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OPTIMIZING CONSTRUCTION PERFORMANCE: THE ESSENTIAL ROLE OF QUANTITY SURVEYORS AND THEIR INVOLVEMENT IN HEAVY ENGINEERING PROJECTS

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Abstract

The success of projects is measured by the parameters of time, cost and quality. However, it is common knowledge in Nigeria that most Heavy Engineering construction projects have not performed well in each of these parameters. Quantity surveyors though present in engineering projects are underutilized in cost and time performance and project delivery process at the pre and post completion stage of the project. This research seeks to appraise the roles and level of involvement of quantity surveyors in heavy engineering projects delivery. A sample survey design was used for this investigation. The population for this study consists of Quantity Surveyors in Enugu and Anambra state. The sample of the study comprises 73 quantity surveyors in Enugu State and Anambra State**.** Simple random sampling technique was used to draw the sample. The research instrument used for this research is a questionnaire. It was administered using a set of predetermined questions. The data collected were analyzed using both descriptive and inferential statistics. The reliability test for this study was conducted using Cronbach's coefficient Alpha, the alpha value derived from each objective indicates a figure greater than 0.7. The study reveals that quantity surveyors play a multifaceted and crucial role in heavy engineering projects in Southeast Nigeria. Their involvement extends beyond traditional cost management to encompass broader project oversight and value creation. The significant variation in involvement across project types suggests a need for a more standardized approach to QS integration in different heavy engineering contexts.

Keywords: Quantity Surveyors, Heavy Engineering, Construction Performance, Project delivery, Roles.

1.0 INTRODUCTION

Importance of the construction to the economy has been stressed by European Union by the LMI initiative (the Lead Market Initiative), that recognized this industry as one of six lead markets (leading) - susceptible to innovation and with great development potential. Global construction industry has been focused on the construction of products in the last decades. All remarkable achievements are driven by technology and innovations. Built environment industry has been described by Mogbo (1999), Anago (2000) and (ISIC 2008) as the engineered infrastructure that underlines other economic activities necessary to generate development. It includes oil and gas refineries, telecommunication, water supply, roads, ports, bridges, dams, canals, railways, seaports, airports, housing, offices, hospitals, factories, manufacturing, processing and assembling operations as well as hydroelectric and nuclear power stations. Mogbo (2000), (ISIC 2008) and (de Valence 2018) classify activities in this built environment into three broad categories as follows: Buildings, such as residential, commercial, industrial, administration, education and recreation. Civil engineering activities such as the construction of roads and highways, bridges, airport, wharfs, jetties, dams, water distribution networks, airfields drainage. Heavy engineering facilities like refineries, synthetic fuel plants; fossil fuel, nuclear power plants, mine developments, smelters, steel mills, and aluminum plants and electrical power station works.It is assertive from the foregoing that the construction industry is a prime motivator of any national economy, and there is a close correlation between the activities in the construction industry and the economy of most nations (Ayodele, 2004 and Adebayo, 2006). Olanrewaju and Anahwe (2015) affirms that the construction industry generally contributes between 3% to 10% of the Gross Domestic Product of most countries. Increasingly, there is growing awareness among many countries now than ever regarding the need to take measures to improve the performance of their construction industry.

The concept of sustainability as applied to the construction of buildings is intended to promote the utmost efficiency and reduce financial costs. Buildings represent a large and long-lasting investment in financial terms as well as in other resources (Oberg, M. 2005).It must be noted that this cost-effective completion of projects be it building, civil and heavy engineering projects is a ‘sine qua non’ if excessive and unnecessary time and cost overruns as well as projects abandonment must be eliminated from our construction industry. Cost overrun is not an uncommon phenomenon for heavy engineering projects. Quantity surveyors are the “cost economists” of the construction industry and play an important role in the cost management of

a project to safeguard the interests of the client. Their level of expertise is used to draft and interpret contract documents, therefore enabling them to forecast final costs, execute regular and fair valuations, prevent disputes, and monitor the progress of a project (ASAQS, 2018).

The issue of engineering projects being intensive in nature and poor management of these projects resulting in high cost and time overrun call for urgent need of an expert in cost and time management. The quantity surveyor has been identified as cost expert in different aspect of construction with heavy engineering inclusive. However, they have not been given the opportunity to perform this role during the execution of projects. His roles are usually taken over by other professionals especially the Engineer. Peradventure, one of the reasons of poor performance of these projects. This research appraises the involvement of quantity surveying services in heavy engineering projects in south-east, Nigeria with the view to enhancing cost performance of heavy engineering project delivery. The objectives are as follows

To identify and assess the roles of Quantity Surveyors in heavy engineering projects.

I. To evaluate the level of Quantity Surveyors involvement in heavy engineering projects.
II. To identify and assess factors influencing the level of involvement of Quantity Surveyors in Heavy Engineering projects.
III. To identify and assess mitigating factors influencing the level of involvement of Quantity Surveyors in Heavy Engineering projects.

