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Factors Influencing Oil and Gas Project Delivery in Nigeria: Cost Management Perspective

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Abstract: Overtime, cost management of construction projects in the Nigeria oil and gas sector has been branded inadequate with critical stakeholders standing aloof from offering requisite expertise to achieve efficiency. Based on pertinent lack of critical literature narrative about the practice of cost management in the oil and gas sector generally and in Nigeria specifically, this study evaluated the issues inhibiting cost management of oil refinery. Using a purposive sample size of 36 construction professionals in the oil and gas sector obtained through snowballing in Rivers state, Nigeria, structured questionnaire was employed to collect data that were analysed using mean item score and Chi-Square. The result revealed that issues dealing with low education, skills, estimating efficiency, non-involvement of core cost management professionals and change in scope as critical issues for affecting the efficiency of cost management in oil refinery construction projects. All the 25 factors evaluated were significant mean item scores (3.01 - 3.94) and the null hypothesis was rejected (p-values < 0.000) to show the consistency of the mean ranking. The study buttresses that inadequate cost management practice in the Nigerian oil and gas sector is due to this range of factors. Recommendations towards improving the state of cost management practice in the sector are directed towards the need to improve the validated barriers as precursors of inefficiencies in the sector.

Keywords: Cost Management, Cost Management Professionals, Barriers, Efficiency and Refinery

1. Introduction

The oil and gas sector is a massive capital-intensive business with most of its investment expended on the upstream sectors [12]. The refinery has emerged as one of the most important components of processed-plant construction globally. It is a form of construction with a disordered web of facilities (equipment, piping and buildings; [3]. Between 1970 and 1996 alone, the volume of investment and capital stocked into the construction and maintenance of refineries globally exceeded $ 100 billion [10]. Refineries are also long-term and extremely explicit properties needing enormous early investments and the option to invest depends primarily on the expected return on investment [13]. Amidst these significant investments and even more, until date the supply of refined products in Nigeria is grossly inadequate and faces constant cost escalation in pump-price for instance and the cost of associated infrastructures. Efforts to improve the infrastructure management in this sector must importantly integrate a systemic understanding of effective management of front-end issues during construction. Every segment of Nigeria's infrastructure is poor. Recent reports recommend that the Nigerian nation needs to invest $12 to $15 billion yearly for six years to meet this infrastructure need and the contribution of the private sector is not just desirous but essential on the grounds that the government cannot summon the resources to meet this need [6].

According to Fahim *et al.,* the current efforts by the Organisation of Petroleum Exporting Council (OPEC) to strengthen market stability by improving the supply of essential outputs to clients have caused the construction of new refineries across the globe; including Nigeria [11]. On-going in Nigeria, are a number of modular refineries and the famous Dangote Refinery and Petrochemical plants. Despite ongoing efforts to improve the refinery infrastructures to support the supply of refined products in Nigeria results in enormous economic waste, failed infrastructure and

moribund facilities. A collective outlay of capital for achieving the required on-going plans for new refinery construction until late 2018 was estimated at $60billion [21]. The global oil and gas construction projects are likewise facing a broad range of issues. In Oman, Al-Sadi and Dawood, affirmed there is a significant problem of cost overrun and delay in oil and gas construction projects in almost 70% of project initiated in that country [27]. Although the contexts of factors affecting oil and gas projects have been discussed in terms of financial risks [4], cost and time overrun [14, 27], limited literature expositions exist on the contexts of cost management issues predisposing projects failures in oil and gas sector of Nigeria focusing on oil refinery.

In this regard, cost management embeds finance risks facing oil and gas sectors projects [4]. The term deals with practice of cost estimating and control in construction project delivery. In delivering the all-important cost management duties, the state of knowledge among critical stakeholders notably, among cost management professionals about the operation and functionality of this important infrastructure sector is sketchy and unruly very low [3]. Ajator, maintained that stakeholders in the oil sector are not only aloof to cost management issues but the practice of cost management in the sector is inadequate [3]. These viewpoints suggest the need to provide an effective cost management for the procurement of related services in the critical sector. This study therefore seeks to unravel the critical influences on the cost management of refinery projects in Nigeria. The objective was to evaluate the factors affecting cost management and costs of refinery construction projects in Nigeria. Unravelling these factors is premonitory to developing an effective cost management blue-print for cost management of oil and gas projects in the country.

