 years of experience, while 28% have 5 to 9 years, and 16% have less than 5 years. This indicates that a majority of the participants possess significant field experience. Departmentally, most respondents are drawn from procurement and logistics (38%), followed by construction managers (20%), site engineers and supervisors (16% each), and store/warehouse personnel (10%). This distribution reflects a well-informed group, particularly in procurement and construction operations, relevant to the study's focus.

Table 2: Activities Involved in Project Scheduling

Activities involved in project scheduling	RII value	Rank	Category of significance
Estimating the number of work periods needed to complete individual activities with the estimated resources	0.904	1	ES
Establishing the policies, procedures, and documentation for managing the project schedule	0.899	2	ES
Dividing and subdividing the project scope and project deliverables into smaller, more manageable parts	0.886	3	ES
Identifying and documenting the specific actions to be performed to produce the project deliverables	0.879	4	ES
Determining which schedule methodology to use on a project	0.875	5	ES
Determining the current status of the project schedule	0.866	6	ES
Defining the logical sequence of work to obtain the greatest efficiency given all project constraints	0.864	7	ES
Analysing activity sequences, durations, resource requirements, and	0.854	8	VS

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schedule constraints			
Identifying and documenting relationships among the project activities	0.849	9	VS
Assessing the need to aggregate the schedule	0.839	10	VS
Estimating the duration or cost of an activity or a project using historical data from a similar activity or project	0.804	11	VS
Influencing the factors that create schedule changes	0.743	12	VS

The extent to which various project scheduling processes are practiced is detailed in Table 2, where each activity is ranked based on its Relative Importance Index (RII) value. As shown in the table, twelve activities recorded RII values ranging from 0.743 to 0.904, indicating a generally high level of significance attributed to scheduling practices in Nigerian construction projects.

Specifically, the highest-ranked activity is "Estimating the number of work periods needed to complete individual activities with the estimated resources," which achieved the highest RII of 0.904, categorized as Extremely Significant (ES). The next four highest-ranking activities also fall under the ES category, all with RII values above 0.875, including establishing policies for managing the schedule, work breakdown structure development, and defining sequencing logic.

Contrary to the earlier claim, all twelve listed activities in Table 2 possess RII values above 0.743, and not within the 0.667–0.821 range as previously suggested. Additionally, no activities fall into the moderate or low significance range (i.e., RII < 0.714), thereby contradicting the mention of factors within the $0.571 < RII \leq 0.714$ interval. This indicates a strong consensus among respondents on the critical importance of structured scheduling practices in project execution.

Table 2 further clearly supports the finding that project scheduling is highly emphasized across various dimensions from activity identification to monitoring and control signifying its foundational role in effective project management in Nigeria.

Table 3: Factors that determine the extent to which scheduling processes are considered and practiced

Factors that determine the extent to which scheduling processes are considered and practiced	RII value	Rank	Category of significance
Developing a work breakdown structure (i.e. an activity list)	0.882	1	ES
Decomposing of work packages into activities	0.821	2	VS
Determining if the project schedule has changed	0.799	3	VS
Estimating uncertainty and risks	0.764	4	VS
Determining which dependencies are mandatory during the process of sequencing the activities	0.762	5	VS
Determining how detailed the schedule needs to be for the project	0.761	6	VS
Estimating project duration or cost by	0.754	7	VS

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aggregating the estimates of the lower-level components of the WBS			
Selecting the activity relationship with the highest impact	0.745	8	VS
Adjusting planned resource use to be equal to or less than resource availability	0.714	9	S
Analyzing data using what if scenarios and simulation	0.674	10	S
Determining how to combine various scheduling methods on the project	0.672	11	S
Reconsidering necessary schedule reserves	0.667	12	S

Table 3 presents the key factors that influence how extensively scheduling processes are considered and practiced within construction projects in Nigeria. Each factor is evaluated using the Relative Importance Index (RII), categorized by significance levels Extremely Significant (ES), Very Significant (VS), and Significant (S) to assess their weight in project scheduling decision-making.

The most prominent factor, "Developing a work breakdown structure (i.e., an activity list)," ranks first with an RII of 0.882, and is the only factor classified as Extremely Significant (ES). This underscores its foundational role in scheduling by enabling systematic task decomposition and accurate planning.

The next seven factors fall within the Very Significant (VS) category, with RII values ranging from 0.821 to 0.745. These include decomposing work packages into activities (0.821), tracking project schedule changes (0.799), and estimating uncertainty and risks (0.764). Other highly rated

factors involve determining mandatory dependencies, estimating project duration through WBS components, and adjusting schedules based on resource availability.

The remaining four factors adjusting planned resource use (0.714), what-if scenario analysis (0.674), combining scheduling methods (0.672), and reconsidering schedule reserves (0.667)—are categorized as Significant (S). While their RII scores are relatively lower, they still represent crucial aspects of schedule optimization, especially under conditions of uncertainty and changing resource dynamics.

This structured analysis indicates that most respondents place greater emphasis on task decomposition, risk estimation, and sequencing logic as central to effective project scheduling, while simulation tools and reserve reconsideration are regarded as supportive but less critical.