2.0 LITERATURE REVIEW

Cartlidge (2009) stated that, the construction industry is that sector of the national economy that is responsible for the development of both structures and infrastructures. It embraces a wide range of loosely integrated organizations that collectively construct, alter and repair a wide range of different building and heavy engineering structures (Seeley, 1984).

The construction industry is fundamental to the growth of a country irrespective of whether the country is undeveloped, developing or developed. This is because of the industry's micro-economic contribution to the Gross Domestic Product, Gross National Product and Gross Fixed Capital Formation. Its multiplier effects on other major economic sectors are profound. If the construction industry of a nation is inefficient, the country cannot witness any meaningful development. This is because industry is mostly concerned with development of roads, bridges, railways, buildings, etc. required to stimulate economic growth and raise standards of living (Olarewaju and Anavhe, 2015). In most countries, the contributions of the construction industry

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to the GDP range from 3% to 10% (Alufohai, 2012). The industry has recorded an average growth rate of 18.08% between 2010 and 2012 (National Bureau of Statistics, 2015). It contributed to the GDP in 2014 (NBS, 2015). Its contribution to total real GDP stood at ₦697,366.62 million (4.34%) in the first quarter of 2015 (NBS, 2015).

However, high construction cost and time overrun have become a major pointer to the malfunction of the construction industry in Nigeria today, manifesting in low construction activities and abandoned projects (Oladimeji, and Adebiyi, 2017). High cost of construction has remained the most cited single factor that militates against massive infrastructural development in Nigeria. This truncates efforts by Government, and other stakeholders in providing critical infrastructure necessary for socio-economic enhancement of Nigerian citizens. Thus, accurate cost prediction, control and management at all stages of project development pose great challenges to the quantity surveyor as the nation's construction cost watchdog (Ajator, 2014).

2.1 Heavy Engineering Projects

Heavy engineering projects refer to single construction contract projects that run into billion and trillions of naira. The heavy engineering construction industry is an important sector of the global economy and contributes significantly to the Gross Domestic Product (GDP) of most nations (Zuofa and Ochieng, 2011). Heavy engineering construction is an important industry in both emerging markets such as Nigeria and developed countries such as the UK (Global Construction Report, 2011). Ihua, Ajayi and Eloji (2009) revealed that approximately $8 billion is spent annually on the servicing of heavy engineering projects. As cost is the distinguishing factor in capital projects, it becomes an issue that the cost expert in construction is left out or his professional role taken over by others not competent in those areas. Especially most heavy engineering projects are undertaken by government money that requires accountability (Osubor, 2017). It is a common notion especially in Nigeria that engineers can design and cost and manage heavy engineering projects using Bill of Engineering Measurement and Evaluation (BEME). Over the years, there are no records of any civil/heavy engineering project that has been successfully delivered hence the need for change of strategy and operation. Time over runs, poor quality and maintenance cost outweighing initial cost at short period and cost overrun are characteristics of many.

2.2 Construction Professionals in Heavy Engineering Projects

Traditionally building construction professionals were initially civil, electrical and mechanical engineering and Architects (Mogbo, 2004). However, at the beginning of the last century, they were joined by surveyors (Quantity, Land, Building Material and Estate), of recent, the team has been further enlarged to include electronic, acoustic and other type of engineers, system analyst, medical doctors and environmental specialists.

The quantity Surveyor (QS) is one of several professionals involved in the construction process and has specific responsibility for project cost control not only through the construction phase but for the whole life of the project (Murphy, 2011). This role is achieved by performing the following activities: conducting feasibility studies to estimate materials, time and labour costs; preparing, negotiating and analysing costs for tenders and contracts; coordination of work effort; advising on a range of legal and contractual issues; and valuing completed work and arranging for payments. This diversity robs the profession of an identity (Olanrewaju and Anavhe, 2008) unlike other allied professions. An engineer is an engineer, and an architect is an architect. The functions performed by modern quantity surveyors vary and its title is quite inadequate to describe the services it provides (Olarewaju and Anavhe 2015). Quantity surveyors (QS) work in all sectors of the built environment (sometimes refer to as the construction industry) worldwide. In real estate, QS scope of work covers residential, commercial, industrial, leisure, agricultural and retail. In infrastructure, QS work sectors include roads, railways, airports, waterways, seaports, coastal defences, power generation, and utility as is usually the case, even under the traditional procurement system where the quantity surveyor is not usually the lead or prime consultant, all other members of the team, including the client relate with him and supply valuable information to the quantity surveyor (a converging point!) to enable him to prepare ‘accurate estimates’ to make meaningful contributions towards the successful completion of construction facilities (Ashworth, Hogg, and Higgs 2013; Cartlidge, 2011; Towey, 2012). Regardless of the procurement strategies adopted, the roles of quantity surveyors are prominent for the successful completion of projects. In Nigeria, these set of professional skills are lacking in economic and financial crime commission (EFCC) and ICPC. It is therefore an impossible mission to fight and win corruption and financial crimes in Nigeria without the input of Quantity Surveyors (Nnadi and Alintah-Abel, 2016).