2. Refinery Construction

The construction projects in this sector are multifarious including processing plants (refineries and petro-chemical) flow-lines and stations, pipelines, electro-mechanical components as well civil structures (buildings, roads, drainages and the likes). The integrating components functions as a unit of two systems, namely: cooling and heating where chimney and cooling towers are integrated. Cost management-wise, these projects are classified as heavy engineering construction, industrial engineering projects and process plant installations. Contextually, the refinery refers to a composite industrial set-up, having wide-ranging piping systems for the transportation of different liquid between the various components of the unit, which enhances the conversion of crude oil into refined product consumed directly [25]. Ajator, described the refinery as a chaotic web of equipment, pipping and building among other facilities [3]. However, whether the equipment, pipping systems and building are disordered remains uncontested for almost a decade now. In sum, a refinery simply transforms crude oil into petroleum product using diverse refining procedures, which decompose the oil into various products at various boiling points [26]. The need to undertake the construction of related facilities has always been predicated on the market demands; a researcher, Plummer, maintained this must be predicated on foresight [22]. Refineries are operated through a pooling policy; this suggests the functionality of a refinery is not limited to functional operation unit. More important concern involves the routine scheduling of the functions of the relevant units to ensure that the final products blend into a usable product in the market. Based on this notion, the operating cost emerging from all operational modes of a refinery must be known [22].

