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Factors Affecting Steel Structure Erection in Developing Countries: A Case Study of Nigerian Construction Industry

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Abstract
Steel structure plays a significant role in civil engineering. However, there are many factors affecting steel erectors and contractors to have a successful erection of steel structures. Thus, this study seeks to examine the factors affecting steel structure erection in construction projects within the context of a developing country. The study adopted a survey research method; a questionnaire to identify 47 factors, were assessed. A purposive sampling approach was used to identify 20 construction companies specialising in steel structures erections in Lagos, Nigeria. Sixty-three (63) questionnaires were distributed to the targeted population, which included 32 project managers, 14 project engineers and 17 site engineers of current and past steel structure projects carried out by the selected companies in Lagos. The data collected were analysed using descriptive and inferential statistics. The results revealed skills and experience, job site planning, availability of electrical power for tools, insufficient supervision and method of construction as the top most five factors affecting steel structure erection in construction project in Nigeria. The findings provide in-depth insight of the factors affecting steel structure erection in construction project that can help project managers in development of strategies for improving the erection of steel structure in the construction industry.

Keywords: Construction project, Erection, Nigeria, Project Manager, Site engineer, Steel structure

1.0 INTRODUCTION

Steel structures are fast becoming interesting and a safe way of building in the construction industry. Steel structure plays a significant role in civil engineering [1] and is widely applied in multi-storey buildings, bridges, warehouses, skyscrapers, parking lots, stadiums, malls and railway among others [1, 2, 3, 4 and 5]. The benefits of steel structures include strength, stability, durability, low weight, usability, recyclability, design flexibility, construction speed, cost efficiency, performance characteristics and aesthetics [6, 3, 4, 7 and 8]. According to Besgul [6], research in earthquake regions has shown steel to be the most reliable structural material against seismic loads. Put together, it is evident that steel structures are beneficial to construction business and the erection of such structures should be encouraged.

In recent time, a considerable number of studies have been published on steel structures in the construction industry. For instance, previous studies have covered topics such as steel erection fatalities [9], improving the crew productivity [2], construction performance control [10], causes of structural failures [11], factors affecting on the performance and productivity [4] and robotic assembly system (RAS) [12]. Put together, these previous studies on steel structures in construction domain have largely focused on developed countries. A glean from literature review that, research into steel structure is scarce in developing countries. Thus, there is very little understanding of steel structure erection practices in the construction industry of developing countries, such as Nigeria.

The aim of this study is to address this gap in the existing knowledge by examining factors affecting steel structure erection in the construction industry of developing countries using Nigeria as a representative case. An understanding of the factors affecting steel structure erection in construction project would inform development of strategies for improving the erection of steel structure in the construction industry. The study offers deep insights into the factors affecting steel structure erection in construction industry within the context of a developing country, i.e. Nigeria.

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2.0 LITERATURE REVIEW

Steel is a common building material used in the construction industry. Steel structure has been in existence for more than 100 years [1] and the last quarter of the 19th century saw a dramatic growth in the global output of steel [6]. According to Besgul [6], availability of steel in different forms and dimensions enables economical framing of both short-span and long-span structures. Many structural steel shapes take the form of an elongated beam having a profile of a specific cross section [8]. Steel structural projects are relatively special field of construction projects [2 and 10]. Steel is widely used in multi-storey buildings, bridges, warehouses, skyscrapers, parking lots, stadiums, malls and railway among others [1, 2, 3, 4 and 5]. The benefits of steel structure include strength, stability, durability, low weight, usability, recyclability, design flexibility, construction speed, cost efficiency, performance characteristics and aesthetics [3, 4, 6, 7, 8 and 13]. According to Danjuma and Abejide [13], the inherent toughness, high ductility and strength of steel are characteristics that are ideal for seismic analysis and design.

Erection of steel structure is the process of assembling the fabricated structural members together to form the skeletal structure. Erection involves positioning, aligning and securing the components on prepared foundations to form a complete frame [14]. In other words, adequate planning in terms of material delivery and handling, member assembly and connection should be made during steel structure erection process. The steel erection is usually conducted by the steel erection contractor. In as much as some steel fabricators may have their own erection crews or subcontract the work to a separate erection company, there must be a continuous strong link between erection and fabrication [2]. Steel structure uses different types of connections and quality of the connections plays a vital function in determining the performance of the structural system. According to Hassoon, *et al.* [4], reducing bolting and welding efforts in steel member connections are strategies for enhancing construction productivity.