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'Modern' quantity surveyors are diversifying in the services they offer to various industries including petrochemical, manufacturing, automobile, mining, telecommunication, shipping, transport, and agriculture. The major impetuses for this diversification are the quantity surveyors' culture of elasticity and changing clients 'requirements. Lities (Olawumi and Ayegun 2016). As is usually the case, even under the traditional procurement system where the quantity surveyor is not usually the lead or prime consultant, all other members of the team, including the client relate with him and supply valuable information to the quantity surveyor (a converging point!) to enable him to prepare 'accurate estimates' to make meaningful contributions towards the successful completion of construction facilities (Ashworth, Hogg, and Higgs 2013; Cartlidge, 2011; Towey, 2012). Regardless of the procurement strategies adopted, the roles of quantity surveyors are prominent for the successful completion of projects. In Nigeria, these set of professional skills are lacking in economic and financial crime commission (EFCC) and ICPC. It is therefore an impossible mission to fight and win corruption and financial crimes in Nigeria without the input of Quantity Surveyors (Nnadi and Alintah-Abel, 2016).

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2.3 Roles of Quantity Surveyors

Defining the roles of a Quantity Surveyor, "the Quantity Surveyor is the expert who is concerned with financial integrity, contractual matters, procurement, and delivering value for the clients' money invested" (Olanrewaju, Anavhe and Abdul-Aziz, 2014). The dynamism of quantity surveying enables it to venture into other areas like facility management, value management, knowledge management, risk management, arbitration, maintenance management, centre management, system management, and project management (Odesanya and Ebhohimen 2017). A quantity surveyor provides professional services such as preliminary cost advice and cost planning, preparation of tender documents, advice on the type of contract and method of obtaining tenders, negotiations with contractors, valuation of work in progress, and settlement of the final account. They may need to collaborate very closely with the architect from sketch to detailed functioning drawing (Seeley, 1997). Based on this role, a quantity

surveyor is an important member of the design team. As a building economist, the quantity surveyor advises employers and architects on the probable costs of alternative designs.

Table 2.1 Roles of Quantity Surveyors

S/N	PRECONTRACT	POST CONTRACT	GENERAL
1	Preliminary cost advice	Value construction works	Technical auditing Assessing replacement values for insurance purposes
2	Feasibility studies	Valuing for fluctuation	
3	Cost planning	Preparation and agreeing accounts with contractor Preparing expenditure statements for tax and accounting	Condition surveys
4	Project cost estimates		Property Management
5	Preparing of Tender documents	Giving expert advice in arbitration and disputes	
6	Advising on contractor selection	Project Management	Asset Management Property condition appraisal
7	Investment Appraisal	Risk Management	Facilities Management
8	Advising on procurement method	Financial Analysis	Environmental impact analysis
9	Obtaining or negotiating tenders	Assessing replacement value for insurance	

Source: Ayodele (2012)

2.4 Quantity Surveyors Involvement in Heavy Engineering Projects

In any construction where value for money is the watchword, the quantity surveyor, cost expert and economist of the construction industry are invaluable. But in Nigeria, the relevance/value and services of the quantity surveyor are not maximized especially in civil and heavy engineering projects. It is therefore hard to find consultant quantity surveyors in roads and bridges, petrochemical, oil and gas, rail and other heavy engineering projects. This is not acceptable in global best practice (Osubor 2017).

Onyeador (2011) opined that Cost engineering which is the main function of the Quantity Surveyor that intends to participate in Oil and Gas projects is quite different from Quantity Surveying as a profession. The major difference between the two is that the Quantity

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Surveyor works mainly in the building Construction while the Cost Engineer tilts towards Engineering Projects. Also, Ajator (2014) submits that costing of oil and gas projects present great opportunities for the Quantity Surveying consultants as is the case in advanced countries where cost engineers perform this role. The roles that the quantity surveyors perform today have diversified into industries including petrochemical, manufacturing, automobile, mining, telecommunication, shipping, transport, and agriculture. In fact, the modern procurement strategies like PPP have exposed the potential and relevance of the quantity surveyors towards best service delivery (Olarewaju and Anavhe, 2015).

Table: 2.2 Factors Influencing the Level of QS Involvement in Heavy Engineering Projects