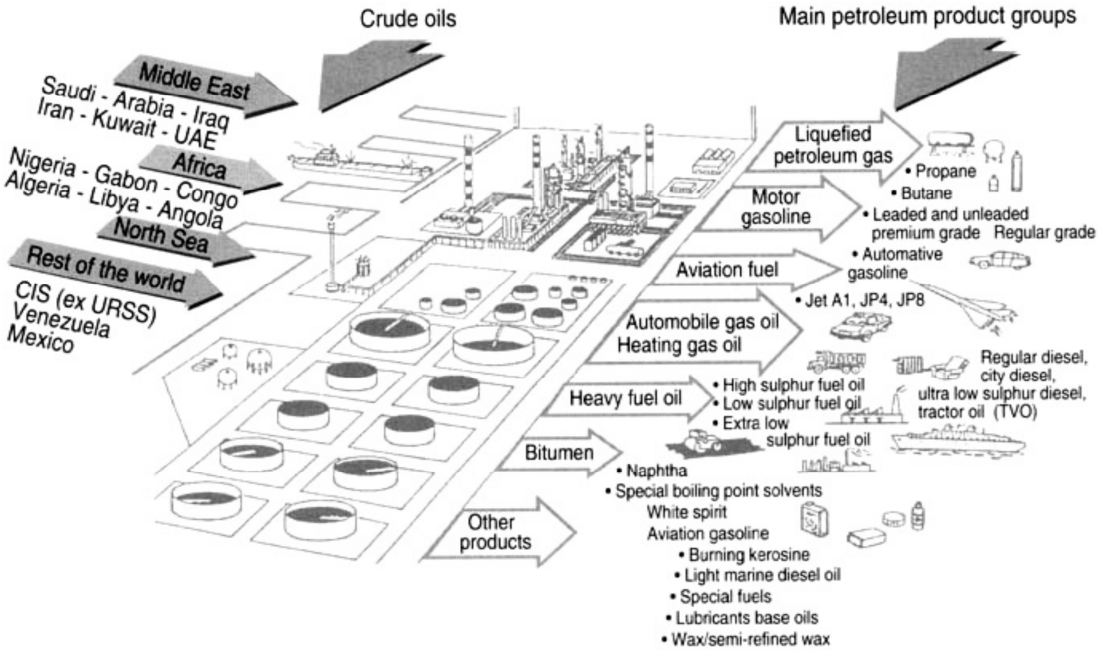

Figure 1. *A view and functions of a refinery [12].*

3. Refineries in Nigeria

Nigeria have a four refineries with an aggregated capacity of 445,00 Barrels Per Day [16]. Nigerian National Petroleum Corporation (NNPC) indicated that these plants operate at 23% of their constructed capacity [16]. The Nigerian communities' existing demand for refined product is 270,000 barrels of oil per day [15, 18]. At the stated output, the regular output is 102,000 Barrels Per Day. This discloses a deficit that necessitates the need for additional refining by construction additional refineries. At the moment several modular refineries are under construction across the Nigeria with two major refineries under various phases of completion that is Dangote refinery and petro-chemical, Lagos and BUA petro-chemical in Akwa Ibom State. Okafor noted that the four refineries in Nigeria are in a state of disrepair despite the significant investments in maintenance contracts [19].

3.1. The Cost Management of Refineries

Fahim *et al*. identified two basic cost components across refinery designs, namely: operating and capital cost [9]. The allies of the operating costs exist as variable and fixed cost. The capital costs consist of process units; utilities; security and environmental facilities; storage and handling facilities; civil works, buildings and other infrastructures. Various literature, in evaluating the cost management practices across Nigeria refineries outlined direct and indirect costs; a model that has been further adopted in other studies in Nigeria including [3]. Providing specific details of these costs, [10] defined a variable cost item as those costs, which changes with the output yield. This cost therefore varies reliant upon the volume of product generated and increases as production expands and reduces with decrease in production. Examples of cost items in this category includes processes for preventing corrosion, oxygenates for octane number improvement, cetane number enhancers, pour pint depressant and other additives [11]. On the other hand, the fixed cost refers to expenditure that does not reduce or increase in relation to the volume of output produced. In this category, the cost centres include labour, maintenance, overhead, cost of capital among others.

3.2. Factors Influencing Cost Management of Refineries

A number of criteria define the cost management of refinery construction. Fahim et al. highlighted that three principal factors, complexity, outputs and location are precursors of the capital investment in a refinery [10]. Speight, defined the context of complexity as being contingent on the type of refining processes as well as the type of manufactured product targeted [25]. Overall, the complexity of a refining system depends on the scope and quantities of process units. On the other hand, stricter environmental regulations, increasing demands for gasoline, jet fuel and diesel, feedstock variability and technical development of new catalysts and processes are critical drivers of modifications in the management of new refineries constructions [24]. Due to these factors, production units and process configurations of the refineries are now diverse [24]. Specifically, the construction of refinery projects has a long construction cycle, capital intensive and infinite risks. Due to these problems, the development of new oil refineries faces enormous cost management issues including financial risks [4]. The typical construction period for a refinery is two to four years [22]. Within this period, market demands and other various that are important determinants of the construction costs, expected outputs and profitability are expected to vary, therefore, the critical issue for cost management at this interface is how to manage these changes while maintaining project balance. This context suggests that scope changes are pertinent issues for cost management of refinery projects across the globe. On the other hand, are maintenance issues, the rate of disintegration of a refinery is more rapid than the physical wears and tears thereby making breakdowns intermittent [23]. Although the understanding of chemical corrosion pattern has been suggested, preventive maintenance practice is scaled to prevent close-down. Favennec, discussed that the volume of capital invested into a refinery construction is contingent on the future oil price increases; therefore, refining emerges as third most important cost component of a refinery [12]. This factor therefore suggests stakeholders must underline future changes in investment prospect as the prime drivers of viability of refinery projects.

Besides outputs, location and complexity issues, the cost of refinery construction is also contingent on the long-lead time associated with its front-line activities such as preliminary studies, feasibility studies, licensing, design and commissioning [10]. Safety concerns are likewise critical issues for cost management of petroleum oil refineries around the world. This is significantly aggravated by the advances in refining technologies which come with very high specifications for ecological, health and safety management and safe work practices [11]. The high cost of refinery are necessarily the additional criteria in achieving safety requirements [22]. Fahim et al. stated that in addition to safe environmental practices before now, the plant layout essentially requires an aggregation of pertinent factors to achieve cost efficiency during construction [10]. Citing earlier works, Fahim et al. emphasised that site-related issues for cost management of the refinery would include the following: the geological confinements of the site, the distances the for exchange of materials in the middle of the plant and stockpiling units to decrease expenses and risks, the spaces for plant operability and practicality, association with existing or arranged offices on location, for example, existing roadways, drainage and utilities routings and the need to provide satisfactory working conditions for operators [9]. Others include the dangerous and combustible material stockpiles, forestalling and/or relieving the heightening of nearby events (domino effect), guarantees that the wellbeing of operators inside on-site and off-site structures is maintained, crisis administration and escape routes for on-site personnel, and controlling the access of unauthorised persons to the site. These emerging possible issues for cost management of oil