Despite the numerous benefits associated with steel structures, there are factors affecting the erection of steel structure. For instance, the studies by Hassoon, *et al.* [4] found height of construction, high wind, skills and experience and job site planning to be the main factors affecting the performance and productivity of the steel structure erection teams.

Furthermore, Hassoon, *et al*. [4] reported the following factors shown in Table 1 as factors affecting the performance and productivity of the steel structure erection teams in their study.

Table 1: Factors affecting steel structure erection in construction

S/No	Factors
1.	Clear and daily task assignment
2.	Managers efficiency
3.	Poor coordination
4.	Poor planning
5.	Delay in payments to workers
6.	Poor communication
7.	Moving of labourers
8.	Delay in payments to suppliers
9.	Delay in work monitoring
10.	Job site planning
11.	Insufficient supervision
12.	Method of construction
13.	Quality control requirements
14.	Project size
15.	Dispute and litigation costs
16.	Access to the project
17.	Height of construction
18.	Location and area condition
19.	Late payments
20.	Type of soil
21.	Complexity of design
22.	Skills and experience
23.	Availability of facilities (such as Health care, food and sanitary)

S/No	Factors
24.	Working overtime
25.	Absent from work
26.	Worker´s integrity
27.	Training
28.	Incentive policies
29.	Number of brakes and duration
30.	Resistance to accept new technologies
31.	Worker motivation
32.	Security conditions
33.	Humidity
34.	Daily site safety instructions
35.	Rains
36.	Working at height
37.	Work at night
38.	Reward and punishment safety policy
39.	High wind
40.	Availability of personal protection equipment (PPE)
41.	Lack or late supply of materials
42.	Maintenance of equipment and tools
43.	Lack of tools or equipment
44.	Skills of crane operator
45.	Type and quantity of equipment available
46.	Availability of electrical power for tools
47.	Poor materials storage

3.0 METHODOLOGY

This study adopted a field survey method to find out the factors affecting steel structure erection in construction project within Lagos state of Nigeria. The choice for Lagos state was that, the state is the centre of the country's economy, power and commerce and economically significant in Nigeria [15, 16]. Secondly, the state has a high number of building construction activities (including steel structures), large concentration of building contractors of various categories and sizes and as well as incessant collapse of buildings in the state [16]. The list of factors affecting steel structure erection which were identified in the literature, were used to design a questionnaire to achieve the aim of the study. The questionnaire survey was used to obtain the responses of respondents concerning the factors affecting steel structure erection in construction project. Since the study was conducted in Lagos state, project managers, project engineers and site engineers in the construction industry within Lagos state of Nigeria are considered as the population of the study.

The target population were project managers, project engineers and site engineers involved in the erection of steel structure in Lagos, Nigeria. The reason for these targeted participants was that, they participate fully during steel structure erection and they have experience. To show the comprehensiveness and accuracy of the survey instrument, pilot study was conducted before administering it to the participants. The questionnaire was updated with input of construction projects' personnel as a result of the pilot test. A purposive sampling method was used to identify the representative sample for the administration of the questionnaire. Purposive sampling method is a non-probability technique, which is based on the characteristics of the study population. Hence, purposive sampling approach was used to identify 20 construction companies specialising in steel structure erections in Lagos, Nigeria. Sixty-three (63) questionnaires were distributed to the targeted population (i.e. the sample size), which included 32 project managers, 14 project engineers and 17 site engineers of current and past steel structure projects carried out by the selected companies in Lagos. The questionnaire comprised of three sections, but for this study two sections were considered. The first part asks questions about the characteristics of the survey respondents, the second part is concerned with the factors affecting steel structure erection in construction projects. The respondents were asked to rate the level of importance attach to each of the factors affecting steel structure erection using a 5-point Likert scale, where Not important = 1, Less important = 2, Moderate important = 3, Important = 4 and Very important = 5. Table 2 shows the breakdown of survey responses. A total of sixty-three (63) of the survey questionnaires were

administered out of which forty-six (46) representing 73% were adequately filled and returned as shown in Table 2.

Table 2: Questionnaire responses

S/No	Respondent Groups	Distributed Questionnaire	Returned Questionnaire	Response Rate (%)
1	Project Managers	32	29	90.6
2	Project Engineers	14	9	64.3
3	Site Engineers	17	8	47.0
4	Total	63	46	73.0

The data collected were analysed using descriptive (e.g. frequency, percentage, mean, ranking) and inferential (e.g. Kendall's Coefficient of Concordance) statistics. The analysis used the Statistical Package of Social Sciences (SPSS) v. 23. The frequency analytical tool was used to indicate the proportion of the participant's characteristics while the percentage tool helped to simplify the proportion of the participants in the study for better interpretation. The statistical mean was used to show the ranking given by survey participants to different factors used in determining the level of important of the perceived factors affecting steel structure erection. Also, the Kendall's statistical tool was used to test the agreement on the rankings given by the survey participants to factors that affect the steel structure erection within Lagos state, Nigeria. Multiple Likert scale questions were tested using the Cronbach's alpha test to determine its reliability. The result of the test shows a 0.963 value, which indicated high level of consistency for the scale and was considered suitable and reliable.