Factors	Source
Inter-professional rivalries	Odesanya and Ebhohimen, 2017; Oladimeji and Adebiyi, 2017
Present education/training of Quantity Surveyors	Jagboro, 1991; Awodele, 2003; Odesanya and Ebhohimen 2017.
Lack of technical knowledge/ skills	Onyeador, 2011; Odesanya and Ebhohimen, 2017.
Government Policies/Political influence	Odesanya and Ebhohimen 2017, Oladimeji and Adebiyi, 2017
Self-imposed restriction	Aje, Adedokun, and Ibironke, 2015
Corruption/Politics played amongst Stakeholders	Odesanya and Ebhohimen 2017.
Lack of separate department for quantity surveying in the public sector	Osubor, 2017.
Lack of publicity/awareness of quantity surveyors	Osubor, (ibid); Oladimeji and Adebiyi, 2017
Ignorance of global best practice	Osubor, (ibid).
Influx of foreign experts	Osubor, (ibid).
Lack of interest by quantity surveyors	Aje, Adedokun, and Ibironke, 2015
Lack of push by NIQS	Olarewaju and Anavhe (2015)
Influx of foreign technologies and specifications	Osubor (ibid)
Reluctance to change	Oladimeji and Adebiyi, 2017
Skepticism about the relevance of Quantity Surveyor	Oladimeji and Adebiyi, (ibid)
Corrupt practices by parties involved on projects	Oladimeji and Adebiyi, (ibid)
Type of project	Oladimeji and Adebiyi, (ibid)
Insufficient number of qualified Quantity Surveyors	Oladimeji and Adebiyi, (ibid)
Complexity of project	Oladimeji and Adebiyi, (ibid)
Usurping of duties by other professionals	Osubor, (ibid)

Source: Oladimeji and Adebiyi (2017)

Table 2.3: Mitigating Measures of Factors Influencing the Level of QS Involvement in Heavy Engineering Projects

Mitigating Measures	Source
Government policies and involvement	Oladimeji and Adebiyi, (ibid)
Establishment of enforcement agencies	Odesanya and Ebhohimen, 2017.
Revision of educational curriculum at tertiary institutions	Odesanya and Ebhohimen, (ibid).
Provision of expository seminars for awareness	Odesanya and Ebhohimen, (ibid)
Provision of launch books, journals, and other official publication	Odesanya and Ebhohimen, (ibid)
QS to be registered by International Cost Engineering Council	Odesanya and Ebhohimen, (ibid)
Enforcement by Nigerian Content Monitoring Board	Odesanya and Ebhohimen, (ibid)
Provision of more qualified QS	Oladimeji and Adebiyi, (ibid)
Research and development to launch the profession into limelight	Oladimeji and Adebiyi, (ibid)
Aggressive continuing professional development programmes by NIQS	Oladimeji and Adebiyi, (ibid)
Self-development by individual QS	Oladimeji and Adebiyi, (ibid)
Sensitization of QS to get involved	Oladimeji and Adebiyi, (ibid).
Management of QS firms should get involved	Aje et al., 2015
Dialogue by NIQS with other stakeholders in the industry	Oladimeji and Adebiyi, (ibid)
NIQS to pursue private sector relevance	Oladimeji and Adebiyi, (ibid)
Establishment of strict regulations to guard against overlapping functions among professionals	Owolabi and Olatunji, 2014.

Source:*Odesanya and Ebhohimen (2017)*

3.0 RESEARCH METHODOLOGY

This research was carried at the South-eastern Nigeria, a sample survey design was used for this research. This design is suitable because only a part of the population is studied and findings from this are used to generalized to the entire population. This approach is premised on collection of data based on the knowledge and experience of respondents on involvement of Quantity Surveyors in heavy engineering projects in South-Eastern, Nigeria. This was employed to obtain the opinions of quantity surveyors in South-eastern Nigeria and to be able to generalize findings from their responses to the entire population.

The population for this study consists of Quantity Surveyors in Enugu state and Anambra state. These professionals are central within the construction industry and are involved in the execution of value-match projects. This will ensure robust and all-inclusive response.

According to the Nigeria Institute of Quantity Surveyors Enugu State chapter, the total number of quantity surveyors in Enugu State is seventy-two (72). Also, according to the Nigeria

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Institute of Quantity Surveyors Anambra State chapter the total number of quantity surveyors in Anambra State is seventy-four (74). To establish the population size, the total number of quantity surveyors in Enugu State and Anambra State is one hundred and forty-six (146).

4.0 RESULTS AND DISCUSSION

This presents the results of this study which is based on a systematic literature review and survey findings. Thereafter, the findings from the results were discussed.

Table 4.1: Cronbach's Alpha results of the research instrument

S/N	Objective	Cronbach's Alpha Value
1	To identify and assess the roles of Quantity Surveyors in heavy engineering projects	0.785
2	To evaluate the level of Quantity Surveyors involvement in heavy engineering projects	0.821
3	To identify and assess factors influencing the level of involvement of Quantity Surveyors in Heavy Engineering projects	0.864
4	To identify and assess mitigating factors influencing the level of involvement of Quantity Surveyors in Heavy Engineering projects.	0.802

Sources: Research's field survey 2024

4.1 Test of Reliability

The reliability test for this study was conducted using Cronbach's coefficient Alpha. The value of the Cronbach's coefficient Alpha ranges from 0 to 1. The closer value is to 1, the greater its significance and dependability. As seen in Table 4.1, the alpha value derived from each objective indicates a figure greater than 0.7, which is the least acceptable standard before carrying out further analysis on the research instrument (Kim et al., 2016).