refineries were adopted to evaluate their severity and level of influence on costs management of refinery projects in Nigeria.

4. Research Methodology

This section details the approaches and methods adopted in investigating the factors influencing cost management of refineries construction projects in Nigeria. The focus is identifying the factors inhibiting effective cost management practices of oil refineries, collecting data and data analysis. In this study, 25 factors were extracted individually and collectively from the literature as possible determinants of the cost management practice in oil refinery project in Nigeria. The details of the extracted factors from the literature are presented in Table 1.

After identifying the potential factors that may constitute barriers to effective cost management and the costs of refinery project from the literature, questionnaire was designed to survey the perceptions of relevant stakeholders in oil and sector of Nigeria about the significance of the identified factors. The questionnaires consist of two parts, namely: general information section and the measurement of the severity of the principal factors influencing cost management practices in the oil and gas sector of Nigeria. In the first section, questions related to the education, professional qualification, years of experience and level of engagement in cost management activities were evaluated. The second section presented the possible influencers of cost management practice as earlier identified for severity ranking using a 5-point Likert scale, where 1 is very low, 2 is low, 3 is moderate, 4 is high and 5 very high.

The data collection commenced with the determination of the sample size. Due to the specialty nature of refineries construction projects, relative few cases (existing and on-going) and other related construction projects in the oil and gas sector, the study involved experienced mainstream construction professionals in oil and sector in South-South, Nigeria. This population of 72 respondents were snow-balled using the network of key practitioners in key oil exploration and servicing companies in Rivers States Nigeria. The snowballing began with the loop of professional networks currently engaged in the sector and developed further to those outside this boundary who were reached mainly through online or web-based questionnaires. The use of small sample is adequate regarding the limited and once at a time nature of projects in the oil and gas sector. Moreover, studies by [4] and [5] involving fewer than 25 participants were considered successful due to the contexts of projects studied (that is, oil and gas projects). Therefore, the sample size of this study compares favourably with the studies highlighted [4, 5].

Table 1. *Extracted possible factors in the literature and their measurement.*

Factors (CF1-25)	Sources	Measurement
Complexity of projects	[9]	5-point Likert
Size and outputs of projects	[10]	5-point Likert
Long lead-time before construction	[14]	5-point Likert
High rate of disintegration of components	[14]	5-point Likert
Design and commissioning costs	[14]	5-point Likert
Economic cycle and down-turn	[27]	5-point Likert
Cost inflations and cost escalations	[27]	5-point Likert
foreign exchange policy of a country	[27]	5-point Likert
Ability to source components locally	[14]	5-point Likert
Location and closeness to waterways	[9]	5-point Likert
Environmental regulations	[10]	5-point Likert
Non-involvement of cost management professionals	[11]	5-point Likert
Availability of funding	[4, 8, 7]	5-point Likert
Availability of local technologies	[14]	5-point Likert
Safety concerns	[27]	5-point Likert
Government policy	[14]	5-point Likert
Availability of local designers and consultants	[27]	5-point Likert
Lack of knowledge of refinery technologies and construction	[11]	5-point Likert
Difficulties in securing loans	[4]	5-point Likert
Bidding management policy	[4]	5-point Likert
Dearth of expert	[3]	5-point Likert
Poor feability studies	[27]	5-point Likert
Inaccurate engineering estimate	[3]	5-point Likert
Change in scope	[27]	5-point Likert
Weather conditions	[27]	5-point Likert

Data analysis in the study involved mean item score and Chi-square test. The mean item score was used to evaluate the hierarchy of the factors influencing the cost management of oil refinery projects. The Chi-square was applied to determine the hypothesis, which sought to determine the significance of the identified factors influencing cost management practice in the oil and gas sector of Nigeria. The test was valid at a p-value greater than or less than 0.05. The null hypothesis which states that the identified factors CF1-25 are not significant factors affecting cost management of oil refineries in the study area are not significant was rejected when the p-value is < 0.05 and accepted when the p-value is > 0.05.