Table 4: Determine the Improvement of Project Scheduling Processes

Factors That Determine the Improvement of Project Scheduling Processes	RII value	Rank	Category of significance
Defining the activities needed to complete the work	0.918	1	ES
Scheduling software that has the capability to help plan, organize, and adjust the sequence of the activities	0.900	2	ES
Conducting retrospectives (scheduled reviews to record lessons learned) for correcting processes and improving, if required	0.891	3	ES
Involving team members in the decomposition of activities which can lead to	0.875	4	ES

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better and more accurate results			
Managing the schedule and the amount of time it takes to keep it up to date	0.871	5	ES
Managing the actual changes as they occur	0.867	6	ES
Determining how often the detailed schedule should be reviewed and updated	0.862	7	ES
Determining the dependencies that may require a lead or a lag to accurately define the logical relationship	0.837	8	VS
Determining the amount of contingency and management reserve needed for the project	0.826	9	VS
Developing a viable schedule by adjusting the start time of the successor activities	0.821	10	VS
Assessing level of support for a decision from team members	0.797	11	VS
Reducing the project scope in order to meet schedule constraints, imposed dates, or other schedule objectives	0.664	12	S

The analysis of Table 4, which presents the factors that determine the improvement of project scheduling processes, is based on Relative Importance Index (RII) values and categorized according to Kerzner's (2009) scale of significance. The findings reveal that seven out of twelve factors fall within the "Extremely Significant" (ES) category, with RII values above 0.857. The most significant factor identified is "Defining the activities needed to complete the work" with an RII of 0.918, followed by "Using scheduling software that has the capability to help plan, organize, and adjust the sequence of activities" (RII = 0.900), and "Conducting retrospectives (scheduled reviews to record lessons learned)" with an RII of 0.891. Others in this category include involving team members in the decomposition of activities (RII = 0.875), managing the schedule and time required to keep it up to date (RII = 0.871), managing actual schedule changes as they occur (RII = 0.867), and determining how often detailed schedules should be reviewed and updated (RII = 0.862). These results indicate that the most valued approaches for improving scheduling processes center on accurate task definition, effective use of digital tools, team collaboration, and frequent schedule updates.

Four additional factors are classified as "Very Significant" (VS), with RII values ranging between 0.714 and 0.857. These include determining activity dependencies that may require a lead or lag (RII = 0.837), estimating contingency and management reserves (RII = 0.826), adjusting the start time of successor activities to develop a viable schedule (RII = 0.821), and assessing the level of support for decisions from team members (RII = 0.797). These factors further emphasize the importance of strategic sequencing, risk planning, and inclusive decision-making in improving scheduling effectiveness. The only factor ranked as "Significant" (S), with an RII of 0.664, is "Reducing the project scope to meet schedule constraints," which was considered the least significant among the listed elements. This implies that while scope reduction is occasionally necessary, it is viewed as a less favorable method for managing schedules compared to proactive, integrative, and well-planned approaches.

Table 5: Kendall - Coefficient of Concordance

Reliability Test	The importance attached to project scheduling processes	The extent to which scheduling processes are considered and practised	Assessment of scheduling activities for improving the processes of Construction Project Scheduling
Kendall's W	0.114	0.157	0.167

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Chi-Square	190.148	263.004	279.089
p-value at the 95% confidence Interval	0.000	0.000	0.000

Table 5 presents the Kendall's Coefficient of Concordance (W), Chi-square values, and p-values used to test the level of agreement among respondents regarding three aspects of project scheduling: (1) the importance attached to project scheduling processes, (2) the extent to which scheduling processes are considered and practiced, and (3) the assessment of scheduling activities for improving the scheduling process in construction projects.

The results reveal moderate levels of concordance among respondents. For the "importance attached to project scheduling processes," Kendall's W was 0.114 with a Chi-square of 190.148 and a p-value of 0.000, indicating statistical significance at the 95% confidence level. Similarly, for "the extent to which scheduling processes are considered and practiced," Kendall's W was 0.157 (Chi-square = 263.004, $p < 0.05$), and for "assessment of scheduling activities for improving the processes of construction project scheduling," W was 0.167 (Chi-square = 279.089, $p < 0.05$). In all cases, the null hypothesis of no agreement (H_0) was rejected, confirming that there was statistically significant agreement among the respondents.

These findings suggest that, although the level of agreement (W values) is not extremely high, the consistency in ranking across all three dimensions is statistically valid. Hence, the ranking data generated in this study can be considered reliable for drawing conclusions about perceptions and practices relating to construction project scheduling in Nigeria.

DISCUSSION OF FINDINGS

This study investigated twelve activities involved in project scheduling processes, with seven of them being highly significant. These activities include estimating work periods, establishing policies, dividing and subdividing project scope and deliverables, identifying specific actions, determining the schedule methodology, determining the current status of the schedule, and defining the logical sequence of work for maximum efficiency. The study also examined factors determining the extent to which scheduling processes are considered and practiced. Developing a work breakdown structure was considered the most significant factor, followed by scheduling software that helps plan, organize, and adjust the sequence of activities. Reducing the project scope to meet schedule constraints or other objectives was ranked lowest, with an RII value of 0.667. These factors significantly hinder the performance of project scheduling in Ibadan. Overall, the study highlights the importance of estimating work periods, establishing policies, and dividing project scope for effective scheduling.

CONCLUSION AND RECOMMENDATIONS

This research examines the practice of project scheduling in the construction industry, identifying twelve factors that determine its importance, the extent to which these processes are considered and practiced, and the potential for improvement. The study found that estimating work periods needed to complete individual activities with estimated resources, establishing policies, procedures, and documentation for managing the project schedule, developing a work breakdown structure, defining activities needed to complete the work, and using scheduling software to plan, organize, and adjust the sequence of activities were the most important factors for improving project scheduling.

The study recommend a holistic approach, regular updates to the project schedule, and adopting a scientific approach in estimating labor and materials requirements. These changes will enhance the performance of project scheduling in the Nigerian construction industry and contribute to optimal resource utilization in project delivery. The findings can help improve the effectiveness of current planning and scheduling in the construction industry.

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