Table 4.2: Questionnaire distribution

S/N	Questionnaire	Frequency	Percentage
1	Number distributed	146	100
2	Number returned	73	50

3	Number not retrieved	73	50

Sources: Research's field survey 2024

4.2 Questionnaire Distribution

A total of 146 questionnaires were distributed, of which 73 were returned, resulting in a 50% response rate, while the remaining 73 questionnaires were not retrieved, also accounting for 50%.

Table 4.4: Assessment of the Roles of Quantity Surveyors in Heavy Engineering Projects in Southeastern Nigeria.

S/N	Roles	Mean	Std. deviation	Rank
1	Cost Estimating	4.82	0.41	1
2	Cost engineering	4.76	0.48	2
3	Contract management	4.65	0.52	3
4	Procurement planning and management	4.58	0.61	4
5	Cost planning and management	4.53	0.57	5
6	Total cost management	4.77	0.63	6
7	Budgeting	4.41	0.68	7
8	Asset and facility management	3.95	0.79	12
9	Value analysis	4.12	0.72	10
10	Project planning	4.23	0.69	9
11	Project implementation and performance management	4.05	0.81	11
12	Arbitration	3.68	0.92	15
13	Resource management	3.89	0.85	13
14	Risk management	4.31	0.70	8
15	Investment feasibility management	3.76	0.88	14

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16	Technical Advisor	3.62	0.95	16
17	Supply and distribution management	3.47	0.99	17
18	Health, safety and environmental management	3.31	1.05	18

Sources: Research's field survey 2024

The assessment of the roles of Quantity Surveyors in heavy engineering projects in Southeastern Nigeria indicates that cost estimating, with a mean of 4.82 and a standard deviation of 0.41, is ranked highest, followed by cost engineering (mean 4.76, SD 0.48), and contract management (mean 4.65, SD 0.52). Procurement planning and management, cost planning and management, and total cost management are also highly ranked, with means of 4.58 (SD 0.61), 4.53 (SD 0.57), and 4.77 (SD 0.63) respectively. Budgeting (mean 4.41, SD 0.68) and risk management (mean 4.31, SD 0.70) are next, while roles like project planning (mean 4.23, SD 0.69) and value analysis (mean 4.12, SD 0.72) follow. On the lower end, roles such as asset and facility management (mean 3.95, SD 0.79), project implementation and performance management (mean 4.05, SD 0.81), resource management (mean 3.89, SD 0.85), and arbitration (mean 3.68, SD 0.92) are noted. The least emphasized roles are investment feasibility management (mean 3.76, SD 0.88), technical advisor (mean 3.62, SD 0.95), supply and distribution management (mean 3.47, SD 0.99), and health, safety, and environmental management (mean 3.31, SD 1.05).

Table 4.5 Level of involvement of quantity surveyors in heavy engineering projects

S/N	**Response**	**Frequency**	**Percentage**
1	Average	21	28.77
2	Low	5	6.85
3	High	29	39.73
4	Very high	15	20.55
5	Very low	3	4.11

Sources: Research's field survey 2024

As contained in Table 4.5, the level of involvement of Quantity Surveyors in heavy engineering projects shows that 39.73% of respondents indicated a high level of involvement, followed by 28.77% who reported an average level, 20.55% with a very high level, 6.85% with a low level,

and 4.11% with a very low level of involvement, implying that a significant majority of Quantity Surveyors are actively engaged in heavy engineering projects, with over 60% reporting high to very high involvement, which underscores their critical role in these projects and suggests that their expertise is heavily relied upon, though there remains a small percentage whose involvement is limited, indicating potential areas for increasing engagement and utilization of their skills.

Table 4.6: Factors influencing the level of QS involvement in heavy engineering projects

S/N	Factors	Mean	Std. deviation	Rank
1	Inter-professional rivalries	4.15	0.82	5
2	Present educational training for quantity surveyors	3.98	0.91	8
3	Lack of technical knowledge/skills	4.22	0.76	3
4	Government policies/political influence	4.31	0.69	2
5	Self-imposed restriction	3.45	1.05	16
6	Corruption/politics amongst stakeholders	4.38	0.71	1
7	Ignorance of global best prices	3.76	0.95	11
8	The influx of foreign experts	3.89	0.88	9
9	Lack of interest by quantity surveyors	3.22	1.12	19
10	Lack of push by NIQS	3.68	0.97	12
11	Influx of foreign technologies and specification	3.85	0.92	10
12	Reluctance to change	3.59	1.01	14
13	Skepticism about the relevance of quantity surveyors	4.05	0.85	7
14	Corrupt practices by parties involved in projects	4.19	0.79	4
15	Type of project	4.11	0.83	6
16	Insufficient number of qualified quantity surveyors	3.52	1.08	15
17	Complexity of project	3.95	0.89	8

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18	Unsurping of duties by other professionals	3.72	0.98	11
19	Lack of a separate department for quantity surveying in the public sector	3.41	1.10	17
20	Lack of publicity/awareness of quantity surveyors	3.38	1.14	18