5. Results

Out of 72 respondents contacted with the research instruments (the questionnaire), 36 valid responses were retrieved and processed for data analysis. The respondent rate of the study was 50%. This is significant in diverse ways and compares creditably with past studies involving a lesser response rate [4, 5]. The first set of data analysis considered respondents' background information as seen in Figure 2. The results show that the level of experience is significant. Even though the largest proportion of the sample were engineers, quantity surveyors were the second largest group in the study. The result of quantity surveyors' participation suggests there is an engagement of quantity surveyors in oil and gas construction projects in Nigeria. Out of the total sample, only 5.50% had experience in oil refineries construction. The remaining 94.50% are likewise important segments of the study as their relevant experience in other oil gas construction projects suffice their position of knowledge in cost management of oil refinery construction. Hence, the data emanating from this group is therefore significant. Apparent concern has further emerged from the data, which have immense implications for the oil and gas construction and quantity surveyor's involvement in cost management of its construction projects. By the larger involvement of the engineer's sample, this group are apparently responsible for cost management in projects. The range of cost management services in the oil and gas sector and oil refinery construction encompasses estimating, cost control and participants' involvement in these services is heterogenous.

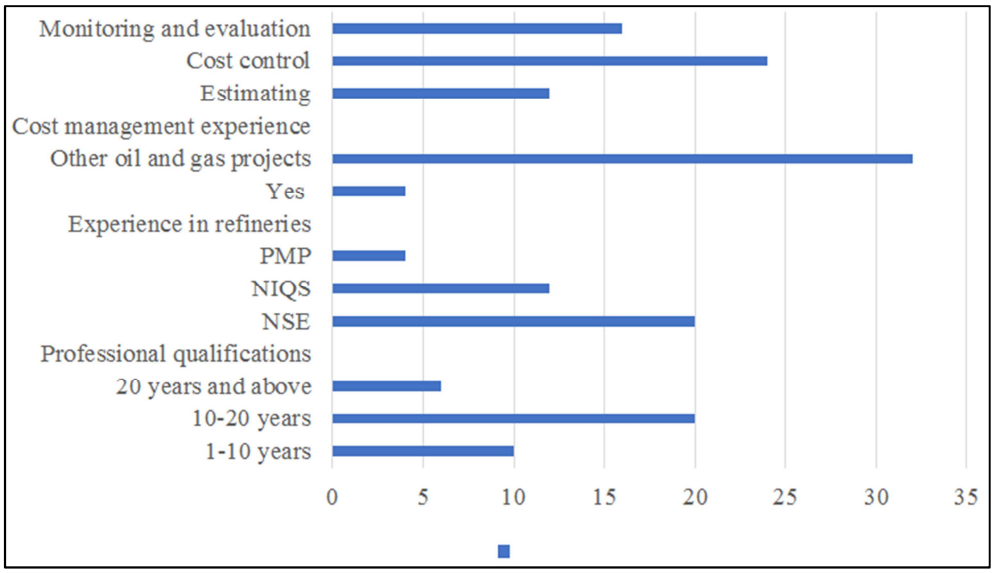

Figure 2. *Respondents' background information.*

5.1. Factors Affecting Cost Management Oil Refineries Construction

The results in Table 2 show the perceived degree of impact of factors influencing cost management of oil refinery projects in the study area. Even though all the factors are rated significant with mean item score (MIS) ranging between 3.01 - 3.94, the complexity of projects, size and outputs, long-lead-time, high rate of maintenance and design, dearth of experts, poor feasibility studies and inaccurate estimate are important and within the top seven ranking factors. Other significant factors worthy of mention includes foreign exchange policy, cost escalation and inflation rate among others. Stakeholders in refinery construction must take conscious steps to address these problems in order to improve the cost management of projects in the oil and gas sector of Nigeria.