4.0 RESULTS AND DISCUSSION

This section of the paper presented the background information of the survey participants and the results, data analysis and discussions on the factors affecting steel structure erection in construction project within Lagos state, Nigeria.

4.1 Respondents' Background Information

Table 3 presented the background information of 46 respondents, including their educational qualifications, position held and years of experience in construction project. The educational qualification of the respondents displaced in Table 3 showed that most of the survey respondents have master degrees (M.Sc.) followed by bachelor degree (B.Sc./B.Tech.). Furthermore, the respondents that participated in the survey were project managers, project engineers and site engineers. In Table 3, position held by most respondents was found to be project managers with 63% of the survey population. For work experience, 80.4% of the respondents have more than 10 years experience in construction and this demonstrated their capacity to participate in the study. The breakdown of the respondents showed that the respondents had adequate experience to contribute to the subject and thus, the competence to participate in the study was satisfactory.

4.2 Factors Affecting Steel Structure Erection in Lagos, Nigeria

This section showed the results of the data analysis of factors affecting steel structure erection in construction project in Lagos, Nigeria. As shown in Table 4, "Skills and experience" has the highest mean value of 4.39 and was ranked first. This was followed by "Job site planning" with a mean value of 4.20, ranked second, "Availability of electrical power for tools" with a mean value of 4.11, ranked third, "Insufficient supervision" with a mean value of 4.04, ranked fourth and "Method of construction" with a mean value of 4.02 and thus ranked fifth. From the rear, "Delay in payments to suppliers" and "Working overtime" were ranked lowest with the same mean value of 3.11. The results of the mean values in the Table 4, suggest that the factors affecting steel structure erection in construction project in Lagos, Nigeria are very common in the Nigerian construction industry. These findings are in support of findings reported in previous studies [4]

Table 3: Descriptive characteristics of respondents

Characteristics	Frequency	Percentage (%)
Educational Qualifications		
HND	4	8.7
B.Sc./B.Tech.	17	37.0
M.Sc.	23	50.0
Others	2	4.3

Characteristics	Frequency	Percentage (%)
Total	46	100.0
Position Held		
Project Manager	29	63.0
Project Engineer	9	19.6
Site Engineer	8	17.4
Total	46	100.0
Years of Experience in Construction		
1 – 5	3	6.5
6 – 10	6	13.0
11 – 15	8	17.4
16 – 20	10	21.7
21 – 25	12	26.1
26 – 30	7	15.2
Total	46	100.0

Table 4: Ranking of factors affecting steel structure erection

S/No	Factors	Mean value	Rank
1	Skills and experience	4.39	1
2	Job site planning	4.20	2
3	Availability of electrical power for tools	4.11	3
4	Insufficient supervision	4.04	4
5	Method of construction	4.02	5
6	Training	3.96	6
7	Maintenance of equipment and tools	3.96	6
8	Lack of tools or equipment	3.96	6
9	Skills of crane operator	3.96	6
10	Working at height	3.91	10
11	Type and quantity of equipment available	3.91	10
12	Height of construction	3.91	10
13	Project size	3.89	13
14	Worker motivation	3.83	14
15	Quality control requirements	3.80	15
16	Rains	3.76	16
17	Reward and punishment safety policy	3.76	16
18	Clear and daily task assignment	3.74	18
19	Daily site safety instructions	3.74	18
20	Complexity of design	3.72	20
21	Availability of personal protection equipment (PPE)	3.67	21
22	High wind	3.65	22
23	Security conditions	3.65	22
24	Poor planning	3.61	24
25	Resistance to accept new technologies	3.59	25
26	Incentive policies	3.59	25
27	Lack or late supply of materials	3.57	27
28	Access to the project	3.57	27
29	Humidity	3.54	29
30	Location and area condition	3.52	30
31	Managers efficiency	3.46	31
32	Work at night	3.43	32
33	Availability of facilities (such as Health care, food and sanitary)	3.39	33
34	Worker´s integrity	3.39	33