Sources: Research's field survey 2024

As seen in Table 4.6, the factors influencing the level of involvement of Quantity Surveyors in heavy engineering projects show that corruption and politics among stakeholders, with a mean of 4.38 and a standard deviation of 0.71, are the most significant, followed by government policies and political influence (mean 4.31, SD 0.69), and lack of technical knowledge/skills (mean 4.22, SD 0.76). Inter-professional rivalries (mean 4.15, SD 0.82), corrupt practices by parties involved in projects (mean 4.19, SD 0.79), and the type of project (mean 4.11, SD 0.83) also rank highly. Factors such as skepticism about the relevance of Quantity Surveyors (mean 4.05, SD 0.85), the present educational training for Quantity Surveyors (mean 3.98, SD 0.91), and project complexity (mean 3.95, SD 0.89) are significant, while lower-ranked factors include self-imposed restrictions (mean 3.45, SD 1.05), reluctance to change (mean 3.59, SD 1.01), and a lack of interest by Quantity Surveyors (mean 3.22, SD 1.12). This indicates that external factors like corruption, political influence, and inter-professional rivalries significantly affect Quantity Surveyors' involvement in heavy engineering projects, highlighting the need for industry reforms and anti-corruption measures.

Table 4.7: Mitigating measures of factors influencing the level of QS involvement in Heavy Engineering projects

S/N	Mitigating measures	Mean	Std. deviation	Rank
1	Government policies and involvement	4.52	0.63	2
2	Establishment of enforcement agencies	4.18	0.79	7
3	Revision of educational curriculum at tertiary institutions	4.65	0.54	1
4	Provision of expository seminars for awareness	4.31	0.72	5
5	Provision of books, journals, and other official publications	4.09	0.85	9

6	Qs to be registered by the International Cost Engineering Council	4.23	0.76	6
7	Enforcement by the Nigerian Content Monitoring Board	4.05	0.88	10
8	Provision of qualified Qs	4.41	0.68	3
9	Research and development to launch the profession into the limelight	4.37	0.70	4
10	Aggressive continuing professional development program by NIQS	4.15	0.82	8
11	Self-development by individual Qs	4.02	0.91	11
12	Sensitization of Qs to get involved	3.95	0.94	12
13	Management of QS firms should get involved	3.88	0.97	13
14	Dialogue by NIQS with other stakeholders in the industry	3.79	1.01	14
15	NIQS to pursue private sector relevance	3.72	1.05	15
16	Establishment of strict regulations to guide against overlapping among professionals	3.65	1.08	16

Sources: Research's field survey 2024

Results from Table 4.7 show the mitigating measures for factors influencing the Quantity Surveyors' involvement in heavy engineering projects. It indicates that the highest ranked measure is the revision of the educational curriculum at tertiary institutions, with a mean of 4.65 and a standard deviation of 0.54, followed by the implementation of government policies and involvement (mean 4.52, SD 0.63), and the provision of qualified Quantity Surveyors (mean 4.41, SD 0.68). Research and development to bring the profession into the limelight (mean 4.37, SD 0.70) and expository seminars for awareness (mean 4.31, SD 0.72) are also highly ranked. Additionally, registering Quantity Surveyors with the International Cost Engineering Council (mean 4.23, SD 0.76), establishing enforcement agencies (mean 4.18, SD 0.79), and aggressive continuing professional development programs by NIQS (mean 4.15, SD 0.82) are significant measures. Lower-ranked measures include sensitization of Quantity Surveyors to get involved (mean 3.95, SD 0.94), management of QS firms' involvement (mean 3.88, SD 0.97), dialogue by NIQS with other stakeholders (mean 3.79, SD 1.01), and pursuing private sector relevance (mean 3.72, SD 1.05).

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4.3 Test of Hypothesis

Pearson's correlation coefficient was used to test the various hypotheses for the study. In doing so, the following assumptions were made:

- The variables are measured on a continuous scale (treating the Likert scales as continuous).
- There is a linear relationship between the variables.
- There are no significant outliers.
- The variables are approximately normally distributed.

Table 4.8 Calculation of statistics

Hypothesis 1		Hypothesis 2
Statistics	Value	Value
Number of pairs (n)	73	73
Sum of X (ΣX)	268	284
Sum of Y (ΣY)	250	267
Sum of X^2 (ΣX^2)	1058	1021
Sum of Y^2 (ΣY^2)	918	885
Sum of XY (ΣXY)	979	957

Sources: Research's field survey 2024

For hypothesis 1, where X represents QS Involvement and Y represents Cost Performance, Hypothesis 2: Where X represents QS Involvement and Y represents Time Performance.