Table 2. *Severity of factors affecting cost management of refinery projects.*

CF	Factors	MIS	Rank	Remark
1	Complexity of projects	3.94	1st	Significant
2	Size and outputs of projects	3.68	2nd	Significant
3	Long lead-time before construction	3.64	3rd	Significant
4	High rate of disintegration of components	3.56	4th	Significant
5	Dearth of expert	3.55	5th	Significant
6	Poor feasibility studies	3.54	6th	Significant
7	Inaccurate engineering estimate	3.5	7th	Significant
8	foreign exchange policy of a country	3.41	8th	Significant
9	Ability to source components locally	3.38	9th	Significant
10	Location and closeness to waterways	3.38	10th	Significant
11	Environmental regulations	3.37	11th	Significant

CF	Factors	MIS	Rank	Remark
12	Non-involvement of cost management professionals	3.36	12th	Significant
13	Availability of funding	3.33	13th	Significant
14	Availability of local technologies	3.32	14th	Significant
15	Safety concerns	3.32	15th	Significant
16	Government policy	3.27	16th	Significant
17	Availability of local designers and consultants	3.26	17th	Significant
18	Lack of knowledge of refinery technologies and construction	3.22	18th	Significant
19	Difficulties in securing loans	3.21	19th	Significant
20	Bidding management policy	3.19	20th	Significant
21	Design and commissioning costs	3.18	21st	Significant
22	Economic cycle and down-turn	3.17	22nd	Significant
23	Cost inflations and cost escalations	3.09	23rd	Significant
24	Change in scope	3.08	24th	Significant
25	Weather conditions	3.01	25th	Significant

5.2. Hypothesis Testing

The hypothesis determined test the degree of interdependency between respondent's perceptions of about the significance of the listed factors the Chi-square using Cross-Tab. The results presented in Table 3 shows the Chi-square values Asymp. Significance for the validated factors. The results in Table 3 shows that the p-values for the 25 factors (CF1-25) affecting cost management of oil refinery are less than 0.05. The null hypothesis for the 25 dimensions of factors affecting cost management of oil refinery were rejected. The implication is that these factors (C1-25) influences cost management of oil refinery.

Table 3. *The significance of factors affecting cost management of oil and gas projects.*

CF	Factors	Chi-Square	Df	Asymp. Sig.	Decision
1	Complexity of projects	38.077[b]	3	0.0000	Reject
2	Size and outputs of projects	45.423[a]	4	0.0000	Reject
3	Long lead-time before construction	32.346[a]	4	0.0000	Reject
4	High rate of disintegration of components	67.538[a]	4	0.0000	Reject
5	Design and commissioning costs	41.000[a]	4	0.0000	Reject
6	Economic cycle and down-turn	23.692[a]	4	0.0000	Reject
7	Cost inflations and cost escalations	80.327[a]	4	0.0000	Reject
8	foreign exchange policy of a country	36.769[a]	4	0.0000	Reject
9	Ability to source components locally	36.769[a]	4	0.0000	Reject
10	Location and closeness to waterways	80.615[a]	4	0.0000	Reject
11	Environmental regulations	77.346[a]	4	0.0000	Reject
12	Non-involvement of cost management professionals	77.250[a]	4	0.0000	Reject
13	Availability of funding	69.750[a]	4	0.0000	Reject
14	Availability of local technologies	62.635[a]	4	0.0000	Reject
15	Safety concerns	76.962[a]	4	0.0000	Reject
16	Government policy	27.308[b]	3	0.0000	Reject
17	Availability of local designers and consultants	35.327[a]	4	0.0000	Reject
18	Lack of knowledge of refinery technologies and construction	50.350[c]	4	0.0000	Reject
19	Difficulties in securing loans	69.558[d]	4	0.0000	Reject
20	Bidding management policy	33.231[e]	4	0.0000	Reject
21	Dearth of expert	50.327[f]	4	0.0000	Reject
22	Poor feability studies	52.350[e]	4	0.0000	Reject
23	Inaccurate engineering estimate	65.558[d]	4	0.0000	Reject
24	Change in scope	30.231[e]	4	0.0000	Reject
25	Weather conditions	48.327[f]	4	0.0000	Reject