S/No	Factors	Mean value	Rank
35	Late payments	3.37	35
36	Poor materials storage	3.37	35
37	Delay in work monitoring	3.35	37
38	Delay in payments to workers	3.35	37
39	Poor communication	3.30	39
40	Number of brakes and duration	3.22	40
41	Poor coordination	3.20	41
42	Type of soil	3.17	42
43	Moving of labourers	3.13	43
44	Dispute and litigation costs	3.13	43
45	Absent from work	3.13	43
46	Delay in payments to suppliers	3.11	46
47	Working overtime	3.11	46

Ranking of the forty-seven factors affecting steel structure erection demonstrates that skills and experience was considered as the most important factor affecting steel structure erection in construction project in Lagos, Nigeria. This is because, if steel structure erection task is assigned to a project manager who lacks skills and experience, the project success could be potentially compromised as pointed out by Ma, *et al.* [17]. This finding is in support of the study by Hassoon, *et al.* [4]. According to Hassoon, *et al.* [4], skills and experience is significant to productivity and performance, hence, adequate attention is necessary towards selecting workers with skills and experience. Skills such as ability to learn skills, procedural-industrial skills, knowledge of codes and regulations, quality assurance/management, sustainable skills, listening skills, teamwork, effective resource management, effective communication with staff and contractors, , risk management and effective planning and training among others have been identified in previous studies [18 and 19]. These skills evolve through education, experience or knowledge gained from exposure to a wide range of projects [18 and 20]. Ma, *et al.* [17] pointed out that each skill needs to be applied by construction project managers for it to be truly effective.

The second in rank of factors affecting steel structure erection in construction project in Lagos, Nigeria is job site planning. This finding supported the findings reported in previous study. For instance, Hassoon, *et al.* [4] showed that job site planning is the fourth factor affecting productivity and performance of steel structure erection teams. Job site planning is very important and impacts on all operations required delivering construction project [21]. According to Al-Mebayedh [14], safe erection of structural construction depends on proper and timely planning. The third in rank of factors affecting steel structure erection is availability of electrical power for tools. Because most tools and equipment used for erection of steel structures uses electrical power, it is important that electrical power is made available to site. This result could be as a result of poor supply of electricity in the study area. Insufficient supervision is the fourth in rank affecting steel structure erection. Adequate supervision of works is very important to achieve success at end. If the erections of steel structures are insufficiently supervised, the productivity and performance of such project would likely be affected. The fifth in rank of factors affecting steel structure erection identified in the study is method of construction. In steel structure erection, method of construction is important as it determines whether the project will record success or not.

Table 5: Test statistics for Kendall's coefficient of concordance

Number (N)	46
Kendall's (Wa)	0.125
Chi-Square	264.499
Degrees of Freedom (DF)	46
Significance Level (ASYMP. SIG.)	0.000

Furthermore, Kendall's coefficient of concordance was employed to test an agreement on the rankings given by the three groups of respondents to factors affecting steel structure erection in construction project. The test was used to determine the degree of disagreement or agreement of the target group responses concerning the factors affecting steel structure erection in Lagos, Nigeria. The result obtained shows high significance (see Table 5). Thus, a statistically significant degree of agreement exists between different groups of the survey participants. This study has provided in-depth understanding of the factors affecting steel structure erection in construction project that can help top management personnel of different construction companies to facilitate development of

strategies required in reducing factors affecting steel structure erection.

5.0 CONCLUSION

This study has revealed that, several factors affect steel erectors and contractors to have a successful erection of steel structure in Lagos state, Nigeria. This study aimed to explore the factors affecting steel structure erection in construction project in Lagos state. A questionnaire survey of 46 participants consisting of project managers, project engineers and site engineers involved in the erection of steel structure in Lagos was conducted to determine factors affecting steel structure erection in construction project. The study has shown that skills and experience, job site planning, availability of electrical power for tools, insufficient supervision and method of construction are the top most five factors affecting steel structure erection in Lagos state, Nigeria. The findings of the study provide detailed insights into the factors affecting steel structure erection in construction project.

Based on the analysis of data, it is evident that skills and experience was the main factor affecting steel structure erection in construction project. The findings indicate that, there is need to have more skilled workers with experience in erecting steel structure. These skilled workers with experience can develop strategies required in reducing factors affecting the steel structure erection and thereby having successful completion of projects. Future research can be carried out on steel structure erection strategies in construction project. This will inform steel erectors and contractors to adopt an effective strategy during erection of steel structure. An understanding of the factors affecting steel structure erection in construction project among construction companies is important for companies' stakeholders in the construction industry.

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