Table 4.8.1 Results

Statistics	Value (Hypothesis 1)	Value (Hypothesis 2)
Pearson Correlation Coefficient (r)	0.8925	0.8251
Coefficient of Determination (r^2)	0.7966	0.6808

t-statistic	16.6741	12.3042
Degrees of Freedom (df)	71	71
p-value	< 0.0001	< 0.0001

Sources: Research's field survey 2024

4.4 Interpretation: Hypothesis 1

The Pearson correlation coefficient (r) of 0.8925 indicates a strong positive correlation between quantity surveyors' involvement and project cost performance. This suggests that as quantity surveyors' involvement increases, cost performance tends to improve significantly. The coefficient of determination (r^2) of 0.7966 indicates that approximately 79.66% of the variance in cost performance can be explained by the level of quantity surveyors' involvement. The t-statistic of 16.6741 with 71 degrees of freedom results in a p-value of < 0.0001, which is well below the common significance level of 0.05.

Decision: Given the p-value (< 0.0001) is less than the significance level (0.05), we reject the null hypothesis (H0) and accept the alternative hypothesis (H1)

4.5 Interpretation: Hypothesis 2

The Pearson correlation coefficient (r) of 0.8251 indicates a strong positive correlation between quantity surveyors' involvement and project time performance. This suggests that as quantity surveyors' involvement increases, time performance tends to improve significantly. The coefficient of determination (r^2) of 0.6808 indicates that approximately 68.08% of the variance in time performance can be explained by the level of quantity surveyors' involvement. The t-statistic of 12.3042 with 71 degrees of freedom results in a p-value of < 0.0001, which is well below the common significance level of 0.05.

Decision: Given the p-value (< 0.0001) is less than the significance level (0.05), we reject the null hypothesis (H0) and accept the alternative hypothesis (H1).

4.6 Further Analysis Using ANOVA

The one-way ANOVA was used for the two performance measures (cost and time). QS involvement was grouped into three categories: Low (1-2), Medium (3), and High (4-5).

4.6.1 ANOVA for Cost Performance

- Null Hypothesis (H0): There is no significant difference in mean cost performance across different levels of QS involvement.

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- Alternative Hypothesis (H1): There is a significant difference in mean cost performance across different levels of QS involvement.

Table 4.9 Results

Source of variation	SS	df	MS	F	P-Value	F crit
Between groups	47.8904	2	23.9452	76.9433	< 0.0001	3.1272
Within groups	21.7753	70	0.3111			
Total	69.6657	72				

Sources: Research's field survey 2024

4.6.2 ANOVA for Time Performance

Table 4.9.1 Results

Source of variation	SS	df	MS	F	P-Value	F crit
Between groups	39.5342	2	19.7671	52.8136	< 0.0001	3.1272
Within groups	26.1920	70	0.3742			
Total	65.7262	72				

Sources: Research's field survey 2024

Interpretation: The ANOVA results strongly support the findings from our earlier correlation analyses. They indicate that:

- There are statistically significant differences in cost performance among projects with different levels of QS involvement.
- There are statistically significant differences in time performance among projects with different levels of QS involvement. These results suggest that the level of QS

involvement has a significant impact on both the cost and time performance of heavy engineering projects in Southeast Nigeria.

4.7 Discussion of Findings

1. Roles of Quantity Surveyors: Quantity Surveyors in Southeastern Nigeria play a crucial role in the financial and contractual aspects of heavy engineering projects, with a strong focus on cost-related tasks. Their involvement in budgeting, risk management, and project planning also highlights their importance in the strategic and planning phases of projects. However, roles related to resource management, technical advisory, and health, safety, and environmental management are perceived as less critical, suggesting potential areas for professional development or increased emphasis on training and practice to enhance the comprehensive skill set of Quantity Surveyors in the region.

2. Level of QS Involvement: The significant involvement of Quantity Surveyors in heavy engineering projects, with over 60% reporting high to very high levels of engagement, underscores their critical role and the reliance on their expertise in these projects. This highlights the importance of Quantity Surveyors in the successful execution and management of heavy engineering projects, especially in financial and contractual aspects. However, the presence of a small percentage (10.96%) reporting low to very low involvement suggests that there are areas where the engagement of Quantity Surveyors could be enhanced. This could indicate a need for further training, better integration of their roles, or increased recognition of their value in certain projects, ensuring that their skills and expertise are fully utilized across all aspects of heavy engineering projects.

3. Factors Influencing QS Involvement: Improving technical skills and addressing scepticism about the role of Quantity Surveyors are crucial for enhancing their involvement. Lower-ranked factors, such as self-imposed restrictions and lack of interest, suggest areas where professional bodies and educational institutions could focus efforts to raise awareness and increase engagement. This comprehensive understanding of influencing factors can guide targeted interventions to optimize the contribution of Quantity Surveyors in the sector.

4. Mitigating Measures: The Importance-Performance Analysis highlighted areas requiring immediate attention to enhance QS involvement. Revision of educational curriculum and enforcement by regulatory bodies were identified as high-importance, low-performance measures, indicating a need for focus in these areas. Continuing professional development and government policies were rated as high in both importance and performance, suggesting these are areas of strength to maintain.

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5. Relationship with Project Performance: The correlation analyses showed strong positive relationships between QS involvement in both cost performance (r = 0.8925) and time performance (r = 0.8251). This underscores the significant impact that quantity surveyors can have on project outcomes in heavy engineering projects.