6. Discussion

Global oil and gas construction projects are facing a broad range of issues. As shown in this study and other literature, the scope of these problems varies but its peculiar to a given environment. In Oman, Al-Sadi and Dawood, affirmed there is a significant problem of cost overrun and delay in oil and gas construction projects in almost 70% of projects initiated in that country. Generally, this study headlines issues dealing with education, skills, estimating efficiency and change in scope as critical issues affecting the efficiency of cost management in oil refinery construction projects. The results are consistent with extant literature; a growing volume of studies reporting related context in global oil and gas projects have predominantly headlined that these issues are critical to the cost performance of oil and gas projects [27]. Al-Sadi and Dawood, eported that in the study of schedule and cost factors in Oman, the most significant factors are ineffective coordination, change in scope, dearth of technical expertise, poor feasibility study, and inaccurate estimates [27]. Iman *et al*. also reported using the experience of Iranian oil company

projects that client-related issues such as availability of finance, excessive dependence on the importation, and environmental issues such as weather are pertinent cost overrun factors for the sector [14].

Complexity: The results show that issues related to complexity significantly shape the efficiency of cost management practice as well as the cost of the refinery itself. The context of complexity influencing the cost management of a refinery consists of a wide range of factors. The complexity of a refinery could be in terms of design scope; which could be defined as simple with the crude distillation process, catalytic reforming and product hydro treating unit [9]. It could also be complex based on arrangements with vacuum distillation and cracking units [10]. The implication for cost management is that the greater the complexity of refineries, the greater the difficulties associated with their cost management practices.

Size of the refinery: Like other critical infrastructure development, the size of a refinery is important and sensitive to cost and applicable cost management practices. Fahim et al. analysed the cost-effect of size on the cost of refinery stating that the fixed costs, namely: labour, managerial and other overheads are independent of the size of the refinery as they would remain non-variable with production output once installed [11]. Also, the maintenance and capital cost are likewise independent of the size of the project, even though these cost management decrease per cost of output overtime.

Location: location affects the cost of construction generally [1]. Normally, facilities for the refineries are often situated around areas to enable the transportation of products. The climate in the locality additionally influences operational expenses. Since the 1970s, oil producers have advanced a policy of establishing export-oriented refineries. The profitability of export-oriented refineries is restricted because the construction cost is higher than that of the refineries for locally consuming nations, and the cost of transporting processed oils and fuels is higher than transporting crude oil. Notwithstanding, a number of new refineries are generally situated in oil-producing nations like Saudi-Arabia, Iran and Venezuela. This finding is consistent with conclusion in previous studies including [2, 17, 20].

Environmental constraints: Due to more strict environmental regulations with respect to air, water and soil pollution, refineries have to add units and processes to ensure compliance with gas emissions and other regulations.

7. Conclusion

Based on the pertinent lack of critical literature narrative about the practice of cost management in the oil and gas sector generally and in Nigeria specifically, this study evaluated the issues inhibiting cost management of oil refinery. The study seeks to bridge the gap in the dearth of adequate cost management practice in the oil and gas industry. Using data from construction professionals in the oil and gas sector, this study headlined issues dealing with low education, skills, estimating efficiency and change in scope as critical issues for affecting efficiency of cost management in oil refinery construction projects. Even though all the factors were rated significant with mean item score (MIS) ranging between 3.01 - 3.94, the complexity of projects, size and outputs, long-lead-time, high rate of maintenance and design, dearth of experts, poor feasibility studies and inaccurate estimate are important and within the top seven ranking factors. Factors dealing with foreign exchange policy, cost escalation and inflation rate among others are other deserving concerns that must be addressed to improve cost management of oil refinery in Nigeria. Based on these results, the study buttresses that inadequate cost management practice in the Nigerian oil and gas sector is due to complexity of projects, size and outputs, long-lead-time, dearth of experts, poor feasibility studies, inaccurate engineering estimate, foreign exchange policy, cost escalation and inflation. Recommendations towards improving the state of cost management practice in the sector suggest these frontal issues must be addressed as precursors of inefficiencies in the sector.

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