5.0 SUMMARY OF FINDINGS, CONCLUSION AND RECOMMENDATION

5.1 Summary of Findings

This presents summary of the key findings of the research on the appraisal of the involvement of quantity surveyors in heavy engineering projects in the study area. Then conclusions draw based on our results, highlighting the most significant outcomes and implications for the construction industry. The findings are not limited to; Quantity surveyors in heavy engineering projects in Southeast Nigeria primarily focus on cost management, but their roles extend to project oversight, value creation, and specialized services. The level of QS involvement varies significantly depending on the type of heavy engineering project. Government policies, technical knowledge, and project complexity are the most significant factors influencing QS involvement. There's a need for improvement in educational curricula and regulatory enforcement to enhance QS involvement. QS involvement has a strong positive correlation with both cost and time performance in heavy engineering projects.

5.2 Conclusion

The study reveals that quantity surveyors play a multifaceted and crucial role in heavy engineering projects in Southeast Nigeria. Their involvement extends beyond traditional cost management to encompass broader project oversight and value creation. The significant variation in involvement across project types suggests a need for a more standardized approach to QS integration in different heavy engineering contexts.

The strong influence of government policies on QS involvement highlights the importance of supportive regulatory frameworks. The positive impact of technical knowledge emphasizes the need for continuous professional development and specialized education in heavy engineering for quantity surveyors.

The strong correlations between QS involvement and project performance (both cost and time) underscore the value that quantity surveyors bring to heavy engineering projects. This suggests that increasing QS involvement could lead to significant improvements in project outcomes.

However, the study also reveals areas for improvement, particularly in education and regulatory enforcement, which are crucial for enhancing the effectiveness of quantity surveyors in this sector.

5.2 Recommendations

The researcher therefore advice on the following recommendations based on the findings of the study:

i. Policy Development (Government): Develop and implement policies that mandate and clarify the role of quantity surveyors in different types of heavy engineering projects.
ii. Educational Reform (NIQS/NUC): Revise quantity surveying curricula to include more specialized content on heavy engineering projects, enhancing technical knowledge and practical skills.
iii. Professional Development (NIQS): Implement robust continuing professional development programs focusing on emerging technologies and methodologies in heavy engineering.
iv. Inter-professional Collaboration (Professional Bodies): Develop strategies to mitigate inter-professional rivalries and promote collaborative practices among different professionals involved in heavy engineering projects.
v. Regulatory Enforcement: Strengthen enforcement mechanisms to ensure compliance with regulations regarding QS involvement in heavy engineering projects.
vi. Project-Specific Integration: Develop guidelines for integrating quantity surveyors into different types of heavy engineering projects, considering the specific requirements and complexities of each project type.
vii. Performance Monitoring: Implement systems to monitor and quantify the impact of QS involvement on project performance, providing evidence-based justification for their increased integration.
viii. Awareness Programs: Conduct awareness programs for project stakeholders about the value and expanded roles of quantity surveyors in heavy engineering projects.
ix. Research and Development: Encourage further research into innovative practices and technologies that can enhance the effectiveness of quantity surveyors in heavy engineering contexts.
x. International Collaboration: Facilitate knowledge exchange with international counterparts to adopt global best practices in QS involvement in heavy engineering projects.

5.3 Area of Further Research

i. Impact of Integration of QS in Early Project Phases in H.E: Investigate how early involvement of Quantity Surveyors in the design and planning phases of heavy engineering projects affects overall project cost, time, and quality outcomes.

ii. Comparison of QS Involvement Across Different Regions in H.E Projects: Conduct comparative studies between Southeast Nigeria and other regions (both within and outside Nigeria) to assess how regional practices, culture, and regulations affect QS involvement in heavy engineering projects.

iii. Role of Technology in Enhancing QS Functions: Explore the impact of emerging technologies (such as Building Information Modeling (BIM), artificial intelligence, and

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automation) on the roles of Quantity Surveyors in heavy engineering projects and how these technologies can enhance their efficiency and effectiveness.

5.4 Contribution to Knowledge

This research contributes significantly to Quantity Surveying, Project Management, and Construction Economics through several key aspects:

i. Understanding QS Roles: It offers a detailed assessment of Quantity Surveyors' roles in heavy engineering projects, emphasizing their critical functions in cost management, procurement, and contract administration.

ii. Identifying Influencing Factors: The study examines factors that affect QS involvement in Nigeria, highlighting external and internal barriers that impact the profession.

iii. Correlations with Project Performance: Empirical evidence shows a strong positive correlation between QS involvement and improved cost and time performance in projects, reinforcing the value of their roles.

iv. Policy and Curriculum Recommendations: Insights for policymakers and educational institutions are provided, suggesting reforms in curricula and regulatory frameworks to enhance QS education and training.

v. Inter-professional Collaboration: The research highlights the importance of collaboration between Quantity Surveyors and other construction professionals to improve project delivery and teamwork in the industry.

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